

UNIVERSITY OF MINNESOTA
AGRICULTURAL EXPERIMENT STATION

COMMON INJURIOUS MAMMALS
OF MINNESOTA

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THE STRIPED GOPHER

UNIVERSITY FARM, ST. PAUL

CONTENTS

	Page
Introduction	3
Rodents (gnawing animals).....	4
House rats and mice.....	4
Rats	4
Mice	11
Field mice	13
White-footed mice	16
Other mice, and mouselike animals.....	18
Muskrat	18
Red-backed mouse	19
Lemming mouse	19
Grasshopper mouse	19
Harvest mouse	20
Pocket mouse	20
Jumping mouse	20
Ground squirrels, or gophers.....	20
Chipmunks and tree squirrels.....	22
Chipmunks	22
Tree squirrels	23
Woodchucks, or ground-hogs	25
Pocket gophers	28
Porcupines	30
Beavers	33
Rabbits	34
Jack rabbit	35
Varying hare	35
Cottontail rabbit	35
Insect eaters	38
Moles	39
Shrews	42
Bats	44
Small flesh eaters.....	47
Skunks	48
Weasels and minks.....	50
Larger flesh eaters.....	53
Badgers	53
Otters	55
Wolverenes	55
Martens	56
Fishers	56
Raccoons	57
Bears	57
Wild cats	59
House cats	60
Pumas	60
Red foxes	60
Gray foxes	61
Wolves	61
References	63
Appendix—Types of damage done by mammals.....	64
Key to families of mammals discussed.....	66

COMMON INJURIOUS MAMMALS OF MINNESOTA¹

M. S. JOHNSON

INTRODUCTION

The purpose of this bulletin is to give a brief description of each of the common injurious mammals of this state, its habits, relative abundance, and distribution, and to suggest methods of destroying it or preventing damage by it. For the sake of completeness, mention is made of several animals which, tho ordinarily harmless or beneficial, may under some conditions do damage, or which are likely to be mistaken for injurious species.² Several animals, which are much too rare to be of economic importance, are mentioned briefly because the group to which they belong is mainly injurious. Similarly, mention is made of a few species which formerly occurred but which are now extinct in the state. The scope of the paper thus has been extended to include all the wild mammals of Minnesota except the hoofed animals and the opossum. The hoofed animals are omitted from the discussion because no member of that group is considered chiefly injurious. The opossum has been omitted because it probably does not belong in a list of Minnesota mammals.

Recommended control measures for the common small mammals form an important part of the discussion, but no attempt is made to give detailed directions for the hunting and trapping of the larger animals.

Mammals may spread parasites or disease to man or domestic animals; eat or waste growing crops or stored food, or defile food and render it unfit for use; kill or damage orchard and other trees; kill domestic animals or valuable wild animals; damage buildings, lawns, and other property by gnawing and burrowing; cause fires and floods; and render locations unattractive or undesirable for human occupation.

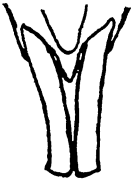
¹ The frontispiece is from a photograph taken by the author. The line figures of teeth and claws were drawn from the author's material by Mr. Carl Schmidt. The other figures are from the files in the Division of Entomology and Economic Zoology collected by the late Professor Luggler.

² Many small animals of woods and fields are common, yet are not generally known. A little time spent trapping with ordinary mousetraps will often reveal small mammals whose existence had not been suspected. Rolled oats makes a good bait; so does bacon. Traps may be set beside logs or stumps, or fence posts, or in the thick tangled grass of field or roadside, in wet marshy places, in gardens or cultivated fields, or even on bare ploughed land. Wherever set, some of the traps are almost certain to have a catch. If any animals caught are unknown, send them to the Division of Entomology and Economic Zoology, University Farm, St. Paul, Minn., to be identified. Any information as to the circumstances under which the animal was caught will be appreciated. Before being mailed for identification small animals should be thoroly moistened with alcohol, formalin solution, or some common antiseptic such as zonite, wrapped in absorbent cotton or a cloth wet with the solution, and put in a tin or cardboard container.

Injurious mammals can be roughly grouped on the basis of both structure and food habits, as (1) rodents or gnawing animals, (2) insect eaters, and (3) flesh eaters. The information that follows is only in part based on the writer's own experience. Indebtedness is acknowledged to numerous books and magazine articles, publications of the United States Biological Survey, various state experiment stations, and to a previous circular of this station, "Some Four-Footed Farm Pests," by F. L. Washburn.

RODENTS (Gnawing Animals)

Rodents are the most numerous group of mammals, in both individuals and species, and they are also the most destructive. As a group they are vegetarians, tho most of them vary their diet with animal food. They can be recognized by the two large chisel-shaped front teeth on each jaw, separated by a wide space from the rather flat-topped back teeth. Rodents may be responsible for all the types of damage listed as being caused by injurious mammals. (See pages 3, 64.) Several kinds vary in numbers—in some years they may be scarce and in other years extraordinarily numerous. Field mice and rabbits offer the best examples of such periodic changes.



Upper Front Teeth
of the Squirrel

House Rats and Mice

By far the best known, and undoubtedly the most injurious, of rodent enemies of man are house rats and mice. Both species were brought from Europe to the United States, spreading into new territory nearly as fast as it became settled. Both species are most at home in or near human habitations and are almost unknown where man does not, directly or indirectly, provide them food and shelter. These animals can be distinguished from other ratlike or mouselike rodents by the tail, which is nearly or quite as long as the head and body, is scaly but not flattened, and is only sparsely covered with hair.

Rats

Description.—The common house rat, or brown rat (*Rattus norvegicus*) is so well known that it hardly needs description. A full-grown rat measures about 15 inches from nose to tip of tail, the tail being about four fifths of the combined length of head and body. The rat has no conspicuous color markings, being brown above and grayish white beneath.

Varieties and range.—Rats are found almost everywhere there is a human settlement, and except where definite measures are taken against them the rat population is likely to be greater than the human.

Economic importance.—In many parts of the world, including coast cities of the United States, the rat is even more important as a menace to the public health than as a destroyer of property. The rat and the rat flea, which it carries, are mainly responsible for the spread of bubonic plague. This disease, known also as "black death," has swept over entire countries in the severest epidemics known in history. Cases of plague in human beings are usually caused by the bite of fleas from rats having the disease. These rats and infected persons are found in many important seaports. The most serious outbreaks of the plague in the United States occurred in California. The plague has never been known in Minnesota, or in the interior of the United States generally; but with through freight transportation plague-infected rats may be brought in. The plague infection, once established, is spread by fleas from rat to rat, from rat to man, and even from rats to native rodents, such as ground squirrels.

Altho the plague is unknown in Minnesota, rats endanger public health in many ways. Rats infected with a muscle parasite, known as trichinella, are occasionally eaten by hogs, infecting them with the parasite. Pork from these hogs, if eaten without being thoroly cooked, causes outbreaks of trichinosis—a painful and frequently fatal disease. The rat is a migratory animal and may frequently spread disease germs. No stored food is safe if rats have access to it. Many times as much is wasted as is eaten. On farms, rats especially damage grain, eggs, and poultry. They damage buildings by gnawing through floors, walls, and partitions, and by burrowing under the foundations. They may cause fires by gnawing the heads of matches or the insulation from electric wires. Even aside from the actual destruction they cause, rats lower the value of real estate they infest by rendering it unattractive and undesirable for human occupancy.

Habitat.—The rat is a burrowing animal. Altho it may spend most of its active hours in buildings it usually has underground burrows in which it makes its home and by which it enters and leaves the building. Rat burrows are usually under some additional artificial shelter—floors, walks, or buildings set on or close to the ground, piles of trash, or behind the walls of cellars and basements. Where food conditions are exceptionally favorable for rats, burrows may be found even where there are no buildings or walks for protection and concealment. In such cases the burrows are more likely to be made in the sides of banks or terraces than in level ground.

Breeding habits.—Rats produce litters of 6 to 12 or more and several litters per year. The females may breed when less than three months old. The period of gestation is 21 days. The interval between litters may be less than a month. At this rate of increase, if all the young lived and bred without interruption, the descendants of one pair

of rats would in three years be several times more numerous than the people in the United States. The fact that such uninterrupted increase, tho theoretically possible, actually does not occur, has an important bearing on control measures. The young are usually born in a nest of soft material in an underground burrow. They are about 2 inches long, pink, naked, blind, and helpless. They cling with their mouths so firmly to the nipples of the mother that if the nest is suddenly disturbed the young may be dragged as the mother runs. This is true also of many other rodents. When the young are about 7 days old the eyes open and the hair appears. Partly grown rats are more gray and less brown than their parents, and may look like mice. Usually the body is thicker and the fur coarser than in a mouse of similar size.

Other habits.—Rats do not hibernate, but with the approach of cold weather there is a tendency to seek sheltered quarters. They frequently appear in houses in winter, even tho they may be absent at other seasons. Breeding is usually suspended in winter, but if the rats have plenty of food and are well protected from the cold, it may continue throughout the year.

Rats are migratory. They may travel several miles in a few days. To destroy or drive away the rats from a place does not insure continued freedom from them, for where conditions of food and shelter are favorable they will sooner or later re-establish themselves.

Food.—The rat is omnivorous, yet discriminating. It will eat anything man uses for food and many things that man does not use. It thrives on garbage. It is fond of animal food, living or dead. It is not offended by food in various stages of decomposition. Yet the rat has a truly remarkable ability as a dietary expert. Rats kept in cages and offered a choice of food sometimes pick out combinations on which they thrive as well as or better than on the best mixtures that can be prepared for them by expert human dietitians.

Enemies.—A small active dog of the terrier type, with a little encouragement and training, will do much to keep premises free from rats. Most cats, especially well-fed ones, are useless as rat catchers. Among the important wild natural enemies of the rat are the skunk and the weasel, and several kinds of hawks and owls. These animals are important natural enemies of other injurious rodents as well. Skunks and weasels may establish themselves under farm buildings and wage war on rats until the latter are exterminated. The skunk will not use its well-known weapon unless disturbed, and as it can not climb it does not molest poultry that are shut up at night. The weasel is deadly to rats, but is more destructive to poultry than the skunk. Weasels should be encouraged on premises where poultry are not kept. Most hawks and owls destroy rats when they have the opportunity, as is indicated by the numbers of rat skulls to be found near their nests.

Rats destroy many more eggs and poultry than do all their natural enemies combined.

Control measures.—The natural enemies of the rat are important, especially where man has not hunted them with more zeal than he has the rats. It is perhaps because of their natural enemies that rats are scarce or lacking except in the vicinity of buildings, cultivated lands, rubbish piles, and other evidences of civilization. But in most cases, in order to insure the extermination of rats in a given place, man must take active measures against them. Generally speaking, three classes of methods are useful in the war against rats—rat-proofing, poisoning, and trapping.

RAT-PROOFING, that is, depriving rats of food and shelter, is the only permanently effective means of rat control. As has been pointed out, the capacity of rodents to increase in numbers is tremendous. The number of rats in a given place is, on the average, the largest number for which food and shelter are available. Killing some of them only makes conditions more favorable for those remaining. Rats are not likely to establish themselves in numbers where either food or shelter is lacking. The problem can be solved in most cases by using concrete, fine-mesh woven wire, or by raising the building off the ground; and by using metal or metal-lined containers with tight-fitting covers for all food material not otherwise protected. Rat control is relatively simple for the city dweller. If the building has stone or concrete foundations and if the walls and floor of the basement are similarly protected and all garbage is kept in tightly covered metal containers there will be no food and shelter for rats, and no rats. If basement windows are allowed to remain open they should be screened. Rat control in the country is complicated because of grain and other crops, domestic animals and their feeds.

The centers of rat infestation on farms are usually under barns, chicken houses, granaries, or corn cribs. The floors of these buildings are usually laid directly on or a few inches above the ground. Such places provide shelter and abundant food. A concrete floor on the surface of the ground without a foundation around it sunk below the ground level is an invitation to rats. If the floor is tight, so that rats can not burrow from inside the building, and if concrete foundations set into the ground prevent them from burrowing under the building from the outside, they are deprived of shelter so far as that building is concerned. If the foundation does not extend considerably above the ground level, a width of heavy wire cloth of one-fourth or one-half inch mesh should be fastened around the bottom of the building, the lower edge close to the foundation, the upper edge 2 feet or more above ground level. If the building is to be "banked" with earth or other material to keep out the cold, the upper edge of the wire should be

correspondingly higher. This arrangement will prevent rats from gnawing through the wall, as they are unlikely to gnaw at a distance above the ground and away from any shelter. If buildings are not to be provided with a rat-proof foundation, as described, they can be made rat-proof by being set on strong upright posts or on brick or cement columns so the sills are 2 feet or more above the ground. The rats then have no shelter under which to burrow. Strips of galvanized iron around the upper part of the posts and around the bottom edge of the building will keep rats out unless the doors are left open. The space under the building should be open and free from rubbish.

When rat-proofing buildings other sources of food and shelter should be removed. Trash of various sorts should be burned or otherwise disposed of. Odds and ends that are to be saved should be piled neatly on a raised platform. Domestic animals should be fed in places inaccessible to rats.

One of the most serious problems in rat control is the private or public dump or refuse pile. These dumps should be abolished in favor of a more sanitary method of waste disposal. Frequently, however, such places fill a real need and can not simply be done away with. Neither can they be rat-proofed. In their very nature they provide abundant food and shelter for rats. Under these conditions rats breed rapidly and there is a constant surplus to migrate and infest other premises, which otherwise could be kept rat-free. Controlling rats in such places by poisoning or trapping is difficult or impossible. The most promising method in such circumstances is through the alternate use of two or more such dumps, somewhat as rotation of crops is used as a control measure against certain insects. With such a program there would be frequent (perhaps every other month) shortages of rat food supply, when most of the rats could easily be killed by poisoning according to directions given in the following paragraphs.

POISONING.—If prevention in the form of rat-proofing has not been applied, it is frequently necessary to use a “cure” and destroy the rats. Rats are usually killed by either poisoning³ or trapping. Except where there is some special reason why poison can not be used, poisoning is quicker, cheaper, and simpler than trapping. Rat poisons are usually mixed with food, but sometimes poison gases forced into the burrows can be used effectively. Any substance that is poison to rats is also poison to man and to domestic animals. No poison is “poison only to rats.” Of most poisons, the amount required to kill is roughly proportional to the weight of the animal, so the amount of a poison required to kill a rat might not be fatal to man or domestic animals.

³ The law states that unprotected quadrupeds may be taken in any way, except that poison may be used only by permission of the Game and Fish Commissioner. This rule is interpreted by the Conservation Department as applying only to placing poison in game bird or animal habitats.

A few common-sense precautions will remove the danger of accidental poisoning. No poison will prevent decay of animals killed by eating it.

Barium carbonate, an odorless and tasteless white powder, is the best poison to mix with food. It is slow acting, causing death usually in 18 to 24 hours, so that rats usually die underground or outdoors instead of in buildings. It is less expensive than most other poisons. One disadvantage is that when baits containing this poison spoil or sour they become bitter and objectionable to the rats. Baits that are likely to spoil should be collected in two or three days, and fresh baits put out. One part of barium carbonate is thoroly mixed with four parts of any kind of food the rats are not already obtaining in abundance. Fruits, vegetables, meat, and fish make good bait where rats are living principally on grain. The bait may be ground or finely chopped to mix it thoroly with the poison. Cooked cereal or bread and milk may be used as bait if food of this general type is not otherwise available; or bread containing barium carbonate can be made, cut into thin slices, and buttered. Use two or three kinds of bait at the same time so that the rats have some choice. The poisoned food is put out, about a tablespoonful at a spot, in places frequented by rats. If the bait is placed on squares of heavy paper or pieces of thin board, the unused portion will be easier to collect; or, still better, if it is put in small paper bags, closed by twisting the top, the rats may drag the bags into their burrows and there, being free from interruption, may eat more of the bait than they otherwise would. Rats can be poisoned in poultry yards without danger to the poultry if the bait is placed under boxes turned upside down. If the boxes are slightly raised at one end or holes are cut in them, rats can get at the bait and poultry can not. Use finely ground or semi-liquid bait so that rats can not carry it and drop it where it may be picked up by chickens.

Other substances are in common use as rat poison, but they are all inferior to barium carbonate. Many commercial rat pastes contain phosphorus. This is a good poison, but is likely to cause fire. Arsenic is not effective against rats. Strychnine is one of the best poisons for most rodents, but rats are especially resistant to it. A further disadvantage of strychnine as a rat poison is that it acts so quickly that rats killed by it are likely to die where they would cause annoyance by decay. Squill, a powder obtained from the bulb of a plant of the same name, is less poisonous to man and domestic animals than most other rat poisons, but unfortunately it can not be depended upon to kill the rats. Its effect varies and because it has a peculiar taste rats not killed by the first dose are likely to avoid it in the future. Several preparations, or "viruses," are said to kill rats by spreading disease among them, and are said to be harmless to man and domestic animals. Neither claim can be substantiated. Severe cases of disease in human

beings have sometimes resulted from accidental infection with these disease germs. Some of the rats in any locality are likely to be immune to such a disease or to recover from it, and afterwards are able to eat any amount of the virus without ill effects. These viruses are more expensive and less effective than ordinary rat poisons.

Rats can be killed by filling their burrows with poison gas. One method is to attach one end of a short length of hose to the automobile exhaust pipe. The other end is pushed into a rat burrow. The motor is run several minutes with the carburetor adjusted to give a "rich" mixture. This method should not be used in the immediate vicinity of a building, because of the risk of fire. A newer method of killing rats is the use of a dust or powder containing calcium cyanide. The powder is placed in a dusting pump and blown in a smoke-like cloud into the rat burrows. In contact with the moisture of the air the poisonous cyanide gas is given off. Burrow openings from which the dust is seen to come out should be plugged to keep the gas in. Rats that are not killed in their burrows by the gas come out for fresh air, so nearly overcome by the gas that they can be stepped on or killed with clubs. This dust should not be handled or used in closed rooms. The dusting pump may safely be filled outdoors or in an open shed. The dust remaining after the gas has been given off is harmless, which is an advantage over bait poisons. This method of killing rats is more expensive than the barium carbonate method, but its effectiveness may justify the extra expense where the rats are confined in a definite system of burrows (as under a floor) that can be easily and completely filled with the gas, and where an abundant supply of other food makes it difficult to get the rats to take poison baits. The war tear-gas, chlorpicrin, used extensively in many types of fumigation, may be suitable for controlling rats.

TRAPPING.—Rats may be trapped instead of poisoned where the use of poison bait would be dangerous, or where the dead bodies would be obnoxious. Ordinary snap traps—built like mouse traps but larger and stronger—are best for catching rats. Wire cage traps, designed to catch rats alive, cost more and catch fewer rats. Traps are not effective if set in open places; they should be set at the end of passageways along which rats are in the habit of traveling. Place a box about $1\frac{1}{2}$ inches from a wall, or lean the edge of a board against a wall, and place a trap at the end with the trigger in front of the opening. Use bait of a type different from what the rats have been in the habit of getting. Use several traps and catch as many rats as possible the first few nights. The rats become suspicious and will soon be more difficult to catch. To catch rats that can not be easily trapped, prebaiting is frequently useful. Place where rats will find it, a shallow pan partly

filled with bran or flour, on which are pieces of attractive bait. After a few days, when the rats have formed the habit of going there for food, set a steel trap concealed just beneath the surface of the flour.

Mice

Description.—The house mouse (*Mus musculus*) is similar to the rat, but smaller. A full-grown mouse is between 6 and 7 inches long; its tail is as long as the head and body combined. The color is variable, being brownish gray above and lighter gray, sometimes with a rusty tinge, below.

Varieties and range.—Like the rat, the mouse is an immigrant to this country, introduced from Europe. Its distribution is worldwide and it is everywhere closely associated with man. The house mouse is not so strictly limited to houses as its common name would imply, being often found in fields, and occasionally in woods, usually near a human habitation.

Economic importance.—House mice are much more abundant than rats, and do a great deal of damage, altho not so much as do rats. Like rats mice destroy many times more than they eat, and many materials that are not edible. The mouse is not sanitary, and its presence in or near food is not pleasant to contemplate, but it is not directly responsible for the spread of plague and trichinosis. The main charge against the mouse is that it destroys property.

Habitat.—The house mouse is not a burrowing animal, but requires shelter and hiding places. Out of doors it hides in tangled grass, under corn shocks, grain stacks, old boards, or other rubbish. In buildings the favorite hiding places are between the partitions in double walls or floors, altho mice live between or behind boxes, bags, and other more or less temporary shelters.

Breeding habits.—The breeding habits of the house mouse are in many respects similar to those of the rat, altho usually the nests are not made in underground burrows. The nests are made from grass or any other convenient material. House mice frequently chew paper or cloth for nest building.

Other habits.—House mice are more active at night than in the daytime. This tendency is partly due to the fact that the buildings in which they live are usually quieter at night. With the approach of winter, many mice that have spent the summer outdoors seek the shelter of barns and houses, of hay and grain stacks, and corn shocks. If conditions of food and shelter are especially favorable, breeding may continue through the winter. A most peculiar habit of some house mice is that of "singing." The "song" is said to resemble that of a canary. This singing may be the result of some disease, altho this is not certain.

Food.—Grain is the principal food of the house mouse. Its vegetarian diet may be varied with insects. Its fondness for cheese, cereals, bread crumbs, and milk is well known. The problem of getting water may be more serious for the mouse than that of getting food.

Enemies.—House mice have the same natural enemies as the rat, and at least two others—the house cat and the short-tailed shrew. Most cats will catch mice when they have the opportunity. To be really effective in keeping down the numbers of mice, cats must be kept in the building where the mice are and must be made to depend to a large extent on them for food. Cats that hunt outdoors usually destroy more birds than mice. The short-tailed shrew (see page 42) is a sharp-nosed little animal with short velvety fur, slightly larger than a house mouse. Tho frequently mistaken for a mouse, it is one of the most important enemies of mice of all kinds. Rats, also, are enemies of mice, so rats and mice seldom appear in the same place at the same time.

Control measures.—Mouse-proofing, on a scale comparable to rat-proofing, is not practicable. Most buildings, no matter how well constructed, occasionally are invaded by a few mice; and if plenty of food is available and no control measures are taken these few may increase until they overrun the place. The best means of destroying mice in buildings is the common mousetrap. As the traps cost only two or three cents each, it is economy to use plenty of them. They should be placed at the openings of passageways along which mice travel, as between two boxes, or between a box and the wall. They may be baited with toasted cheese, bread or cake crumbs, scraps of meat, half a salted peanut, or left unbaited. If bait is used, it should be pressed firmly into the hole in the trigger. The position of the trap is more important than the bait. Even a well-baited trap is unlikely to catch anything if placed in the middle of the room. A few traps judiciously placed are much more effective than a cat in ridding a house of mice. Where the odor from dead mice is not likely to be an annoyance, poisoning may be more convenient than trapping. The poisoned bait is placed under inverted boxes with openings through which the mice can enter. A convenient bait is made by mixing one-fourth ounce of gopher poison with one quart of (dry) rolled oats. (This amount contains about one-eighth ounce of strychnine. It can be bought already prepared or can be made by thoroly mixing $1/8$ ounce of strychnine alkaloid, $1/8$ ounce of baking soda, and $1/80$ ounce saccharine.) It is seldom worth while to make war against house mice outdoors. Many house mice and other small rodents are killed incidentally as a result of campaigns against meadow mice (also called field mice).

Field Mice

Description.—Under the term “field mice” are included several species of short-tailed, stout-bodied, blunt-headed mice of the genus *Microtus*. The name, which means “small ear,” is given because the ears are more or less concealed in the fur. The muskrat is a member of this branch of the mouse family, resembling the field mouse even in the arrangement of the folds of enamel in the teeth. The muskrat differs from the field mouse in being larger, in having a long tail, and in being more aquatic. The two Minnesota species of field mice are *Microtus pennsylvanicus* (the eastern meadow mouse) and *Microtus minor* (the little field mouse). The total length of an adult meadow mouse is 6 or 7 inches. The tail is about two-fifths as long as the head and body. The total length of an adult little field mouse is about 5 inches. Besides the difference in size, *pennsylvanicus* and *minor* can be distinguished by a difference in color. The meadow mouse is chestnut-brown above and grayish beneath. The little field mouse has a peculiar “pepper-and-salt” appearance, because of the light colored ends of the long hairs showing against a background of the dark under fur. Differences in teeth and feet also distinguish the two species.

Varieties and range.—The little field mouse is scattered through the southwestern half of the state. The common meadow mouse is most abundant in low and moist locations throughout the state. The little field mouse lives in higher and dryer places. The two species are similar in habits, and will be discussed together. Because it occurs in vastly greater numbers, the common meadow mouse is of greater economic importance than the little field mouse.

Economic importance.—The damage done by field mice may be considered under three general topics: destruction of grass, destruction of shrubs and trees, and destruction due to mouse plagues. The destruction of grass is the type of damage least likely to be noticed but perhaps is most important. A field mouse will eat, on the average, its own weight of grass each day. One hundred mice to the acre, which is not an unusual number in favorable situations, will eat half a ton of hay per acre per year. Clover and alfalfa are especially favorable, providing food and shelter. Field mice occasionally eat the bark at the base of trees, especially fruit trees. If the bark is eaten around the trunk, the tree will die unless it is saved by grafting across the injured area. Young trees are more frequently attacked than old ones. The damage is usually done under cover of snow or tall grass. Hundreds of trees may be damaged or killed by the mice in a single orchard. Field mice may in some years and over limited areas increase far beyond their normal numbers, and do correspondingly greater damage. They first consume all the food that is locally available, then move on and on to fresh territory, destroying everything edible as they go. Such

outbreaks are disastrous, but are usually temporary and local. The field mouse is perhaps the most numerous and most destructive mammal enemy of the farmer. In favor of the field mouse it can be said only that it is the main food supply of its natural enemies. Much of the fur crop of the nation thus depends on the field mouse.

Habitat.—The field mouse is at home only where there is thick grass, which serves for food and for protection from enemies. When especially numerous the mice overflow temporarily into surrounding territory, but neither pressure of numbers nor scarcity of food can establish them permanently outside the type of habitat to which they are adapted. The mice have a complicated network of runways covered over with grass, just at the surface of the ground. These are connected with underground burrows. Except under conditions of overcrowding and scarcity of food, field mice seldom venture out into the open, away from the shelter of their runways. For this reason a cleared area or a screen around a fruit tree frequently protects the tree against mouse injury. Under cover of snow, field mice may do injury in places where otherwise they would never dare to venture; they may eat bark from branches of trees, above the top of a screen.

Breeding habits.—Field mice are among the most prolific of mammals. They far surpass rabbits in this respect. Breeding is practically continuous. The period of gestation is 21 days. The female mates again immediately after the young are born. Young females, by the time they are 45 days old, have litters of their own. Breeding is promiscuous, with no permanent pairing of individuals. The number of young in a litter may be 6 or more, tho the first litters produced are usually smaller. Hair and teeth begin to appear when the young are 5 or 6 days old, the eyes open about the 8th day; the young are weaned about the 12th day. Breeding is interrupted by lack of food or by uncomfortable living conditions. The mice do not breed in winter except in especially sheltered situations.

Other habits.—Field mice live together in colonies in a communistic fashion. The runways are interconnecting and seem to be common property. The mice may be active at any time of day or night, and seem to have no preference as to time of activity. They do not hibernate.

Food.—There is some tendency to store surplus food, especially in the fall. The stores consist more of tubers and roots and less of seeds than do those of most other mice. Field mice eat more grass and less seeds and grain. Clover and alfalfa are preferred to grass. Vegetables and grains also are eaten. Experiments on another species of field mouse have shown that on a diet of green food the animals need no other water than what is obtained in their food.

Enemies.—The more important bird enemies of field mice in-

clude crows and most species of hawks and owls. Several species live almost entirely on field mice and other injurious rodents. Only a small proportion of the food of crows consists of mice, but crows are so much more numerous that they may be as important as hawks and owls in keeping down the number of mice. Among the more important mammal enemies of field mice are skunks, foxes, badgers, raccoons, weasels, minks, and shrews. Shrews (see page 42) are the most numerous of these, and in spite of their small size may be as important as any. Some other birds and mammals and some of the larger snakes, such as the bull snake, eat mice.

Control measures.—Control measures against field mice consist in: (1) preventing damage; (2) encouraging natural enemies; (3) killing.

Methods of preventing mouse damage include removing all shelters and placing a screen or other mechanical guard or a repellent wash around the trunk of each tree to be protected. The screen should be of one-fourth inch mesh wire cloth, and should be formed into a cylinder enclosing the trunk of the tree. Undiluted lime-sulphur solution (such as is used diluted as an orchard spray) painted on the trunk of the tree with a brush will keep mice from gnawing the bark. The addition of a pound of cheap glue to each gallon of lime-sulphur will make it stick better and last longer. Either the screen or the repellent mixture will protect a tree against rabbits, too, if it reaches as high on the trunk of the tree as rabbits will be able to reach when there is snow on the ground.

Some of the important enemies of field mice have been listed. Too often they are classified as "vermin" and shot at sight. This general attitude must be reversed if a natural balance is to be maintained and the numbers of injurious rodents are to be kept within reasonable bounds. Except for fur animals taken in reasonable numbers when their furs are prime, the natural enemies of injurious rodents ought to be protected by public sentiment, and only those should be killed that have been caught in objectionable practices. A skunk, for example, may get the habit of raiding the poultry yard, and must be killed, unless the difficulty can be remedied by shutting up the poultry; but in general skunks are beneficial.

Often the best and simplest way to protect trees and crops from field mice is to kill the mice. The mice are easily taken in ordinary mousetraps, but on any considerable area trapping would require so much time and effort as to be impracticable. For poisoning mice in orchards, the "poison stations" recommended by the United States Department of Agriculture are best. "Square pieces of 1x8 inch boards are cut for the tops and of 1x6 inch boards for the bottoms. A groove to hold the poison bait is made across the bottom board with a chisel

(or with a group of circular saws). The two walls of the station are cut from $1 \times 1\frac{1}{2}$ strips into 6-inch lengths. The whole is fastened together with four nails." The poison station consists simply of a square floor, two sides, and a roof which, being larger than the floor, protects the poison bait from the weather. Poison stations not only protect the bait from the weather but prevent other animals than mice from getting at it.

A convenient bait is made by mixing $\frac{1}{4}$ ounce of "gopher poison" with one quart of dry rolled oats. (This amount of gopher poison contains about $\frac{1}{8}$ ounce of strychnine. It can usually be bought already prepared or can be made by mixing $\frac{1}{8}$ ounce strychnine alkaloid, $\frac{1}{8}$ ounce baking soda, and $\frac{1}{80}$ ounce saccharine.) The mixture is thoroly stirred, and heated in an oven. While it is still hot, 6 tablespoonfuls of melted beef fat and paraffin (in the proportion of 3 parts of beef fat and one of paraffin) are poured over the heated oats and poison and the mixtures stirred together. The beef fat and paraffin hold the poison to the oats and keep the bait from absorbing moisture. A poison station is placed at the base of each tree (if an orchard is to be protected from mice) and a teaspoonful of the bait is placed in each station. The poison station should be partly covered with grass or tree prunings to shelter the mice. If the poison stations are restocked with bait about twice a year, the orchard can be kept permanently free from field mice.

White-footed Mice

Description.—White-footed mice, or deer mice, of the genus *Peromyscus* are common everywhere in the state. Unlike the house mouse, which they resemble in size and shape, deer mice are native Americans. They are brown or gray-brown above, with this color sharply marked off from the white underneath. The hairs of the underparts are pure white, as on the feet and underside of the tail, or are slate-gray at the base and tipped with white. The eyes are large and prominent compared with those of house mice. On the whole, these animals are attractive in appearance, easily tamed, and make good pets.

Varieties and range.—There are three kinds of white-footed mice in Minnesota. The forest deer mouse (*Peromyscus leucopus noveboracensis*) is found in about the southern half of the state, and is characteristic of deciduous forests. This form and the species of which it is a variety occur throughout the deciduous forest area of the eastern United States. The prairie deer mouse (*Peromyscus maniculatus bairdii*) occurs in open fields and cultivated land in the southern and western parts of the state. At the western edge of the state its range extends north to the Canadian border. The Canadian deer mouse (*Peromyscus maniculatus gracilis*) is characteristic of coniferous forests and occurs in the northern and eastern parts of Minnesota. In

all three, the color varies with age—young mice being more dark gray and less brown—and with the season (as the fur becomes worn). For these reasons color is not a reliable guide for distinguishing varieties. The simplest way to distinguish one of these deer mice from another is by the length of the tail in proportion to that of the head and body. This proportion is variable, but is less so than color. The tail of the prairie deer mouse (to the end of the last bone) is less than three-fourths as long as head and body combined; that of the forest deer mouse is usually between three-fourths and nine-tenths as long. The Canadian deer mouse has the longest tail, both relatively and actually, as it is more than nine-tenths as long as the head and body combined, and sometimes fully as long.

Economic importance.—All three kinds of deer mice are common or abundant, but probably are of only slight economic importance. They are primarily seed-eaters, living largely on nuts and other tree seeds, weed seeds, and grain. They lay up surprisingly large stores of food for winter use. They capture and eat insects, and in captivity are likely to kill and eat each other. Altho at harvest time the forest species sometimes enters fields that border on woods, probably only the prairie deer mouse eats any considerable quantity of grain, much of it being waste. The forest deer mouse and the Canadian deer mouse are important chiefly in relation to reforestation. In laying up their reserve stores, they are responsible for the planting of many seeds. On the other hand, in reforestation enterprises carried on by man, extermination of the mice may be necessary to prevent loss of the seed. Deer mice may enter houses or camps, but usually do no serious damage.

Habitat.—All three deer mice live on the ground, altho the forest species may build nests in low branches of trees or in hollow trees. The shallow runways are usually beneath a fallen tree or, with the prairie species, just below the surface of the ground. The runway leads to the nest which is made of dry leaves and grass.

Breeding habits.—Deer mice breed at all seasons except in the coldest winter months. There are 5 or 6 young in a litter, and probably several litters a year. The young are so firmly attached to the mother's nipples that if the mother mouse is frightened from the nest she drags the young with her.

Other habits.—Deer mice seem to communicate with one another by rapid drumming on the ground with the front foot. They do not hibernate. They are active at night and usually quiet all day. If a forest deer mouse is kept in continuous darkness, it still continues to be active at night and quiet in the daytime. Forest deer mice caught alive and carried 150 yards or more may return to the original location. This may be true of other small wild mammals, but they have not been tested.

Food.—Most of the foods of the deer mice were mentioned in the discussion of the economic importance of these animals. Green plants are eaten to some extent when seeds are not available. Deer mice do not eat the bark from trees.

Enemies.—Even tho deer mice are mostly nocturnal, some are captured by hawks; more are caught by owls. They are eaten by most flesh-eating mammals—shrews, weasels, skunks, and foxes, and probably by snakes.

Control measures.—It is seldom worth while to undertake control measures against white-footed mice. Some will be killed by measures against other rodents. Where forestry planting is to be undertaken it may be necessary to exterminate rodents, including white-footed mice. Methods used against field mice are effective, and methods used in poisoning ground squirrels and chipmunks will be successful with deer mice.

Other Mice and Mouselike Animals

Other mice and mouselike rodents occurring in Minnesota are the muskrat, the red-backed mouse, the lemming mouse, the grasshopper mouse, the harvest mouse, the pocket mouse, and two kinds of jumping mice. All of these are less common and all except the muskrat are of much less economic importance than the field mice and deer mice already mentioned. The pocket mouse and jumping mouse, tho somewhat like mice in appearance, differ from true mice in internal structure.

Muskrat

The muskrat is an extra large, aquatic field mouse. It resembles the field mouse in nearly all details of structure, even to the arrangement of folds in the pattern of its teeth.

The tail of the muskrat is quite unlike that of the field mouse, however, as it is scaly, flattened laterally, and about four-fifths as long as the head and body combined. The muskrat species common throughout the greater part of Minnesota, *Ondatra zibethica zibethica*, is about 22 inches long, is brown above, darker toward the middle of the back, and whitish underneath. The form occurring in the western part of the state, *Ondatra zibethica cinnamomina*, is smaller and paler than the typical species, with the cinnamon-brown color that the name suggests.

Muskrats are economically important chiefly for their fur. In total value, tho not in individual value, they surpass all other fur bearers in the United States. This value is being increasingly recognized, and many marsh areas that are suitable for no other purpose are being fenced and used for raising muskrats. Muskrats not on fur farms are protected except for a brief trapping season in March. However, locally and under certain conditions muskrats may become serious pests,

and for that reason are included in this list. Muskrats may do damage by burrowing into railroad and highway embankments, especially by burrowing into the walls of reservoirs and canals designed to keep back water. Occasionally they raid gardens near the marsh or stream where they live, but this is a minor fault compared with the release of stored water and the causing of floods. The most favorable situation for muskrats is in a marsh where there is some open water. Here they build "houses" in shallow water, using the stalks of water plants. They will also live in burrows in the banks of ponds and streams. There may be two or three litters of 6 or 8 young. Some of the males, but not all, are polygamous. Muskrats do not hibernate but are active throughout the winter, under the ice. They do not store food to any appreciable extent. In summer they eat all parts of a great variety of aquatic plants and vegetables; in winter their plant food consists mostly of roots and tubers. They eat fresh-water clams and sluggish fish such as carp. Among their important enemies are minks, pickerel, and snapping turtles. Muskrats are protected by law for the greater part of the year. Even when they are doing some damage it is best, if the need is not too urgent, to postpone trapping until the fur is prime. Steel traps or box traps may be used. Some of these traps are designed to drown the muskrat at once and others to keep it alive. Poisoning is not to be recommended, as the skins would not be obtained.

Red-Backed Mouse

The red-backed mouse (*Clethrionomys gapperi gapperi*) is similar to the common meadow mouse in proportions, tho slightly smaller. It is distinguished by a reddish chestnut band down the middle of the back, sharply marked off from the buff of the sides. A variety in the western part of Minnesota (*Clethrionomys gapperi loringi*) is smaller and brighter colored than the species in the rest of the state. Red-backed mice may be locally abundant, but as they are mostly confined to woods and thickets they are probably of slight economic importance.

Lemming Mouse

The lemming mouse (*Synaptomys cooperi*) is rare. It is similar to a meadow mouse but has a much shorter tail—no longer than the hind foot. There is a groove on each upper front tooth. The lemming mouse is most likely to be found in swamps or in moist meadows near brooks. Practically nothing is known of its habits and only a few specimens have been captured. It has been recorded from Lake and Sherburne Counties. It is too rare to be of economic importance.

Grasshopper Mouse

The grasshopper mouse (*Onychomys leucogaster*) resembles a meadow mouse in its stout body and short tail. In its color and in the

pattern of its teeth it resembles a deer mouse. It is known to occur only in the extreme western part of the state. It lives in burrows in the open, not in wooded areas. It lives on animal food to a greater extent than other rodents, and seems especially fond of insects and mice.

Harvest Mouse

The harvest mouse (*Reithrodontomys megalotis dychei*) is a small mouse with a long tail. It has a groove on each upper incisor tooth. It has been recorded in this state only from Homer, in Winona County, but may occur in small numbers throughout the southern and central parts of the state.

Pocket Mouse

The pocket mouse (*Perognathus flavescens perniger*) has fur-lined cheek pouches like the pocket gopher. It differs from the true mice also in having 4 instead of 3 back teeth. It is about 5½ inches long, with the tail nearly as long as the head and body. It is known to occur in Sherburne and Anoka Counties, in fields and open sand-hill localities. It probably occurs also in the more western part of the state, as it is found in North and South Dakota.

Jumping Mouse

The jumping mouse occurring throughout most of Minnesota is *Zapus hudsonius hudsonius*. It is widely distributed but nowhere abundant. It has large hind feet (one-third the length of head and body), and a tail that is half again as long as head and body. It is brown or yellowish brown above, darker in the middle of the back, and the underparts are white. The total length is about 8 inches. In the extreme western part of the state this typical form intergrades with a slightly larger prairie variety (*Zapus hudsonius campestris*), which is nearly 9 inches long. Near the extreme northeastern corner of the state, on the Brule River in Cook County, is a single record of another kind of jumping mouse (*Napacozapus insignis abietorum*) that is still larger. It is distinguished from the more common form by having only 3 back teeth instead of 4 on each side of the upper jaw, and by having a white tip on its tail. When startled, jumping mice travel by a series of jumps, each of which may be 10 feet. They live in nests of fine grass, which may be on the surface of the ground or in shallow burrows. Their food is mostly seeds of grass and other plants. They do not store up food. They hibernate during the winter.

Ground Squirrels, or Gophers

Description.—Two ground squirrels, or so-called "gophers," are found in Minnesota, the striped gopher, or 13-lined ground squirrel (*Citellus tridecemlineatus*) and the gray, or Franklin's gopher (*Citellus franklini*). The striped gopher is smaller, more abundant, better known,

and of greater economic importance. The striped gopher can be distinguished from any other mammal by the 6 light yellow stripes alternating with 7 rows of dots on its brown back. The total length is about 11 inches, which corresponds to that of the gray-striped chipmunk. Aside from the differences in the stripes, ground squirrels in Minnesota (both species) can be distinguished from chipmunks and squirrels by the ears, which are inconspicuous, almost concealed in the fur of the head. In both squirrels and chipmunks the ears project conspicuously. The gray gopher is about 15 inches in total length, the tail being about half the length of head and body. The general color is gray or brownish gray, flecked or speckled with darker. Both species occur throughout the greater part of Minnesota, but are not found in the northeastern third. The gray gopher is very uncommon except in the western part of the state. Both species live in burrows. The striped gopher prefers open grassy lands, especially at the edge of fields. The large gray gophers, being more conspicuous, require more cover. Their burrow openings are usually located in thickets or other protected places.

Breeding habits.—Striped gophers emerge from hibernation late in March or early in April—the males appearing first. About a month later mating takes place, and the young are born after a gestation period of 27 to 28 days—late in May or early in June. The average number of young is said to be 6 or 8. There is only one litter a year. When the young are 4 weeks old their eyes open; by the time they are 6 weeks old they are more or less independent and begin to dig shallow burrows for themselves. The breeding habits of the gray gopher are not known in detail, but are probably similar.

The habits of these two species of ground squirrels are much alike. Both species are active in the daytime. Both lay up a large store of grain and other seeds in branches of their burrows as a reserve food supply. Both hibernate in their burrows all winter, after they have plugged the entrances from the inside.

Food.—About half the food of these ground squirrels consists of insects, but their usefulness in this way is more than balanced by their destructiveness to cultivated crops, particularly grain. They do not penetrate far into cultivated fields, but may do considerable damage around the edge. They dig up seed grain when it is first planted and when it is sprouting; later they attack the growing grain at all stages, wasting a great deal more than they eat. They occasionally capture a young chicken, or the young of some wild ground-nesting bird, but the damage done in this way is not to be compared with that done to grain fields. Individually, gray gophers are fully as bad as the striped, but they are too scarce to do much damage.

Badgers, skunks, weasels, the larger snakes, hawks, and owls are important natural enemies of ground squirrels.

Control measures.—Ground squirrels can be trapped or shot or snared. When a considerable number are to be destroyed the only effective method is poisoning. A teaspoonful of poisoned grain is placed near (not in) each burrow entrance. The poison is prepared by adding an ounce of strychnine alkaloid (or 2 ounces of the prepared "gopher poison") to a pint of hot water and a tablespoonful of gloss starch, heating until a thick paste is formed, and stirring this paste into 20 quarts of oats until every grain is coated. As the ground squirrel carries the grain in its cheek-pouches and takes it into the burrow, the poison is absorbed and kills the animal even more quickly than if the grain had been eaten. A second application of poisoned grain will usually kill any that were missed the first time. If whole corn is used instead of oats, the danger to harmless small birds will be reduced. It is best to poison a large area at once, or ground squirrels from neighboring fields will promptly take the place of those that were killed.

Chipmunks and Tree Squirrels

Two kinds of chipmunks and several kinds of squirrels are found in Minnesota. In habits, the chipmunks are intermediate between squirrels and ground squirrels, or gophers. Squirrels spend most of their time in trees, and do not make their homes in underground burrows. Ground squirrels live in underground burrows; they come to the surface of the ground for food, but seldom climb trees. Chipmunks live in stumps or hollow logs or rock piles, but they usually have underground burrows where they lay up stores of nuts and where they spend the winter in hibernation.

Chipmunks

The Lake Superior chipmunk (*Eutamias minimus jacksoni*) occurs in about the northern and northeastern half of the state. It is about 8 inches in total length, with the tail more than two-thirds as long as the head and body. The gray-striped chipmunk (*Tamias striatus griseus*) occurs in suitable locations throughout the state. It is 9 or 10 inches long, with the tail about half as long as the head and body. Both chipmunks have 5 longitudinal black stripes on the back, separated by paler ones. The lateral pale stripes are nearly white. An important difference between the two, not readily evident in the live animal, is that *Eutamias* has 5 back teeth instead of 4 in each upper jaw. Chipmunks are of economic importance mainly when they live near the edge of fields and feed on grain, as ground squirrels do. They also, like the ground squirrels, eat insects, young birds and eggs, and mice.

Because they live in wooded localities to a greater extent than ground squirrels, a larger proportion of their food consists of nuts. Chipmunks hibernate in the winter in a large nest of grass and leaves in an enlargement of the burrow. The entrance of the burrow is closed from the inside. The little Lake Superior chipmunk goes into hibernation later than the gray-striped chipmunk.

Tree Squirrels

The squirrels of Minnesota are the red, the gray, the fox, and the flying squirrels—at least two varieties or species of each. The tails of squirrels are bushier than those of ground squirrels or chipmunks.

The fox squirrel (*Sciurus niger rufiventer*) is variable in color, but is usually a yellow-brown above and pale orange underneath. The hairs of the tail are mixed black and yellowish red. The average total length of this squirrel is about 21 inches.

The gray squirrel (*Sciurus carolinensis leucotis*) is about 20 inches in total length, upper parts are silvery gray slightly mixed with rusty brown, hairs of tail tipped with white, underparts whitish. The Minnesota gray squirrel (*Sciurus carolinensis hypophaeus*), described from Elk River, is slightly larger with less white underneath. Both the gray and the fox squirrels are variable in color and some of both species are partly or wholly black. As will be seen from the figures given, the gray and the fox squirrels are similar in size. The color of the tail hairs will distinguish them, except for the black ones. The most constant difference is that fox squirrels have 4 and gray squirrels have 5 back teeth on each side of the upper jaw. Fox and gray squirrels occur in about the southern half or two thirds of the state.

The Minnesota red squirrel (*Sciurus hudsonicus minnesota*), described from Fort Snelling, is the largest of the red squirrels but much smaller than either the gray or the fox squirrel. It averages about 13½ inches in total length. In the northern part of the state it intergrades with the common eastern red squirrel (*Sciurus hudsonicus loquax*) which is slightly smaller. The color is reddish brown above and white or gray beneath, sometimes with a rusty tinge. In summer a black stripe at the side separates the brown of the back from the white of the underparts. Red squirrels occur in suitable locations throughout the state.

Flying squirrels are of two kinds, both somewhat smaller than red squirrels. The southern flying squirrel (*Glaucomys volans*), which occurs in about the southern half of Minnesota, is about 9½ inches long (from nose to last bone of tail), and the northern flying squirrel (*Glaucomys sabrinus sabrinus*), occurring in the northern half of the state, is about 12 inches long. In the southern part of the range of the northern flying squirrel is a variety, *Glaucomys sabrinus macrotis*, that

is slightly smaller, paler, and has longer ears. It is this variety that occurs in the vicinity of Elk River. Flying squirrels have thicker, softer fur than other squirrels. They also have a fold of skin between the front and hind legs that forms a flying membrane used in sailing from one tree to another. Flying squirrels are yellowish brown above and white or whitish underneath. The hairs on the underparts of the northern species are lead gray at the base, and white-tipped; on the southern species they are pure white.

Economic importance.—Gray and fox squirrels are classed as “game” and protected except for an open hunting season from October 15 to January 1. Black individuals of these species are given complete protection. Red and flying squirrels eat birds and eggs, but probably not enough to make any great difference in the number of birds. The greatest damage done by red squirrels is probably in eating the growing tips from coniferous trees, causing the trees to become deformed. Red squirrels climb apple trees and damage apples by biting into them. All squirrels, chipmunks, and some mice, are agents in reforestation, planting many nuts and other tree seeds that they do not afterward dig up for food. However, when tree seeds are being planted by man these animals are likely to dig them up and carry them away. Of the squirrels, probably only the red squirrel deserves to be classed as injurious, and then only under unusual conditions.

Habitat.—Squirrels live only in the woods—at least where there are groves or shade trees. They seem to prefer to make their homes in hollow trees or in holes formerly occupied by woodpeckers. When these are not available, they sometimes make outside nests—large balls of leaves, grass, and other materials among the limbs—or roof over the deserted nests of crows and other large birds.

Breeding habits.—The breeding habits of squirrels are not well known. There are usually 4 to 6 young in a litter (probably less in the case of fox squirrels). The young are born in spring or early summer. There may be a second litter.

Other habits.—Flying squirrels are strictly nocturnal; other squirrels are usually active only in the daytime. Flying squirrels are less abundant than the other kinds; certainly they are much less well known. If hollow trees are struck sharply with a stick, flying squirrels may be discovered where their presence had not been suspected. They occasionally establish themselves in the attics of houses. None of the squirrels hibernate as the chipmunks do, tho gray and fox squirrels, especially, are likely to stay in their nests a few days at a time during the most severe winter weather.

Food.—All squirrels live principally on nuts and seeds when these are available. The red squirrel harvests large quantities of seeds of coniferous trees where these occur. Berries are eaten, also mush-

rooms. Mushrooms are hung from the crotches of trees to dry. The squirrels seem able to distinguish between the poisonous and non-poisonous species. Buds are eaten from the twigs of trees, and occasionally some of the bark. The red squirrel lays up stores of food to a greater extent than other squirrels. Besides burying large numbers of single nuts or little collections of nuts, as do other squirrels, red squirrels store sometimes as much as a bushel of nuts and seeds in hollow trees. Squirrels can locate buried nuts or pine cones even when the ground is covered with snow. They may be guided in this by memory of location rather than by sense of smell. They sometimes strip the bark from dead branches to get the insects underneath. Red and flying squirrels occasionally eat birds and birds' eggs.

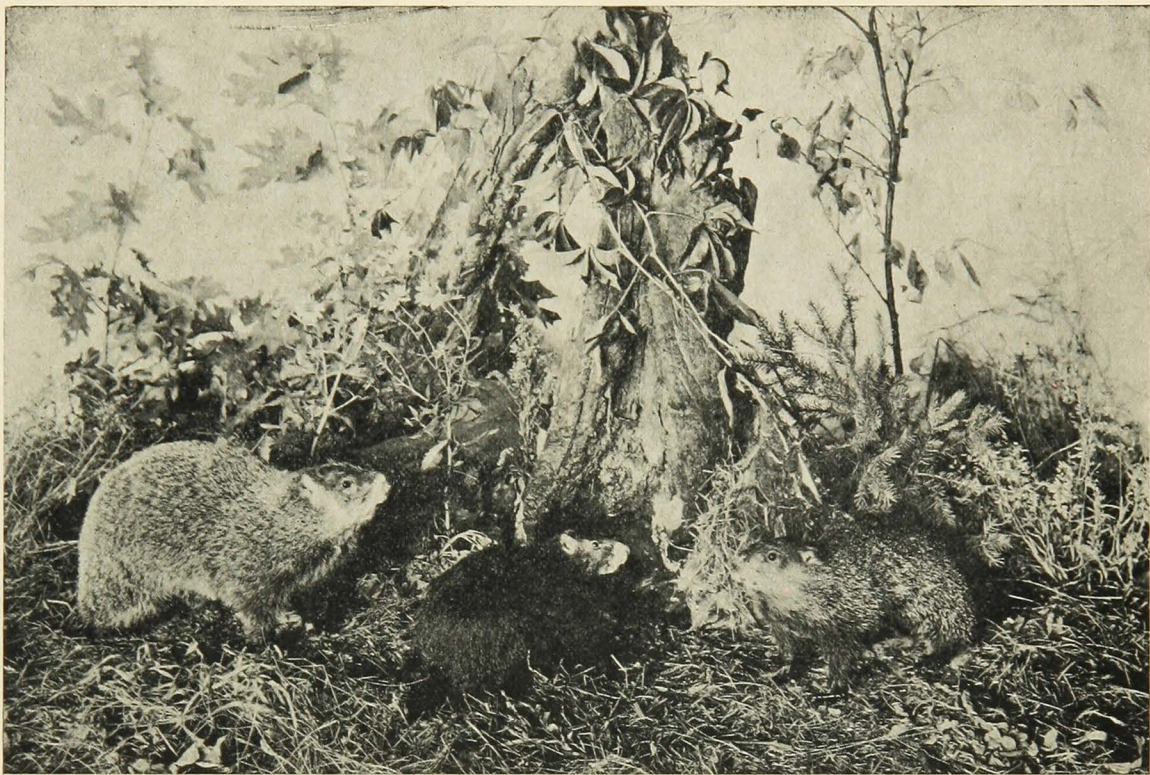
Enemies.—Red squirrels have been known to injure the much larger gray squirrels. Aside from antagonism between individuals and species, the more important natural enemies are probably hawks, owls, and weasels. Owls destroy many of the nocturnal flying squirrels.

Control measures.—Chipmunks can be poisoned, as ground squirrels are, by dropping a little poisoned grain in places they frequent. If red squirrels are very numerous, or are doing some particular damage, they may be controlled by shooting. Other squirrels are seldom numerous, are usually harmless, and are welcomed as pets.

Woodchucks, or Ground-hogs

Varieties and range.—Woodchucks are large, thick-set animals similar to ground squirrels, with short, bushy tails. There are two varieties in Minnesota, the rufescent woodchuck (*Marmota monax rufescens*), about 22 inches long, in the southern and central parts of the state; and the slightly smaller Canadian woodchuck (*Marmota monax canadensis*), about 20½ inches long, in the northern part of the state. Both forms have a distinctly reddish tinge to the general gray-brown color. Woodchucks are burrowing animals, originally inhabitants of wooded areas. Many locate on or near cultivated land and take advantage of the more abundant food supply.

Economic importance.—Woodchucks not in the immediate vicinity of gardens and cultivated land are of no economic importance. On cultivated land both food habits and burrowing habits are injurious. They eat a great deal of grass, preferring clover and alfalfa, trample much that they do not eat, and may raid neighboring gardens. Woodchuck burrows and mounds in hay fields are dangerous to horses and mowing machines. Burrows at the base of orchard trees are injurious to the trees. Abandoned woodchuck burrows are frequently used by skunks and other useful animals. This fact does not balance the woodchuck's destructiveness, however, especially as fur animals are capable of making their own burrows if they can not find any ready made.



Woodchucks Are Harmless Except on Cultivated Land

Breeding habits.—Woodchucks have only one litter a year, of 5 or 6 young, usually born in the latter part of April.

Other habits.—Woodchuck burrows usually have side branches and two or more openings. A burrow is occupied by a pair or a family group in most cases. No food is stored for winter use. In this respect woodchucks differ from ground squirrels and chipmunks, which, even tho they hibernate, lay up a reserve food supply. Woodchucks become fat in the fall, curl up in their burrows, and sleep through the winter. They sometimes appear in the spring before the snow is off the ground. In this state they are not to be expected to live up to their traditional reputation of appearing above ground on February 2 of each year. During the active season they usually appear above ground to feed for a while in the morning and again in the afternoon. They have been known to feed on moonlight nights. A woodchuck is strictly an underground animal, but will sometimes climb to a low crotch of a leaning tree near its burrow to sun itself, or to get out of reach of dogs. They keep a sharp lookout when they are feeding and usually can get back to the burrow in case of danger. Woodchucks are not considered aquatic animals, but they have been known to enter the water voluntarily and swim.

Enemies.—Foxes and dogs are the only important natural enemies of woodchucks, which are captured by being cut off from their burrows or by being dug out. A woodchuck cornered may sometimes prove a match for a dog.

Control measures.—If woodchucks are doing damage they can be controlled by shooting, trapping, or fumigating. They offer tempting targets for marksmanship. Even when fatally wounded they frequently manage to tumble into their burrows out of reach. They are unsuspecting and are easily trapped in steel traps placed in the burrow entrance. Where any considerable area is to be rid of large numbers of woodchucks, neither of the above methods is as effective as gassing. The poison gas (or the material from which it is formed) is introduced into the burrow and all entrances are plugged. A cloth soaked with a few teaspoonfuls of carbon disulphide is pushed into the burrow, and exploded by a lighted match, thrown on it. If calcium cyanide is used for gassing, a heaping teaspoonful is put as far into the burrow as possible, or the dust is pumped into the burrow as described for rat runways. Automobile exhaust gas may be forced through a hose into the burrow. After any of these gas treatments the burrow entrances should be closed. Any burrows opened a few days later should be treated again. A serious campaign against woodchucks should be undertaken in April or May, when the grass is short and the burrows can readily be located. It is important to distinguish burrows occupied by woodchucks from woodchuck burrows occupied by more valuable

animals. That a burrow is occupied by a woodchuck is usually indicated during the active season by fresh earth on the mound and by evidence that the grass in the immediate vicinity is being eaten.

Pocket Gophers

Description.—Pocket gophers are so named because they have a fur-lined pouch or pocket (a fold of skin) opening on each side of the mouth and extending back to the shoulders. They are of a brownish color, lighter underneath, and are about 10 inches long, with stout body and short legs. The tail (in Minnesota pocket gophers) is about two-fifths the length of head and body. Long, curved claws on the front feet are adapted to digging.



Side View of Left Front Foot of the
Pocket Gopher

Varieties and range.—Two kinds of pocket gophers are recorded for Minnesota—the Mississippi Valley pocket gopher (*Geomys bursarius*) which is common throughout the state except in the northeastern part; and the Dakota pocket gopher (*Thomomys talpoides rufescens*), a more western form that reaches Minnesota only at the extreme northwestern corner. *Geomys* is the larger of the two, the adults averaging slightly more than 10 inches; and it is distinguished by two conspicuous grooves on the front of each upper incisor tooth.

Economic importance.—The pocket gopher, because of its habits, is one of the serious enemies of agriculture, and yet is fairly easy to control. A principal evidence of the presence of gophers, and one of the main sources of damage, are the mounds of earth. Two or three gophers in a field can make dozens of such mounds in a few days. The size of the mounds varies from a few quarts to a bushel or more. If mounds are numerous, in fields of hay, clover, or alfalfa, there may be a considerable loss from the killing of the vegetation covered by them. They make the operation of mowing machines difficult, and may damage the blades. Reduction of the crop is not limited to areas actually covered by the mounds, as the gophers eat the roots below the surface of the ground, and cut off and store a great deal besides what they actually eat. Gophers may kill orchard trees by eating off the roots. They may invade gardens, following along the rows and eating off bulbs, tubers, and roots.

Habitat.—Pocket gophers, more than any other of our mammals except moles, live underground. They prefer fertile soil that is not thickly wooded. They seldom venture out of their burrows except in winter, when the burrows are extended through the snow, altho the males probably travel above ground to some extent during the mating season

in the spring. A gopher burrow consists of a main runway, which may be fairly straight or very crooked and irregular, and numerous short branches or "laterals," by means of which the excavated earth is brought to the surface. After the mound is made the opening of the lateral is plugged from the inside, so the main runway has no connection with the surface. The main runway is about 4 inches in diameter; the laterals are smaller.

Breeding habits.—Male and female pocket gophers are sometimes found occupying the same burrows in the spring, but not usually at other seasons. There is one litter, with an average of 4 young. The young are at first naked, blind, and helpless. As soon as they are able to care for themselves they start branch burrows of their own which presently are shut off from the original burrow in which they were born.

Other habits.—Pocket gophers are not social animals and during the greater part of the year each burrow is occupied by only one gopher. They are active all winter, burrowing through the snow as well as underground. They frequently store away considerable quantities of food in their burrows. Gophers dig with their front feet and push the earth from the burrows with the head and feet. The pouches are not used for carrying earth, as is commonly believed.

Food.—Pocket gophers are usually thought to be strictly vegetarian in their food habits, tho in captivity they have been known to eat meat. They are quick to try to kill other animals they encounter, but do not always eat them. The greater part of the food eaten is such as can be obtained underground—roots and bulbs—but this is mixed with green vegetation obtained at the openings of the laterals before the earth is pushed out to form the mound.

Enemies.—The most important enemies of pocket gophers are weasels and large snakes, which hunt the gophers in their burrows. The so-called "gopher-snake" or bull-snake (*Pituophis sayi*) is particularly useful in this respect and has fewer bad habits than the weasels. Unfortunately these snakes are much less common than the gophers. Badgers and other flesh-eating mammals kill pocket gophers, and occasionally gophers are captured at their burrow entrance by hawks or owls.

Control measures.—The most effective ways of controlling pocket gophers are trapping and poisoning. Trapping with ordinary traps, such as are used for other animals, is not satisfactory unless the trap is set in the main runway. They can not be used successfully in the laterals because the gopher almost always enters the lateral pushing a load of earth ahead of him, and the trap is sprung before the gopher is near enough to be caught. For this reason several kinds of gopher traps have been devised in which the trigger is several inches beyond

the jaws of the trap. In a freshly dug mound the plug of earth closing the lateral is removed with a strong, long-handled spoon, and the trap is placed in the lateral with the trigger end toward the opening.

Poisoning pocket gophers is usually quicker and easier than trapping them. The poison is prepared by mixing 1/8 ounce strychnine alkaloid, 1/8 ounce baking soda, and 1/80 ounce saccharine. These are all dry powders, and are stirred together and placed in a sifter-top can. This poison can be bought ready mixed. Four quarts of 1/2-inch cubes of any convenient vegetable, potatoes, carrots, or beets, is rinsed with water, and drained. The cubes are placed in a pan and stirred while the poison is sifted over them. The poison sticks to the moist surface of the cubes, which are now ready to be distributed in the pocket gopher runways. The next step is to locate the main runways of the gopher burrows. In this connection it should be remembered that the plug of earth closing the lateral is on the side of the mound toward the main runway. A probe made of heavy wire is pushed into the ground a foot or two from the mound until the main runway is located. The runway can be found more readily if the probe is slightly enlarged at the tip. The runway is usually 6 to 12 inches below the surface and is easily recognized as the probe passes through it without meeting any resistance. Once the runway is located, the hole made by the wire is enlarged with a pointed stick (a broomstick sharpened at one end will do nicely); then a cube of poisoned bait is dropped into the runway, and the hole is closed. In the same way the main runways opposite each of the recent mounds are located and poison bait is applied, and all mounds are leveled. After a few days the same treatment should be given wherever new mounds have been made. If necessary, a third application of poison can be made wherever new mounds indicate that some of the gophers are still alive. The best time to make a campaign against pocket gophers is in the spring or early summer, when the animals are busy pushing up new mounds and grass is so short that the mounds are conspicuous. The treatment is effective at any time when new mounds are being pushed up, and the time to act is when the first one is seen. The pocket gopher is a serious pest, but one of the most easily controlled. It does not travel far, its work is conspicuous, and it is easily and quickly poisoned.

Porcupines

Description.—The porcupine, or hedgehog (*Erethizon dorsatum*), can not possibly be mistaken for any other animal. It is (except for the beaver) the largest of our rodents. The most distinctive feature is the armor of pointed quills in the hair of the upper side of the body. In total length a full-grown porcupine measures about 3 feet. The average weight is about 16 pounds, tho some considerably exceed that figure. Porcupines are heavily built, short-legged animals with a clumsy



Most Animals Know Better Than To Attack a Porcupine

shuffling gait. The hair is fairly long; the general color is dark brown or black. The whitish quills, showing against the dark hair, are conspicuous. The quills are especially thick strong hairs, covered with minute barbs. Porcupines occur in about the northern half of the state, but in most places are not abundant.

Economic importance.—The economic importance of the porcupine is a matter of serious question, tho it is probable that this animal will in the future be regarded more and more as undesirable. Porcupines do serious damage to trees—by stripping off the bark for food they kill many and deform many more. They enter camps at night and frequently do considerable damage. They are especially known for their habit of gnawing through wooden objects such as axe handles that have been soaked with perspiration. The desire for salt seems to be the reason for such attacks. Porcupines are also in disfavor because of the injuries suffered by dogs that are reckless enough to attack them. The sharp points of the quills easily penetrate the skin of any animal. The quills readily separate from the porcupine and because of the barbs they work deeper and deeper into the flesh of the unfortunate attacker. Opposed to all this evidence against the porcupine is the fact that sometimes, quite involuntarily, it has been the means of saving the lives of men lost in the woods. It is a walking meat supply. It is the only animal that an unarmed man can kill. Probably, however, in a settled country where the chances of getting lost are slight, the harm the porcupine does outweighs its possible usefulness as a source of food.

Habitat.—Porcupines are found for the most part in coniferous forest areas. They usually make their dens in hollow logs or in rock piles.

Breeding habits.—Porcupines are said to mate in November, and the young are born in March. One litter is produced a year, and that may consist of only one offspring. The young are larger and better developed at birth than the young of other rodents. They are born with the eyes open and with a covering of hair. Within a week after birth the quills are well developed.

Other habits.—Porcupines are extremely clumsy and sluggish, whether on the ground or in a tree. They do not hibernate, and they do not always retire to their dens even in severe weather. One may remain for days in the same tree, and then perhaps move only as far as the next tree. If attacked, a porcupine may merely turn its back on the assailant and, if touched, will lash its tail. This accounts for its supposed quill-throwing habit. It is thus safe from most enemies.

Food.—The main food of the porcupine is the inner bark of a great variety of trees and shrubs, especially in winter; in summer the

variety is greater, including grass and leaves, apples and berries, and the tops of such aquatic plants as can be reached from the shore.

Enemies.—Most wild animals, unless desperate with hunger, wisely let porcupines alone. An inexperienced dog will often come to grief through reckless attacks on a porcupine, but after a few painful encounters will learn discretion. Porcupines are probably as free from attacks by natural enemies as are any mammals.

Control measures.—Where porcupines are abundant, control measures of some sort are necessary if reforestation is to be attempted. They are exceptionally fond of salt, and can be poisoned if strychnine is mixed with salt. The poison is most effective if it can be placed in the animals' dens.

Beavers

The beaver (*Castor canadensis*), once a common animal in the ponds and streams of Minnesota, was trapped until it became nearly or quite extinct. Beavers from Canada were introduced into Itasca Park about 1899. Under a system of careful protection and permanent closed season they have increased until they are common in parts of northern Minnesota.

Description.—Beavers are most readily recognized by their stout, horizontally-flattened, scaly tails. The total length of an adult beaver is $3\frac{1}{2}$ feet.

Beavers are protected by law at all times, and may be taken only under special permit from the Game and Fish Commissioner. They are not classed as injurious animals.

Economic importance.—Altho they may sometimes do serious damage, their value as fur-bearers outweighs any ordinary loss. The principal types of damage done by beavers are:

1. The killing of stands of timber by flooding, due to the raising of water levels by dams.
2. The cutting of shade or ornamental trees on lake fronts near cottages.

Other charges against the beaver, less important because not fully proved, are in regard to the relation of these animals to forest fires and to trout.

Habitat.—Beavers live in colonies in natural ponds, or in artificial ponds formed behind dams, which they construct. Beaver families may live in bank burrows, or in houses of sticks built in the water. Their houses resemble those of muskrats, except that they are larger and stronger.

Breeding habits.—Beavers are often polygamous, tho they sometimes appear to pair. They produce one litter of about 4 per year.

born in May or June. They are covered with fur when born, and are able to swim within a few days.

Other habits.—Beavers adapt their surroundings to their own convenience probably to a greater extent than any other mammals except man. They build dams across streams, forming ponds—sometimes chains of ponds—in which they build their houses. Both dams and houses are substantial, and are proof against the attacks of most enemies. The houses can be entered only under water. Beavers fell trees, cut them into pieces of a convenient size to handle, and carry them to the pond, where the bark is used for food and the trunk for building dams and houses. Trees and branches, with bark attached, are stored under water for a winter food supply. Extensive canals are made, along which the trees can be floated to the pond.

Food.—The inner bark of various kinds of poplar is the principal source of food. Willow is also used, and the bark of various other deciduous trees is eaten when more desirable food trees are lacking. In summer, grass and various aquatic plants form a part of the diet.

Enemies.—The larger size of the beaver protects it from many of the natural enemies of the muskrat. In the water, especially in their house, adult beavers are safe from nearly every enemy. Snapping turtles probably get some of the young. On land, when they are cutting trees they are at a disadvantage, and wolves and wild cats no doubt kill some of them. Most colonies near civilization are destroyed by dogs or poachers.

Control measures.—In most cases beaver damage can easily be prevented without killing the animals. Damage by flooding can usually be prevented by putting an overflow pipe through the dam in such a way that a certain water level is maintained no matter how high the dam is built. The intake end of the pipe must be surrounded with stones or the beavers will plug it. Valuable trees that are to be protected can be enclosed at the base by wire netting. Where beavers are doing serious damage that can not easily be prevented, a permit to trap them can be obtained.

Rabbits

Description.—Rabbits can be distinguished from the other gnawing animals by their long and powerful hind legs, long ears, and short tail. Rabbits are also peculiar in having a second pair of upper front teeth, which are small and hidden behind the main pair. All rabbits differ from most other rodents in having the feet completely covered with hair.

Variety and range.—There are three principal kinds of rabbits in this country: the varying hare or snowshoe rabbit, the jack rabbit,

and the cottontail. All three are found in Minnesota. There are two varieties of cottontail within the state, those from the extreme western part being smaller and grayer than those from the eastern and central parts. The jack rabbit, the snowshoe rabbit, and the cottontail form a series as to both size and relative length of ears.

Jack Rabbit

The white-tailed jack rabbit (*Lepus townsendii campanius*) is much larger than any of the other rabbits found in Minnesota. The total length is about 24 inches. The tail is white and is about $3\frac{1}{2}$ inches to the end of the last tail bone—much longer than the tail of other rabbits. The ears are considerably longer than the head, and are tipped with black; those of all other rabbits have more or less distinct tips or margins of black, but are shorter. In summer the upper parts of this rabbit are pale yellowish buff and the underparts pure white. In winter the entire animal is white except the black tips of the ears. Underneath the white outer coat and hidden by it is the shorter underfur, which is brownish. The range of jack rabbits in Minnesota includes a little more than the southwest half of the state. They occur along the entire western boundary, and are much more common in the western than in the southeastern part. There are none in northeastern Minnesota.

Varying Hare

The Minnesota varying hare, or snowshoe rabbit (*Lepus americanus phaenotus*), is considerably smaller than the jack rabbit and somewhat larger than the cottontail. The total length is about $18\frac{1}{2}$ inches. The tail is even shorter than that of the cottontail, only $1\frac{1}{2}$ inches. The ears are about as long as the head. The hind feet are larger in proportion to the body than those of other rabbits. A fringe of stiff hairs around the feet in winter is the reason for the common name "snowshoe rabbit." In summer the upper parts of this rabbit are dull brown, and the under parts are bright white; the top of the tail is mixed black and dingy white, and the tips of the ears are bordered with black. In winter the coat is pure white except for this black border. The short underfur, hidden by the white outer coat, is dull gray at the base and tipped with rusty yellow. The jack rabbit changes its coat and gets a white winter covering just as truly as this species does, but the term "varying hare" is applied to this snowshoe rabbit and not to the jack rabbit. The Minnesota varying hare occurs in about the northern half of the state, reaching farther south in the eastern than in the western part.

Cottontail Rabbit

The cottontail rabbit is smaller than the varying hare, and the hind feet are decidedly smaller. The hind foot of a cottontail is about 4

inches; that of the varying hare about $5\frac{1}{2}$ inches. The general color is pinkish buff above and white beneath. The upper side of the tail is dull brown and the ears are bordered with black on the anterior margin and tip. The general color resembles the summer coat of the varying hare. Cottontail rabbits do not get a white coat in the winter. In the eastern and central parts of the state is the so-called "Mearns" cottontail (*Sylvilagus floridanus mearnsii*) described from Fort Snelling. In the extreme western part of Minnesota this variety integrades with the slightly smaller and paler Nebraska cottontail (*Sylvilagus floridanus similis*). Cottontail rabbits were originally confined to the southern part of the state, but have gradually extended their range. Rabbits are ordinarily unprotected by game laws, but to encourage the northward spread of cottontails this species was given temporary protection in St. Louis and Lake Counties in 1926.

Economic importance.—When any of the rabbits mentioned are numerous where they come in contact with valuable trees and shrubs or any kind of crops, they are very destructive. They cut off growing buds and shoots of seedling trees and shrubs and girdle larger trees. They are among the most important factors limiting natural reforestation, and in some places making it entirely impractical to set out tree seedlings. They attack a great variety of garden vegetables, and are fond of clover and alfalfa. On the other hand, they are hunted for food and sport and are valuable from the fact that in many parts of the state they afford the only hunting to be had. Rabbits in general and (in Minnesota) varying hares in particular are subject to extreme fluctuations in numbers, becoming excessively numerous and then in a few years extremely scarce. The scarcity seems to result from epidemic diseases, the spread of which is favored when the rabbits are numerous. One of these diseases is tularemia, which can be transmitted to human beings. Several persons have become sick and some have died in Minnesota and in other states from tularemia acquired from handling diseased rabbits. Other cases of tularemia have probably escaped public attention because not correctly diagnosed. Rubber gloves should be worn as a safeguard when one is handling or dressing wild rabbits. Thoroly cooked rabbit meat is entirely safe. When rabbits are numerous the harm they do is many times greater than their usefulness; otherwise the harm they do is slight and control measures other than shooting are unnecessary.

Habitat.—These various rabbits are noticeably different in local distribution, even where all three kinds occur in the same town or county. Jack rabbits are animals of open plains, not seeking holes or other shelter, and depending mostly on speed for safety. Varying hares, or snowshoe rabbits, are closely restricted to woods. They damage orchards, gardens, and fields that are in small clearings or near the

edge of a forested area, and may seriously interfere with natural or artificial reforestation.

In its choice of habitat the cottontail is intermediate between the other two rabbits. It favors thickets in wooded areas, or open country where there is plenty of underbrush. Cottontails are most abundant in or near the areas of woods or brush along the banks of streams, especially in the western part of the state. Cottontails are not at all discouraged by civilization. Within the city limits of St. Paul and Minneapolis are places where cottontails are common. In winter their tracks are seen in the snow on city lots, often more than the tracks of dogs. At University Farm, cottontail rabbits are seen more often than any other wild mammal except squirrels. None of the wild rabbits make burrows, as tame rabbits do. Unlike the jack rabbit and the varying hare, cottontails often hide among rocks or in the openings of burrows of other animals.

Breeding habits.—All these rabbits produce litters of 3 to 6 young, cottontails usually producing more young to a litter than the others. Cottontails usually have two or three litters per year; other rabbits may do so. A striking difference between cottontails and rabbits of the genus *Lepus* is in the condition of the young at birth. Cottontails are born blind and hairless; varying hares and jack rabbits have a good coat of fur, have their eyes open, and can hop around almost as soon as they are born. Rabbits do not form permanent family groups, and the males have no share in raising the young.

Other habits.—Rabbits are, in a sense, more nearly homeless than most other mammals. They have no den or burrow or nest that is a permanent home. Usually a nest is provided for the young in a little depression, lined with soft grass and fur and covered over and hidden by more grass. When not in search of food, rabbits are usually crouched quietly and inconspicuously in a shallow depression or "form" under a tree, in a thicket or brush pile or bunch of weeds, always prepared to run at the close approach of an enemy. They do not hibernate. They have no permanent shelter in which they could hibernate. Varying hares and cottontails keep clear paths through thickets and deep snow, and jack rabbits make temporary burrows or tunnels in the snow—for convenient travel and escape from enemies.

Food.—The food of rabbits has already been discussed briefly in connection with their economic importance. Rabbits are strictly vegetarian in their diet. The summer food consists of a large variety of leaves, grass, and vegetables, and some bark and twigs. The winter food is largely bark and buds of trees and shrubs. They do not store food for future use.

Enemies.—Rabbits constitute the principal food supply of foxes and some of the larger hawks and owls. Coyotes, minks, and weasels

get their share; the smaller birds of prey, and crows, can capture young rabbits and then eat them, and many are killed by men and dogs. Rabbits, for their size, are about the most defenseless of animals, and they can escape their enemies only by speed and cleverness. Their continued abundance is proof of their ability to do this.

Control measures.—Where rabbits are doing serious damage the trees or crops which they threaten must be protected or the rabbits killed. A cylinder of fine-mesh woven wire, or some other mechanical guard such as building paper, placed around the trunk of the tree will protect it from rabbit injury. Repellant washes painted or sprayed on trees and shrubs give satisfactory protection. Lime-sulphur solution (used as a spray against certain tree insects) painted on the trunks of trees or sprayed on shrubbery protects them from damage by rabbits as long as it sticks to the bark. A pound of glue added to each gallon of concentrated lime-sulphur solution makes it stick better. The lime-sulphur solution should be applied in the fall and, if necessary, again on a mild day in winter. It should not be allowed to freeze on the trees. If tree prunings are left in the field, and some grain and vegetables are put where the rabbits will find them, the trees will usually be left alone. Poisoning the rabbits is sometimes the simplest means of preventing damage. Twigs or grain coated with poison starch paste are good for this purpose, or a few crystals of strychnine can be inserted with the point of a knife blade into pieces of apple or vegetable. Poisoned twigs are especially safe, as only rabbits and mice are likely to touch them. The poison starch paste is prepared by mixing one tablespoonful of gloss starch in $\frac{1}{2}$ pint of cold water, stirring the mixture into $1\frac{1}{2}$ pints of hot water, and heating until the starch is clear. Then sift and stir into the hot starch 2 ounces of gopher poison (a mixture of one ounce strychnine alkaloid, one ounce baking soda, and $\frac{1}{10}$ ounce saccharine). The hot paste should be stirred into about 12 quarts of oats, or smeared in a thin coating on small twigs from tree prunings. The poisoned grain or twigs are distributed where the rabbits are doing damage. If they are placed on little patches of alfalfa hay the rabbits are more likely to find them.

Poisoning of rabbits or any quadruped is legal only if permission is secured from the Game and Fish Commissioner.

Where rabbits are common it is not difficult to snare them or catch them in box traps. If they are hunted persistently other control measures are not likely to be needed.

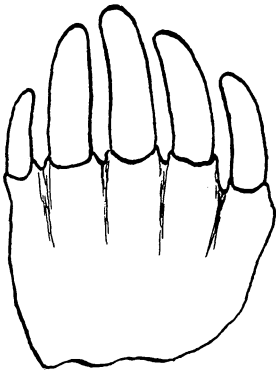
INSECT EATERS

Several of the gnawing animals already discussed eat insects. The skunk in particular among the group of flesh eaters lives largely on insects. Three groups of mammals in Minnesota—moles, shrews,

and bats—are almost entirely insect eaters. Many of the commonest insects are injurious to the interests of man, and the animals that feed on them must be regarded as more or less beneficial; yet many people kill these animals on every possible occasion. Moles are useful in their food habits, but when they disfigure lawns by burrowing for their favorite food they must be destroyed. Shrews are almost wholly beneficial, but are killed because they are mistaken for mice. Bats feed wholly on insects, which they collect while flying at night, but they are often killed because many people have an unreasoning (and wholly unfounded) fear of them, and because they cause annoyance when they establish their homes in attics or between the partitions of houses. All these insect eaters have continuous rows of teeth with no long gaps such as are found between the front and back teeth of rodents.

Moles

Description.—Moles are burrowing animals, most readily recognized by their enormously developed front feet from which the five powerful claws project like the teeth of a comb or rake. The fur is soft and velvety. The eyes are very small and are concealed in the fur. The common moles, frequently reported as damaging lawns and gardens in about the southern third of the state, represent two varieties of the same species.



Dorsal Aspect of Left Front Foot
of the Common Mole

Varieties and range.—The prairie mole (*Scalopus aquaticus machrinus*) occurs in the extreme southeastern part, and the Missouri Valley mole (*Scalopus aquaticus machrinoides*) in the central and western part of southern Minnesota. Both these moles have a pointed proboscis-like snout and a short ($1\frac{1}{2}$ inch or less), scaly, almost hairless tail.

The front feet are wider than they are long. The toes on both front and hind feet are webbed. The prairie mole is brownish above and 7 or 8 inches long. The Missouri Valley mole is grayer and smaller (usually slightly less than 7 inches). They are alike in habits. The great majority of the moles in Minnesota belong to the Missouri Valley variety. In about the northeastern half of the state, but much too rare to be of economic importance, is another—the star-nosed—mole (*Condylura cristata*). It is peculiar in having at the end of its snout a disk from the edge of which 22 long fleshy processes stick out. The star-nosed mole is dark chocolate brown or blackish in color, is about 7 inches in total length (of which the tail is about $2\frac{3}{4}$ inches), and does not have webbed feet. The front feet are about as wide as they are long. In

summer the tail is slender; in winter it is much thickened in the middle but constricted at the base.

Habitat.—Common moles (varieties of *Scalopus aquaticus*) extend their burrows in lawns and gardens, golf courses and cemeteries, leaving



Star-Nosed Mole

a network of ridges wherever they have been. Moles may injure gardens by uprooting bulbs and other plants. Except in cases so rare as to be of no practical importance, they do not eat vegetable food; but mole runways are frequently used by mice, which often do serious damage by gnawing bulbs and roots of plants. Where mole ridges spoil lawns and gardens, the moles are usually after white grubs and other injurious ground insects. In many cases the moles do more damage than the insects they are hunting, and then measures must be taken to get rid of the moles.

It should not be supposed that moles occur only in lawns, gardens, and similar places. Their work is more quickly noticed there, and probably their favorite food—earthworms and insect larvae—is found there in greatest abundance, but moles are also found on the uncultivated land of roadsides and woods. The varieties of *Scalopus aquaticus* are not aquatic; the name refers to their webbed feet. The star-nosed mole lives in wet land or along the banks of streams and is perfectly at home in the water.

Breeding habits.—The young are born in the underground nest connected with the system of burrows. The nest is nearly spherical, is made of rootlets and grass and sometimes leaves, and is a foot or more below the surface of the ground. The majority of the very few nests of the star-nosed mole that have been described were in mounds of earth on land high enough to be out of reach of ordinary high water. There are about four young to the litter, and one litter per year. The young of the common mole are usually born in April and those of the star-nosed mole in May. They are hairless at birth, but closely resemble their parents in form. The fleshy processes are on the nose of the star-nosed mole at birth.

Other habits.—Common moles are the most completely underground mammals known. Star-nosed moles, also, have burrows but

have surface runways as well. Common moles have a network of burrows just beneath the surface of the ground, indicated by ridges on the surface. A mole has been known to make as much as 100 yards of tunnel in one night. Besides this extensive system of shallow tunnels made in a search for food, a set is made about a foot below the surface. The earth excavated from these deeper tunnels is pushed to the surface in little piles, instead of in ridges. In any case the tunnels are made by digging with the front feet, and not by pushing the earth aside with the nose and back as is sometimes supposed. The greatest extension of the shallow tunnels is made in the spring when the earth is moist and soft and easy to dig. Later, a set of tunnels is made just below the first, and the earth excavated is pushed (with the front feet, not with the nose and back) into the upper set, which is no longer to be used. In this way the moles keep their tunnels at a level where the soil is moist and food is abundant. Moles do not hibernate; in the winter they work below the frost line.

Food.—The food of the star-nosed mole has never been studied in detail, but is probably similar to that of common moles. Common moles live almost entirely on earthworms and insect larvae, which they encounter in digging their tunnels or which enter the tunnels. Moles eat a little vegetable matter—mostly seeds that have been softened by the moisture in the ground—and some insects. The average amount of food eaten each day is about one third of the body weight of the animal.

Enemies.—Moles are nearly free from the natural enemies of most wild mammals because of their underground life and because of a taste or odor that seems to make them undesirable for food. Dogs and cats occasionally kill moles, but seldom eat them.

Control measures.—The best way to get rid of moles that are causing trouble is to trap them. Special traps are necessary; those used for other animals are of no use. Mole traps are of several types—spear or jaws or loop—but all operate on the same general principle. When noticed in a lawn, all the ridges should be pressed down either by stepping along them or by using a roller. This will largely prevent the grass being killed by drying where the ridges have been, and new ridges will be seen immediately. The next day on a new ridge press the earth down at one point to close the tunnel and set a mole trap there. The trigger should rest snugly against the ground at the point where the tunnel has been blocked. The trap should be sprung once or twice before it is finally set, to make sure that the soil is loosened and that there are no pebbles in the way that might interfere with the operation of the trap. The mole traveling along the tunnel pushes up the earth at the point where the tunnel is blocked, springs the trap, and is caught. As moles are generally useful except where the ridges they make are

undesirable, it is sometimes possible to drive them away from lawns and gardens by dropping a teaspoonful of paradichlorobenzine (a white, flaky substance resembling mothballs) into the tunnels at intervals of about 8 feet.

Shrews

Description.—The family of shrews includes the tiniest of our mammals. The length of head and body (not including the tail) of the common shrew is a little less than $2\frac{1}{2}$ inches; of the pigmy shrew and the little short-tailed shrew about $2\frac{1}{4}$ inches. The larger shrews of Minnesota are the black-backed shrew, with a head and body length of about 3 inches; and the short-tailed and the water shrew, each nearly 4 inches.

Shrews can be recognized by the long pointed snout, which is like that of the common mole. The front feet are normal (not greatly enlarged like those of moles), and except for their pointed snouts shrews are mouselike in appearance. The teeth are tipped with dark, reddish brown. The front teeth extend forward from the jaws; the upper front tooth on each side has a pointed cusp or projection at the base, and appears almost like two teeth.

Varieties and range.—Of the two kinds of short-tailed shrews of the state the larger form (*Blarina brevicauda*) is widely distributed and more or less abundant. The little short-tailed shrew (*Cryptotis parva*) is a more southern form; only a single specimen, taken at Homer, being recorded from Minnesota. In both these short-tailed shrews the tail is less than a third the length of head and body. The other shrews are long tailed, with the tail at least half as long as head and body. The common shrew (*Sorex cinereus*) is abundant throughout the state. The pigmy shrew (*Microsorex hoyi*) is usually slightly smaller than the common shrew, but cannot be distinguished by size or proportions or color. These two forms differ in the number of single-pointed teeth on the upper jaw between the large two-pointed incisor teeth and the broad back teeth. The common shrew has 5 of these; the pigmy shrew appears to have only 4, for the third is small and hidden by the second. Both these small shrews are sepia-brown above and ashy gray underneath. The pigmy shrew probably occurs in all except the southern and southwestern parts of the state, but is evidently much less abundant than the common shrew. The black-backed or saddle-backed shrew (*Sorex arcticus laricorum*), like the pigmy shrew, is a northern form not found in the southern or southwestern parts of the state. It is larger than the common or the pigmy shrew, and can be distinguished by the color. The back is dark brown (not actually black) and in strong contrast to the light yellowish brown of the sides. The water shrew (*Sorex palustris hydrobadistes*) occurs

throughout the greater part of Minnesota, but is scarce. It is not found in the most southern part of the state, and in the extreme north it integrades with a slightly larger form (*Sorex palustris palustris*). The water shrew is readily recognized by its large size and by the hind feet and toes, which are fringed with stiff hairs. This water shrew is almost white underneath in winter; the more northern form is almost white underneath all the year.

Economic importance.—Shrews may be set down as almost wholly harmless or useful. They live on worms and insects of the ground surface, and flesh of mice and other vertebrates in proportion to their ability to obtain it. The only shrews common enough to be of economic importance are the common and the short-tailed shrews. The short-tailed shrew, where it is abundant, is more important in the control of mice than all other natural enemies of mice combined. It is probably not swift enough to catch mice in the open, but hunts them persistently in their runways and burrows. A short-tailed shrew is more than a match for a field mouse considerably larger than itself. It is unfortunate that most people do not recognize their usefulness or distinguish them from mice, and so kill them on sight.

Habitat.—The private life of the water shrew is not well known. Apparently this animal lives at the edge of streams or pools and is as aquatic as a muskrat. Other shrews, at least the short-tailed and the common shrew, are much less restricted in their choice of habitat—less so than most other small mammals. They seem equally at home in fields or waste land or woods. They do not climb, and apparently burrow only slightly. The common shrew is less given to burrowing than is the larger, short-tailed shrew. Both animals require some shelter of leaves or grass.

Breeding habits.—The breeding habits of shrews are not well known. The short-tailed shrew probably has two or three litters a year, and the adults sometimes remain together in pairs throughout the year.

Other habits.—No species of shrew is known to hibernate. As they require large quantities of food, and as the smaller ones, especially, live almost wholly on worms and insects, the problem of winter food supply must be a serious one. Many insects are found hibernating under leaves at or just below the surface of the ground, and they probably form the bulk of the winter food of shrews. Shrews are quarrelsome and cannibalistic—at least in captivity. If a mouse and a short-tailed shrew are caught alive together in the same trap or put into the same cage, the mouse is sure to be killed and eaten. They are not strictly nocturnal, but prefer shade and cover for their activities. Their eyes are minute and probably useful only in distinguishing light from darkness.

Food.—It has already been mentioned that insects, worms, and mice form the principal food of shrews—most of the mice being eaten by the large, short-tailed shrews. Snails are eaten to some extent. The food is not adapted to storage, and usually no attempt is made to lay away a reserve supply. Vegetable food is eaten when animal food can not be had. A shrew can eat an average of one and one-half times its own weight per day. A shrew probably eats more in proportion to body weight than any other mammal.

Enemies.—Shrews of all kinds are killed by cats, dogs, owls, and weasels, but usually are not eaten. Their strong odor evidently makes them unpalatable.

Control measures.—Shrews are useful, and control measures against them are unneeded and undesirable except in rare cases. They are included in this list because they are often mistaken for injurious animals.

Bats

Description.—Six different kinds of bats occur in Minnesota. All are furry, mouselike animals with much elongated fingers on their front limbs, or wings. A membrane-like fold of skin extending from the arm and the long fingers along the side of the body forms the wing. When the wings are not in use they can be folded against the body. The wing, or flying membrane, extends to the hind legs, and is almost continuous with an interfemoral membrane extending between the legs and including all the tail except the very tip. The first finger of each front limb is not included in the wing, but remains as a claw. Another peculiarity is a little flap called the tragus, which partly covers the opening of the ear. The various kinds of bats are recognized by their size, color, teeth, amount of hair on the interfemoral membrane, and size and shape of ear and tragus.

It is not surprising that bats, with their ability to fly, should be less restricted in distribution than other mammals. The kinds of bats represented in Minnesota are not equally abundant, but all may occur in any locality, except that the red bat is not known in the extreme north-eastern part of the state.

Varieties and range.—The little brown bat (*Myotis lucifugus*) is probably, in most parts of the state, the one commonly seen flying in early evening in summer. It is about $3\frac{1}{2}$ inches long and has a wing spread of about 10 inches. It is dull brown above, slightly paler below. Another bat of the same genus (*Myotis subulatus*) is also known as a little brown bat, or Say's bat. The two species are similar in size, color, and general appearance and, so far as is known, their habits are similar. They can be distinguished on close examination by the fact that *M. subulatus* has a longer ear and a longer, more slender tragus than *M. lucifugus*. The ear of the former, when bent forward, ex-

tends beyond the end of the nose; that of the latter does not quite reach the end of the nose. In both these species the interfemoral membrane between the tail and hind legs is bare of fur.

The silver-haired bat (*Lasionycteris noctivagans*) is covered with sooty brown or black hair, tipped with white. The white is more conspicuous on the young. The basal third or half of the upper side of the interfemoral membrane is covered with fur continuous with that on the body. This bat is slightly larger than the little brown bats—about 4 inches long with a wing spread of about 11½ inches.

The big brown bat (*Eptesicus fuscus*) closely resembles the little brown bat in color, but can be distinguished by the larger size and by the fur on about the basal third of the upper side of the interfemoral membrane. It differs also in having 7 teeth on each side of the upper jaw instead of 9. The big brown bat is 4½ or 5 inches long, and the wing spread is about 12 inches.

The other two bats occurring in Minnesota belong to the genus *Nycteris*, and differ from those already mentioned in having the upper side of the interfemoral membrane entirely covered with fur. The red bat (*Nycteris borealis*) is of a conspicuous reddish orange color, and when seen plainly can not be mistaken. It is 4 or 4½ inches long and has a wing spread of about 12 inches, being intermediate in size between the silver-haired and the big brown bat. The hoary bat (*Nycteris cinerca*) is much larger than any of the others—5 or 5½ inches long, with a wing spread of 15 to 17 inches. The fur is a dull yellowish brown frosted with white, giving the animal a grayish appearance. The ears are nearly round and have a black rim. These descriptions make possible the identification of any bat occurring in Minnesota if it can be captured and closely observed. There is no way in which bats flying at night can be distinguished from each other except in a general way by their size and by previous observation as to what bats are likely to be present.

Economic importance.—Bats are useful and deserve to be protected. At present they have no legal protection. The United States species live entirely on insects. Altho detailed studies have not been made of the proportions of various kinds of insects eaten, it is reasonable to suppose that in destroying harmful insects bats compare favorably with insectivorous birds. In some southern cities bat towers have been built especially to provide homes for bats and encourage them. This is not practicable, as most of the towers are not occupied by colonies of bats. Much of the dislike and fear with which many people regard bats is due to ignorance or misunderstanding of their habits and usefulness. The widespread beliefs that bats tangle themselves in the hair and that they carry fleas and bedbugs are unfounded. Yet, apart from the unreasoning fear inspired in many people, these

animals may be annoying when they locate in the attic or between the partitions of a house.

Habitat.—The red bat and the hoary bat, particularly, are tree bats, making their homes in hollow trees, and are sometimes found in the daytime hanging head downward from low limbs. The other bats usually choose darker hiding places—in eaves or crevices or behind the loose bark of trees; and they are likely to be found in dark places in or around buildings. Bats flying at night are most frequently observed in the vicinity of streams or ponds.

Breeding habits.—The breeding habits of bats are not fully known. There is some evidence that mating takes place in the air, while the bats are flying. Bats are peculiar in the long time that intervenes between the mating (which takes place in summer) and the beginning of development of the young (the following spring). The young of some bats, and perhaps of all, are born in June—well developed but without hair. There are usually two young at a birth, sometimes one, sometimes more than two. The female apparently does not build a nest for herself or for the young. Even very young bats can cling tightly to their mother, and are carried when she goes on nightly insect-hunting trips. At other times they may be left hanging head down in some hiding place while the mother goes for her meal of insects. At this season the males apparently are not associated with the females. The young bats develop very rapidly and are able to fly when three or four weeks old.

Other habits.—Bats remain quiet and more or less hidden in dark places during the day. During an hour or two of early evening twilight, and for a corresponding period just before daylight in the morning, they leave their hiding places in search of the insects on which they feed. The different kinds of bats appear in a more or less regular succession, the larger bats flying when it is darker. When winter comes, bats have an advantage over other mammals. They fly to a warmer climate as do birds. Some remain behind and hibernate instead of migrating. The big brown bat, in particular, sometimes appears in houses in cold weather—aroused from hibernation when the building is overheated. As fliers, bats excel many birds. A bat can carry half-grown young, which together weigh as much as the adult, and yet fly and dodge quickly enough to catch insects in the air. They probably do not swim voluntarily, but bats that are shot and fall into water can swim well. Bats have a peculiar sensitiveness—perhaps an extraordinarily developed sense of touch—quite unlike anything known to man. It depends apparently on an extremely delicate discrimination of vibrations reflected from near-by objects. A bat with eyes covered can fly about a room as well as if it could see, and can even avoid obstacles placed suddenly in its path.

Food.—Bats feed on insects that fly at night. As they chew their food thoroly what has been eaten is not easily determined. Moths, beetles, and mosquitoes are probably eaten in considerable quantities. The smallest insects are caught directly in the mouth; larger ones are caught in the interfemoral membrane, used as a scoop. The smaller bats sometimes fly into houses at night in pursuit of insects. Bats do much of their hunting over bodies of water. They drink by skimming along the surface and scooping up water in their mouths.

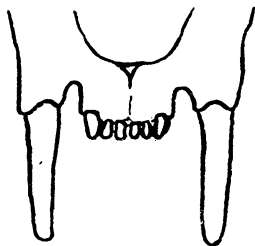
Enemies.—Compared with most other mammals, bats are relatively safe from natural enemies. When inactive, they are usually well hidden; when flying, they are much too swift for most of the birds that would like to feed on them. Owls occasionally capture one, and probably other enemies rarely catch a bat asleep.

Control measures.—Bats are ordinarily harmless and useful. Wherever they cause any real annoyance by living in buildings, they can easily be kept out by screening the openings when they leave in the evening to hunt for insects. They do not stay permanently in the building as mice and rats do.

SMALL FLESH EATERS

The flesh eaters, or carnivores, of Minnesota include a larger number of species than any other group of mammals except the rodents. They range in size from the smallest weasel to the bear. The former, when full grown, is smaller than a meadow mouse; the latter is exceeded in size only by the moose. The flesh eaters are better known than the animals already discussed. The arrangement of their teeth is characteristic and is suited to their food habits. There are 6 small

front teeth, or incisors, in each jaw, and a prominent pointed canine tooth on each side behind the incisors. Behind the canines are the premolars and molars—sharp-edged cutting teeth and more flattened crushing teeth. The crushing teeth are best developed in such animals as the bear, which is omnivorous rather than strictly carnivorous. Nearly all the most valuable fur animals are flesh eaters. Aside from their value as fur producers, these animals are injurious or beneficial according to



Upper Front Teeth of the
Cat

their food habits. Species that feed mainly on livestock and game animals are to that extent injurious and must be controlled; those that feed mainly on rodents and insect pests may be even more useful for their food habits than for their pelts.

Skunks

Varieties.—The skunk is best known by its unfragrant reputation, which is for the most part undeserved; that is, its actions are by no means as objectionable as its well-known scent. Two kinds of skunks occur in Minnesota—the large northern skunk (*Mephitis hudsonica*) and the little spotted skunk (*Spilogale interrupta*). Both are black and white, but the distribution of the colors is different.

Description.—The northern, or striped skunk (*M. hudsonica*), is the common well-known species and occurs through the state. It has a narrow white line from the tip of the nose to the top of the head. A white stripe extends back from the neck, divides just behind the shoulders and passes along each side of the back, reaching nearly to the tip of the tail. The rest of the fur is black—glossy black in winter and slightly brownish in summer. The little spotted skunk is black with a small white patch on the forehead and with four parallel white stripes lengthwise on the back. These white stripes are not continuous, but are broken up into spots, hence the technical name. Sometimes this skunk is almost entirely black, with only a few inconspicuous white spots. The little spotted skunk occurs only in the southeastern part of the state, but its range seems to be extending northward. The first record of its occurrence in Minnesota was in 1904. The two kinds of skunks differ in size and general body conformation, as well as in color pattern. The adult male striped skunk is about 29 inches in total length; the spotted skunk is about 20 inches. In both species the females are considerably smaller. The tail is about two-thirds the length of the head and body, tho this ratio is variable. The striped skunk is a thick-set, heavy-bodied, slow-moving animal, unlike the more typical members of the weasel family; the little spotted skunk is smaller, more slender, more active, and can even climb to some extent.

Economic importance.—The skunk is of outstanding economic importance because of its fur and its food habits. It is protected except for an open season from November 15 to March 1. Altho skunk skins are relatively low priced (nearly always less than \$5), in total value of fur, skunks are exceeded only by muskrats. This order of value is for the United States as a whole. In Minnesota, the total value of fur of minks and of muskrats usually exceeds that of skunks. Because of the low value of the pelts, skunks are not used to any great extent in fur-farming. In their food habits skunks are for the most part highly beneficial. Their useful habits are not generally enough known, and their bad or supposedly bad habits are well advertised. The food of skunks consists chiefly of insects, field mice and other rodents taking second place. The insects and mammals on which they chiefly feed are some of the principal enemies of agriculture—grasshoppers, army

worms, and white grubs. Occasionally a skunk will establish itself under a building until it has exterminated all the rats and mice in the building. The "scent gun" is not used unless the skunk is disturbed.

The charges against the skunk are that it eats poultry, the eggs and young of ground-nesting game birds, and bees. Skunks may do all this, but the damage is unusual and easily prevented. As common skunks can not climb, poultry shut up at night are safe. Raiding poultry yards is a habit not acquired by most skunks, even when the poultry are not protected. During the nesting season of game birds, skunks have plenty of other food and are not likely to bother the nests. Cases are on record of game birds having nested and reared their young in the immediate vicinity of skunk dens without any loss from skunks. Sometimes a skunk will eat nearly all the bees in a hive. It scratches on the front of the hive at night and, as the bees come out, rolls them under its paws and eats them. The few stings it receives seem to be no great discouragement. Hives placed on stands instead of on the ground are out of reach of skunks, and safe from them.

The damage done by skunks is only slight and occasional as compared with their constant usefulness. To class such useful animals as "vermin" and to wage war upon them in the name of "conservation" is unfortunate.

Habitat.—The burrows in which skunks live probably more often than not have been made and formerly occupied by woodchucks. Skunks can make their own dens, but prefer a ready-made shelter if one is to be had. The hollow trunk of a fallen tree or the space under a building will do as well as a hole in the ground. Skunks are not notable for shyness, and neither in the location of a den nor in their leisurely wanderings do they make any effort to avoid human habitations.

Breeding habits.—Breeding habits of skunks, and possible differences in different regions or with different species, are not known in detail. Skunks may be by nature monogamous, tho in captivity they are exceedingly polygamous. Striped skunks mate the last of February or the first of March, and the young are born late in April or early in May. They are about the size of a mouse at birth, are almost hairless, but show sharply the color pattern they are to have. There is only one litter per year, averaging 4 to 6 young. The young are practically full grown by fall.

Other habits.—By far the best known and most interesting habit of the skunk is the use of its peculiar weapon of defense. The two scent glands open by papillae into the rectum close to the anus. A skunk can project these papillae and can shoot the charge of musk accurately in any desired direction without changing the position of the head and front feet. A warning signal that can be readily observed

and which should be regarded is the position of the tail. When the musk is about to be discharged, the skunk's tail is held rigid and bent as far forward over the back as possible. Baby skunks will assume the posture of "musking" before they are old enough to have any musk to emit. Musk is ejected by the action of muscles enclosing the scent glands. The two thin jets of liquid break up into a fine spray before reaching the object of attack, and may reach as far as 20 feet. The skunk delays the discharge until sure of making a direct hit. The odor spreads, and may be strong enough to defile clothing beyond the effective range of the spray.

Skunks are nocturnal, only rarely moving about in daytime. They are not aquatic, tho like most other mammals they can swim if necessary. The skunk family keeps together during the summer, hibernates together during the severest part of the following winter, and separates the following spring.

Food.—The principal items of the skunk's food have been mentioned in connection with its economic importance. Skunks hibernate during the severest part of winter, mainly January and February, when insects, field mice, ground squirrels, and the like are unobtainable. When the skunk emerges from hibernation it is still fat but quickly becomes thin, as there is still some time before its favorite foods become abundant. A skunk could hardly catch a rabbit in the open, but probably succeeds in trapping an occasional one in a burrow.

Enemies.—The skunk is about as safe from attack as any wild animal. Like the porcupine, it moves deliberately about its business, needing neither speed nor sharp wits, secure in the assurance that its rights will be respected. It is able to teach almost any would-be assailant the wisdom of leaving it alone. Perhaps an occasional fox or bobcat or owl, if desperate with hunger, might succeed in killing a skunk; but successful attacks on skunks, by wild birds or animals of any sort, must be exceedingly rare.

Skunks are occasionally victims of automobiles; some are killed for frequenting poultry yards, and many are trapped for their fur.

Control measures.—In view of the usefulness of skunks in insect and rodent destruction, and of their importance as fur producers, it is a serious economic waste to destroy them when the fur is unprime except in the case of animals raiding poultry yards or otherwise definitely known to be doing damage. They are unsuspecting, and can easily be trapped.

Weasels and Minks

Description.—The most blood-thirsty and aggressive of the flesh eaters are the weasels. The mink (*Mustela vison letifera*) is merely a large species of weasel. Like the other three species of weasel occur-

ring in Minnesota, it is a long-bodied, short-legged, fierce, and active fur-bearer. The Minnesota long-tailed weasel (*Mustela longicauda spadix*) may be recognized by its large size (up to 18 inches for an adult male) and by the fact that the tail is slightly more than half the length of head and body. The common or short-tailed weasel (*Mustela cicognanii*) is smaller (11 inches for the adult male) and has a tail slightly less than half the length of head and body. The ranges of the two species overlap considerably, but the long-tailed weasel occurs mostly in the southern part of the state and the common weasel mostly in the northern part. Both species can be distinguished from the least weasel (*Mustela rixosa*) by their larger size and by the black tip on the tail. The least weasel is only 6 inches long; the tail is only one-fourth the length of head and body, and is without a black tip. The least weasel is not as big as a meadow mouse, and is the smallest of our carnivores. It occurs in the northern part of the state, but is less common than the larger species. The mink reaches a length of 26 inches; the proportion of length of tail to that of head and body is about the same as in the long-tailed weasel. The mink is brown, with white spots on chin, throat, and breast. In the extreme northern part of the state, the common Mississippi Valley mink (*M. vison letifera*) is supposed to intergrade with two darker forms—the eastern mink (*M. vison vison*) in the extreme northeast, and the Hudson Bay mink (*M. vison lacustris*) in the northwest. Minks do not show a seasonal change in color. The true weasels (aside from the mink) in this climate become white in winter except for the black tip of the tail. The least weasel becomes entirely white. In summer all three species are dark brown above; the underparts are white in the least weasel, white with a yellowish tinge in the common weasel, and light yellowish brown with white on lips and chin in the long-tailed weasel. The white winter coat of the common weasel has a yellow tinge on rump, tail, and underparts. The long-tailed weasel has a little yellow on the tail; in both the tip of the tail is black. In none of these species is any difference in color evident between males and females. The females are distinctly smaller than the males.

Economic importance.—In Minnesota, minks are usually second only to muskrats in total value of fur production. Weasels and minks are unprotected by game laws. Minks are relatively abundant, and the best pelts occasionally being \$40 or more. The variety of mink (*letifera*) occurring throughout most of Minnesota is characteristically light-colored and the pelts are less valuable than the darker ones. Weasels are more abundant than minks (except the least weasel), but are of only minor importance as fur producers. The business of fur farming with minks is growing rapidly.

The economic status of minks and weasels depends as much on their

habits as on the value of their fur. They can successfully attack animals considerably larger than themselves. Weasels, especially, when opportunity offers may kill recklessly, many times more than they require for food. The mink is semi-aquatic, and the damage it does corresponds with this characteristic. It is the most important natural enemy of the muskrat. It catches fish. It does a great deal of damage to water fowl, especially during the nesting season. It may do extensive damage in poultry yards, sometimes killing the entire flock—especially if the poultry yard is near a body of water. The mink eats relatively few injurious rodents, and its useful habits do not balance its injurious ones.

Weasels are of mixed importance from the standpoint of their food habits. They are terrestrial, without aquatic tendencies. The smaller ones live mainly on insects and mice; the larger ones on mice, ground squirrels, gophers, and rabbits. Weasels are admirably fitted by their slender forms to follow rodents along their runways and burrows, and are among the most important agencies in keeping down their numbers. Their diet is not confined to injurious rodents; they destroy birds and birds' eggs, and occasionally raid poultry yards. Instances are recorded of their having exterminated rats and mice around farm buildings without molesting the poultry—but a poultry owner would hardly be safe in trying that experiment. Both weasels and minks can climb, but usually do their hunting on the ground.

Breeding habits.—Weasels and minks mate in early spring, and produce one litter of young. The breeding habits of weasels are not known in detail, but probably are not greatly different from those of minks. Many points as to the breeding habits of minks have been learned from animals kept in captivity on fur farms. There are three brief periods, about ten days apart, when the female will mate. At other times she will usually show a strong aversion to the male. The gestation period is ordinarily 42 to 43 days, altho in some cases it is considerably longer. On an average there are about 5 young to a litter. The young are born in late April or early May. They are hairless and blind at birth, and about the size of a man's little finger. When they are about 3 weeks old they begin to suck at solid food brought to them by the mother. At about 4 weeks their eyes open, and at six weeks they appear outside the den. They hunt with their mother for a time, but leave her before the end of the summer. By the first winter they are practically full-grown, and will breed the following spring.

Other habits.—Weasels and minks have scent glands somewhat similar to those of the skunk, but are unable to aim the discharge as the skunk does. They are great travelers, and solitary. They have

simple burrows, which they make or appropriate. They may stay in one place as long as the hunting is good there, and then move on. They do not hibernate, and store little food. Of the flesh eaters occurring in Minnesota, only skunk, badger, raccoon, and bear hibernate.

Food.—The food habits of minks and weasels are an essential feature of the economic importance of these animals, and have been mentioned under that heading. Except for the crayfish, sometimes eaten by minks, practically all the favorite foods of minks and weasels are of economic significance.

Enemies.—Neither weasels nor minks have important natural enemies. One may occasionally fall victim to a large owl or hawk. According to the experience of fur farmers, there is some loss through disease. Perhaps the most important reason why they do not become more abundant is that when opportunity offers they fight and kill each other. Fur farms suffer occasional losses from killing when a male and a female are put together during the mating season; at any other time this would mean almost certain death of one or both.

Control measures.—The destructive habits of minks require that their numbers be kept moderately low. Unless they are doing particular damage they should be trapped only in the season when the fur is prime. As weasels are capable of doing much good by destroying rodents as well as much harm in other ways, it is not practical to make any special effort to trap them except where individuals are doing particular harm. Weasels are bold and are more easily trapped than minks.

LARGER FLESH EATERS

The flesh eaters yet to be mentioned include two members of the weasel family that are fairly common in some localities—the badger and the otter; and three that are extinct or scarce in this state—the wolverene, the marten, and the fisher; also the raccoon, the black bear, two kinds of wild cats, two kinds of foxes, and two kinds of wolves. As these larger flesh eaters are, in proportion to their numbers and economic importance, better known than the other groups of mammals, relatively less space has been devoted to describing their habits. Sufficient description is given in each case for identification.

Badgers

Description.—The badger (*Taxidea taxus*) is limited chiefly to the plains region of the state. In some places it is still fairly common, but is becoming less so. Its markings and flattened form distinguish it from other mammals. The general color is a pepper-and-salt effect of grizzly gray. The head is black, with a white stripe from muzzle to shoulder and white patches beside the eyes and on the ears. The feet



The Badger Can Readily Dig Out Ground Squirrels But Is Not Fast Enough To Catch Them in the Open

are black. The total length of a full-grown specimen is about 28 inches. The tail is only one-fourth the length of head and body. The badger can not climb and is a clumsy runner. It is an extraordinarily powerful and rapid digger, and lives mainly on ground squirrels, which it captures in this way. The badger continues to dig up ground squirrels in the fall after the latter have gone into hibernation. It thus becomes very fat. When the ground freezes and becomes too hard for digging, the badger itself hibernates until the following spring. In their food habits badgers are extremely useful, even tho one will occasionally take a chicken. The holes made by badgers in digging after rodents are less important than the destruction of the rodents. Badger pelts bring about \$50 as a top price, but are not considered valuable enough to justify their production on fur farms.

Otters

Description.—The otter (*Lutra canadensis*), like the beaver, was once an important fur animal of the state, was nearly exterminated, was then given strict protection, and has since increased in some localities. In Minnesota otters are fully protected by law at all seasons. The otter is weasel-like in form, but much larger. The total length is about $3\frac{1}{2}$ feet. The tail is half the length of head and body and is considerably thicker at the base than the tails of most other mammals. The feet are webbed. The color is dark, glossy brown—a little lighter underneath but without definite markings. The otter is more truly aquatic than the muskrat and the beaver. It does not build its home in open water as they do, but is a much better swimmer. The otter can outswim and catch most kinds of fish, and lives chiefly on them, altho it eats various other animals found along the shores it frequents. The economic importance of the otter depends on its destruction of fish and on the very considerable value of its fur. Otters are more intelligent and more readily tamed than minks or weasels. They are not raised on fur farms because they do not breed regularly in captivity. They are extensive travelers, usually following streams or lake shores. The den is made in a bank, with the opening under water. They are active and powerful enough to avoid or resist the attack of any animal except man.

Wolverenes

Description.—The wolverene (*Gulo luscus*) is the most powerful and most hated member of the weasel family. In the early history of Minnesota the skins of the wolverene or "carcajou," as it was called, had a regular tho minor place in the fur trade. The animal has been nearly extinct in the state for several years, tho a specimen was reported taken in the extreme northern part of S^t. Louis County in 1918.

The total length is slightly more than 3 feet, the general form is stocky and bearlike, the color is dark brown or nearly black, with broad bands of lighter color on the sides, across the forehead, and on the chest. The tail is about 8 inches long to the last bone, with long hairs. The wolverene is sometimes called "glutton," a name that it well deserves. It can kill almost any animal it can catch. Its most objectionable habit is the systematic destruction and robbing of trap lines, and raiding caches of provisions. It shows much intelligence and is difficult to trap.

Martens

Description.—The marten (*Martes americana*) is another member of the weasel family that is believed to be extinct or very scarce in Minnesota. Martens are weasel-like in form. Adult males are about 2 feet in total length, females a little smaller; the tail is about half the length of head and body. The color is a nearly uniform rich yellowish brown, somewhat darker on legs and tail, with less of a yellow tinge underneath, and with a bright buff area on throat and chest.

Habits.—The marten is a tree-dweller to a much greater extent than any other member of the weasel family except the fisher. As its range is limited to northern or coniferous forest areas it is naturally called "pine marten." It is so active that it can catch a squirrel in a tree. It feeds also on birds and rodents, caught on the ground. It is a valuable fur-bearer, related to the Russian sable. The better pelts bring \$100 or more. Martens have not been raised much on fur farms because of the difficulty of getting them to breed in captivity. The mating season is in August, the gestation period is 8 or 8½ months, the young being born in April. This is in sharp contrast to other members of the weasel family, in which the gestation period is much shorter.

Martens are secretive and are seldom seen, but they are readily trapped. They are among the first animals to leave a locality as settlers come in. Because of the high value of the fur the disappearance of this species from the state is regrettable.

Fishers

Description.—The fisher (*Martes pennanti*) is an extra large marten. It, too, is a tree-dweller, so active that it can catch even the pine marten. As it eats much the same kind of birds and mammals as the marten, the name "fisher" is inappropriate. Probably this animal still exists within the state, altho it is notably scarce. The fisher and marten are now given complete protection under the game laws. The total length of a male fisher is about 3 feet, the tail being two-thirds

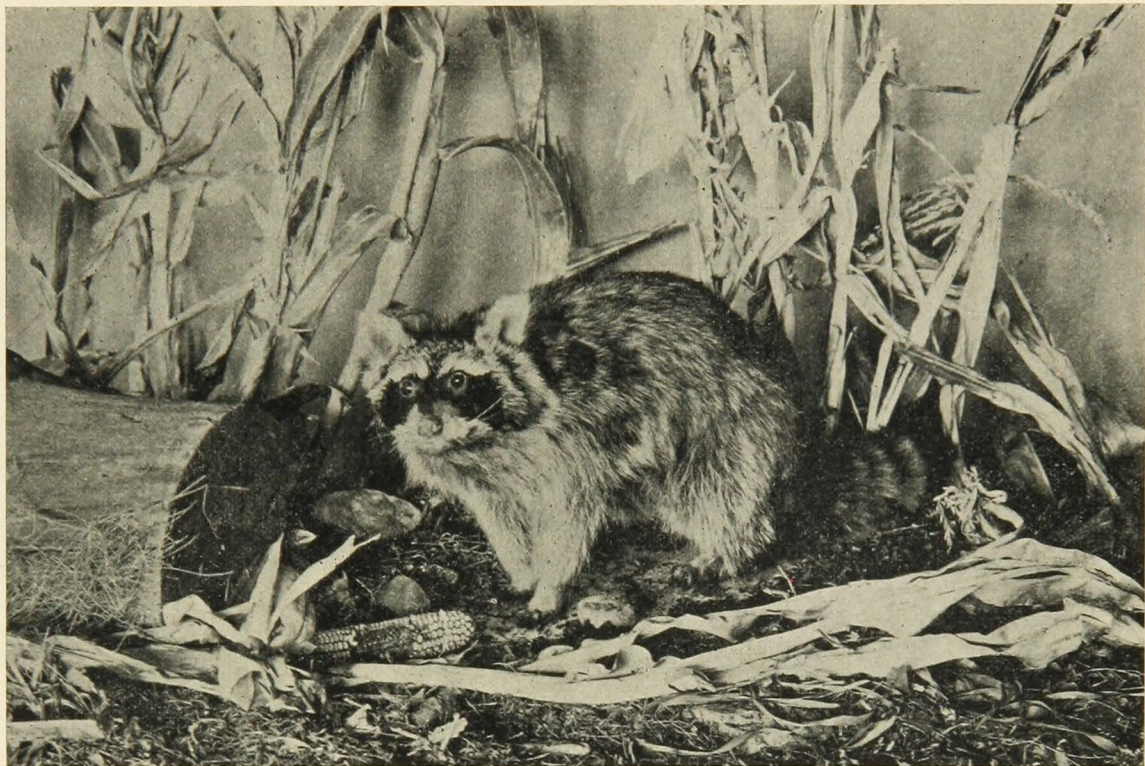
the length of head and body. The female is smaller than the male. The general color is dark brown, which may be nearly black, darkest on nose, back, tail, and legs. The fur of the fisher is higher priced than that of any other Minnesota animal except the silver fox. The better pelts bring \$200 to \$300. Fur farming of fishers has been delayed, as the animals do not breed readily in captivity. According to breeders the mating period is in February and March, and the young are born 60 to 65 days later. This is surprising in view of the different breeding habits reported for the marten.

Raccoons

Description.—The raccoon (*Procyon lotor*) belongs in a family by itself. The flesh eaters already considered belong to the weasel family. The raccoon is readily recognized by the 5 or 6 dark rings on its tail, by its rather stout body, and by the black mask across its eyes. The adult is about 2½ feet in total length, the tail half the length of head and body. The general color is a grizzled mixture of gray and brown and black, familiar on coonskin coats. Raccoons range throughout practically the entire state, but they are becoming increasingly scarce. They are protected except for an open season from October 15 to November 15. Their favorite habitat is wooded regions where large hollow trees are available as dwelling places, and in the vicinity of streams or other bodies of water. The diet is much more varied than that of most flesh eaters—they eat frogs, crayfish, fish, rodents, birds and birds' eggs, fruits, nuts, and a wide variety of other kinds of food both plant and animal. Their fondness for corn in the "milk" stage is especially well known. The skin is of moderate value, intermediate between that of skunks and minks. Raccoons are raised on fur farms to some extent. They are not difficult to raise, tho the lower value of the fur and the larger size and greater appetite make them less popular than minks. Raccoons become very fat in the fall and hibernate during the coldest part of the winter. They mate usually in February. The young average about 4 to the litter and are born in April or May.

Bears

The black bear (*Euarctos americanus*) is the largest of the flesh eaters occurring in Minnesota, but judged either by the teeth or by food habits it is less typically a flesh eater than most of the others. It is readily distinguished from other mammals by size, body form, color, and apparent absence of tail. It is of thick, stocky build with large, flat feet and a uniform black color (sometimes dark brown) except for a brown muzzle and sometimes a white spot on the breast. The length of a full-grown bear is about 5 feet, and the inconspicuous



The Raccoon's Fondness for Corn Is Well Known

tail is only about as many inches. Bears are occasional throughout the wooded portion of the northern half of the state. They eat ants, bees, and honey, any birds and mammals they can catch, grass, vegetables, nuts, berries and other fruits, fish, sometimes animals that they find dead, and almost any other food. They raid the provisions of campers, and sometimes kill pigs, sheep, and other livestock. They are capable of doing considerable damage, but actually do very little. There seems to be no truth in stories of their unprovoked attacks on human beings; in many cases bears go to some trouble to avoid meeting people. The bear is one of the most interesting of the larger animals remaining in the state and should not be recklessly destroyed; it is equally important that there be no restrictions on the killing of bears doing damage. Bears are now protected except for a fall open season coinciding with the deer hunting season in even-numbered years; and a spring open season from April 15 to May 15 in odd-numbered years. Permits can be obtained at other times to kill bears that are doing damage.

The black bear can climb trees, but spends most of its time on the ground. The mating season is in June or July. The adults are usually not together except at that time. Bears become very fat in the fall, and with the coming of cold weather and the failure of their food supply they choose sheltered places for the winter. Adults do not den together. Partly grown cubs may den with their mother. The young (usually 2) are born in January—naked, blind, and helpless but by the time the mother is ready to leave winter quarters they can follow her around.

Wild Cats

Description.—Two kinds of wild cats occur in Minnesota, the smaller bobcat (*Lynx rufus*), and the larger Canada lynx (*Lynx canadensis*). Both are distinctly catlike in appearance, much larger than a common house cat, with a mere stump of a tail, a definite tuft of stiff black hairs at the tip of each ear, a ruff of long hair at each side of the neck, and extra large feet. The total length is about 3 feet, the bobcat being a little smaller than the Canada lynx. The females are smaller than the males. The larger species has the shorter tail—that of the Canada lynx being about 4 and of the bobcat about 7 inches. The tip of the tail of the former is black, that of the latter is black only on top. The ear tufts of the Canada lynx are long, nearly the height of the ear; those of the bobcat are shorter, only long enough to make the ear appear pointed. The general color is brown, grayish brown in the Canada lynx, yellowish or reddish brown spotted and streaked with dark brown or black in the bobcat. The underparts are lighter than the back in both species.

Habitat.—Both species are sparsely distributed over the wooded portion of the northern half of the state. The bobcat formerly was much more abundant than the Canada lynx, but both have become scarce. According to trappers' reports, more Canada lynxes than bobcats have been taken in recent years; possibly some bobcats were reported as Canada lynxes. Both species are large and powerful, living mainly on rabbits and other rodents, and birds. A lynx can kill a fox and possibly still larger animals. It is not known to make unprovoked attacks on man. One respect in which these animals differ from the common house cat is that they produce only one litter of young a year, instead of several.

House Cats

Along with the wild cats may be mentioned the common house cat (*Felis domestica*). Large numbers of common cats depart from civilized ways and live in woods and fields. They are immensely destructive to birds, and lack the desirable qualities of rodent destruction and fur value characteristic of most flesh eaters.

Pumas

Another true cat, much larger than the lynx, formerly existed in Minnesota but has long been extinct. This is the puma, cougar, or mountain lion (*Felis couguar*). What is perhaps the last record for the state was of an individual killed in 1875, in Chisago County. An adult puma is 8 feet long, the tail being slightly less than half the length of head and body. The color is dull, yellowish brown above, lighter underneath. These large cats preyed on big game and livestock as well as on smaller animals. A few instances are on record, from other states, of pumas killing children.

Red Foxes

Description.—Foxes and wolves are doglike in structure and appearance. Two species of red fox occur in Minnesota, the eastern red fox (*Vulpes fulva*) and the prairie red fox (*Vulpes regalis*). They differ chiefly in size, but there are color differences also. The prairie fox, which is larger, is about 44 inches from nose to tip (of bony part) of tail; the eastern fox, about 40 inches. In both species the female is a little smaller than the male. The tail is about three-fifths the length of head and body. The general color is golden yellow, ears and feet are black, and underparts and tip of tail white. The black areas are larger on the eastern fox than on the prairie species. The eastern fox has a black spot on the upper side of the tail near the base, which the prairie fox lacks.

Varieties and range.—The prairie red fox was described from

Elk River, and extends westward from there. Its range is not well known, but probably includes most of the prairie regions of the state. The range of the eastern red fox extends into the northeastern and southeastern parts of the state and probably overlaps that of the prairie species.

The cross fox and silver fox are merely color varieties of the red fox. The cross fox has a dark band across the shoulders, which, with the darker marking along the back, forms roughly a cross-shaped figure. The silver fox is entirely black except for the white tip of the tail and the silvering of some of the hairs of the back. The silver fox, in particular, is scarce in the wild, but is raised extensively on fur farms. Red foxes are not particularly abundant, but have been fairly successful in maintaining themselves in moderate numbers even in thickly settled districts. Red foxes are unprotected by game laws, except for the provision that cubs shall not be dug out from dens or be shipped out of the state. A red fox was reported shot twelve miles south of Minneapolis on October 21, 1928.

Gray Foxes

Description.—The Wisconsin gray fox (*Urocyon cinereoargenteus ocythous*) occurs in Minnesota only along the southern part of the eastern border of the state. It is intermediate in size between the two species of red fox. This gray fox is strongly marked with yellow on the sides but can be definitely distinguished from the red fox by the black or gray of the back and by the lack of a white tip to the tail. The upper tail hairs are stiff, without a soft underfur.

Habits.—The gray fox is destructive to game birds in the wild life refuge along the Mississippi River in the southeastern part of the state. Both red and gray foxes rely chiefly for food on mice, rabbits, and other rodents; tho when opportunity offers they take birds—either wild birds or poultry. The pelt of the gray fox is of little value, that of the red fox is worth up to \$50 for the best, but does not compare in value with that of the silver fox. The red fox combines boldness with cunning and is notably difficult to trap or shoot. The gray fox is less accomplished in these respects, but it has a limited ability to climb trees. Foxes normally pair, tho some in captivity are polygamous. The gestation period is 51 days, at least for the red fox. The average in a litter is 4, tho it may be more or less. The home is a burrow, either dug by the adult foxes or adapted from the burrow of some other animal.

Wolves

Description.—Two species of wolves are found in Minnesota, the coyote, or brush wolf (*Canis latrans*), and the timber wolf (*Canis*

nubilus). Wolves may be distinguished from foxes by the larger size (alho a small coyote is hardly larger than a large fox), and by the lack of reddish brown or yellow on the sides of neck and body. Less conspicuous differences concern the tail hair, the eyes, and the teeth. Wolves differ from red foxes in lacking the white tail-tip, and from gray foxes in having soft underfur along with the stiff hairs of the tail. The pupils of the eyes are round in wolves, elliptical in foxes. The front teeth of wolves are three-lobed, as in dogs; in foxes the lobes are indistinct or absent.

Varieties and range.—Wolves are so much like dogs that they might readily be mistaken for them. The general color is gray sprinkled with black, becoming yellowish white underneath. The color is variable, and there is no dependable difference between the coyote and the timber wolf. The two species can be distinguished only by size. The total length of the brush wolf or coyote is about 4 feet; of the timber wolf about 5 feet. Weights vary considerably, but do not overlap; the weight of the coyote is about 30 pounds, that of the timber wolf about 100 pounds. The length of the hind foot, from the tip of the longest claw to the hock, is less than 9 inches in the coyote and more than 9 inches in the timber wolf. Wolves still persist throughout most of the state, tho in reduced numbers. Coyotes are not known in the extreme northeastern part of the state, and timber wolves are most abundant in that region; both occur in considerable areas of the state. All the timber wolves, and probably much more than nine tenths of all the wolves of Minnesota are in the northern half of the state, tho occasionally a coyote is reported killed in the southern half. Several of these smaller wolves have been killed in Hennepin County in the last few years; in the summer of 1925 one was killed with a club in a chicken coop. In April, 1927, a litter of 10 was dug out of a den in Wabasha County.

Wolves are the only animals on which a bounty is offered by the state. The bounty on a full-grown wolf (either species) is \$15; on a young one, \$5.

Economic importance.—Wolves are important chiefly as destroyers of game and livestock. In some parts of the state they have been an important factor in limiting sheep raising. They are the most important natural enemy of the deer.

Habits.—Brush wolves and to a lesser extent timber wolves feed also on injurious rodents, but this does not balance their harmful habits. The coyote is a faster runner than the timber wolf. Either is faster than most dogs and is more than a match for any dog that can catch it. Wolves are the only flesh eaters in this country that co-operate noticeably in hunting. They take turns in chasing an animal to tire it out, or unite in attacking an animal that would be more than a match for one.

Usually only one pair or one family of coyotes are associated. Two or three families of timber wolves may join together in winter for hunting. The den used during the breeding season is usually dug by the parents. The gestation period is probably 63 days, as in domestic dogs. The young are blind at birth and have a coat of soft fur. An average litter is 4 or 5; 10 is an unusually high number. There is only one litter of young a year. Wolves are highly intelligent, and as they become better acquainted with man and his ways, they become increasingly hard to trap or poison.

REFERENCES

The following periodicals and books are recommended to those who wish to study further the lives and habits of our native wild mammals:

Periodicals

Fins, Feathers, and Fur—St. Paul, Minn.

A monthly publication of the Minnesota Game and Fish Department. Usually contains some notes on mammals.

Journal of Mammalogy—Baltimore, Md.

Published quarterly by the American Society of Mammalogists. Consists entirely of articles and notes on mammals. The most important papers on Minnesota mammals, published in this journal, are: Cahn, A. R.

1921. Mammals of Itasca County, Minnesota. Vol. 2, pp. 68-74.

Johnson, C. E.

1922. Notes on the Mammals of Northern Lake County, Minnesota. Vol. 3, pp. 33-39.

Bailey, Bernard.

1929. Mammals of Sherburne County, Minnesota. Vol. 10, pp. 153-164.

Books

Anthony, H. E., *Field Book of North American Mammals*. G. P. Putnam's Sons, New York. 1928

An illustrated handbook with description and brief notes on the habits of every species. It does not include a key, but has an index.

Bailey, Vernon, *A Biological Survey of North Dakota*. U. S. Dept. of Agr., North American Fauna No. 49. 1926

An excellent account of the mammals of an adjoining state, with notes on occurrence, habits, and economic status. (Other numbers of the series are of interest as detailed studies of separate groups of mammals.)

Cory, C. B., *Mammals of Illinois and Wisconsin*. Field Museum of Nat. Hist. Pub. 153. 1912

Of special interest, as the mammals of western Wisconsin are in most cases the same as those of eastern Minnesota.

Herrick, C. L., *Mammals of Minnesota*. Minn. Geol. and Nat. Hist. Survey Bull. 7. 1892

Contains much information, particularly on anatomical details and classification. In technical names and distribution of species, the book is obsolete.

- Nelson, E. W., *Wild Animals of North America*. National Geographic Society, Washington, D. C. 1918
A particularly well illustrated account.
- Pratt, H. S., *Manual of the Vertebrates of the United States*. P. Blakiston's Son & Co., Philadelphia. 1923.
A key for the identification of mammals and other vertebrates (except birds).
- Seton, Ernest Thompson, *Life-Histories of Northern Animals*. Chas. Scribner's Sons, New York. 1909. (Two vols.)
Mainly mammals of Manitoba. The most comprehensive account available on wild animal habits and behavior.
- Stone, W., and Cram, W. E., *American Animals*. Doubleday, Page, & Company, New York. 1902
A popular guide to mammals; interestingly written and well illustrated.

APPENDIX

Types of Damage Done by Mammals with Suggestions as to Animals Most Likely to Be Responsible

- Damage due to burrowing
- Earth pushed up in more or less continuous ridges, especially in lawn or garden.....common moles
 - Several mounds of earth (sometimes a half bushel or even more) without openings into tunnelspocket gophers
 - Mounds of earth with open burrows in cultivated fieldswoodchucks or skunks
 - Burrows under floors and foundations of buildings..common rats
- Damage to stored foodstuff
- Almost entirely due tocommon rats
house mice
 - In camps, provisions are sometimes raided by.....bears
porcupines
- Damage or annoyance due to presence in buildings
- Gnawing of doors, floors, partitions, etc.....common rats
house mice
 - Fire hazard from inflammable nest material,
gnawing of electric insulation, matches, etc....common rats
house mice
 - Disturbance or annoyance caused by seeing or
hearing animals in buildingcommon rats
house mice
flying squirrels
bats
 - Annoyance from animals dying in building.....house mice

Damage to trees and shrubs	
Gnawing or cutting roots	pocket gophers
Gnawing bark of base of trunk	field mice
	rabbits
Cutting shrubbery and low twigs	rabbits
Stripping bark high on trunk	porcupines
Cutting growing tips high in tree	red squirrels
Cutting trees	beavers
Damage to planted seeds and grain	
To plantings of tree seeds	chipmunks
	squirrels
	white-footed mice
To plantings of grain	ground squirrels
	white-footed mice
Damage to growing crops	
Grass and alfalfa	field mice
	woodchucks
	pocket gophers
Bulbs, tubers, roots, and vegetables	pocket gophers
	rabbits
	woodchucks
	field mice
	muskrats (near water)
Grain	ground squirrels
	chipmunks
	white-footed mice
Damage to valuable wild or domestic animals	
Poultry and eggs	common rats
	ground squirrels
	weasels
	minks
	skunks
	foxes
	badgers
	coyotes
Larger livestock (especially lambs)	bears
	coyotes
Wild birds	ground squirrels
	squirrels
	short-tailed shrews
	most flesh eaters
Big game	coyotes
	timber wolves

KEY TO FAMILIES OF MAMMALS DISCUSSED

Rodents (gnawing animals)

Animals with two large chisel-edged front teeth in each jaw, separated by a wide space from the rather flat-topped back teeth:

- With quills in fur *Erethizontidae* ... porcupines
- With stout, paddle-shaped, scaly tail.. *Castoridae* beavers
- With stout, elongated digging claws
on front feet *Geomysidae* pocket gophers
- With short tail and with enlarged
hind legs adapted to jumping or
hopping *Leporidae* rabbits
- Without any of the above special characters:
More or less bushy tail..... *Sciuridae* squirrels,
chipmunks,
woodchucks, and
gophers

Mouselike animals, tail not bushy:

- With long tail and with en-
larged hind legs adapted to
jumping or hopping *Zapodidae* jumping mice
- With fur-lined pouches or
pockets on each side of the
mouth *Heteromyidae* pocket mice

Without any of the above special characters:

With one or more of the following characters:

- Tail much shorter than
body; or tail long, scaly,
and laterally flattened;
or body sharply bi-color
with underparts and
underside of tail white;
or front teeth grooved.... *Cricetidae* American mice,
muskrats,
field mice,
white-footed mice,
and others

Without any of the above special characters:

- Tail about the length of
body, round, scantily
haired, and scaly *Muridae* Old World mice,
house mice, and
rats

Insect Eaters

Animals smaller than common house rat; proboscis-like snout; velvety fur; eyes and ears almost invisible; teeth in continuous row with no wide space between; canine teeth not enlarged:

Front feet enlarged, shovel-like,
with stout projecting claws.....*Talpidae*moles

Front feet not modified as above....*Soricidae*shrews

Mouselike mammals with membranous wings:

One family in Minnesota*Vespertilionidae* ..bats

Flesh Eaters

Animals usually larger than common house rat; six small incisor teeth in front of each jaw, followed by a large pointed canine tooth on each side.

With five toes on each foot:

Large size; tail rudimentary.....*Ursidae*bears

Moderate size; tail with bands or
rings*Procyonidae*raccoons

Small or moderate size; tail
without rings; body usually
slender; scent glands*Mustelidae*weasels, minks,
skunks, and others

With five toes on front foot, four on hind foot:

With retractile claws; rather
blunt muzzle*Felidae*cats, wild cats

With non-retractile claws;
pointed muzzle*Canidae*dogs, wolves, and
foxes

The following species, not discussed in this paper, are listed in order to complete the list of the mammals of the state:

Carvidae (Deer family)

Cervus canadensiswapiti or elk

extinct in state; reintroduced

Odocoileus virginianus borealiswhite-tailed deer

rather common in northern Minnesota

Odocoileus virginultusMinnesota black-tailed deer

extinct

Alces americanamoose

occasional in northeastern part of state

Rangifer cariboucaribou

nearly extinct

Antilocapridae (Prong-horn antelopes)

Antilocapra americanaprong-horn antelopes

extinct in state

Bovidae (Cattle family)

Bison bisonbuffalo or bison

extinct in state

Didelphiidae (Opossums)

Didelphis virginianaopossums

possibly not established in state