Economic Mammalogy

# *Economic Mammalogy*

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# PREFACE

The literature of economic mammalogy is very extensive and scattered through numerous books, magazines, journals, and pamphlets. Many of these publications are not available in small public and private libraries. Consequently the information is to a great extent unavailable to anyone except a few specialists who have access to large libraries and know where the more important items may be found. Even they feel the need of a condensed summary or digest of the scattered information. This volume has been prepared for the purpose of bringing together and condensing into compact form as much as possible of the information concerning the economic relations of mammals; their bearing upon the welfare of the human race; their food habits; methods of preserving the more useful species and controlling the more harmful ones; the danger of exterminating certain species; and various other interesting facts pertinent to the subject, thus making them available to the general reader, as well as to teachers and students of biology. The subject is so broad and has so many ramifications that it can scarcely be hoped that this book is either complete or perfect, but it is hoped that but little of much importance has been overlooked, especially concerning North American mammals. Great effort has been put forth to insure accuracy. We do not vouch for the correctness of all statements made by the various authors whose publications we quote or cite. Space does not permit the recital of all the minor details, and, if included, their multiplicity would place an unwarranted burden upon the reader and detract from the readability and usefulness of the volume. For the benefit of those who may wish to delve more deeply into the subject, the appended bibliography and numerous footnotes furnish references to original sources of information where more detailed information may be found.

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# I

## INTRODUCTION

From the dawn of human existence, other mammals have had a very direct and vital bearing upon the welfare, activities and destinies of the human race. The ancient cave man was dependent on the flesh of mammals for much of his food, and upon their skins for raiment with which to protect himself from inclement weather. On the other hand, possessing only rude weapons with which to defend himself and his family from the attacks of large beasts of prey, he must have lived in constant dread of them. From that remote period to the present time, everywhere mammals have played a large part in human life and have exercised considerable influence upon history.

True, man himself is a mammal. The biologist finds it difficult, if not impossible, to believe that there would ever have been a human race had there been no other mammals. If we could imagine a world peopled with human beings and with no other mammals, surely the development of civilization would have proceeded along very different lines and probably the final results would have been different. Without work animals of any kind, no mammals to draw plows or loaded wagons, or to carry heavy loads on their backs, no swift horses or camels to carry men and women long distances in a short time, no wild or domesticated mammals to furnish meat, milk, butter, cheese, cream, leather and other products, the human race would have been greatly handicapped in its efforts to rise from a primitive state to an enlightened condition. If at the present time some great catastrophe should suddenly destroy all mammals but human beings, it would compel an immediate revolution in our habits and methods of living, if, indeed, it did not threaten the existence of our race. Furthermore, if all the mammals considered destructive and detrimental to human interests were suddenly destroyed, their elimination would certainly have a far-reaching effect upon human activities, though no one is wise enough or fully enough informed concerning all the complexities of nature and her biological equilibriums to be able to determine whether all of the results would be altogether beneficial.

When we turn the pages of history we find the ancient patriarchs of Asia and their people dependent upon their flocks of cattle and sheep, pastured on the hills of Palestine and other regions. We find the armies of ancient nations, mounted on horses, elephants and camels, going forth to battle for the extension or defense of the boundaries of empire. We note the merchandise of many people for many centuries transported over the burning sands of the deserts on the backs of camels. Beasts of burden have affected in many ways both the friendly and unfriendly intercourse of tribes and nations. Turning to ancient South America, we find the llama and alpaca domesticated and furnishing meat, milk and wool to a people engaged in building up a civilization in a remote portion of a continent then unknown to the rest of the world. On the western plains of North America we see immense herds of bison and antelope sustaining a population of Indians slowly emerging from a state of savagery, with dogs as their only draft animals, before white men came to destroy those great herds, and to replace them with horses, cattle, sheep and swine. In the Far North of America we see the Eskimos, their lives often depending upon their ability to obtain walruses or related mammals. In northern Europe we see the Laps and Finns for centuries with only the domesticated caribou or reindeer standing between them and destruction, furnishing them with meat, milk, cheese, skins for clothing and shelter, and even the sinews, horns and bones being used about their sledges and for various other purposes. Looking over both ancient and modern Europe, Asia, Africa, Australasia, the Americas and the islands of the sea, we find people everywhere, always using both wild and domesticated mammals and their numerous products for many purposes.

The mammals (Class Mammalia) include all animals that suckle their young, and no others, hence the name. The word "animal" is much used popularly as an exact synonym for mammals exclusive of man. Unfortunately, this is also often carelessly done even by naturalists who know better. Man himself belongs to the Kingdom Animalia, and is therefore an animal. Furthermore, reptiles, fishes, birds, oysters, insects, lobsters and all other living organisms except plants are animals. It is regrettable that there is in the English language no single word that means the mammals with the exception of the human race.

Poole in 1926 said that there were then known 12,540 species and varieties of mammals (about two-thirds as many as of birds), and species new to science are constantly being added to the list, particularly from remote regions of the earth. Comparatively few of the species are large and conspicuous. A very large proportion are small, secretive species, many of them nocturnal in habit, seldom seen by anyone except special students of the subject. To the great majority of men and women a mouse is a mouse and a rat is a rat; but the naturalist recognizes hundreds of species of mice and rats, divided into certain very definite groups such as wood rats, meadow mice, deer mice, pocket mice and so on. Most people in the United States are familiar with the chipmunks, but are surprised to learn that there are many species and varieties of them, not simply one kind.

Though the small species are less conspicuous and less generally known than the larger ones, yet economically some of them are vastly more important. The economic effect of destroying all the bears in the world would not be very great, and the economic effect of destroying all the elephants in the world would, so far as we can foretell, be rather local, but the economic results of destroying all the mice, all of the gophers, or all of the rabbits in the world, would be very pronounced and widespread. Yet one cannot say with certainty that any species can be destroyed without affecting many others in one way or another. If a species that preys upon certain other species suddenly becomes extinct, the latter, released from the attacks of one of its enemies, may multiply enormously and continue to do so until further increase is checked by the limit of its food supply. On the other hand, if a species that furnishes the food supply of another species becomes extinct, the surviving species would be in danger of starvation, unless it turns its attention to some other source of food, and thus affects other species upon which it begins to prey.

As all nature is complex, so economic mammalogy comprises a great mass of interwoven phenomena. The interrelations of organisms and their interactions and influence one upon another are complicated. Through ages of adjustment and re-adjustment each species has, under natural conditions, a more or less definite niche in the whole environment, influencing and influenced by all the species around it. This adjustment has been much disturbed by the rapid advance of civilization, which has within a short time carried into vast stretches of new territory stock-raising and agriculture on a large scale, with the destruction of forests, the draining of swamps, the introduction of plants and animals of various species from other regions; the transformation of large arid areas into cultivated fields, orchards and pastures by systems of irrigation; the destruction of cover and decrease of food supplies for some species, and provision of new cover and food supplies for others; the building of towns and cities and numerous other radical changes in the environment. This has added new complications to the interrelations of organisms. In view of all this, the intelligent understanding and discussion of economic mammalogy involves not only a knowledge of mammals and their habits, but also a comprehensive knowledge of zoology in general and botany, sound views on economics and an accurate insight into certain phases of history, politics and legislative principles.

During the past half-century there has been built up a vast and detailed literature of economic ornithology and much of the information therein is becoming generally diffused, having been systematized and made available to the public in many bulletins and books.[1] The food of many species has been subjected to minute analyses in order to determine just how useful or harmful they may be. On the other hand, few or none of the mammal species have been subjected to such thorough investigation, and the literature of economic mammalogy, though extensive, is still widely scattered. It consists to a great extent of numerous small circulars, bulletins and articles in technical periodicals, concerning a few groups of mammals, and occasional desultory items found here and there in the general literature of mammals, with very little systematic discussion of the economic relation of mammals as a whole.

It is manifestly impossible in a book of moderate size to set forth in detail or discuss adequately all the facts of such a subject, with its multitudinous phases, or even to cite all the publications bearing upon the subject. The best that we can hope to do is to generalize most of the information, adding, in footnotes, many references to the literature from which the reader who wishes to delve more deeply into the subject or any phase thereof may obtain more detailed information. The bibliography and footnotes cannot be made at all complete because of lack of space, but we have in most cases sought to select the publications most readily accessible to or obtainable by American readers.

Two very important facts must not be overlooked. The first is that while most species of vertebrate animals have certain favorite foods upon which they subsist when obtainable, there are other foods that may be used by them in case of emergency, and when they are hungry

[1] Compare Henderson, *The practical value of birds,* New York, 1927, and the numerous publications cited therein.

they are likely to take the most easily obtained food that is at all suitable to their needs. Human beings do so, being much less particular about what they eat when they are really hungry than when they eat simply because the clock says it is mealtime. Consequently, statements concerning the ordinary food habits of vertebrates must be taken with due allowance for the possible taking of other foods at certain times; and the fact that an animal is once seen eating a particular kind of food may not prove that to be a part of its ordinary diet. Thus, when insects are particularly abundant many graminivorous birds temporarily become decidedly insectivorous. Bears may not be particularly fond of veal, but when hungry, if no other food is available, they do not hesitate about attacking a calf. Foxes live largely upon rodents, but when hungry they do not disdain game birds, poultry, young lambs or any other meat within their reach. Furthermore, when their usual food is scarce mammals cannot as readily migrate to other localities in search of it as can the birds with their power of flight.

The red squirrel of New England furnishes an excellent illustration of a recent enforced change of food habit because of a failing supply of its natural food, which consisted of nuts and conifer seeds. The large conifers and nut-bearing trees having been cut from certain areas, the squirrels have adopted the habit of feeding more extensively upon buds and bud twigs, and thereby are said to be doing considerable damage to the younger trees.[2]

The second fact is that often individual animals acquire a taste for special kinds of food not in the normal diet of the species. Lions and tigers do not ordinarily attack men, but occasionally one becomes a man-eater, and, having acquired a taste for human blood, may kill numbers of people before it pays the penalty with its life. Individual birds have often been known to acquire a taste for food not usual in their diet. In case of sheep-killing dogs, however, it is not certain that their depredations are the result of a special liking for mutton. It appears to be due to a lust for killing and the excitement of the chase, as it is with the so-called "game hogs" among men.

[2] Hosley, Red squirrel damage to coniferous plantations and its relation to changing habits, *Ecology*, IX, 43-48, 1928.

## II

## THE ESTHETIC RELATIONS OF MAMMALS

A discussion of the economic relations of mammals would be incomplete without some reference to their esthetic status. The two are in some respects inextricably interwoven. Whatever contributes in a proper way to our entertainment or enjoyment, broadens our outlook upon nature, or ministers to our craving for beauty, making life better worth the living, is of distinct value to the human race. Recreation—the enjoyment of beauty in nature and art, providing temporary relief from the pressure of duty, from the routine and worry of daily life; taking one for a few moments or hours or days into a different environment; changing the current of one's thoughts and actions for a time into different channels—"restores the soul" and sends one back to work with renewed vigor, increased strength and hope, "mends the ragged edges of shattered nerves," and makes one better fitted to cope with the difficulties of life.

As applied to tired brain-workers of sedentary occupation, this is rather universally recognized. The physician, worn by a hard campaign against a serious epidemic disease or many visits to a long list of patients; the lawyer, fatigued by many days and nights spent in the effort to protect the lives and property of his clients; the teacher, tired by the relentless routine of teaching many restless children or young people, grading numerous examination papers long after school hours and helping backward pupils; the housekeeper, breaking down beneath the burden of many household cares, the worry of the sick-room and caring for her children; the secretary or clerk, confined day after day in office or store; the merchant, fighting desperately to avoid bankruptcy; the banker, diligently endeavoring to protect the interests of stockholders and depositors; all, in short, who occupy positions of responsibility or are too closely confined by business or professional duties of any sort or are worried by discouraging and embarrassing circumstances, would be benefited by a few days in the open, where birds are singing, squirrels are chattering and flowers spreading their colors and fragrance to the world. Workers in the field of manual labor, even those whose lives are spent largely outdoors, also are often benefited by a little time spent far from field or shop. Not that they need physical exercise—their need is for relaxation, relief from monotony, a change of scenery or of viewpoint or of mental processes.

All these feel the urgent call of the outdoor world, and wherever the seeker for relaxation may go, in the forest, by the streamside, in the mountains or on the plains, the mammalian life encountered adds largely to the pleasure of the holiday or the vacation. The landscape artist, recognizing this, introduces into his paintings a few cattle in a pasture, horses drawing a cart or a plow through the field, a flock of sheep grazing on a hillside or a deer in the forest.

The esthetic value of mammals is recognized in the laws for their protection in our great public playgrounds, the national parks, where hunting, injuring or destroying the wild animals is strictly prohibited, not because of their intrinsic value but in order that they may be seen by visitors. In consequence of their immunity from molestation they become very tame, and seeing them in the open adds to the delight of thousands of visitors annually. Mammals in cages in circus menageries, those with greater liberty in large enclosures of zoological parks, the bear pits and the like in municipal parks, are usually surrounded by interested spectators, both old and young, who derive much pleasure from the privilege. Automobile tourists, crossing the continent on vacation tours, are delighted at every exhibition of wild life along the route—prairie-dogs on their mounds "barking" at the passers-by, jack rabbits bounding over the plains, ground squirrels scurrying to their holes, tree squirrels chattering among the trees, an occasional coyote loping over a distant slope, and great is the rejoicing at a rare glimpse of a deer or an antelope.

Some species of wild animals captured alive or raised in captivity for the purpose of exhibition in menageries and zoological parks bring high prices. Three pygmy elephants brought $15,000. A pair of full-grown giraffes is worth from $15,000 to $20,000 dollars. One Indian rhinoceros cost $8,000. An adult Indian elephant is worth about $3,000, a common hippopotamus about the same and a pygmy hippopotamus about $4,500. The price of a pair of Prjevalsky wild horses was $5,000, and $6,000 was paid for one Abyssinian wild ass.[1]

Thousands of men and women who do not hunt frankly say that they would be willing to give considerable sums of money for the privilege of seeing deer, elk, moose and other such animals in a wild

[1] Blair, *In the zoo,* pp. 11, 12, 63, 65, 78, 92, 96, 1930.

state; yet the great majority, who wish only to see, not to kill game, have always permitted the small minority of hunters to make and enforce the game laws. Fortunately, the hunters themselves are in large numbers awakening to the fact that game laws must be wisely drawn and effectively administered, or there will soon be no game to hunt. Therein lies the hope for the future of game mammals. With increasing knowledge and experience the laws are being constantly bettered and their enforcement made more certain.

Hunting game animals with guns, as a recreation, has a bearing upon the esthetic side of life, as strange as that may seem to some, but there are also utilitarian phases of that subject, so it seems better to treat it in a separate chapter. However, there is a growing army of hunters whose only weapons are field glasses and cameras and who get just as much sport out of their peaceful pursuit of mammals as do those who go forth armed with rifles and shotguns. Furthermore, obtaining good photographs of wild mammals often requires much more skill and patience, more accurate knowledge of mammalian habits, and sometimes more courage, than does shooting them.

## III

## THE ECONOMIC RELATIONS OF MAMMALS IN GENERAL

The investigation of wild birds has taught us that most of the species are more useful than harmful and many of them almost altogether useful. A large proportion of the species of mammals also are either useful or comparatively harmless, but the proportion of individual mammals that are very harmful is probably much greater than in case of birds. This is due to the fact that the most abundant mammals belong to the Rodentia, which order includes many very destructive groups, such as prairie-dogs, gophers, rats and mice, that increase very rapidly under favorable circumstances. Much damage is also done by beasts of prey of the cat and dog families, such as the tiger, lion, leopard, puma, lynx, wolf, coyote and fox, though some or all of them also do more or less good to offset their iniquities. Some of the fur-bearing mammals (weasels, skunks, etc.) are destructive to poultry and wild birds, though they, too, have some useful habits.

Though economic mammalogy is a very large and complex subject, with many ramifications, it centers about four main questions, namely: What species are useful or harmless and entitled to reasonable protection? How may they best be encouraged and protected? What species are more harmful than useful and should be kept in check? How may they best be controlled or destroyed, or the damage they do be minimized?

That all sounds perfectly simple and easy, but one soon discovers many complications. A species that is not very injurious or is even definitely useful under ordinary circumstances may, under other circumstances, temporarily become exceedingly injurious. For example, meadow mice in most localities are not usually abundant enough to do a great amount of damage, but when, during favorable seasons, their numbers are enormously augmented by a low mortality rate and high fecundity, they become a menace. In an unsettled region, infested by an overabundance of rabbits, prairie-dogs and ground squirrels, a few coyotes to keep those rodents in check may be quite useful, but with the advent of stock and poultry raising a marked increase in the coyote population would make them quite harmful in the destruction of poultry, lambs and calves, or entail much expense in the effort to prevent their depredations. Prairie-dogs in an uninhabited region would do no harm to mankind, but on cattle ranges and about cultivated fields they are often very destructive. Weasels are very useful in the destruction of rodents, but may be very destructive to poultry unless the henhouses are so constructed as to exclude them.

A few deer in the woods and pastures are harmless and pleasant to see, but it is quite conceivable that if their enemies were all destroyed and they were for a few years free from disease and the effects of disastrous storms, they might become so abundant as to be destructive to forests, gardens and farm crops. Indeed, deer have locally become harmful in some places. Even some highly useful animals must sometimes give way to a certain extent before the encroachment of extensive agriculture and other activities of advancing civilization. To the Indians and white explorers on the Great Plains of the West the bison was a blessing, but the large herds migrating through cultivated fields of the thickly-settled portions of that region as they are now would be a calamity. Dogs are useful in their proper places, pleasant companions and faithful friends, but occasionally one develops the sheep-killing habit, and it must then be controlled or disposed of.

It is quite possible that, as with birds, no species of mammal may be considered, under all circumstances, either wholly beneficial or entirely harmful. Certainly the great majority of species are beneficial in some ways and harmful in others. The first problem of economic mammalogy is to place in the balance the beneficial and injurious habits of each species, and thus to ascertain whether it is more or less useful than harmful. This process requires an intimate knowledge of the habits of many other organisms. For example, an insectivorous mammal may take some useful species of insects and some harmful ones, in which case its economic status must be based upon an exact knowledge of the proportions of the various groups of insects in the mammal's food, and an equally exact knowledge of the habits of the various groups of insects themselves. However, it is possible that the greatest value of insectivorous mammals lies in their work in keeping the whole insect tribe in check, rather than their destruction of particular kinds of insects.[1] The same idea may be applied also to mammals that destroy mice and other injurious animals.

[1] This subject is discussed more at length in Henderson, *The practical value of birds,* pp. 42-45, 74-75, 1927, with footnote references to other publications.

It is doubtful whether we are justified in the complete extermination of any species, even the predatory mammals. In addition to the fact that they destroy some injurious animals, they are of scientific, educational and recreational value, which should be placed in the balance in weighing their good and bad qualities. We are not yet fully enough informed as to all of the interrelations and interactions of various species to determine the wisdom of the total extermination of any of them. Man may kill, but he cannot re-create.[2]

Certain burrowing rodents do some good by stirring the soil and bringing subsoil to the surface; but, to offset this, their holes, tunnels and mounds are in various ways a nuisance and sometimes dangerous. Wolves and coyotes kill harmful rodents, but also kill very useful animals. Beavers are valuable fur-bearers, but sometimes cut down trees of very much greater value than their pelts. Minks and weasels, also valuable as fur-bearers, and as enemies of injurious rodents, sometimes make raids upon the poultry houses, though they can be "built out" by proper construction of the pens and houses. Rabbits furnish us with great quantities of meat and fur, but do much damage to orchards, gardens and farm crops. Cats catch some mice, but are not as good mousers as some of the predatory birds, and do considerable harm by catching insectivorous and other useful birds. It is therefore very evident that it is often difficult to strike a balance and decide with certainty whether a given species should be listed with the injurious, neutral or beneficial species.

There are, however, many species of mammals of very great and beneficent importance to the welfare of mankind, particularly those that have been domesticated, of which there are many kinds, discussed more at length in other chapters. Especially valuable are those that furnish us with large quantities of meat, milk, butter, cheese, wool, lard, furs, leather, oil and other commodities of great aggregate value, the beasts of burden, and the dogs that guard our homes and help herd and drive our sheep and cattle.

The branches of business of the modern world that revolve around mammals and mammalian products are numerous and aggregate in value billions of dollars per annum. In the succeeding chapters we shall consider some of the esthetic relations of mammals. Then, turning to the practical phases of mammalogy, we shall see, on one hand, the

[2] See Adams, The conservation of predatory mammals, *Journ. Mammalogy*, VI, 83-96, 1925. Compare Goldman, *ibid.*, pp. 28-33.

almost immeasurable value to the human race of certain mammals that provide us with meat, milk, butter, leather, furs and other products, and those that in the past have furnished the chief means of transportation. On the other hand we shall see the great injury done by other mammals by the destruction of crops, foodstuffs and other property, and by interference in various ways with the industrial and commercial operations of mankind. It is not practicable to exhaustively discuss any of these phases of economic mammalogy in the several chapters devoted to them, without making a ponderous and expensive volume of this book, but much additional information bearing upon all these matters may be found in Part II, where the economic relations of the various groups of mammals are considered in systematic order.

# IV

## THE BALANCE OF NATURE

The adjustment of various species of plants and animals to one another under natural conditions, and the danger of suddenly disturbing the equilibrium, have been much discussed, particularly in the literature of economic ornithology, but the principles involved apply with equal force to the mammals.[1]

Perhaps there is no such thing in nature as an absolutely perfect biological equilibrium—a condition in which no species is either increasing or decreasing, their relative numbers remaining constant. Surely such an equilibrium, if it occurs, is temporary. Local conditions are slowly but constantly changing, demanding constant re-adjustment, which, under natural conditions, is accomplished gradually, with but little disturbance of the balance. World-wide conditions also change, though even more slowly. That this has been going on throughout the geological ages is shown by abundant fossil evidence. At many times during the past, whole faunas and floras have become extinct and have been replaced by new faunas and floras, but these changes have doubtless been exceedingly slow.

The environmental changes wrought by civilized man are often much more rapid. In a few decades we destroy vast forests, bring under cultivation thousands of square miles of prairie soil, carry water into arid regions for irrigation, drain great swamps and lakes; destroy immense herds of bison or other mammals, or myriads of pigeons, obliterate the hiding and nesting places of many species and reduce their food supply; introduce various other species, such as cattle, sheep, English sparrows, etc., to provide competition for native species of animals, and grains and other plants to provide competition with native plants and to furnish new, different and perhaps better food supplies

[1] See especially Forbes, On some interactions of organisms, *Bull. Illinois State Lab. Nat. Hist.*, I, No. 3, pp. 3-18, 1880; 2d ed., 1883; The regulative action of birds upon insect oscillations, *ibid.*, I, pp. 3-32. 1883; The ornithological balance wheel, *Trans. Illinois Horticultural Soc.*, XV, 120-131, 1882. Palmer, The danger of introducing noxious animals and birds," *Yearbook U. S. Dept. Agric. for 1898*, pp. 87-110. Goldman, The predatory mammal problem and the balance of nature, *Journ. Mammalogy*, VI, 28-33, 1925. Adams, The conservation of predatory mammals, *ibid.*, pp. 83-96. Henderson, *The practical value of birds*, pp. 26-35, 1927, and publications therein cited.

for some of the native animals. In many other ways we disturb the balance that has been established. Such rapid transformations in the environment introduce many complex and difficult problems, the correct solution of which requires an accurate and comprehensive knowledge of all nature, and taxes the wisdom of the best-informed naturalists; yet men with very little knowledge of nature consider themselves quite competent to decide all such problems very promptly. The tendency of nature is not always to restore the former balance, but sometimes to establish a new one.

One species, unless a very rare one, cannot be destroyed or greatly lessened in numbers without affecting others. One species cannot be introduced into a new region and become abundant there, or become much more abundant than formerly in its native habitat, without affecting others. Small rodents form the favorite food of certain species of hawks, as well as of certain fur-bearing mammals. If such rodents become scarce their enemies are likely to visit the poultry yards, or attack wild birds or find some other food not usually taken by them. Because of improved living conditions, many species of mammals are known to increase in numbers when their food supply is abundant and easy to obtain, and to decrease when the supply becomes scarce or hard to obtain.

Each species is to some extent, sometimes to a great extent, kept in check by competition in the search for food and by the depredations of natural enemies. If removed to a region where it is free from such competition and depredations, or relieved therefrom by the destruction of its competitors and enemies, it is likely to increase to such an extent as to make it a menace to other species or even so to overpopulate the region that its own demand for food exceeds the supply, and thus limits further increase. This is particularly true of species that are naturally very abundant and prolific, such as mice and rabbits. There are many instances known of lemmings, field mice and even house mice eating up the supply of food in one area, then swarming out over adjacent territory and destroying all vegetation in the line of their march, a subject more fully discussed in another chapter. A great increase in the number of small rodents has often followed wholesale destruction of their chief bird enemies, hawks and owls.

On our western plains and in the mountains, coyotes, wolves and other predatory mammals had long lived in proximity to deer, rabbits and other game mammals, in such equilibrium as neither to exterminate them nor to permit them to become overabundant. Then white men moved into the region and introduced large flocks of sheep and herds of cattle, to which more abundant and easily obtained food the predators turned, causing great losses to stockmen, who have been compelled to declare war upon the enemies of their flocks. It is surely quite necessary to keep predatory animals within reasonable bounds, but no human being yet has sufficient knowledge of all the complexities of nature to determine with absolute certainty whether any of the predators should be entirely exterminated. One thing that is quite certain is that though man may destroy a species, he can never bring back into existence one that he has exterminated.

As a necessary result of the destruction of the coyote, man will have to face the problem of accounting for the thousands of ground squirrels which the animals destroy each year, as Dixon clearly points out. Control measures breed control measures. Control in one direction throws nature out of balance and often gives rise to troublesome consequences which must be dealt with through additional control measures. The case has recently been well stated by two British authorities. Watt cited herbivorous animals as a chief cause of failure of natural regeneration of the oak in Britain. As a result of the reduction in numbers of carnivorous animals there has been a general increase in rabbits, mice, moles and certain birds. "Man, by upsetting the balance of nature and assuming control of what directly affected his own interests, is now paying the penalty in other ways, and must, having killed or suppressed the controllers, either assume total control himself or assist in such by a judicious encouragement of those animals he once considered his inveterate foes." The same point is made by Lankester, quoted by Watt, ". . . civilized man has proceeded so far in his interference with extra-human nature, has produced for himself and the living organisms associated with him such a special state of things by his rebellion against natural selection and his defiance of nature's pre-human dispositions, that he must either go on and acquire firmer control of the conditions or perish miserably by the vengeance certain to fall on the half-hearted meddler in great affairs. We may indeed compare civilized man to a successful rebel against nature who by every step forward renders himself liable to greater and greater penalties, and so cannot afford to pause or fail in one single step."[2]

Thorough investigation has shown that most species of wild birds are more useful than harmful. Though not so fully investigated, the same is true of a considerable proportion of mammals, but unfortunately among mammals the most abundant and prolific species are those whose food habits render them particularly destructive—the rodents. However, it is highly probable that no species is entirely harmful, and quite possible that no species is entirely harmless.

[2] Taylor, *Journ. Mammalogy,* II, 177, 1921, quoting Dixon, *California College Agric. Bull.,* No. 20, pp. 379-397, 1920; Watt, *Journ. Ecology,* VII, 201-202, 1919; Lankester, *Kingdom of Man,* pp. 31-32, 1911.

Some often-mentioned illustrations of the effect of disturbing the balance of nature by introducing new elements into the fauna or by increasing or decreasing the relative abundance of native species may well be mentioned here. The mongoose (or mungoose), a great ratter and mouser, was introduced into the West Indies to combat a rat plague. When rats became less abundant and the mongoose numerous, it attacked poultry, wild birds, young pigs and lambs and became a great pest.[3] Disaster also followed its introduction into the Hawaiian Islands and Porto Rico, where it has played havoc with native ground-nesting birds.[4]

In a New York swamp snapping turtles caught young ducks, but were kept in check by skunks, which ate the turtle eggs. When skunk fur became fashionable trappers began to catch skunks. Turtles then became more abundant, and because of their increased depredations the ducks ceased to breed there, but returned to the swamp to nest after boys thinned out the turtles by catching them for market.[5]

The fox, introduced into Australia, has become a menace to native animals.[6] The far-reaching effects of the importation of gipsy moths and English sparrows into the United States and rabbits into Australia are too well known to need more than casual mention here. Because of the destruction of their forage by rabbits, sheep in New South Wales were reduced from 60,000,000 in 1893 to 32,000,000 in 1923.[7] Cahn tells of a lake containing abundant aquatic vegetation and various species of game and pan fishes, into which carp were introduced, resulting in the destruction of the vegetation, as well as of the native fishes.[8] These instances are but a few out of hundreds that show the danger of disturbing the natural adjustment of species.

A classic and oft-repeated illustration of the effect the wholesale destruction of one species may have upon others is Darwin's bumblebee story. The bees aid in fertilizing red clover by carrying pollen from flower to flower. Field mice destroy the nests of the bees. Cats [and, we may add, some other mammals and birds of prey] feed partly

[3] Morris, The mungoose on sugar plantations in the West Indies, London, 1883; reviewed in *Amer. Naturalist,* XVII, 299, 1883. Palmer, *Yearbook U. S. Dept. Agric. for 1898,* pp. 87-110.

[4] Wetmore, *U. S. Dept. Agric. Bull.,* No. 326, pp. 38, 77, etc., 1916.

[5] Fisher, The economic value of predacious birds and mammals, *Yearbook U. S. Dept. Agric. for 1908,* pp. 191-192.

[6] Le Souef, The fox menace and its effect on our native animals, *Bull. Zool. Soc.,* XXVII, 69-71, 1924. *Journ. Mammalogy,* V, 272, 1924.

[7] *Nature,* CXII, 553, 1923.

[8] Cahn, The effect of carp on a small lake, *Ecology,* X, 271-274.

upon mice. Therefore the clover crop may depend upon the number of enemies of the mice in the neighborhood, which in turn would depend upon the number of cats. Cabot has furnished an illustration that deserves to rank with Darwin's. In Labrador, mice had been abundant and bears, wolves, wolverenes and other carnivorous mammals, birds of prey and even trout were feeding largely upon the rodents.

In the spring of 1906 the mice disappeared with the snow.... With the vanishing of the mice the change in the visible life of the country was remarkable. The falcon cliffs were deserted. . . . In the trout reaches of the Assiwaban fish were numerous, but they were living on flies now, with what minnows they could get, and were no longer mousey, but good and sweet. Our bear of the year were living on berries. Ptarmigan were all but wanting, old birds and young. It is fair to suppose that in previous years they were let alone by their natural enemies in the presence of the superabundant mouse supply. . . . Once the wolves found themselves upon the hard times of early 1906 they may have sought the caribou and started them to move. They certainly did move, as the twelve or fifteen hundred carcasses [killed by the Indians] at Mistinipi that year went to show.

The bearing of the mouse situation on the human interests of the region is easy to see. It affected all the game, food game and fur. The abundance of mice tended to build up the ptarmigan, which are of vital importance in the winter living of the Indians through the whole forested area to the Gulf. Likewise it built up the caribou herd by providing easier game than they for the wolves. The departure of the mice did the reverse, reducing the deer and ptarmigan. . . . Nor were the shore people by any means untouched. All their land game came and went, was plenty or wanting, shy or easily taken, according to the supply of mice. London and St. Petersburg, easily, were affected through their great fur trade.[9]

Innis also discusses the fact that the abundance of mice upon which certain fur-bearing mammals feed affects the fur supply of the world.[10]

[9] Cabot, *Labrador,* Boston, 1921; quoted in Allen, *Journ. Mammalogy,* III, 56-57, 1922. Hewitt, *The conservation of the wild life of Canada,* pp. 214-215, 219, 1921.
[10] Innis, *The Canada fur trade,* pp. 90-91, 1927.

# V

## MAMMALS AS A SOURCE OF HUMAN FOOD

Within the limits of two brief chapters only the edges of the various phases of the complex relation of mammals to the human food supply can be discussed. An adequate discussion of it would fill a book. Much additional information and comment may be found under the various species in the systematic portion of this volume.

First and foremost should be considered mammals as a direct source of the meat supply. If we accept the traditional alliterative subdivision of meat into "flesh, fish and fowl," flesh signifies the meat derived from mammals; fish must include the flesh of other cold-blooded vertebrates (reptiles and amphibians), the meat of certain species of which is relished by many people; and fowl must include all birds, not merely those usually designated as fowl. Taking the people of the whole world into consideration, the flesh of mammals probably occupies a more commanding position in the food supply than all other meat.

Though used very extensively as food by people of certain regions, particularly along seacoasts, there are vast areas where fishes are insignificant in numbers or wholly wanting, because of the lack of a suitable habitat. Who would expect to live on a fish diet in the Sahara desert? Even on the well-populated Great Plains and in the Rocky Mountains of western United States the quantity of native fishes consumed is not relatively large, though augmented by shipments from the Great Lakes and both oceans; while in the Great Basin and the arid Southwest the native fish supply is almost entirely negligible. Domestic chickens, turkeys, ducks and geese, and all the game birds brought in by the hunter form only a small percentage of the total food of the nation. The same holds true in the main also for the interior of British America, Mexico, Central and South America, Europe, Africa, Asia and Australasia. On the other hand, over a large part of the world the flesh of mammals is a very substantial item in the bill of fare, its consumption in some areas much exceeding that of grain, vegetables and other direct products of the soil.

By far the most important part of the world's meat supply is derived from domesticated animals. From time to time the United States Department of Agriculture issues statistical publications concerning domestic animals and their products, from the latest of which now available the following figures have been gleaned:[1]

MEATS AND LARD AVAILABLE FOR CONSUMPTION IN THE UNITED STATES IN 1927

| | | |
|---|---|---|
| Beef and veal | 7,800,000,000 pounds, | 65.8 pounds per capita |
| Lamb and mutton | 645,000,000 pounds, | 5.4 pounds per capita |
| Pork | 8,122,000,000 pounds, | 68.5 pounds per capita |
| Total meats | 16,567,000,000 pounds, | 139.7 pounds per capita |
| Lard | 1,634,000,000 pounds, | 13.8 pounds per capita |

EXPORTS AND IMPORTS OF MEATS IN 1926

| | *Exports* | *Imports* |
|---|---|---|
| United States | 1,445,219,000 pounds | 102,626,000 pounds |
| All other countries | 5,468,765,000 pounds | 6,576,038,000 pounds |

VALUE OF EXPORTS AND IMPORTS OF MEATS, ETC., FROM AND TO THE UNITED STATES IN 1925

| | *Exports* | *Imports* |
|---|---|---|
| Beef and veal | $ 2,765,000 | $1,765,000 |
| Pork (fresh $1,390,000) | 106,081,000 | |
| Mutton and lamb | 313,000 | 610,000 |
| Canned meats | 7,250,000 | |
| Bouillon, etc. | 4,250,000 | |

The average American eats the equivalent of his own weight in meat annually. In some countries the average is much less, and in the United Kingdom and France, as well as in many other countries, the relative importance of mutton in the menu is much greater than in the United States.[2] We must not overlook the fact, also, that in many countries goats are largely used for food. Horseflesh is eaten in some countries, the flesh of camels in Asia and of the domesticated camel-like animals, llama and alpaca, of South America, is all esteemed, and there are people who do not disdain dog flesh, all these adding to the total meat supply derived from domesticated animals.

Domesticated mammals supply not only the greater part of the world's meat supply, but also the almost indispensable dairy products. The production of milk, butter and cheese and their by-products in the United States in 1923 was estimated at $2,652,877,000 in value; and in 1926, at $2,952,012,000.[3] This probably did not include goats'

[1] Statistics of farm animals and animal products, Separate No. 976 from *Yearbook U. S. Dept. Agric. for 1927. Statistical Bull. No. 20,* U. S. Dept. Agric., 1927.
[2] Dearborn, *Yearbook U. S. Dept. Agric. for 1918,* p. 145.
[3] *The World Almanac for 1928,* p. 370.

milk, of which considerable is consumed in some localities. Some other countries also engage extensively in the dairying industry. In addition to the milk of cows and goats, that of reindeer, camels and llamas is used as food by their owners.

Turning now to wild mammals, it is, of course, much more difficult to make even a satisfactory guess at the number available for food or the amount of meat therefrom actually consumed annually. We shall see in another chapter how very important they were as food for the early explorers and settlers in the United States and British America. In North America at the present time the members of the deer family are far the most important large game mammals. Since the elk has been so restricted in its range and reduced in numbers in the United States, the only really important one now is the deer. The bison is no longer available in a wild state, bears, mountain sheep and mountain goats are not sufficiently abundant or easy to obtain, and moose and elk are not only confined to few localities, but the total number in the country is small. The prong-horned antelope, once more abundant than bison over an immense area extending from Mexico northward far into British America, is no longer common in most regions, and hunting them is entirely forbidden in nearly all states where they were once abundant.

Deer have been exterminated or are so scarce in about one-third of the states that there is now no open season for them and in some other states the open season is very short, with a limit usually of but one animal to each hunter during the season. In many localities where game laws have been wisely devised and well enforced the deer have increased, and in places are as abundant as they ever were. It is estimated that there are about 600,000 deer in the national forests alone. An average of about 75,000 are killed in the states annually, which yield about 11,250,000 pounds of meat, according to Palmer,[4] worth, at twenty cents a pound, $2,250,000.

In British America the wild caribou, closely related to the domesticated reindeer, is still found in great herds, which occur also in Alaska. One herd in migration, estimated at from 100,000 to 200,000, is said to have been fourteen days in passing Fort Rae, in such an unbroken mass that "daylight could not be seen" through the column,[5] and another herd was estimated at 25,000,000 animals.[6] This animal is a

[4] Palmer, Game as a national resource, *U. S. Dept. Agric. Bull.*, No. 1049, 1922.
[5] Preble, *North American Fauna*, No. 27, p. 141, 1908.
[6] Seton, *The Arctic prairies*, p. 259, New York, 1917, cited in Adams, *Roosevelt Wild Life Bulletin*, III, 575-576, 1926.

very important source of food for prospectors, miners, trappers and others over a vast area of the northern country. Its flesh, together with that of the moose, is served to travellers on Yukon River steamers and in the hotels of that region. The great herds of bison that once provided meat for early travellers over the Great Plains, and for the workmen engaged in the construction of the first railroads across the plains, are more fully discussed in other chapters.

The reindeer has for centuries been a domesticated animal in northern Europe, where its flesh is used as food. It was introduced into Alaska in 1891 as a source of food for the natives, the herds now numbering over 250,000, and into Labrador in 1907.[7]

In Africa, buffaloes, many species of antelopes and other large mammals have always furnished meat in abundance to the natives, as well as to exploring expeditions and white settlers. Though in many localities they have been greatly reduced in numbers, they are still an important source of human food.

Of the smaller mammals, rabbits are far the most important as a food supply for the human race, in addition to providing healthful recreation for a large army of hunters. Palmer estimates that 25,000,000 wild rabbits are killed annually in the United States, worth, at an average of twenty cents each, $5,000,000 for their meat, in addition to the value of such of the skins as are utilized in the fur industry; 465,000 cottontails were killed in New York State in 1918, 2,700,000 in Pennsylvania in 1919, and 293,625 in Virginia in 1920.[8] Estimates for other states are not at hand. There are short open seasons in nearly half the states, mostly eastern, where rabbits do no great amount of harm, but no restrictions elsewhere except the usual requirement of hunting licenses in order to hunt any game. Dearborn tells us that prior to the World War 100,000,000 rabbits were annually marketed in France; that England produces from 30,000,000 to 40,000,000 and imports $1,000,000 worth from Belgium and $4,500,000 worth from Australia and New Zealand annually; that in 1911 London consumed 500,000 pounds and Paris 200,000 pounds of rabbit meat daily.[9] Those from Australasia are the wild species unwisely introduced there, but the others are likely largely raised in confine-

[7] Hadwen and Palmer, Reindeer in Alaska, *U. S. Dept. Agric. Bull.* No. 1089, 1922. Jones, *Fur farming in Canada,* pp. 92-95, 1913. Hewitt, *Conservation of the wild life of Canada,* 1921. McAllister, *California, Fish and Game,* IX, 14, 1923.

[8] Palmer, *U. S. Dept. Agric. Bull.* 1048, 1922. Seton makes the value $25,000,000 annually.

[9] Dearborn, Rabbit growing to supplement the meat supply, *Yearbook U. S. Dept. Agric. for 1918,* pp. 145-152; Rabbit farming, Dept. Bull. No. 1090, 1920.

ment. Over $1,000,000 worth of rabbit meat was sold in Los Angeles in 1926.[10]

The meat of muskrats, if properly cooked, is pronounced excellent by many who have used it, and it is now sold regularly in the markets of several eastern American cities, where it appears under the trade name "marsh rabbit" during the trapping season, the trappers getting from $2.50 to $3.00 a dozen for the carcasses,[11] which gives them a neat addition to the amount they receive for the furs, when one considers that they catch the muskrats by the hundreds and must skin them anyhow. A great many other small mammals are used to some extent for food and the aggregate amount of meat derived therefrom the world over must be very large. In America one naturally thinks at once of the squirrels, raccoons and opossums. Trappers often express a liking for beaver meat, some relish skunk, and one of the authors of the present volume found young prairie-dogs quite palatable. According to one trapper, wildcat flesh is very tender and agreeable food, and while dogs like it, they are said to dislike fox flesh.[12]

Badgers, porcupines, woodchucks, gophers and many other American mammals are eaten and pronounced good by white men, as well as by Indians. The woodchuck is eaten with great relish by the Kentucky mountaineers.[13] In fact, there is no reason why many of the vegetarian rodents, when not too old, tough and rank, should not be as good as squirrels, if we could only overcome our prejudices. They are certainly as clean in their habits as chickens or hogs, or more so. Natives of some countries are said to eat the flesh of the common house rat.

In South America natives consider monkey flesh a great delicacy, and anteaters are also used as food.[14] Various marine mammals, such as seals and porpoises, are used as food, and whale meat is sometimes sold in American markets.[15] Walrus, when obtainable, has always been one of the chief foods of the Eskimo, but these animals have become so scarce that reindeer were introduced into Alaska as a substitute. It is manifestly impossible to make even a worth-while guess as to the total percentage of the world's daily menu furnished by the flesh of wild mammals.

[10] Ashbrook, *Fur farming for profit,* p. 219, 1928.
[11] Ashbrook, *Fur farming for profit,* p. 218, 1928.
[12] Ross, *Journ. Mammalogy,* IX, 250, 1928.
[13] Hamilton, *Journ. Mammalogy,* XI, 310, 1930.
[14] Holt, Monkeys as human food, *Journ. Mammalogy,* IV, 193-194, 1923. Tate, *Journ. Mammalogy,* XII, 249, 1931.
[15] Radcliffe, Whales and porpoises as food, *U. S. Bureau of Fisheries Economic Circular* No. 38, 1918.

# VI

## MAMMALS AS A SOURCE OF VALUABLE PRODUCTS OTHER THAN HUMAN FOOD

The relations of mammals to the human food supply naturally presents two distinct, contrasting phases,—a productive one and a destructive one,—which are considered in separate chapters. The relations of mammals to products other than human foods presents similar phases, also separately treated. Herein we take up the productive phase, much more pleasant to contemplate than the other. In addition to meat, milk, leather, furs and skins, which are more fully considered in other chapters, there is a long list of other useful products obtained from mammals, only a few of which may be mentioned, in the limited space at our disposal, for purposes of illustration, to which the reader may add many others from his own experience or observation.

Wool immediately suggests itself as a likely candidate for a position at the head of the list, because of its importance to the human race. The domestic production of wool in the United States in 1925 was placed at 301,060,000 pounds, imports 336,646,000 pounds and exports 7,360,000 pounds. The combined imports of wool and mohair were valued at $141,957,000 and of wool manufactures at $73,900,000.[1] The world's production of wool in 1916 was estimated at 2,717,000,000 pounds.[2] Though estimates and actual statistics vary somewhat from year to year, the figures for one year usually may be taken as at least a rough approximation to those of other years.

The foregoing figures apparently include only wool from sheep, but there are other domesticated animals that yield wool or very similar products. The angora goat, from which mohair is obtained, is becoming very important in the United States and some other countries. The mohair clip in this country in 1909 was valued at $901,597, the production having been 454,932 fleeces in 1899 and 1,682,912 in 1909,[3] while in 1921 it was 6,000,000 pounds (two or three pounds

[1] *Statistical Abstract of the United States for 1925,* U. S. Dept. of Commerce, 1926. For 1927 see Separate No. 976, from *Yearbook U. S. Dept. Agric. for 1927,* p. 1036.

[2] Holmes, Wool: Production, foreign trade, supply and consumption, *Yearbook U. S. Dept. Agric. for 1917,* pp. 401-424.

[3] Heller, The Angora goat, *U. S. Dept. Agric. Farmers' Bull.* No. 573, 1914.

a fleece).[4] The rapid increase in production is shown by the fact that in the United States in 1927 it was 13,470,000 pounds, while in 1926 in South Africa it was 10,681,000 and in Turkey 6,500,000.[5]

In South America the vicuna, alpaca and llama yield wool and woolly hair of importance, and, as almost everybody knows, camels' hair from Asia is used for many purposes. We are told of dogs that formerly existed on the northwest coast of North America, whose long hair was mingled with an undercoat of woolly material. They were closely sheared by the Indians, the material having been used in the manufacture of blankets, some of which are still preserved in museums, though apparently the dogs have disappeared.[6]

It is impossible for the present generation, provided with electric lights, numerous petroleum products and other materials better for many purposes than those obtained from whales and other marine mammals, to form an adequate idea of the importance to former generations of whalebone, whale oil, sperm oil, sperm candles and other commodities brought to market by the whalers. Whaling and sealing were once among the most consequential industries of the world, but have now dwindled to relative insignificance, as various other industries have so greatly expanded, although whale oil is yet an important item in the manufacture of soap. The rise and fall of whaling has been spectacular, and much of romance, as well as of hardship, are incorporated into its history, which has been discussed at length by various authors.[7]

Whaling was an ancient industry on the shores of northern Europe and Arctic America. It was introduced along the shores of western Europe by the Northmen, and systematically and extensively followed by the Biscayans in the fifteenth century, though the whale fisheries did not assume great world importance until the seventeenth century. It reached temperate America soon after the discovery of the continent, and finally reached the point where, in 1834, $12,000,000 were invested in whaling enterprises in New England alone—a very large

[4] Williams, The Angora goat, *Farmers' Bull.* No. 1203, 1921.

[5] U. S. Dept. Agric. and Dept. Commerce, Interdepartmental Committee on Angora goat and mohair industry, Miscell. Circular No. 50, 1929.

[6] Leechman, Fleece-bearing dogs, *Nature Magazine*, XIV, 177-178, 1929.

[7] Starbuck, History of the American whale fishery from its earliest inception to the year 1876, *Rept. U. S. Fish Comm. for 1875-76*, pp. 1-779. Jenkins, *A history of the whale fisheries*, London, 1921. Hohman, *The American whaleman: A study of life and labor in the whaling industry*, N.Y., 1928. Cook, J. A., *The whale: A quarter-century of whaling in the Arctic*, Boston, 1926. See also various publications cited in subsequent footnotes of this chapter.

sum for those days. The former importance of the whale to northern regions is thus stated:[8]

The flesh of the whale, which resembles coarse beef, is a necessary article of food. It affords a thin, transparent substance which answers the purpose of window glass, and the sinews, when properly separated, are used for thread. The common bones are employed in building the hut, the whalebone in finishing canoes and rude implements, and the remainder is no despicable material for fuel. Besides, the train oil and oleaginous matter of all kinds are more grateful to the taste of the natives than the choicest delicacies to a refined people.

Geographical science owes a great deal to the voyages of whaling and sealing vessels which sailed uncharted seas and brought back the first information concerning continental bays, inlets, harbors and headlands, as well as many oceanic islands. History also must acknowledge the influence of these kindred industries which once occupied so large a place in the commerce of nations, though now comparatively unimportant. Starbuck says:[9]

In many ports, among hundreds of islands, on many seas, the flag of the country from which they sailed was first displayed from the masthead of a whale ship. Pursuing their avocation wherever a chance presented, the American flag was first unfurled in an English port from the deck of one American whaleman, and the ports of the western coast of South America first beheld the Stars and Stripes shown as the standard of another. It may be safely alleged that but for them the western oceans would much longer have been comparatively unknown, and with equal truth may it be said that whatever of honor or glory the United States may have won in its explorations of these oceans, the necessity for the explorations was a tribute wrung from the government, though not without earnest and continued effort, to the interests of our mariners, who, for years before, had pursued the whale in these uncharted seas, and threaded their way with extremest care among these undescribed islands, reefs and shoals. Into the field opened by them flowed the trade of the civilized world. In their footsteps followed Christianity. They introduced the missionary to new spheres of usefulness, and made his presence tenable. Says a writer in the *London Quarterly Review:* "The whale industry first opened to Great Britain a beneficial intercourse with the coast of Spanish America; it led in the sequel to the independence of the Spanish colonies. . . . But for our whalers, we never might have founded our colonies in Van Dieman's Land and Australia—or if we had we could not have maintained them in their early stages of danger and privation. Moreover, our intimacy with the Polynesians must be traced to the same source. The whalers were the first that traded in that quarter—they prepared the field for the missionaries; and the same thing is now in progress in New Ireland, New Britain and New Zealand." All that the English fishery has done for Great Britain, the American fishery has done for the United States, and more.

[8] *North American Review,* XXXVIII, 85-114, 1834, reviewing at length some books on whaling by Scoresby.

[9] Starbuck, History of the American whale fishery from its earliest inception to the year 1876, *Rept. U. S. Fish Comm. for 1875-76,* pp. 2-3.

St. John says that in 1769 the first fifty Nantucket whaling vessels coming in brought 11,000 barrels of oil. In 1770 they fitted out 197 vessels with 2158 men for whaling.[10]

Sanford[11] says there were over 700 vessels from the United States engaged in whaling in 1850 and less than 100 in 1882. Smiley[12] gives the number in 1853 as 543 vessels, with a total tonnage of 171,484 tons, which in 1884 had declined to 144 vessels, with a total of 33,119 tons. From his statistical tables the following items show the decrease in imports and exports:

| | *Barrels of Sperm oil* | *Barrels of Whale oil* | *Pounds of Whalebone* |
|---|---|---|---|
| Imports 1853 | 103,077 | 260,114 | 5,652,300 |
| Imports 1883 | 24,595 | 24,170 | 254,037 |
| Exports 1867 | 25,147 | 18,253 | 717,496 |
| Exports 1883 | 13,996 | 4,543 | 175,614 |

Stevenson[13] tells us that in 1860 the production of the United States whaling fleet was 73,708 barrels of sperm oil and 140,005 barrels of whale oil, and in 1902 only 21,970 barrels of sperm oil and 4725 of whale oil; and that the manufacture of spermaceti from 1835 to 1845 averaged over 3,000,000 pounds, and then dropped to 200,000 pounds in 1890, and 400,000 pounds, worth $100,000, in 1901. Clark[14] says that in 1880 the American whaling industry employed 171 vessels, worth $2,891,650, with an additional $1,733,000 invested in wharfs, warehouses and oil refineries.

From Starbuck's *History of the American Whale Fishery* the following items are gleaned: During several years from 1804 to 1876 over 5,000,000 gallons of sperm oil, over 10,000,000 gallons of whale oil and over 3,000,000 pounds of whalebone were imported into the United States, the total value of all for that whole period being $331,949,480. Total exports from 1791 to 1876 were—sperm oil, 35,399,785 gallons; whale oil, 105,967,473 gallons; whalebone, 54,967,200 pounds; sperm candles, 33,395,056 pounds; total value of

[10] St. John, An account of the whale industry of Nantucket, Massachusetts, one hundred years ago, *Bull. U. S. Fish Comm.*, III, 179-182, 1883.

[11] Sanford, Notes on the history of the American whale fishery, *Rept. U. S. Fish Comm. for 1882-83*, pp. 205-220.

[12] Smiley, Review of the whale fishery for 1882-1883, *Rept. U. S. Fish Comm. for 1883*, pp. 325-336, including statistics from 1853 to 1883.

[13] Stevenson, Aquatic products in arts and industries, *Rept. U. S. Fish Comm. for 1902*, pp. 177-252; see especially pp. 204, 244-247.

[14] Clark, The whale fishery: History and present condition of the fishery, *The Fisheries and Fishing Industries of the U. S.*, Sec. v, Vol. II, pp. 3, 293, 1887.

all from 1803 to 1876, $116,948,558. This was at a time when the purchasing power of money was much greater than at present, and when "big business" was measured in thousands of dollars, instead of millions or billions. Consequently, $116,000,000 meant a great deal more than it does at present. Starbuck also says that in 1839 there were in the North Pacific only two whaling vessels, with a catch for the season of 2800 barrels of oil; in 1852 there were 278 vessels, with a catch of 373,450 barrels; then followed a steady decline to only eight vessels in 1876, and a catch of only 5250 barrels; that in 1761 there were eight sperm candle factories in New England and one in Philadelphia, and that the exports of sperm candles (then in great demand) from 1791 to 1811 ranged from 127,602 to 294,789 pounds annually.

In 1885 crews of Norwegian vessels killed 1600 or 1700 whales.[15] In Newfoundland waters 1000 whales were taken in 1904 and 1200 in 1905.[16] In 1893 two whaling vessels took 126 bowhead whales and the others of the fleet took from nine to forty each, in the Arctic Ocean north of the Mackenzie River, while in 1904 in that region the largest number taken by one vessel was nine.[17] One whaling vessel took from Hudson Bay to London on a single voyage $150,000 worth of whale oil and whalebone.[18] At one whaling station in the American Antarctic 5500 whales were taken in a single season.[19] From 1874 to 1885 the Arctic whaling fleet, reporting at San Francisco, brought in a total of 194,217 barrels of oil, 2,509,568 pounds of whalebone and 260,485 pounds of ivory. Kellogg has published a detailed table showing that along the Pacific Coast of North America, from 1919 to 1929, both inclusive, 15,985 whales were taken, yielding 530,120 barrels of oil.[20] In 1853 it was estimated by Scammon that 30,000 gray whales annually visited the California coast. From 1919 to 1923 only five individuals of this species were taken, though the total catch of whales of all species along that coast during the period included 1 bottlenose, 1 sei, 4 sperms, 5 sulphur-bottoms, 19 finbacks and 781 hump-

[15] Southwell, Notes on the seal and whale fishery of 1886, *Bull. U. S. Fish Comm.*, VII, 11-16, 1887.

[16] Prince, *The whaling industry and the Cetacea of Canada,* Government Printing Office, Ottawa, Special Rept., 1906.

[17] Preble, *N. Amer. Fauna,* No. 27, p. 127, 1908.

[18] Preble, *N. Amer. Fauna,* No. 22, p. 39, 1902.

[19] Osborne and Anthony, Close of the age of mammals, *Journ. Mammalogy,* III, 219-237, 1922.

[20] Statistics of whaling, cod-fishing and salmon-packing on the Pacific Coast, *Bull. U. S. Fish Comm.,* VI, 89-90, 1886. Kellogg, *Journ. Mammalogy,* XII, 73-77, 1931.

backs; and the right whales, once abundant from Oregon northward, are now also scarce.[21] Starks says that in 1854 "there were shipped from Honolulu (the Pacific whaling center at that time) 1,306,567 gallons of whale oil; that 650 ships and 15,000 men were engaged in Pacific whaling, at a capital invested by United States citizens of not less than $20,000,000.[22]

On the northwest coast of America one vessel in 1910 captured fifteen Arctic right whales, and another reported a cargo of whalebone worth $130,000 at $8.00 a ton. In 1911, 10,000 finback and humpback whales were killed in the Antarctic seas, 3000 in the seas of Europe and 2000 about South Africa, besides many around Japan and South America; and in 1913 it was estimated that 20,000 whales were being killed annually.[23] The latest information, just at hand, is that the 1928-1929 catch of whales for the whole world was 27,566 whales (blue whale 13,650, finback 9132, sperm 1761, sei 1549, humpback 304, others 1170), which yielded 1,867,848 barrels of oil.[24] More than half of these were taken by Norwegian whalers.

Baleen is whalebone in its natural state, before it is split into thin layers. It is not really bone, but is "an elastic, horny substance which grows in place of teeth in the upper jaw" of the group of whales known as whalebone whales (Balaenidae). It functions in straining crustaceans and other food for the whales out of the water. It consists of several hundred thin, parallel plates, from a few inches to several feet in length, and "stands quite alone among animal substances in a particular combination of lightness, toughness, flexibility, elasticity and durability, together with such a cleavage (due to the straightness of the parallel fibers) that it may be split for its whole length to any desired thickness of strips."[25] In the bowhead whale the plates are about 10 feet long and from 10 to 12 inches wide at the base, but before the larger whales were all killed off plates 15 feet long were obtained. In 1821 the production of baleen in the United States fisheries was 62,893 pounds, valued at 12 cents a pound; increasing to 5,652,300 pounds in 1853, with an average value of 35 cents; decreasing to

[21] Evermann, The conservation of the marine life of the Pacific, *Scientific Monthly,* XVI, 526-527, 1923; XV, 310, 1922; *Mid-Pacific Magazine,* XXV, 303-328, 1923. *California Fish and Game,* IX, 31, 1923.

[22] Starks, A history of California shore whaling, *California Fish and Game Comm., Fish Bull.,* No. 6, p. 16, 1922.

[23] Robot, The whale fisheries of the world, *Ann. Rept. Smithsonian Inst. for 1913,* pp. 481-489; reprinted from *La Nature,* Paris, Sept. 14, 1912; citing *Norwegian Fisheries Gazette (Norsk Fiskeritidende).*

[24] Townsend, The whaling situation, *Science,* LXXII, 652-653, 1930.

[25] *Century Dictionary and Cyclopedia,* VIII, p. 6884, 1902.

96,600 pounds in 1906, with a value of $4.50 a pound; $200,000,000 worth obtained from 1850 to 1902; a total of 90,000,000 pounds taken in the nineteenth century, which, at prices ranging early in the twentieth century, would have been worth $450,000,000. One bowhead whale will yield as much as 275 barrels of oil and 3000 pounds of baleen, and one right whale will yield up to 130 barrels of oil and 1500 pounds of baleen.[26]

After extracting the oil and baleen, the waste of the carcass and skeleton is made into food for cattle, bone-meal and fertilizer, these products ranging from $20 to $40 per ton.[27] Though much more rarely obtained, ambergris is far the most valuable product of the whale, in proportion to its bulk.

Ambergris is a wax-like substance found at rare intervals, but sometimes in relatively large quantities, in the intestine of the sperm whale. With the exception of choice pearls and coral, it is the highest-priced product of the fisheries, selling at upward of $40 per ounce. It has been a valuable object of commerce for hundreds of years. It appears to have been prized first by the Arabians, by whom it was called amber, and by this name it was first known among the Europeans. The name was later extended to the fossilized gum, the two being distinguished by their respective colors as *amber gris* and *amber jaune*. In the writings of early travellers to the shores of the Indian Ocean and to southern Asia, references to ambergris are by no means infrequent. Before the time of Marco Polo (1254-1324), Zanzibar was famous for its ambergris. So plentiful was it on the shores of the Indian Ocean in the sixteenth and seventeenth centuries that the name was given to various islands, capes and mountain peaks of the region. It was also found on certain shores of the Pacific, notably the coast of Japan. From their station in Batavia the Dutch traders kept Europe supplied, and also exported it to Asiatic markets. . . . It is now generally conceded that ambergris is generated in either sex of the sperm whale, but far more frequently in the male, and is the result of a diseased state of the animal, caused possibly by a biliary irritation, as the individuals from which it is secured are almost invariably of a sickly appearance and sometimes greatly emaciated. It is not of frequent occurrence, many whalemen with half a century's experience never having seen any. The victim of the malady may eject the morbific substance, thus furnishing the lumps which have been found on the shores or floating on the seas frequented by sperm whales. Although ambergris is of such rare occurrence, the sperm whalers always search for it, especially in diseased or emaciated whales.[28]

Ambergris has been used, according to Stevenson, in sacradotal rites of the church, as a flavor in cookery, as a medicine, but chiefly in the manufacture of perfumery. He reports that a 182-pound lump in 1893

[26] Stevenson, Whalebone: Its production and utilization, *U. S. Bureau of Fisheries, Document No. 626,* 1907; Aquatic products in arts and industries. *Rept. U. S. Fish Comm. for 1902,* p. 181. *National Geographic Magazine,* XIX, 883-885, 1908. Cram and Stone, *American Animals,* pp. 16, 18, 1902.

[27] Bower and Aller, *Rept. U. S. Fish Comm.,* App. X, pp. 58-64. 1914.

[28] Stevenson, Aquatic products in arts and industries, *Rept. U. S. Comm. Fish and Fisheries for 1902,* pp. 177-252.

was sold by the King of Tydore to the Dutch East India Company for 11,000 thalers, and the Grand Duke of Tuscany was reported to have offered 50,000 crowns for it; an alleged 132-pound lump in 1782 brought only £500; in 1791, 362 pounds from one whale was sold for 19s. 6d an ounce, though the prevailing price at the time was 25s.; in 1858 a 600-pound lot which the owners refused to divide was finally sold for $10,500; in 1866, 150 pounds from one whale sold for $10,000 in gold; in 1878 an 18-pound lot brought $150 a pound, a 132¾-pound lot brought $23,231, and at about the same time 125 pounds sold for $20,000 and 100 pounds for $17,500; in 1882, 136 pounds sold for $14,000; 1891, 162 pounds for $10,000; 1894, 109 pounds for $26,000.[29]

Notwithstanding the general slaughter of whales and the fact that certain valuable species have become rare, because of unrestricted hunting by destructive and wasteful methods, some other species are still fairly common in certain localities, though the whole industry is probably doomed unless radical conservation measures are soon adopted and enforced, perhaps by concerted international action. A Council for the Conservation of Whales has been organized by the American Society of Mammalogists. On the west coast of Mexico over 800 whales were taken in six months in 1924-1925, mostly humpbacks and sperms (no grays), weighing from 35 to 100 tons and worth from $400 to $3,000 each.[30] One whaling company in 1918 took 999 whales on the coasts of Washington, British Columbia and Alaska.[31] The total amount invested in the business and the annual product is still large and the methods of hunting and handling the catch and utilizing the by-products have been much improved. It was reported that in Alaska alone in 1914 the investment in the whaling industry was $1,456,649, with a product that year worth $291,099.[32] According to United Press dispatches, the fleet of whaling vessels and floating refineries returning from the South Seas in 1930 brought the largest cargoes of sperm oil and by-products ever loaded, obtained from whales which were located and reported by wireless-equipped airplanes and killed by electric harpoons. One vessel brought 62,000 barrels of oil and another brought 37,000 barrels.

[29] Stevenson, *Rept. U. S. Comm. Fish, etc., for 1902,* pp. 248-252. Prince, *The Whaling industry and the Cetacea of Canada,* Special Reports, Gov. Ptg. Office, Ottawa, 1906. Clark, The whale fishery, in *Fisheries and Fishing Industries of U. S.,* 1887, Sec. v, Vol. 2, pp. 72, 212.

[30] *California Fish and Game,* xi, 79, 1925.

[31] *California Fish and Game,* v, 80, 1919.

[32] Bower and Aller, *Rept. U. S. Fish Comm. for 1914,* App. x, pp. 58-64.

The walrus also has been relentlessly pursued for its oil, as well as for its ivory, until it has become too scarce for profitable hunting. While it was plentiful, its habits made it much more easily obtained than whales. At one rookery in Norway 600 were killed in six hours, and on the northwest coast of North America from 1870 to 1880 about 100,000 were killed, which yielded 1,996,000 gallons of oil and 398,868 pounds of ivory, reducing the number of these animals 50 per cent in ten years.[33] This was a calamity to the natives of the northern Alaskan coast, who were so dependent upon the walrus for food and raiment prior to the introduction of the reindeer for their benefit. The sea-elephants also have fallen prey to the commercial hunters, the production of sea-elephant oil from all the southern islands from 1803 to 1900 having aggregated over 242,000 barrels, valued at $5,420,000.[34] One may well wonder whether that amount is sufficient to pay for the threatened extermination of that interesting animal. Lucas says that prior to 1889 there were killed annually for their oil and leather 875,000 hair seals, in addition to 185,000 fur seals taken annually for their fur.[35] Sea-lions have been destroyed in large numbers for their oil, hides, "whiskers," gall-bladders, etc.[36] Porpoises also have played a part in the production of oil.[37]

In addition to wool, oil, skins, whalebone and other materials more particularly discussed in this and other chapters, the report of imports to and exports from the United States in 1925 include the following:[38]

| | *Exports* | *Imports* |
|---|---|---|
| Gelatin, glue, etc., of animal origin .................... | $684,000 | $1,404,000 |
| Bones, hoofs, horns and articles manufactured therefrom | 744,000 | 1,231,000 |
| Ivory tusks, natural .................................. | | 1,373,000 |

Animal compost from the barnyard, used as a fertilizer, returns to the soil considerable plant food taken from the fields in the shape of crops of hay and grain, and its total value to the farmers must aggregate a very large sum of money. Considerable of the waste of whales at the whaling stations is also converted into fertilizer. Bats as a source of fertilizer have recently been much discussed. Artificial

[33] Stevenson, *Rept. U. S. Fish Comm. for 1902*, p. 214. Clark, *Fisheries and fishing industries of the U. S.*, sec. v, Vol. II, p. 318, 1887. Lucas, *Ann. Rept. U. S. National Museum for 1889*, p. 618.

[34] Stevenson, *Rept. U. S. Fish Comm. for 1902*, pp. 211-214.

[35] Lucas, *Ann. Rept. U. S. National Museum for 1889*, p. 611.

[36] Rowley, *Journ. Mammalogy*, x, 1-36, 1929.

[37] Cook, The manufacture of porpoise oil, *Proc. U. S. National Museum*, I, 16-18, 1878.

[38] *Statistical Abstract of the U. S. for 1925*, U. S. Bureau of Commerce, 1926.

bat roosts in Texas are reported, on inconclusive evidence, to have yielded sufficient guano to be profitable, but that would not be the case in most localities. Bat guano filled some of the rooms in the great Carlsbad Cavern in New Mexico to a depth of 100 feet, the accumulation of many centuries, and it is estimated that 100,000 tons of it, valued at several million dollars, have been removed and marketed.[39] Guano obtained from wood-rat nests in the southwestern United States is used by florists.[40] Bones of various land mammals have been ground up for use as fertilizer. It has been estimated that from 1868 to 1880 $2,500,000 were paid for bison bones from Kansas, Nebraska and Missouri,[41] and an extensive traffic in the bleached bones was carried on from Texas to British America for some years after the bison had practically disappeared from the plains as a living animal. Great piles of bison bones, gathered by Indians and sold to buyers at from $5 to $7 a ton for the manufacture of charcoal, photographed at Saskatoon, Saskatchewan, on August 9, 1890, were estimated to contain the bones of 25,000 individual animals.[42]

Deer antlers are very extensively used in the manufacture of handles for knives and forks, and the waste therefrom is converted into gelatine or size used in the manufacture of cloth.[43] The American Indians used deer-horn and various bones in making tools for several purposes, far back in prehistoric times, as well as during recent years. They have also used porcupine quills and other materials derived from mammals, in the manufacture and ornamentation of clothing, moccasins and other articles. Teeth of the wapiti or American elk are much used as the emblem of a great fraternal organization. Many hundreds of these noble animals have been killed solely for their teeth,[44] partly illegally, a practice that has not entirely ceased. The flesh, skins and antlers are left on the ground for fear of detection in attempting to use or remove such bulky things.

[39] Campbell, *Bats, mosquitoes and dollars,* 1925. Nelson, Bats in relation to the production of guano and the destruction of mosquitoes, *U. S. Dept. Agric. Bull.* No. 1395, 1926. Howard, Mosquitoes and bats, *U. S. Public Health Repts.,* XXXV, 1789-1895, 1920. Bailey, *Animal life in Carlsbad Cavern,* pp. 2, 5, 108, 113, 1928; Bats of the Carlsbad Cavern, *Natl. Geog. Mag.,* XLVIII, 321-330, 1925.

[40] Streator, Commercial fertilizer from wood rat nests, *Journ. Mammalogy,* XI, 318, 1930.

[41] McAllister, California *Fish and Game,* XIV, 155, 1928, *citing Whitney, Reminiscences of the sportsman,* p. 162.

[42] Hewitt, *The conservation of the wild life of Canada,* Plate X, 1921.

[43] Lantz, *U. S. Biol. Surv. Bull.* No. 36, 1910.

[44] Graves and Nelson, Our national elk herds, *U. S. Dept. Agric. Circular* No. 51, 1919. Bailey, *N. Amer. Fauna,* No. 49, p. 33, 1926.

Elephants yield most of the commercial ivory used in the manufacture of billiard balls and other articles. A great deal of fossil mammoth ivory is obtained from the frozen soil of Siberia and some from Alaska and Yukon Territory. Digby[45] says he saw 1000 pairs of mammoth tusks in Siberia in one year. In 1899 it was estimated that 100,000 elephants, "a procession 180 miles long," were killed annually for their ivory, and Carey says that notwithstanding the efforts to protect them by law they are still being slaughtered, $250,000 worth of tusks being annually smuggled out of British Africa.[46] Walrus ivory is also much used, but those animals, too, have greatly diminished in numbers. Many of the ivory articles sold to tourists in the Northwest are said to have been made of mammoth ivory, but some are walrus ivory. The "whitest and hardest ivory known" is that of hippopotamus teeth.[47]

[45] Digby, *The mammoth and mammoth hunting in Northeast Siberia,* 1926.
[46] Lucas, *Ann. Rept. U. S. Natl. Museum for 1889,* p. 611. Carey, *Journ. Mammalogy,* VII, 83, 1926. Lang, *ibid.,* IV, 163, 1923. Phillips, *ibid.,* VI, 130-131, 1925.
[47] Jennison, *Natural History: animals,* p. 308, 1927.

## VII

## DAMAGE TO THE HUMAN FOOD SUPPLY BY MAMMALS

We have briefly considered the bright side of the relation of mammals to our food supply. The dark side is the destructiveness of certain species. It is impossible to make an accurate estimate of the damage done by them. Even where an entire crop is destroyed, as sometimes happens, one cannot determine with certainty just the amount of damage, as the value of an unharvested crop cannot be absolutely known; much less is it possible where the damage is only partial, as is usually the case. However, after making all allowances for possible inaccuracies in estimates, the aggregate amount of damage from depredations of mammals is appalling.

We must admit also the impossibility of completely segregating the damage to the human food supply from damage to food not directly destined for human use, and in the estimates as published are often included damage to commodities not usable for food of any animals. Maize, or corn, as it is commonly called in America, is used to some extent as human food, but is also fed in large quantities to cattle, horses and hogs. Even the latter portion indirectly affects the human food supply, as we eat the beef and pork derived from the cattle and hogs that consume the corn. We do not eat grass or hay, but their destruction by rodents may affect the animals from which we derive our meat and thus indirectly affect our food supply.

In estimates of damage by house rats and mice is often included damage to furs, rugs, textiles and many commodities not usable as food for men and women. All this must be kept in mind in the use of estimates herein contained, in order that they may not be misleading. Rodents, because of their great numbers, are the chief offenders. Bell has estimated the annual damage to crops in the United States by all rodents, evidently including the introduced species, at $500,000,000, with some special estimates for particular states, as follows: Montana, $15,000,000 to $20,000,000; North Dakota, $6,000,000 to $9,000,000; Kansas, $12,000,000; Colorado, $2,000,000; California, $20,000,000; loss to crops and pasturage from native rodents, $300,000,000; damage to orchard trees by pine mice alone in one county of Virginia from 1915 to 1917, $200,000.[1] According to Vorhies and Taylor, house rats and mice annually do damage to the extent of $200,000,000 in warehouses of the United States, while native rodents do damage amounting to $300,000,000 to agriculture in the western states annually.[2] Some students of the subject assert that the damage done to food supplies in homes, stores and warehouses, by tracking in filth from stables, etc., and mussing over the food, making it unfit for food, is as great or greater than that caused by the actual destruction of food.

The brown house rat of Europe, now of world-wide distribution, is characterized as the "most destructive animal in the world." The total damage done by the vast horde of rats the world over has been said to be greater than that wrought by all other noxious mammals. That may be doubted, though it is certainly enough. The brown rat is estimated by Lantz to do damage to the amount of $200,000,000 annually to property of one sort or another in the United States, much of which is to human food.[3] As to abundance of rats, Forbush tells us that 31,981 were killed in five years under supervision of the owner of a 2000-acre farm in England, and it was estimated that 5000 more were killed by workmen in threshing the grain; 38,000 were killed on one Jamaican plantation in one year; 16,050 in one French slaughter house in one month; 47,000 on two Georgia plantations in winter and spring of one year; 278,000 in San Francisco in four months during the campaign against bubonic plague, with probably 500,000 more poisoned; 103,000 in Copenhagen in eighteen weeks; 711,797 in Stockholm in seven years; 12,000,000 in a plague in India, etc. He estimates the annual damage by each rat at $1.82 (citing Surgeon Creel), and the total damage to agriculture alone in several countries as follows:[4] Denmark, $3,000,000; Great Britain and Ireland, $73,000,000; Germany, $50,000,000; France, $40,000,000. To this must be added a wholly unknown amount of intangible damage, such as loss of rent of rat-infested buildings, the cost of trapping, poisoning and other-

[1] Bell, Death to the rodents, *Yearbook U. S. Dept. Agric. for 1920*, pp. 421-438; see also *Yearbook for 1917*, pp. 225-233. Taylor, *U. S. Dept. Agric., Dept. Bull.* No. 1227, p. 1, 1924.

[2] Vorhies and Taylor, *U. S. Dept. Agric. Dept. Bull.* No. 1091, 1922. Taylor and Loftfield, *Dept.* Bull. No. 1227, 1924.

[3] Lantz, The house rat: The most destructive animal in the world, *Yearbook U. S. Dept. Agric. for 1917*, pp. 237-251. Silver, How to get rid of rats, *Farmers' Bull.*, No. 1302, 1923.

[4] Forbush, Rats and rat riddance, *Massachusetts Board of Agric., Biological Bulletin*, No. 1, 1915 (also 32d Ann. Rept.).

wise destroying rats, fumigating ships, rat-proofing buildings and in various other ways seeking to prevent damage by rats, fires caused by rats and the relation of these rodents to public health. Fisher says that rats "kill more young chickens than any other animal."[5] Following this indictment we may add that the house rat has no redeeming feature. Unlike rabbits, for example, its destructiveness is not to any real extent recompensed by its value as food.

Wood rats are not as a rule abundant enough to do much damage, but some species in certain localities become very abundant and do much damage to gardens and along the edges of grain fields. In Oregon they have been known to damage fruit trees by gnawing the bark.[6]

In districts where they occur, pocket gophers are considered among the most injurious of our native mammals, the annual loss caused by them to farmers and fruit-growers of the United States having been estimated at over $12,000,000,[7] $1,000,000 for Nebraska alone.[8]

The house mouse, already mentioned in connection with the house rat, is a great pest and does a large amount of damage by the destruction of grain and other foodstuffs in granaries, stores, warehouses and dwellings, as well as by injury to many other commodities. It is also a potential menace as a field pest. This is well illustrated by a recent house mouse plague in California, when they swarmed over the fields of Kern County at an estimated frequency of 82,000 to the acre, doing great damage to crops.[9] Because of their fecundity, various other species of mice, under conditions favorable to high birth and low death rates, overpopulate their native habitat, destroy their natural food supply and swarm out over adjacent territory. There are many reports of vole and lemming plagues in Europe and Asia. In Scandinavia, lemmings are said to indulge in somewhat periodic migrations from the highlands to the valleys in vast droves, destroying the crops and other vegetation in their paths.[10] As serious as such occasional invasions are locally, on the whole the steady drain of normal mouse popu-

[5] Fisher, *Yearbook U. S. Dept. Agric. for 1908*, p. 193.

[6] Bailey, *Farmers' Bull.*, No. 335, p. 17, 1908. Dice, *Journ. Mammalogy*, VI, 282, 1925.

[7] Bailey, *Farmers' Bull.*, No. 335, 1908; *N. Amer. Fauna*, No. 49, p. 125, 1926. Lantz, *Yearbook for 1909*, pp. 209-218.

[8] Bruner, *Nebraska Agric. Exper. Sta., Press Bull.*, No. 29, 1908.

[9] Hall, An outbreak of the house mouse in Kern County, California, *Univ. California Pub. in Zool.*, XXX, 189-203, 1927.

[10] Lantz, *U. S. Biol. Surv. Bull.* No. 31, pp. 6-7, 1907. Cabot, *Labrador*, 1921, quoted by Allen, *Jour. Mammalogy*, III, 56-57, 1922.

lations is probably more serious, though less spectacular and therefore more likely to escape notice.

The field or meadow mice of the United States are not ordinarily considered very serious pests, though they are abundant in many localities and doubtless require a very large quantity of grass and other vegetation to sustain them. By their injury to pasturage they may to some extent affect our meat supply. In the neighborhood of orchards and nurseries they often inflict much damage by gnawing and girdling the trees, thus also indirectly affecting our food supply more or less. The damage done to nursery stock by these rodents at Rochester, New York, in 1901-1902, was estimated at $100,000 while in 1920 they injured 1500 trees in one orchard and 1000 in another; and in 1918 a mouse plague in one New York county did damage estimated at $200,000.[11] In a field mouse plague in Nevada in 1907-1908 it was estimated that there were 8000 to 12,000 mice per acre, resulting in an almost total loss of the alfalfa crop, even the roots being eaten, necessitating the re-seeding of 15,000 out of 20,000 acres,[12] the loss of the alfalfa affecting the human food supply, in a very indirect, intangible way and perhaps to a slight degree, but none the less certainly. This is also true of the destruction of 90 per cent of the crowns of beets in a Colorado seed-beet silo.[13] The white-footed mice or deer mice are more generally distributed and do considerable damage, especially to grain in the shock.

Kangaroo rats are much more local in distribution than either field or deer mice, but where they occur they are sometimes very abundant and destructive to grain and vegetables. Half a bushel of peas and other seeds have been found in a single burrow.[14] These rodents eat the seeds of important forage grasses, sometimes storing as much as twelve pounds of seeds in a single den, and denuding the ground of vegetation within a radius of from fifteen to twenty-five feet about their burrows.[15] In fact, any small species of rodent is a potential pest, as it may become overabundant during favorable seasons and hence destructive.

[11] Lantz, An economic study of field mice, *U. S. Biol. Surv. Bull.* No. 31, 1907. Silver. Mouse control in field and orchard, *Farmers' Bull.*, No. 1397, 1924.
[12] Piper, The Nevada mouse plague of 1907-08, *Farmers' Bull.*, No. 352, 1909; *Yearbook U. S. Dept. Agric. for 1908*, pp. 301-310. Bailey, *Farmers' Bull.*, No. 335, 1908.
[13] Burnett, *Office of Colorado State Entomologist Circular* No. 25, 1918.
[14] Burnett, *Office Colorado State Entomologist Circular* No. 25, 1918.
[15] Taylor, *Scientific Monthly*, XXI, 2, 1925.

Where they occur in immense colonies over a vast area in the western United States, prairie-dogs do great damage to fields in the vicinity of their colonies, and especially to grass lands, thus reducing the number of cattle and sheep the plains are capable of supporting.[16] Merriam estimated one colony in Texas to cover 25,000 square miles and to contain 400,000,000 prairie-dogs, with an annual loss of from 50 per cent to 75 per cent of the producing capacity of the land so occupied, reducing by a great many thousands the number of cattle the land could support.[17]

Rabbits are more or less injurious wherever they occur about orchards, fields and gardens. The cottontails, found all over the United States, gnaw the bark of orchard trees during the northern winters and in the summer raid the gardens and fields. They are kept pretty well in check in most localities by natural enemies, hunters and epidemic diseases, consequently are not usually abundant enough to be very destructive, and at least partly compensate for the damage done, by the meat and healthful sport they provide. The hares, or jack rabbits of the western plains are larger, in many places abundant, since the destruction of so many coyotes, hawks and other enemies, and are locally very destructive to field crops and pasturage. In one county of California the damage done by them in one year was estimated at $600,000.[18] Their local abundance is well shown by the number killed in annual rabbit drives held in various parts of the West. It is said that 59,000 were killed in one winter in an Oregon county, 40,000 in one Idaho county, 15,000 in another and 20,000 in another.[19] The European hare, introduced into New York, is said to have done damage to the extent of $100,000 in a single county in one winter.[20] Rabbits, introduced into Australia, where they are not native and are exempt from their natural bird and mammal enemies, increased very rapidly

[16] Payne, The prairie-dog as a range pest, *Colorado Agric. Exper. Sta., Press Bull.* No. 16, 1903. Burnett, *Office Colorado State Entomologist Circular* No. 8, 1913; No. 17, 1915; No. 25, 1916. Bailey, *N. Amer. Fauna,* No. 49, 1926. Taylor and Loftfield, Damage to range grasses by the Zuni prairie-dog, *U. S. Dept. Agric.,* Bull. No. 1227, 1924.

[17] Merriam, The prairie-dog of the Great Plains, *Yearbook U. S. Dept. Agric. for 1901,* pp. 257-270.

[18] Palmer, The jackrabbits of the United States, *U. S. Biol. Surv. Bull.* No. 8, 1897. Bryant, Rabbits damage crops in San Diego County, *California Fish and Game,* II, 215-218, 1916 (both jackrabbits and cottontails).

[19] Bell, *Yearbook U. S. Dept. Agric. for 1917,* p. 232. Burnett, *Office Colorado State Entom. Circular* No. 25, 1918.

[20] Silver, *Journ. Agric. Research,* XXVIII, 1133-1137, 1924.

and soon became a menace to agriculture and stock raising. It is said that in ten years from 1878 to 1880, the damage done by them amounted to $15,000,000, in addition to tremendous sums expended in efforts to destroy them and to prevent the depredations.[21]

Many species of the squirrel family are not particularly destructive, but perhaps tree squirrels do sometimes take more nuts than they are entitled to, though as a rule they are easily kept in check. Some species of ground squirrels are much more abundant, less easily controlled and decidedly injurious. In 1908 Bailey estimated the annual damage done by them to agriculture and fruit raising at $10,000,000,[22] but in 1926 he estimated the annual damage in North Dakota alone at from $6,000,000 to $9,000,000, besides $100,000 spent in combating them.[23] On the other hand, some species are about as useful as harmful.[24]

Woodchucks, usually not common enough to be very injurious, sometimes become plentiful about farms and may be injurious to both field and garden crops.[25] Porcupines do more or less damage to forest trees and sometimes make harmful raids upon shade and orchard trees. One orchard in a porcupine district was unmolested for seven years, then in sixteen days they killed 140 plum and cherry trees and damaged apple trees by climbing to the tops and nibbling the fruit spurs.[26]

The larger predatory mammals directly affect our meat supply by their attacks upon cattle, sheep, swine, poultry, game birds and mammals. So great has been their destruction of stock and game on the western stock ranges and in national parks and national forests, that the United States Biological Survey has for a number of years been cooperating with stockmen and with the U. S. Forest Service and the National Park Service in campaigns against wolves, coyotes, mountain lions, bobcats and lynxes. From 1914 to 1920 these campaigns resulted in the capture of 109,346 coyotes and 2936 wolves, besides many

[21] Palmer, *U. S. Division of Ornithology and Mammology Bull.* No. 8, p. 25, 1897; *Yearbook U. S. Dept. Agric. for 1898*, pp. 87-110.

[22] Bailey, *U. S. Dept. Agric., Farmers' Bull.* No. 335, 1908.

[23] Bailey, *N. Amer. Fauna*, No. 49, p. 58, 1926. See also Birdseye, *Farmers' Bull.*, No. 484, p. 10, 1912. Burnett, *Off. Colorado State Entom. Circular* No. 9, 1913, No. 20, 1916.

[24] Burnett, *Off. Colorado State Entom. Circ.* No. 14, 1914; No. 18, 1916. Gillette, *Iowa Agric. Exper. Sta. Bull.* No. 6, 1889. Aldrich, *South Dakota Exper. Sta. Bull.* No. 30, 1892. Bailey, *N. Amer. Fauna*, No. 49, p. 58, 1926.

[25] Birdseye, *Farmers' Bull.* No. 484, 1912. Bailey, *N. Amer. Fauna*, No. 49, p. 67, 1926.

[26] Mosteller, Porcupines in relation to Wyoming orchards, *Seventh Ann. Rept. Wyoming Board of Horticulture*, pp. 25-27, 1915.

mountain lions and other predators. The annual damage to domestic stock in the United States has been estimated at from $20,000,000 to $30,000,000 (in Nevada alone, 34,350 cattle, 165,000 sheep and 850 horses).[27]

Black bears sometimes kill stock, deer or young elk,[28] though, as they also eat the "kills" of mountain lions and other animals, they are often wrongly accused when their tracks are seen about carcasses of cattle, sheep or deer.[29] Anthony says he has often investigated allegations of black bears killing sheep and has "never yet found a clear case of killing by the bear,"[30] but Lorenzen tells of actually witnessing such a case, though he thinks it is exceptional.[31] Grizzlies, though not so common, are individually much more destructive to stock, one having been accused of killing 1200 cattle in fifteen years.[32]

Wolves are very destructive to deer in some localities, as well as to domestic stock. One is supposed to have killed 125 cattle, worth $5,000, in ten months, and another is believed to have killed $25,000 worth in seven years.[33] Coyotes cause an annual loss to sheep raisers of several hundred thousand dollars[34] and sometimes kill young deer,[35] though they feed more extensively upon rabbits and various rodents. Foxes take some poultry and game birds, but feed largely upon rodents.[36] One lair contained remains of many short-eared owls and a number of grouse, ducks, shorebirds, rats, voles and lambs.[37]

An occasional dog develops the sheep-killing habit. The damage caused thereby is frequently mentioned in various reports published by the United States Department of Agriculture, at least as far back as 1862, and laws relating thereto are in force in many of the states, some of them enacted more than sixty years ago. In 1891 it was estimated that the loss of sheep through depredations of sheep-killing

[27] Bell, Hunting down stock killers, *Yearbook U. S. Dept. Agric. for 1920,* pp. 289-301.

[28] Howell, The black bear as a destroyer of game, *Journ. Mammalogy,* II, 36, 1921; *N. Amer. Fauna,* No. 45, 1921.

[29] Bruce, The black bear in relation to stock, *California Fish and Game,* IX, 16-18, 1923.

[30] Anthony, quoted in *California Fish and Game,* IX, 59, 1923.

[31] Lorenzen, A sheep-killing bear, *California Fish and Game,* IX, 151-152, 1923.

[32] Bailey, *N. Amer. Fauna,* No. 49, p. 193, 1926.

[33] Bailey, *N. Amer. Fauna,* No. 49, p. 150, 1926.

[34] Bailey, *Farmers' Bull.* No. 335, 1908; *U. S. Forest Service Bull.* No. 20, 1907. Lantz, *U. S. Biol. Bull.* No. 20, 1905; *Farmers' Bull.* No. 226, 1905.

[35] Jotter, The coyote as a deer killer, *California Fish and Game,* I, 26-27, 1914.

[36] Bailey, *Farmers' Bull.* No. 335, 1908.

[37] Fisher, *Yearbook U. S. Dept. Agric. for 1894,* p. 225.

dogs in Ohio amounted to $152,034 worth, and in Missouri $200,000.[38] The damage of this sort is mostly in the eastern states, the coyote taking the place of the dog as a sheep killer in the western states.

It is generally believed that deer form the customary food of the mountain lion, though these big cats are also dreaded enemies of sheep, pigs, cattle and colts.[39] It is estimated that in California they kill 30,000 deer annually, about 52 deer apiece.[40] Dixon's investigations sustain their evil reputation as deer killers, but indicate that they are not as great enemies of domestic stock as is generally supposed.[41] Of 43 stomachs examined by him, 34 (80 per cent) contained remains of deer and only 2 (less than 5 per cent) contained remains of stock. In their appetite for game they resemble the African lion, which is destructive to almost all the large game animals of that region. Bobcats, wildcats and lynxes live to a considerable extent upon rodents and other small mammals, but sometimes raid poultry pens, catch game birds and kill lambs.[42] They are not abundant enough in most localities to be of much economic importance. The dubious economic status of the house cat is discussed at some length in the systematic portion of this book, and need not be commented upon here, except to say that they do some good as enemies of destructive mice, and do some harm in the destruction of insectivorous birds that are useful in keeping down insect pests of field, garden and orchard crops.

The Carnivora, however, do not entirely confine their depredations to game and stock animals. The fondness of foxes for grapes is proverbial. Nearly everybody is familiar with the old fable of the fox who was unable to reach the grapes, hence decided that they were sour anyhow, whence the much-used phrase "sour grapes." Some trappers have discovered that green corn is an excellent bait for a coyote, though it is doubtful whether these animals ever seriously damage the corn crop. However, from California comes the report of coyotes damaging grapes and melons,[43] and it is said that in some California localities

[38] Lantz, *U. S. Biol. Surv. Bull.* No. 20, p. 17, 1905, citing Sheep industry of the United States, U. S. Dept. Agric., 1902. Coll, Sheep-killing dogs, *Farmers' Bull.*, No. 1268, 1922. Simmons, *Farmers' Bull.*, No. 1268, 1929.

[39] Roosevelt, With the cougar hounds, *Scribner's Magazine*, XXX, 431-433, 1901.

[40] Hunter, *California Fish and Game*, VII, 99-101, 1921. Bruce, *ibid.*, VIII, 108-114, 1922. Bell, *Yearbook U. S. Dept. Agric. for 1920*, pp. 289-301.

[41] Dixon, *Journ. Mammalogy*, VI, 40, 1925.

[42] Dixon, *Journ. Mammalogy*, VI, 36-38, 1925. Bailey, *Farmers' Bull.*, No. 335, 1908; *N. Amer. Fauna*, No. 49, p. 149, 1926. Howell, *ibid.*, No. 45, 1921. Merriam, *ibid.*, No. 3, p. 79, 1890.

[43] *California Fish and Game*, X, 94-95, 1924.

they feed largely upon melons, figs, prunes, grapes and other fruits at certain times of the year.[44] Hewitt says he has seen orchards bordering woods in Canada "assiduously robbed by bears."[45]

Those familiar with monkeys, baboons and their allies only as caged animals are usually surprised to learn that in their native haunts they are sometimes very destructive, many instances of which are incidentally mentioned in the literature concerning them. The leaf-eating monkeys of India are abundant in some localities and become a nuisance, "raiding gardens and orchards, pilfering from shops and stores," and African baboons and grivet monkeys "do a vast amount of havoc among young lambs and kids," and are very harmful to plantations in some localities.[46]

A herd of elephants, visiting gardens and fields in their vicinity, can do about as much damage to the local food supply in a short time as any animals, and one can imagine what would have happened to fields by the migratory movements of the great herds of bison that once roamed the plains of western United States, had there been any fields there at the time. Deer and elk, where not molested, sometimes become very tame and do some damage to gardens. Indeed, any of the large herbivorous mammals, especially those of gregarious habit, if they can gain access to gardens and fields, are likely to do great damage to crops.

This brief summary gives some idea of the enormous influence of various kinds of mammals in limiting our human food supply and the immense aggregate monetary loss therefrom. To all this loss must be added a very large sum to represent the time and money expended in the effort to combat destructive mammals and prevent damage by them, by methods more fully described in another chapter, including trapping, poisoning, building coyote-proof and rabbit-proof fences, rat-proof buildings and so on.

[44] Poole, Coyotes not strictly carnivorous, *California Fish and Game,* XIV, 151, 1928.
[45] Hewitt, *The conservation of the wild life of Canada,* pp. 108-110, 1921.
[46] Ingersoll, *The life of animals, pp.* 24-34, 1907. Roosevelt, *African game trails,* pp. 218-219, 1910. Drake-Brockman, *Mammals of Somaliland,* p. 3, 1910.

## VIII

# DAMAGE BY MAMMALS TO PROPERTY OTHER THAN THE HUMAN FOOD SUPPLY

We have seen in a preceding chapter that mammals, in destroying crops such as are used as food for the human race, also destroy a vast amount of food suitable for domestic stock and for wild game animals. This damage indirectly affects the human food supply by limiting the food for animals that provide our meat, but part of the grain and hay destroyed might otherwise have been fed to horses and mules, whose flesh is not much used for food in America. Hence the destruction of that part of the crop does not affect our food supply except in a very intangible way. However, to the farmer it matters not whether the loss affects the supply of food for meat-producing animals or the supply of food for draft animals. In either case his personal loss is a real one, and if he has less grain and hay to sell he will have less money to spend for clothing, shoes and other merchandise, as well as for the education of his children, for pleasure and for other proper purposes. So the damage to a farmer's crop affects many others and is a distinct loss to business in general. It is obviously impossible to accurately estimate the monetary value of the loss to a community from this source. Rodents eat a great deal of vegetation that would otherwise serve as food for game and fur-bearing animals, thus perhaps indirectly affecting to some extent the interests of the hunter and the business of the trapper and furrier.

There is also an immense amount of damage done by various mammals to crops, commodities and other kinds of property not usable as food by human beings or by domestic or game animals. Thus the cotton rat, in addition to damaging many other crops, also is destructive to cotton. In a former chapter it has been stated that the damage done to material in homes, stores, warehouses and factories, by the imported house rats and mice, is very great. While much of this involves foodstuffs, the injury to other articles of merchandise is exceedingly serious, though in the estimates it is impossible to segregate the items of damage to non-edibles from that to edibles. The whole discussion of the destructiveness of rodents in the preceding chapter is also pertinent here. These rodents attack almost everything that can be eaten by them or used in the construction of their nests, such as clothing, furs, leather goods, cloth, bedding, rugs, carpets, upholstery and textiles of all sorts. They gnaw holes in baseboards, doors and other woodwork of buildings, boxes and bins, injure books, destroy valuable documents and even paper money, where they are accessible, and commit many other depredations. Their status in relation to the fire hazard in buildings is discussed in another chapter.

Native rats, squirrels and other rodents also sometimes enter homes and other buildings, especially in country districts, and carry off, injure, or destroy various articles. The sins of the "pack rat" of the Rocky Mountains, and "trade rat" of California in this respect, are quite notorious.[1] They will carry off almost anything not too large or heavy for them to move, and a single large nest will sometimes represent the ruin of several suits of clothes, quilts or blankets, besides containing jewelry and trinkets of many kinds filched from the human occupants of the premises.

Porcupines, as has been elsewhere noted, sometimes injure fruit trees, but their usual habitat is in the forests, where they undoubtedly do considerable damage to forest trees. In Alaska, birch trees have been found entirely stripped of their bark and thereby killed by porcupines.[2] Fortunately they are seldom plentiful enough to be a serious pest. Mice and other small rodents do more or less damage to forest and shade trees, as also to fruit trees and shrubbery, by gnawing the bark and girdling the roots, trunks and branches. Meadow mice girdled 1000 six-year-old pines on one five-acre tract in New York.[3]

Beavers cut down large numbers of trees for food and to use in the construction of their dams and houses, but in most localities they use only trees of small commercial value, such as aspens in the Rocky Mountains and cottonwoods on the plains. They have been known to cut valuable forest trees in some localities, and in a few instances even shade and fruit trees. When they become troublesome it is not difficult to stop their depredations by trapping them. Trees may be protected, if necessary, by surrounding each with a cylinder of woven-wire fence material. They sometimes build their dams in such positions as to flood and thereby damage roads and fields, and destroy forest trees by turning

[1] Parks, *Journ. Mammalogy,* III, 241-253, 1922. Burnett, *Office Colorado State Entom., Circular* No. 25, p. 9, 1918.
[2] Murie, The porcupine in Alaska, *Journ. Mammalogy,* VII, 109-113, 1926.
[3] Silver, *Farmers' Bull.,* No. 1397, 1924.

low ground near streams into ponds, lakes or swamps. They are charged with destroying browse that would be useful as food for deer in winter, but, as beaver operations are local and deer move about freely in search of food, that charge is not serious. In cool mountain streams beaver ponds are favorable to the development of trout fry, affording quiet water in which they may live until large enough to safely enter the swift, turbulent water of the mountain torrents, and many beaver ponds of long standing furnish excellent trout fishing. In warmer localities, where the higher temperature favors more rapid decomposition of vegetation in the water and the consequent release of deleterious gases and poisons in such ponds, especially when newly formed, they may be detrimental to fishes, a much discussed and partly investigated subject.[4]

In some New England districts where the old cone-and-nut-bearing trees have been logged off, the squirrels, deprived of their natural food, have taken to eating more largely of buds and bud twigs, and are thereby doing a considerable amount of actual damage to young coniferous forests.[5] On the other hand, squirrels and other rodents are well known to aid in the natural reforestation of burned-over areas by the burial of seeds in the forest floor, which thus escape injury by the fires.[6]

Squirrels are known to be fond of fungi, even partaking freely of some species that are poisonous to human beings,[7] but it is not likely that any serious damage or any good is done thereby. It may be also observed that the Allegheny cliff rats, and perhaps other rodents, have developed the habit of storing fungi for food.[8]

[4] Johnson, The beaver in the Adirondacks: Its economics and natural history, *Roosevelt Wild Life Bull.*, IV, 501-641, 1927. Bailey, Beaver habits and beaver control, *U. S. Dept. Agric. Tech. Bull.*, No. 21, 1927 (replacing Dept. Bull. No. 1078, 1922). Lawrie, Beaver vs. trout—More testimony, *Fins, Feathers and Fur* (Bull. Minnesota Game and Fish Dept.), No. 27, p. 5, 1910. Knight, *Science* LXII, 590-591, 1925; LXIII, 209-211, 1926; LXV, 525-526, 1927.

[5] Hosley, Red squirrel damage to coniferous plantations and its relation to changing food habits, *Ecology*, IX, 43-48, 1928. Bowles, The California gray squirrel, an enemy to the Douglas fir, *Amer. Forestry*, XXVI, 26, 1920.

[6] Hofmann, Furred forest planters, *Scientific Monthly*, XVI, 280-283, 1923. Hatt, The red squirrel, *Roosevelt Wild Life Annals*, II, 132-135, 1929.

[7] Hastings and Mottram, Observations upon the edibility of fungi for rodents, *Trans. British Mycolog. Soc.*, V, 364-378, 1929. Murrill, Animal mycophagists, *Torreya*, II, 25-26, 1902. Langham, Squirrel eating Melanogaster ambiguus, *Irish Naturalist*, XXV, 136, 1916. Odell, Squirrels eating Amanita muscaria, *Canadian Field Naturalist*, XXXIX, 180-181, 1925; Further observations on squirrels eating Amanita muscaria, *ibid.*, XL, 184, 1926. Butler, The red squirrel of North America as a mycophagist, *Trans. Brit. Mycol. Soc.*, VI, 355-362, 1920; *Journ. Mammalogy*, II, 119, 1921. Cram, *ibid.*, V. 37-41, 1924.

[8] Newcombe, *Journ. Mammalogy*, XI, 204-211, 1930.

Sheep, and especially goats, deer, elk and moose browse extensively upon shrubs and young trees and the lower branches of larger trees. This may be a good thing where it is desirable to keep the forest floor free from undergrowth or to clear brush land in order to give grass for pasturage a chance. Indeed, goats have been deliberately used for those very purposes. On the other hand, browsing animals may be very harmful to attempts to reforest burnt-over or cut-over land, or may prevent the natural or artificial replacement of dying trees within the forest, by destroying the young trees or nipping the tops off before they get tall enough to be out of reach.[9] Cattle and horses where land is much over-grazed and herbage scarce, also browse to some extent, but they are not natural browsers, as goats and the members of the deer family are.

Only a short time ago newspapers and magazines had much to say about the efforts to drive many of the deer from Kaibab Forest, Arizona, to other ground, because the range in the forest was overgrazed and overbrowsed and the deer were in danger of starving, and good photographs were published showing the condition of the browsed aspens. The "plimsoll" line, or line parallel with the water level, to which cedars are supposed to have been trimmed from below by deer along certain lakeshores in the Adirondacks, is the subject of some recent interesting discussion.[10]

In addition to interference with reforestation and replacement of forest trees, and the destruction of the natural forage for livestock, overbrowsing and overgrazing has another disastrous effect upon property. The vegetative cover (including trees, shrubs, grasses and other plants) serves to break the force of rainfall and the run-off of storm water, and to bind the soil together, thus retarding or preventing erosion. When this cover is destroyed by too much browsing or grazing, or by fire or any other cause, and perhaps the soil is loosened by the trampling of cattle, sheep and other animals, erosion is accelerated on all steep slopes. As a result, sometimes entire hill or mountain sides are denuded of their soil, nothing being left but barren rocks upon which

[9] Colville, Effect of grazing upon aspen reforestation, *U. S. Dept. Agric. Bull.* No. 741, 1919; *U. S. Division of Forestry Bull.* No. 15, 1898. Adams, *Scientific Monthly,* XX, 561, 589, 593, 1925. See also Adams, The economic and social importance of animals in forestry, with special reference to wild life, *Roosevelt Wild Life Bull.,* III, 539, 676, 1926.

[10] Merriam, *Mammals of the Adirondack Region,* pp. 110-111, 1886. Johnson, On the supposed relation of deer to cedars bordering certain Adirondack lakes, *Journ. Mammalogy,* VIII, 213-221, 1927. Burnham, The plimsoll line in white cedars, *ibid.,* IX, 43-47, 1928.

vegetation cannot again get a foothold. To make matters worse, sand and gravel from the slopes, washed out into the valleys, often bury and ruin fields and meadows in the lowlands and choke the channels of the streams. Then the more rapid run-off from barren hills, where the water is no longer absorbed by soil and vegetation and thus retarded in its movement, fills the choked channels, overflows and causes disastrous floods. This is not an imaginary picture, but a description of just what has happened in various parts of the United States and other parts of the world. In the semi-arid West and portions of the South especially have many hills been denuded by erosion and many fields been ruined by deposition of the debris. All this more or less directly affects valuable game and other wild animals. Where slopes are so gentle that destruction of vegetation by overgrazing and trampling of domestic stock does not cause extensive erosion, it often results in the substitution of worthless weeds for the original vegetation.[11]

In the preceding chapter we have seen that predatory mammals destroy $20,000,000 to $30,000,000 worth of livestock annually in the United States.[12] A considerable part of this loss consists of meat, but in addition it includes the skins, a large amount of wool and many horses.

[11] Ligon, *Wild life of New Mexico,* New Mexico State Game Commission, pp. 35-49, 1927. Reynolds, Grazing and floods: A study of conditions in the Manti National Forest, *U. S. Forest Service Bull.* 91, 1911. Colville, Forest growth and sheep-grazing in the Cascade Mountains of Oregon, *U. S. Division of Forestry Bull.* No. 15, 1898.

[12] Bell, Hunting down stock killers, *Yearbook U. S. Dept. Agric. for 1920,* pp. 289-301.

## IX

# THE FUR, LEATHER AND HIDE TRADES

The taking of furs for clothing and the trading in pelts is undoubtedly the oldest industry in the world. This activity goes back many thousands of years into the dim reaches of the Stone Age, when the cave man, crude hatchet or club in hand, killed the beasts of the field, so that he and his family could have covering during the rigorous seasons of the year. . . . We know, from cave pictures, that the Cro-magnon people wore animal pelts. . . . Turning our attention to the age known as the Garden of Eden period, we find in the third chapter of Genesis, twenty-third verse, that Adam and Eve, at the behest of the Creator, wore the skins of beasts of the field following their expulsion. . . . The Babylonians, Assyrians, Greeks and Romans wore furs, history tells us. Mention is made that Queen Semiramis of Babylon in 2182 B.C. brought 8000 tiger skins to her country at the close of her campaign in India. Furs were mentioned by Herodotus. In Biblical and pre-Biblical times, Armenia was the principal fur center, pelts being sent there from northern Asia and Persia and traded to Greece; and ermine, the fur insignia of royalty, is a word derived from Armenia, so it is claimed by etymologists. Furs were worn in Egypt, its early records show; Chinese writings testify to the wealth they secured from furs three thousand or more years ago. . . . During the Middle Ages the men of Europe wore furs exclusively, but they were denied to women, and it was not until the reign of Edward III that furs became fashionable for women, and they have remained so ever since. . . . Cinderella's slipper was not made of glass, as many of us were informed by fairy story books, but was, in fact, a fur slipper. . . . A typographical error has been responsible for the belief long held by English and American children that the slipper the Prince found, which fitted only Cinderella's foot and not those of her ugly and wicked step-sisters, was made of a fragile substance such as glass and not of a durable material such as fur.[1]

Doubtless long before men began to plant seeds and indulge in the rude beginnings of agriculture, before they had domesticated any animals and established pastoral life, they discovered that the skins of the mammals they killed for food or in self-defense would provide warm clothing to protect human beings from the cold. Probably in colder portions of the world such were for a long period the only garments known. Doubtless at first the skins were used just as they came from the animals, with no preparation except to dry them, but in time methods of dressing and tanning them were developed, making the skins softer, more pliable and better suited for clothing.

[1] Arthur, *The fur animals of Louisiana,* pp. 9-11, 1928. Laut, The fur trade of the world—the oldest industry of mankind, *World's Work,* May, 1907, pp. 8862-8878.

When white invaders first penetrated the North American wilderness they everywhere found the Indians clothed in garments made of skins, often highly decorated, and in some portions of the continent their only shelter from storms was the tepee made of skins. The white settlers and trappers found that the skin garments, especially those made of buckskin, were an excellent and easily obtained substitute for cloth garments, and promptly adopted buckskin suits, coonskin caps and the like. Mason has listed 143 distinct species of mammals whose skins are known to have been used by North American Indians, and describes their primitive methods of preparing the skins for use.[2] Reduced to terms in general use in the fur trade, his list would not look so formidable. For example, he lists twelve species of rabbits, twenty-four of squirrels, three of prairie-dogs, four of marmots and eleven of skunks. In fur-trade lists each of these groups would appear under a single name.

In another chapter we shall see how important was the fur trade in the early exploration and settlement of North America. In the present chapter we consider its present importance as a world industry, extending the discussion also to hides and leather obtained from mammals whose pelts are not considered furs and not used in the manufacture of fur garments to a marked extent. Many books[3] and very numerous articles in periodicals have recounted some of the romance, as well as dry and technical phases, of the trapper's art, the furrier's business and fur farming. Limited space will permit reference to only a few of these publications, and the vast amount of information on the subject, with numerous statistics, must necessarily be very much condensed.

A large number of trade names for furs have been devised, some of them apparently for the purpose of deceiving purchasers as to the character of the furs they are buying. These names usually are such as to imply greater values than the furs really possess. To supply the increased demand for fur garments it has been found absolutely neces-

[2] Mason, Aboriginal skin-dressing, *Ann. Rept. U. S. National Museum for 1889*, pp. 553-589.

[3] Chittenden, *The history of the American fur trade in the Far West*, 3 vols., N.Y., 1902. Poland, *Fur-bearing animals in nature and commerce*, London, 1892. Davidson, The Northwest company, *Univ. California Pub. in History*, VII, 1918. Stevens, *Northwest fur trade, 1763-1800*, Univ. of Illinois. Laut, *The fur trade of America*, New York, 1921. Innis, *The fur trade of Canada*, 1927. Dale, *Ashley-Smith explorations*, Cleveland, 1918. Vandiver, *The fur trade and early western exploration*, Cleveland, 1929. Johnson, *Michigan fur trade*, *Michigan Hist. Comm.*, V, 1-192, 1919. Fur trade in Wisconsin, 1812-1825, *Wisconsin Hist. Soc.*, XX, 1911. Peterson, *The fur traders and fur-bearing animals*, Buffalo, N.Y. 1914. Amer. Nat. Fox. and Fur Traders' Assn., *Manual of the silver fox and fur farming industries*, 5th ed., 1930.

sary to use many inferior skins, such as rabbit and the like. Methods have been developed of so dressing and dyeing them that they present a much better appearance and are more serviceable than when used in their natural condition. Their sale and use is quite justifiable, providing the purchaser understands just what he is buying and its real value, and is not deceived by the trade name. Almost anyone wearing a coat of inferior fur would rather have it called by another name that would indicate to his friends that it is not inferior, but calling rabbit skin "polar seal" will not make it wear like seal. Honest dealers always tell their customers just what they are offering, if they themselves know, but there are less scrupulous, as well as some honest, but ignorant, dealers who simply use the trade names and let it go it that. With the present great demand, many department and general clothing stores have put in fur-goods departments in which the clerks are inexpert in this line of merchandise. They may be selling inferior goods in perfect good faith, in reliance upon the plain implications of the trade names, of the real meaning of which they are ignorant. Following is a partial list of such trade names, with their real equivalents, prepared by the United States Biological Survey:[4]

| *Trade Name* | *Real Name of Animal* |
|---|---|
| Adelaide chinchilla | Australian opossum |
| Alaska bear | Raccoon (dark pelts) |
| Alaska sable | Raccoon (dark pelts); skunk (natural black or dyed) |
| Aleutian seal | Muskrat (plucked and dyed) |
| American seal | Rabbit (plucked and dyed) |
| Arctic seal | Rabbit (plucked and dyed) |
| Astrakan, Astrachan | Persian lamb (loose curl) |
| Australian fisher | Wallaby (sheared and dyed) |
| Baltic fox | Northern hare |
| Baltic seal | Rabbit (clipped and dyed) |
| Bear | Goat (dyed) |
| Beaver | Coypu rat (plucked natural), or opossum (sheared and dyed) |
| Black furs | Black cat |
| Black lynx | Northern hare (dyed) |
| Black marten | Skunk (dyed or natural black) |
| Black Japanese wolf | Goat (dyed) |
| Brazilian mink | Marmot (blended) |

[4] Ashbrook, Trade names in the fur industry, *Journ. Mammalogy,* IV, 216-220. 1923. Many other, but less-used names are contained in a pamphlet by George W. Pauli, distributed by Jonas Bros., of Denver. See also Jones, *Fur farming in Canada,* pp. 7-8, 1913. Laut has an interesting chapter on "False furs and false trade names" in *The fur trade of America,* pp. 42-49, 1921. See also Arnold, Dictionary of fur names, *The Fur Journal,* I, 42-48, 1927.

| *Trade Name* | *Real Name of Animal* |
|---|---|
| Broadtail | Persian lamb (moire silk pattern) |
| Brown Newfoundland seal | Seal (brown hair) |
| California mink | Ringtail cat |
| Cape seal | Rabbit (sheared and dyed) |
| Caracul, Karakule, Caracool | Persian lamb (close curl) |
| Cat | Rabbit (sheared and dyed) |
| Civet cat | Small striped skunk; or hydrophobia skunk |
| Chinchilla | White rabbit (dyed) |
| Clipped seal | Rabbit (plucked and dyed) |
| Coney | Rabbit |
| Electric seal | Muskrat (plucked and dyed); coypu rat (plucked and dyed); rabbit (sheared and dyed) |
| Ermine (weasel) | White rabbit |
| Fitch | European polecat |
| Fox | Hare (dyed) |
| French sable | Rabbit (dyed) |
| Geller seal | Rabbit (plucked and dyed) |
| Genet | Cat |
| Hudson Bay seal | Muskrat (plucked and dyed) |
| Hudson seal | Muskrat or coypu rat (plucked and dyed), or rabbit (sheared and dyed) |
| Isabella fox | Dog (dyed and curled) |
| Japanese lynx | Black Manchurian dog |
| Karakule kids | Kid (dyed) |
| Koala | Wallaby (sheared and dyed) |
| Kolinsky | Red sable or Siberian mink |
| Krimmer | Gray lamb skin resembling Astrachan |
| La Meuse seal | Rabbit (plucked and dyed) |
| Mink | Marmot (dyed) |
| Mole | Muskrat (sheared and dyed) |
| Monkey | Goat (dyed) |
| Muskrat | Rabbit (sheared and dyed) |
| New seal | Rabbit (plucked and dyed) |
| Northern seal | Rabbit (plucked and dyed) |
| Nutria | Coypu rat |
| Patagonian bison | China sheep (short-haired) |
| Persian lamb | Domestic dog (dyed and curled); kid (dyed) |
| Persianer | Persian lamb (close curl) |
| Pointed fox | Red fox dyed black, white badger hairs stuck in, and white tip sewed on tail |
| Polar seal | Rabbit (plucked and dyed) |
| Red Russian sable | American marten (sable); Hudson Bay marten (sable) |
| Real seal | Muskrat (plucked and dyed) |
| Red River seal | Muskrat (plucked and dyed); coypu rat (plucked and dyed); rabbit (sheared and dyed) |
| River mink | Muskrat (blended) |
| River sable | Muskrat (natural) |

| *Trade Name* | *Real Name of Animal* |
|---|---|
| Russian otter | Muskrat (blended) |
| Semeuse seal | Rabbit (plucked and dyed) |
| Sable | Hare, marmot, mink, rabbit or Norwegian fitch (dyed) |
| Sable fitch | Norwegian fitch (dyed) |
| Seal | Coypu rat (plucked and dyed); otter (plucked and dyed) |
| Seal musquash | Rabbit (sheared and dyed) |
| Sidney raccoon | Wallaby (sheared and dyed) |
| Skunk | Marmot or wallaby (dyed); opossum or wallaby (sheared and dyed) |
| Two L seal | Rabbit (plucked and dyed) |
| White fox | Northern hare |
| Wombat | Koala |

There is at present a fight in progress against the use of fur garments, partly on humanitarian grounds and partly because the enormous destruction of wild life in order to obtain the more desirable furs is jeopardizing many species of interesting and useful animals, just as the feather trade at one time seriously threatened the existence of many species of birds and actually exterminated some of them. It is true that there is more or less cruelty about the trapping of fur-bearing mammals, just as there is about the trapping of rats and of predatory mammals that destroy livestock. Unnecessary cruelty should be avoided in all industries and trapping is no exception to the rule, but if everything should be suspended that involves an element of cruelty the habits of the whole human race would have to be very much amended as to food, clothing and in other ways. Sheep sometimes suffer from cold storms after the shearing process and many other necessary operations of men result in unavoidable or not easily avoidable cruelty. Humanitarians are quite within their rights in insisting on the reduction of trapping cruelty to the practical minimum, but this whole subject should be squarely faced in the light of common sense, coupled with lively sympathy for the fur-bearing mammals, on the one hand, and due regard for some important facts of commerce and natural history, on the other. A recent symposium in *American Game* has discussed the proposed anti-steel trap legislation from various points of view. An Anti-Steel Trap League has been organized in the United States for the purpose of outlawing the use of steel traps and other "torturing devices" and several states have enacted laws regulating the use of such traps. Massachusetts by a referendum vote of 589,013 to 259,014, on November 4, 1930, adopted an anti-steel trap law, according to *Nature Magazine*, 1931, p. 134.

Most people who protest against the use of furs on humanitarian grounds, themselves regularly indulge in the use of meat and of shoes and other leather goods, which are obtained only by killing animals, either wild or domesticated, sometimes by methods as cruel as those practiced by the most uncultured native trapper of the American wilderness. In any case, the animal should be caught and put to death in the most humane way that is practicable. In some places where large numbers of animals are slaughtered, more humane methods are now in use than formerly, but in many slaughter houses and on farms the old-fashioned way of hitting them on the head with a hammer or axe is still the style, and we eat the meat without asking how the animal was killed. So with furs, many trappers have adopted the least cruel method of killing their catches that they know, because they believe that if the animal is caught and handled with the minimum amount of struggle and worry its pelt will be in better condition and bring a higher price. Many of the dealers encourage the trappers in the use of better methods, and urge more frequent visiting of the traps, in order to avoid losses and get a larger percentage of prime pelts.

Close seasons have been established by law as a conservation measure, in order to protect females during the breeding season and when nurturing their young, and to prevent the taking of pelts that are not in prime condition. Incidentally this has partly removed one cause of cruelty by preventing the starvation of the young that would result from catching the mother while the young need maternal care. It is said that in Alaska as many as 30,000 young fur seals starved in a single year because of the killing of their mothers, before the present regulations were adopted.[5]

It should also be remembered that nature herself, though in so many ways benign, is in many respects cruel. A large proportion of the species of mammals whose furs are most valuable are themselves hunters, living upon various species of mammals, birds, fishes and other living creatures that they succeed in killing. When the trapper catches and puts to death a carnivorous or omnivorous mammal, for its pelt, he may thereby commit one act of cruelty, but in so doing he prevents the animal from killing many others. Furthermore, most of the fur-bearers eventually meet violent death, even though not caught by the trapper. This, of course, is not an argument in favor of any cruelty that can well be avoided by the trapper, but merely an assertion that no matter whether the fur-bearers be trapped by men or not, their end

[5] Laut, *The fur trade of America*, pp. 125-133, 1921.

will in most cases be tragic, and trapping need not make it much, if any, more so. The death of a weasel at the hands of a trapper need not be more cruel than death the weasel would inflict upon many other mammals and birds if it were permitted to live.

It must also be kept in mind that it is often necessary to trap or otherwise dispose of many of the animals used in the fur trade in order to keep them in check, especially in thickly populated districts. A few weasels or minks probably do more good than harm, but if they became very plentiful they would find their usual food scarce and turn to other food, such as poultry and insectivorous birds, the destruction of which would be harmful. Many rabbits and squirrels are now used in the fur trade, but both are very destructive when they become overabundant. Beavers are sometimes destructive, and the larger predatory mammals, such as wolves, mountain lions, coyotes and bobcats, whose skins are used in the fur industry, are all destructive to stock.

The campaign against the use of furs upon the ground that excessive trapping threatens the very existence of some of the more valuable species has some support in the facts of the case. If the campaign were directed toward the protection of the particular species most in danger, with adequate laws regulating the trapping of all species, properly enforced, it might bring worth-while results. There is no necessity for destroying the vast business, involving investment of millions of dollars, giving employment to thousands of men and women. A considerable part of the business is the handling of skins of animals that need no protection, or at least not complete protection, such as rabbits, muskrats and squirrels; also the handling of large quantities of furs from animals raised on fur farms, where the value of the farm depends upon keeping up the stock and caring for it, just as is the case with domestic stock, such as cattle and sheep.

Though some observers of the trend of affairs take a more optimistic view of the future of the fur-bearing mammals than others do, yet all must agree that if the use of furs continues to increase, or even remains as great as at present, only radical measures for conservation, the increased substitution of inferior furs of animals that breed rapidly, and a marked increase in such activities as fur farming, can save some of our best native fur-bearing animals from extermination. The rapid increase in the demand, coincident with restriction of the range of many species by advancing civilization, the clearing and cultivating of former forest lands, the draining of swamps, together with local extermination of many species in large areas by unregulated trapping, is seriously threatening the future supply of furs.[6] A few species, like the muskrat, are still common, "but the remnants of the once rich fur resources of the country are fast dwindling under the conditions that have prevailed."[7]

The following figures by Fraser, condensed from tables published by Jones,[8] show that most of the species enumerated decreased in numbers from 1882 to 1911, while increasing in price. The increase in skunk furs handled, is perhaps due to better methods of deodorizing. Though the muskrat, lynx, white fox and land otter show a marked increase, it was accomplished during the first decade of the period, and there was an actual decrease after the first decade. The sales of blue fox, marten and fisher also increased during the first decade, but lost all that they had gained and much more thereafter.

| *Name of Animal* | *Per cent Increase in Price* | *Per cent Decrease in Numbers* | *Per cent Increase in Numbers* |
|---|---|---|---|
| Fox, silver | 300 | 50 | |
| Fox, cross | 125 | 70 | |
| Fox, red | 245 | 55 | |
| Fox, blue | 100 | 23 | |
| Fox, white | 350 | | 510 |
| Marten, pine | 580 | 20 | |
| Fisher or pekan | 430 | 95 | |
| Mink | 300 | 20 | |
| Skunk | 150 | | 110 |
| Muskrat | 230 | | 215 |
| Lynx | 200 | | 700 |
| Otter, land | 80 | | 5 |
| Otter, sea | 240 | 85 | |

Increase of lynx for first decade, 3800 per cent, of muskrat, 250 per cent, of white fox, 750 per cent, of land otter, 45 per cent, showing that there was a marked decrease after the first decade.

That the soaring of prices of furs has not been confined to the period since the World War, as seems to be believed by many people, is shown also by the following comparative figures of maximum prices of certain furs presented by Brass, the great German fur statistician:[9]

[6] Lantz, *Farmers' Bull.*, No. 396, p. 9, 1910. Hornaday, The fur trade and the wild animals, *Bull N.Y. Zool. Soc.*, 1921. Osborn and Anthony, Can we save the mammals?, Nat. Hist., XXII, 289-405, 1922. Close of the age of mammals, *Journ. Mammalogy*, III, 219-237, 1922.

[7] Ashbrook, *Fur farming for profit*, pp. 5-6, 1928.

[8] Jones, *Fur farming in Canada*, p. 4, 1913.

[9] Brass, Statistics of fur prices, in Jones, *Fur farming in Canada*, p. 146-147, 1913.

| | 1880 | 1900 | 1910 |
|---|---|---|---|
| Australian opossum | $ .16 | $ .28 | $ 1.95 |
| Wallaby | .10 | .75 | 1.70 |
| Kangaroo | .12 | .60 | 1.45 |
| Wombat | .12 | .36 | .73 |
| Native cats | .04 | .24 | .49 |
| Bastard chinchilla | .73 | 2.92 | 9.73 |
| Japan mink | — | .12 | .60 |
| Chinese weasel | — | .07 | .33 |
| Japan marten | — | 1.43 | 3.81 |
| Japan fox | — | 1.43 | 4.05 |
| Skunk | — | 2.07 | 7.06 |
| Raw Persian | — | 3.09 | 6.70 |
| Stone marten | — | 2.86 | 6.66 |
| Marmot | — | .12 | .90 |
| Black fox | 632.70 | 2,822.66 | 2,628.00 |
| Sea otter | 584.00 | 1,362.67 | 1 703.33 |
| Muskrat | .16 | .16 | .87 |
| Mink | .73 | 2.58 | 6.34 |
| Red fox | 3.11 | 9.00 | 16.55 |
| Lynx | 4.87 | 10.80 | 39.85 |

Prices given in the various reports are those at the regular fur markets, unless otherwise stated, and are much higher than the amounts the trappers receive for the same furs. Thus in 1912 prime muskrat skins in Canada were quoted at about $1.25, but the trappers received only about 50 cents.[10] As this book goes to press during a time of great commercial depression, fur prices are much lower than those of two or three years ago.

The following list of prices of some important furs at three different periods is obtained from Laut:[11]

| | *1875* | *1913* | *1920* |
|---|---|---|---|
| Beaver | $ 1.00 | $ 8.00 | $ 17.50 to $ 20.00 |
| Ermine | .50 | 1.50 to $ 5.00 | .50 to 4.00 |
| Fisher | 5.00 | 15.00 to 50.00 | 143.00 to 345.00 |
| Silver fox | 50.00 | 125.00 | –300.00 to 1225.00 |
| Black fox | 100.00 | 500.00 | |
| Fur seal | 10.00 | 30.00 to 125.00 | 146.00 to 165.00 |
| Lynx | 3.00 | 12.00 to 50.00 | 45.00 to 60.00 |
| Marten | 2.00 | 2.50 to 20.00 | 18.00 to 60.00 |
| Muskrat | .10 to .12 | .40 to 1.00 | 5.00 to 7.50 |

The prices of furs vary enormously with the locality from which they are obtained, as the average quality of furs from different localities is quite different, and in many cases the animals are specifically or subspecifically, sometimes generically distinct, though given the same vernacular name. The colder climate of the North requires heavier fur

[10] Jones, *Fur farming in Canada*, p. 89, 1913.
[11] Laut, *The fur trade of America*, p. 5, 1921.

to protect the animals from the climatic rigors than in the South, therefore the northern furs in many cases are better and bring higher prices, as is well illustrated by some of the figures in the ensuing table. Also there are, of course, great individual differences in pelts of the same species all from the same region, just as some men are larger, in better health, and have thicker and finer hair than others. In addition the season for prime furs is usually short, in many species only about two month long, and furs taken out of season are inferior. Five animals trapped in California in July and sold for $2.50 would have brought $200.00 had they been caught in the winter.[12] Size, color, thickness of hair, the care with which the animal has been skinned, and the method of caring for fur and its whole general condition must all be considered in grading furs for sale, which is done by high-salaried experts. In order to show the great differences in value we have compiled from the report of an auction sale held in New York from January 23 to February 1, 1928, the maximum prices for the largest and best and the minimum prices for the smallest and poorest pelts of the principal kinds from various regions.[13]

| | *Minimum* | *Maximum* |
|---|---|---|
| Badger | | |
| Canadian | $10.00 | $42.50 |
| Northwestern | 9.75 | 29.50 |
| Western | .80 | 14.50 |
| Southwestern | .24 | 4.50 |
| Bear | | |
| Black | .70 | 15.75 |
| Brown | 4.75 | 10.75 |
| Polar | 19.00 | 38.00 |
| Beaver | | |
| Quebec and Ontario | 6.00 | 33.75 |
| Western Canadian | 11.50 | 32.00 |
| Alaska | 7.25 | 31.50 |
| Western U.S. | 4.00 | 31.25 |
| Broadtail (sheep) | 6.00 | 13.00 |
| Caracul (sheep) | 1.50 | 6.50 |
| Cat | | |
| Civet | .28 | 1.10 |
| House | .12 | .62 |
| Ringtail | 4.60 | 5.10 |
| Sundry | .45 | 2.40 |
| Cat, Wild | | |
| Northern | 7.00 | 21.50 |
| Western | 1.00 | 12.25 |
| Southwest | .60 | 6.00 |
| Southern | .08 | 3.10 |
| Ermine | | |
| Northwest and Canada | .30 | 4.50 |
| East Canada | 1.40 | 2.20 |
| Brown | .25 | 2.70 |
| Russia | 2.20 | 4.70 |
| Fisher | 30.00 | 182.50 |
| Fitch | | |
| Orenburg | 2.90 | 5.10 |
| Russia | | 2.60 |
| Mongolia | | 1.50 |
| Fox | | |
| Australia | .40 | 5.20 |
| Blue | 1.00 | 115.00 |
| Cross | 2.75 | 255.00 |
| Gray | | |
| Eastern | 2.80 | 4.70 |
| Western | 2.80 | 4.50 |
| Southwestern | 2.00 | 2.70 |
| Kitt | | |
| Russia | .80 | 6.10 |

[12] *California Fish and Game*, p. 120, 1917.

[13] *The Fur Market Digest,* issued by the New York Auction Co., Inc., obtained by us through the courtesy of E. A. Stephens & Co., Denver, who write: "Prices paid to trappers would average approximately 10 per cent to 20 per cent less than these prices, but on account of a different system of grading it is rather difficult to say whether or not the difference would be that much."

| | *Minimum* | *Maximum* |
|---|---|---|
| Swift | $ 2.80 | $ 3.00 |
| Red | | |
| Kamchatka, etc. | 52.00 | 54.00 |
| Alaska | | 43.00 |
| Northwest Canada | 48.00 | 52.00 |
| Labrador | 35.00 | 44.00 |
| Maine and Eastern Canada | 26.00 | 30.00 |
| New England | 3.00 | 25.00 |
| New York and Pennsylvania | 2.75 | 20.00 |
| Central | 2.25 | 17.75 |
| Northwest States | | 30.00 |
| Saghalien | 15.00 | 30.00 |
| Siberia | | 24.50 |
| West Mongolia | 16.00 | 19.00 |
| East Mongolia | 10.75 | 14.75 |
| Shuntefu | 10.75 | 14.75 |
| Manchuria | 7.00 | 10.75 |
| Sweden | | 28.00 |
| Poland | 4.25 | 11.25 |
| Swiss and German | 2.75 | 7.75 |
| Silver | | |
| All silver | 50.00 | 395.00 |
| Three-fourths silver | 50.00 | 600.00 |
| One-half silver | 50.00 | 685.00 |
| One-fourth silver | 70.00 | 320.00 |
| Slightly silver | 15.00 | 145.00 |
| Black | 25.00 | 115.00 |
| Rubbed, etc. | 1.00 | 95.00 |
| South American | | |
| Chubut | 4.20 | 5.10 |
| Mendoza | .60 | 3.75 |
| Rio Negro | 1.40 | 1.90 |
| Pampas | | .65 |
| Sundry Fox | .80 | 4.10 |
| Turkish | 1.30 | 10.75 |
| White | | |
| Russia | 5.50 | 63.00 |
| Labrador | 42.00 | 70.00 |
| Jackal | 1.20 | 1.70 |
| Kid skins | .15 | 2.30 |
| Kolinsky | 1.70 | 3.20 |
| Krimmer | 2.20 | 7.25 |
| Leopard | 1.25 | 34.00 |
| Lynx | | |
| Alaska | 5.50 | 73.00 |
| Labrador | 15.00 | 74.00 |
| Marten | | |
| Alaska | 17.00 | 60.00 |
| West Canada | 3.25 | 58.00 |
| British Columbia | 22.50 | 32.00 |
| Coast | 16.00 | 22.00 |
| Laborador | 16.50 | 54.00 |

| | *Minimum* | *Maximum* |
|---|---|---|
| Marten, Baum | $ 7.00 | $26.00 |
| Japanese | | |
| Northern | | 11.75 |
| Mainland | 5.50 | 8.50 |
| Stone | 16.00 | 19.25 |
| Mink | | |
| New England | 2.75 | 47.00 |
| Michigan | 10.50 | 25.75 |
| New York and Pennsylvania | 14.00 | 20.50 |
| Ohio and Illinois | 9.75 | 14.50 |
| Carolina | 8.00 | 12.00 |
| Interior Alaska | 8.75 | 30.50 |
| Manitoba | 7.75 | 10.75 |
| Coast | 9.75 | 11.75 |
| Rocky Mountains | .70 | 18.00 |
| Iowa and Minnesota | 9.50 | 14.25 |
| Central | 5.50 | 10.50 |
| Mississippi and Tennessee | 3.10 | 12.00 |
| French Settlement | 8.25 | 13.25 |
| Louisiana | 2.00 | 10.25 |
| Japan | 1.00 | 3.05 |
| Mole | .04 | .18 |
| Monkey | | |
| Gold Coast | .15 | 6.50 |
| Abyssinia | 1.10 | 2.60 |
| Moufflon | 2.50 | 5.10 |
| Muskrat | | |
| Black | .88 | 2.90 |
| New England | 1.45 | 2.32 |
| New York and Pennsylvania | .96 | 1.98 |
| Maryland and Delaware | .42 | 1.76 |
| Wisconsin and Michigan | 1.86 | 2.20 |
| Ohio and Indiana | 1.54 | 1.80 |
| Iowa and Illinois | 1.32 | 1.78 |
| Nebraska, Dakota, and Minnesota | .54 | 1.66 |
| Manitoba | 1.48 | 1.98 |
| Alberta and Saskatchan | 1.24 | 1.82 |
| British Columbia and Coast | .96 | 1.70 |
| Alaska | 1.30 | 1.78 |
| Nova Scotia and New Brunswick | .68 | 1.70 |
| Southern | .20 | 1.74 |
| Nutria | 2.70 | 6.70 |
| Ocelot | 1.00 | 6.75 |
| Opossum | | |
| American | | |
| Central | .76 | 2.00 |

| | Minimum | Maximum |
|---|---|---|
| Virginia and Carolina | $ .64 | $ 1.44 |
| Arkansas and Oklahoma | .24 | 1.45 |
| Southwestern | .16 | 1.38 |
| Southern | .05 | 1.18 |
| South American | .44 | .68 |
| Australian | .35 | 3.20 |
| Otter | | |
| Labrador and Province of Quebec | 20.00 | 39.00 |
| Alaska | 23.50 | 30.00 |
| Northwest States | 28.00 | 28.00 |
| Carolina and East | 18.00 | 32.00 |
| Louisiana, Mississippi, and Alabama | 15.50 | 26.00 |
| Florida | 9.00 | 20.50 |
| Norway | 14.00 | 23.00 |
| South America | 9.75 | 14.50 |
| Lake | 3.50 | 9.75 |
| Persian Lamb | .25 | 8.75 |
| Petchaniki | | .34 |
| Pony | .80 | 2.60 |
| Raccoon | | |
| Eastern | 2.20 | 15.00 |
| Carolina | 5.40 | 7.50 |
| Northwest and Coast | 2.50 | 12.00 |
| Central | 1.70 | 9.00 |
| Alabama and Mississippi | 2.20 | 8.10 |
| Louisiana | 5.00 | 8.80 |
| Salt water | 1.50 | 6.40 |
| Florida | .10 | 6.60 |
| China and Japan (damaged) | $ 1.00 | $ 1.25 |
| Sable | | |
| Russian | 13.00 | 350.00 |
| Japanese | 20.00 | 21.00 |
| Shiraz (broadtail) | .11 | 5.70 |
| Skunk | | |
| Northwest | 2.60 | 3.65 |
| Iowa | 1.00 | 3.10 |
| Kansas and Nebraska | 1.95 | 2.90 |
| Coast | 2.00 | 2.75 |
| Southwest | .20 | 2.55 |
| New York and Pennsylvania | .10 | 3.10 |
| New England | .75 | 3.10 |
| Virginia | 1.35 | 2.55 |
| Squirrel, foreign | .08 | 1.56 |
| Weasel, Chinese | .20 | .45 |
| Wolf | | |
| Canada | 7.50 | 27.25 |
| Montana | 10.00 | 24.50 |
| Washington and Oregon | 10.25 | 18.50 |
| Northwestern | 2.60 | 19.75 |
| Western | .50 | 10.75 |
| Southwestern | .01 | 3.00 |
| Russia | 1.00 | 12.25 |
| Wolf, Timber | | |
| Arctic | 25.00 | 28.00 |
| Dark | 8.50 | 19.50 |
| Gray | .10 | 32.00 |
| Wolverene | 2.75 | 26.50 |

The large fur dealers are alive to the need of wise regulation and less wasteful methods of trapping, and of saving the pelts in good condition. Some of them are engaged in a campaign of education along such lines, as they realize that the future of their trade depends upon keeping up the supply. Laws regulating trapping have been adopted in many of our states, as well as in the Canadian provinces, providing close seasons and carrying other provisions for the conservation of fur-bearing animals and the betterment of the condition of the average catch. The laws are discussed in a special chapter. As furs taken in proper season are much more valuable than those taken out of season, confining the legal open season for trapping to the few best months of the year does not reduce the total value of the annual catch.[14]

The license fees, taxes on pelts and royalties in some jurisdictions

[14] Walker, Getting public support for mammal protection, *Journ. Mammalogy,* IX, 196-200, 1928.

produce considerable revenue directly from trapping operations, in addition to the general taxes upon the furriers' and dealers' plants, stocks and business. As examples, fur royalties paid to the government in various Canadian provinces in 1926 amounted to $439,542.47, while in Louisiana in the season of 1926-1927 the following amounts were received by the state: From trappers' license fees, $25,946; dealers' licenses, $11,940; tax on pelts taken, $34,042; total, $71,928.[15] In Canada, about ten or twelve years ago, it was proposed that the Dominion Government "take over the entire control and exploitation of the fur trade and wild life resources of the Northwest Territories," establish trading posts, purchase the rights of the Hudson Bay Company, etc., for the better protection of useful animal life.[16]

The falling off in the catch of some species is significant. For example, the muskrat is one of the most important of our fur-bearers, and better able to hold its own than are many other species, but it has been so intensively trapped in some areas since prices reached their recent height that its numbers have been greatly reduced. One Boston dealer declared that in the seasons of 1918-1919 and 1919-1920, when prices were at their peak, there was a drop of 50 per cent in the catch each season, while in Wisconsin 800,000 were taken in 1917, 300,000 in 1918, and only 150,000 in 1919, though each year there was a 10 per cent increase in the number of trapping licenses issued.[17] In the season 1925-1926 the catch of furs in the United States was 20 per cent less than in 1924-1925, the decrease in the season of 1926-1927 being even greater,[18] perhaps mostly because of the pernicious practice of catching out of season.

An increase or decrease in the total value of the annual catch of furs does not necessarily mean a corresponding increase or decrease in the number of skins obtained. A fair understanding of some of the statistics herein set forth, as well as of the much more detailed figures given in various publications cited in the footnotes, requires strict attention to the fact that there has been an enormous increase in the prices of the individual furs during the last two decades. This general advance is quite independent of the fluctuations from year to year in the value of particular kinds of furs, due to changing fashions. The general advance is due largely, though not entirely, to the greatly in-

[15] Arthur, The fur animals of Louisiana, *Louisiana Dept. Conserv. Bull.* No. 18, p. 422, 1928.

[16] Hewitt, *The conservation of the wild life of Canada,* p. 260, 1921.

[17] Dearborn, Maintenance of the fur supply, *U. S. Biol. Surv. Circular* No. 135, 1920.

[18] *American Forests and Forest Life,* XXXIV, 124, 1928.

creased demand for furs of all kinds, which demand was accelerated during and after the World War, but it had been going on more slowly for many years prior thereto, as the more valuable furs were becoming fewer in proportion to the demand. Beaver pelts were sold in 1875 for $1.00, in 1920 for $17.50 to $20.00; muskrat in 1875 for ten cents, in 1913 for 40 cents to $1.00, in 1920 for $5.00 to $7.50; rabbit skins once 10 cents a pound, but in 1920 the best Australian rabbit skins brought $1.40 to $3.15 a pound in New York.[19] In 1921 the market declined rapidly and has never recovered, though prices are still very high as compared with those of a decade or two ago. It is said that puma skins sold for $1.00 each in St. Louis in 1880.[20]

Complete statistics of the fur trade are not available—indeed, are practically impossible to obtain. There are many items upon which much definite information is at hand, such as the number sold at particular auction sales, the quantity handled by particular companies or organizations, the quantity imported to or exported from various countries, and so on. After all this information concerning the number of pelts passing through the great centers of the fur trade is assembled, a very large, but unknown, amount must be added to cover the furs used locally in various parts of the world, that do not pass through the regular channels of the trade. The "big business" in the trade is in the form of regular auction sales in a few trade centers, such as St. Louis, New York, London, Leipzig, and other cities. Much additional information bearing upon the trade will be found in the systematic discussion, Part II of this book.

Some sort of an idea of the tremendous drain annually made upon wild life by the fur trade may be drawn from the following figures given by Osborn and Anthony of actual recorded sales of the skins of 23 kinds of fur-bearing mammals in 1919, 1920 and 1921, and there are at least 100 other kinds used in the trade, the exact number being difficult to ascertain, owing to the use of trade names:[21]

| | | | |
|---|---|---|---|
| Mole | 23,801,908 | Weasel or ermine | 3,492,412 |
| Squirrel | 14,858,316 | Civet cat | 2,114,535 |
| Muskrat | 14,109,288 | Nutria | 1,941,784 |
| American opossum | 9,987,742 | Wallaby (Kangaroo) | 1,722,588 |
| Skunk | 6,895,674 | Mink | 1,683,900 |
| Australian opossum | 4,265,621 | Ring-tail opossum | 1,321,625 |
| White hare | 3,713,036 | Red fox | 1,295,258 |

[19] Laut, *The fur trade of America,* p. 5, 1921.
[20] Townsend, *Zoe,* III, 311, 1893.
[21] Osborn and Anthony, Close of the age of mammals, *Journ. Mammalogy,* III, 219-237, 1922.

| | | | |
|---|---|---|---|
| Kolinsky | 1,151,553 | Alaska fur seal | 85,164 |
| Wolf | 1,094,502 | Kangaroo | 41,238 |
| Beaver | 420,490 | Silver or black fox | 26,350 |
| Wombat | 208,977 | Sea otter | 76 |

We do not know what is meant by civet cat in this list, as that name is used for several very different animals, and the item is omitted from a later list by the same authors,[22] in which they give the number of mink skins for the same period as 2,540,971, add the following species, and make the total 107,689,927:

| | | | |
|---|---|---|---|
| Chinchilla | 36,448 | Land otter | 111,059 |
| Fisher | 32,014 | Marmot | 3,107,759 |
| Marten | 309,808 | European polecat | 1,094,411 |
| Stone marten | 107,075 | White fox | 166,071 |
| Sable | 57,908 | Bobcat | 191,799 |
| Cross fox | 32,296 | Raccoon | 1,713,700 |

The world's production of furs of aquatic mammals in 1900 has been estimated as follows at the low prices then prevailing:[23]

| | United States | | All other countries | | Total | |
|---|---|---|---|---|---|---|
| | Number of skins | Value | Number of skins | Value | Number of skins | Value |
| Beaver | 8,000 | $ 39,860 | $ 58,000 | 301,200 | 66,000 | $ 341,060 |
| Fur seal | 24,000 | 660,000 | 71,485 | 1,471,000 | 95,485 | 2,131,000 |
| Mink | 578,000 | 810,000 | 150,000 | 330,000 | 728,000 | 1,140,000 |
| Muskrat | 4,035,000 | 565,000 | 1,250,000 | 138,000 | 5,285 000 | 703,000 |
| Nutria | — | — | 1,950,000 | 444,000 | 1,950,000 | 444,000 |
| Otter | 14 600 | 93,260 | 19,040 | 170,850 | 33,640 | 264,110 |
| Sea otter | 330 | 133,980 | 260 | 105,560 | 590 | 239,540 |

The following table of estimates of annual world sales for some of the important fur-bearers, far from a complete list, is slightly modified from Laut's 1921 table:[24]

| | | | |
|---|---|---|---|
| Badger | 160,000 | to | 185,000 |
| Beaver | 81,000 | to | 99,000 |
| Ermine | 1,000,000 | to | 1,110,000 |
| Fitch (polecat) | 300,000 | to | 350,000 |
| Silver fox | 4,300 | to | 6,000 |
| Red fox | 1,000,000 | to | 1,200,000 |
| Marten | 150,000 | to | 210,000 |
| Stone marten | 250,000 | to | 380,000 |
| Mink | 640,000 | to | 1,000,000 |
| Muskrat | 5,000,000 | to | 8,000,000 |

[22] Osborn and Anthony, Can we save the mammals?, *Nat. Hist.*, XXII, 389-405, 1922.
[23] Stevenson, Utilization of the skins of aquatic animals, *Rept. U. S. Com. Fish and Fisheries for 1902,* pp. 285, 287.
[24] Laut, *The fur trade of America,* p. 84, 1921.

| | |
|---|---|
| Otter | 90,000 to 124,000 |
| Coon (raccoon) | 500,000 to 600,000 |
| Sable | 175,000 to 235,000 |
| Skunk | 1,200,000 to 1,500,000 |
| Squirrel | 15,000,000 |
| Rabbit | 70,000,000 to 80,000,000 |
| Fisher | 10,000 |

Innis[25] presents an elaborate and very instructive table giving estimates of many kinds of furs of various countries in 1863, 1907-1909, 1913 and 1923-1924, for purposes of comparison. A very few important standard items are here chosen from the table, to show the general trend of the market during that long period:

| | North and South America 1863 | North and South America 1913 | Europe 1913 | North America alone 1923–24 | Europe 1923–24 |
|---|---|---|---|---|---|
| | (000's omitted) | | | | |
| Skunk | 100 | 1,700 | — | 3,500 | — |
| Muskrat | 2,850 | 5,000 | 5 | 18,000 | 400 |
| Mole | — | — | 1,000 | 500 | 10,000 |
| Rabbit | 580 | — | 50,000 | 1,000 | 80,000 |
| Domestic cat | — | 75 | 700 | 150 | 400 |
| Mink | 200 | 500 | 20½ | 300 | — |
| Foxes, all kinds | 108 | 365 | — | 680 | — |

The same author (Innis, p. 83) gives another table showing the total number and value of all the furs for the various countries for 1863, 1907-1909 and 1923-1924, in which the grand totals for the world are as follows: 1863, $17,456,650; 1907-1909, $73,400,000; 1923-1924, $212,600,000. In 1911 Russia produced 4,525,000 squirrel skins, sold as raw pelts for $2,000,000, and 21 tons of squirrel skins valued at $5.50 a pound, and annually sold about 200,000 ermine skins for $350,000.[26]

At the February, 1920, fur auction in Saint Louis, $27,000,000 worth of furs were sold in twelve days.[27] The New York sales during the same month totalled $10,600,000, and included the following domestic furs:[28] 27,000 red fox, 175,000 opossum, 73,000 raccoon, 32,000 wolf, including coyote, 239,000 skunk, 4350 badger, 6200 gray fox, 41,500 mink, 7700 marten, 58,000 "civet cat," 68,000 ermine and 9800 wildcat and lynx. Also the following foreign furs: 234,000

[25] Innis, *The fur trade of Canada,* table opposite p. 76, 1927.
[26] Jones, *Fur farming in Canada,* p. 106, 1913.
[27] Dearborn, The fur situation, *Journ. Mammalogy,* 1, 144-145, 1920.
[28] N. H[ollister], *Journ. Mammalogy,* 1, 160, 1920.

Australian opossum; 325,000 squirrels; 23,500 kangaroo and wallaby. One London firm alone in 1912 sold 9,435,125 pelts,[29] and at one sale in that city 30,000 monkey skins changed hands.[30] A press dispatch from St. Louis, dated May 3, 1919, said that on that day 90,000 wolf skins were sold at auction for $904,450. At one New York auction 4,000,000 pelts were sold (600,000 muskrat and 280,000 mole being the largest single items), and at a St. Louis auction a total of nearly 4,000,000 were sold, including the following:[31] Muskrat, 900,000; Russian squirrel, 810,000; marmot, 173,000; ermine, 118,000; mole, 750,000; mink, 279,000; nutria, 135,000; oppossum, 300,000; skunk, 215,000; raccoon, 130,000; and "thousands of others."

The value of annual catch of furs in the United States twenty-five or thirty years ago was estimated at $25,000,000 and in 1925 at $70,000,000,[32] the increase being largely due to advancing prices rather than to increased numbers. The latter figure would pay interest at 5 per cent on a capitalization of $1,400,000,000. Therefore the fur-bearers at present values should be worth to the country more than one billion dollars—an asset well worthy of careful conservation and wise administration.

Early in 1928 it was said that the fur catch of the United States is worth *to the trapper* $60,000,000 each year; about $26,000,000 worth of furs imported and $100,000,000 worth exported annually, $121,000,000 worth used annually in the States (retail value of furs and trimmings annually used in the United States $500,000,000); 20,000 concerns in the United States handling furs; 2000 wholesale manufacturers of furs in New York, with 8000 workers; 160 fur-dressing and fur-dyeing concerns, with 5500 workers, annual pay roll $8,400,000, dressing and dyeing 40,000,000 skins annually, exclusive of rabbits; 100,000,000 rabbit skins imported annually, 40 per cent for manufacture of fur garments, 50 per cent for manufacture of felt hats.[33] The United States in one month imported furs and skins from 37 countries, and during the first three months of 1926 imported furs from 55 countries; total imports of raw and dressed furs for 1924 were valued at $87,000,000 and for 1925 at $115,000,000, being exceeded by importations of only cane sugar, raw silk, coffee, crude rub-

[29] Hornaday, *Our vanishing wild life,* pp. 193-194, 1913.
[30] Lucas, *Ann. Rept. U. S. Natl. Museum for 1889,* p. 611.
[31] *The Oologist,* XXXVI, 27-29, 1919.
[32] Ashbrook and Earnshaw, *Farmers' Bull.,* No. 1469, p. 1, 1925. Taylor, Fur-bearing mammals: An unappreciated natural resource, *Science,* XXXVII, 485-487, 1913.
[33] Ashbrook, *Fur farming for profit,* p. 4, 1928.

ber, newsprint paper and manufactured wool; United States produces $70,000,000 worth of furs annually, Canada $15,000,000 and Soviet Russia $35,000,000.[34]

In the campaign of the United States Biological Survey against predatory mammals in national forests and on western stock ranges, from 1915 to 1925, 222,503 skins were obtained and sold for $310,306.76, as follows:[35] coyotes, 186,172; wolves, 4916; bears, 579; mountain lions, 999; bobcats, 23,274; lynxes, 83.

Prior to the World War the greater part of the fur business was centered in Great Britain and Germany, and a large part of American furs were sent abroad, where they were dressed, dyed and prepared for use, then returned to this country for sale to ultimate American customers. During and immediately after that war many fur-dressing plants were established in Canada and the United States, and the center of the fur trade, with its secrets of dressing and dyeing furs, crossed the ocean to North America.

The following items concerning the fur trade of the United States for three years, compiled by the United States Bureau of Foreign and Domestic Commerce and published by Ashbrook, will show something of the magnitude of our trade in this line since this country became the leading fur market of the world:[36]

| | *1918* | *1919* | *1920* |
|---|---|---|---|
| Imports of undressed furs | $ 32,158,939 | $ 69,289,909 | $ 84,427,592 |
| Imports of dressed furs and fur manufactures | 2,491,278 | 7,472,336 | 9,131,348 |
| Manufactures and exports of domestic furs | 11,374,174 | 23,788,599 | 32,866,995 |
| Dressed by Fur Dressers' and Fur Dyers Association | 35,212,230 | 51,366,253 | 52,910,589 |
| Total turnover of fur industry in U. S. as estimated by Board of Trade of Fur Industry | 232,748,201 | 342,441,687 | 352,605,927 |

| *Auction Sales* | *St. Louis* | *New York* |
|---|---|---|
| 1915 | $ 1,000,000 | |
| 1916 | | $ 250,000 |
| 1919 | 7,924,330 | 6,000,000 |
| 1920 | 27,102,588 | |
| 1921 | 11,000,000 | 2,000,000 |

Ten per cent federal revenue on articles manufactured from fur in 1920 equalled $15,311,214.24.

[34] Mills, The international fur trade, *Journ. Home Economics,* XVIII, 623-626, 1926.

[35] Adams, *Roosevelt Wild Life Bull.,* III, 583, 1926. See also Bell, Hunting down stock killers, *Yearbook U. S. Dept. Agric. for 1920,* pp. 289-301.

[36] Ashbrook, The fur trade and the fur supply, *Journ. Mammalogy,* III, 1-7, 1922. Nelson, The economic importance of wild life, *Scientific Monthly,* XVI, 271-273, 1923.

The less-pronounced increase in exports, imports and manufactures from 1919 to 1920, and the marked drop in auction sales in 1921 are due partly or wholly to declining prices, rather than to decrease in the quantity of material handled. To the totals must be added a considerable amount of small business scattered over the country, not reported. We are told that the amount spent annually for fur garments in America is about $100,000,000 with from $200,000,000 to $300,000,000 invested in the industry.[37]

The following information is obtained from the Statistical Abstract of the United States for 1925:[38]

| | | |
|---|---|---|
| Total exports of furs and fur manufactures from the United States in 1925 | | $ 26,482,000 |
| Fox | 1,537,000 | |
| Muskrat | 1,969,000 | |
| Raccoon | 393,000 | |
| Skunk and civet cat | 7,825,000 | |
| Opossum | 4,653,000 | |
| Other furs | 9,042,000 | |
| Miscellaneous fur manufactures | 1,063,000 | |

| | | |
|---|---|---|
| Total imports of furs and fur manufactures to the United States for 1925 | | $115,349,000 |
| Furs, undressed— | | |
| Beaver | 3,676,000 | |
| Fox, except silver and black | 15,839,000 | |
| Hare, cony and rabbit | 23,731,000 | |
| Marten | 1,940,000 | |
| Mink | 2,426,000 | |
| Mole | 396,000 | |
| Muskrat | 1,920,000 | |
| Squirrel | 13,725,000 | |
| Miscellaneous | 37,940,000 | |
| Furs, dressed and manufactured | 13,756,000 | |

Total furs dressed and manufactured in the United States in 1925:

| | *Cost of material* | *Value added by manufacture* | *Value of finished product* |
|---|---|---|---|
| Furs dressed | $ 20,558,000 | $ 47,326,000 | $ 67,884,000 |
| Fur manufactures | 340,143,000 | 214,037,000 | 554,180,000 |
| Total | $360,701,000 | $261,363,000 | $622,064,000 |

According to Innis, from 1914 to 1919 the number of fur-dressing plants in the United States increased from 96 to 141, the total capitalization from $2,489,868 to $8,867,403, the wages from $906,030 to $6,338,835, and the value of the product from $2,875,036 to

[37] Dearborn, The maintenance of the fur supply, *U. S. Biol. Surv. Circular* No. 135, pp. 3-12, 1920. Johnson, *Roosevelt Wild Life Bull.*, III, 208-209, 1925.

[38] *Statistical abstract of the United States—1925,* U. S. Bureau of Foreign and Domestic Commerce, 1926.

$20,384,569. To this must be added the producing (trapping, etc.) and marketing ends of the business to get the total value of the industry in the United States. In Canada, from 1910 to 1924, the number of plants increased from five to eight, capitalization from $198,500 to $926,270. Of 3,473,909 skins dressed in Canada in 1924, 1,615,520 were muskrat and 649,836 were rabbit. Of raw furs Canada in 1923 exported to the United Kingdom $4,743,986, and to the United States $11,290,514. The manufactured fur goods industry in Canada in 1924 included 218 reported establishments, with a capital investment of $9,910,979, paying $1,916,421 in wages, products valued at $12,265,371.[39]

In 1867 Alaska was purchased by the United States for $7,200,000. Since then the territory has exported $80,000,000 worth of furs, $2,000,000 in 1918 alone.[40] In 1912-1914, $600,000 worth were shipped out, not including the Pribilof Island seals and foxes.[41] In 1917 the total shipments were valued at $1,141,609 (Pribilof Island seals and foxes $109,971).[42] In 1923 the total was $1,794,159.85 (muskrat 319,611, valued at $367,552; white fox 7939, $297,476; beaver 14,341, $258,138; red fox 10,787, $215,741; mink 20,668).[43] In 1929, 297,440 mammal skins were exported from Alaska, valued at $4,513,863.76, 38,629 fewer than in 1928, but an increase of $215,226.63 in value, because of the increased value of individual furs.

In Minnesota fur-bearing animals were reported to have been taken under trappers' licenses as follows: Season of 1920-1921, 219,685; 1921-1922, 474,544; 1922-1923, 273,055; 1923-1924, 264,253.[44] The fur catch in New York State in 1919 was as follows: Muskrat 388,938, value $599,907; skunk 187,703, $750,812; all others 53,660, $432,046.[45] Though California is not usually thought of as a fur-producing state, the value of the catch reported for the season of 1925-26, under 3530 trapping licenses, was $257,711. That state had 5243 licensed trappers in 1927-1928 and 6482 in 1928-1929, an increase of 1139. Of these numbers 3402 reported in 1927-1928 and 3652 in 1928-1929, an increase of 250. Notwithstanding the increase in the number of trappers licensed and reporting, the catch of furs fell

[39] Innis, *The fur trade of Canada,* pp. 120-123, 1927.
[40] Laut, *The fur trade of America,* p. 65, 1921.
[41] Bower and Aller, *Ann. Rept. U. S. Comm. Fish. for 1914,* Appendix x.
[42] *Science,* June 7, 1918. *California Fish and Game,* v, 34-35, 1918.
[43] *California Fish and Game,* x, 82, 1924; xvi, 258, 1930.
[44] Ashbrook and Earnshaw, *Farmers' Bull.,* No. 1469, 1925.
[45] Johnson, The muskrat in New York, *Roosevelt Wild Life Bull.,* iii, 208, 1925.

off from 167,202 skins, of twenty species, valued at $468,960.46, in 1927-1928, to 103,508 skins, valued at $280,309.66 in 1928-1929.[46] The foregoing examples are taken at random, including one of the largest and one of the smallest producers, but every state in the Union produces some furs.

Even residents of Louisiana were astonished by the statement of Arthur to the effect that the catch of furs in Louisiana per annum exceeds that of any other state in the Union, and is also greater than that of all Canadian provinces and territories and Alaska combined,[47] the Louisiana catch for the season of 1924-1925 having been 6,771,265 pelts, Alaska only 285,645, and Dominion of Canada combined catch 3,820,326. The value of the 1924-1925 catch in some of the states and Canadian provinces is given by him as follows:

| *United States* | | *Canada* | |
|---|---|---|---|
| Louisiana | $6,490,340 | Ontario | $3,406,868 |
| Michigan | 3,000,000 | Quebec | 2,272,095 |
| Pennsylvania | 2,500,000 | Alberta | 2,030,974 |
| Minnesota | 2,399,200 | Northwest Territory | 1,780,666 |
| Tennessee | 2,000,000 | Manitoba | 1,589,078 |
| Alaska | 1,657,448 | British Columbia | 1,403,769 |
| New York | 1,500,000 | Prince Edward Island | 326,669 |
| Arkansas | 1,500,000 | Yukon Territory | 309,549 |
| Wisconsin | 1,341,000 | Nova Scotia | 271,753 |
| Texas | 1,000,000 | New Brunswick | 246,091 |
| Maryland | 500,000 | | |
| Kansas | 250,000 | | |
| Oregon | 250,000 | | |
| Virginia | 200,000 | | |
| Vermont | 150,000 | | |

However, on page 415, while giving the total catch of Canada for 1926-1927, from figures furnished by the Dominion Bureau of Statistics, as only 4,289,233 pelts, their value is given as $18,864,126, nearly three times as much as that of Louisiana, the difference being due to the fact that the Louisiana fur-bearers are chiefly muskrat and other lower-priced furs, while a very much larger proportion of Canadian furs are higher-priced kinds.

In Kansas, for the fur season of 1927-1928, 742 fur dealers' licenses were issued. Five dealers reported a business aggregating $462,766. The following is the catch reported for the season, the values being the amounts paid by the dealers to the trappers:[48]

[46] *California Fish and Game,* XII, 272, 1927; XVI, 164, 1930.

[47] Arthur, The fur animals of Louisiana, *Louisiana Dept. of Conservation Bull.* 18, pp. 14, 47, 411, 415, 1928.

[48] Dose, Kansas' enormous fur trade, *Kansas Fish and Game, No. 2,* pp. 67-69, 1928. *Third Biennial Report of Kansas State Forestry, Fish and Game Commission,* for period ending June 30, 1930, p. 32.

| | Number of skins | | Value |
|---|---|---|---|
| Opossum | 350,286 | | $ 350,000 |
| Skunk | 279,647 | over | 560,000 |
| Muskrat | 239,174 | over | 240,000 |
| "Civit" (probably spotted skunk) | 107,277 | | |
| Weasel | 3,392 | | |
| Raccoon | 5,789 | | |
| Wolf | 1,416 | | |
| Coyote | 6,169 | | |
| Badger | 9,789 | | |
| Mink | 5,527 | | |
| Total | 1,008,466 | | $1,273.708 |

As trappers in that state are not required to report their catches, the actual number taken was probably much greater than the figures indicate. The number of pelts reported by Kansas dealers for the biennial period 1929-1930 is as follows:

| | *1929* | *1930* |
|---|---|---|
| Muskrat | 280,719 | 276,338 |
| Skunk | 269,940 | 258,493 |
| Mink | 7,587 | 5,867 |
| Raccoon | 24,447 | 22,666 |
| Opossum | 349,469 | 316,297 |
| Badger | 9,389 | 8,344 |
| Civet cat | 116,344 | 117,309 |
| Miscellaneous | 26,979 | 25,756 |
| | 1,084,874 | 1,031,070 |

The number of trapping licenses issued for the season 1928-1929 was 17,616, while the number for 1929-1930 was 28,147. With a great increase in the number of licensed trappers, there was a decrease in the catch as reported by dealers.[48]

There is considerable evidence of a very serious decrease of some of the most valuable fur-bearers, and though some writers are optimistic about the future, the great majority do not view the prospect at all cheerfully and all admit that some species are in grave danger of extinction. A few species are becoming so rare that they constitute an almost negligible part of the fur supply, though their present high prices give them a disproportionately large place in the total value of the product of all furs. The sea otter was sold by thousands a century ago, 2369 in one year as late as 1891, but only 202 in 1912 and 25 in 1920, some rather poor pelts then bringing $1,700 to $2,000 each in St. Louis and London,[49] though it is said that they sold for $80 in 1880.[50]

[49] Laut, *The fur trade in America*, p. 113, 1921; *World's Work*, May, 1907, p. 8875. Preble, *N. Amer. Fauna*, No. 46, 1923.

[50] *California Fish and Game*, III, 80, 1917.

The Alaska fur seal herd was estimated at 3,000,000 to 4,000,000 in 1873, and had been reduced to about 200,000 by 1911, but with better protection and wiser administration the herd has very materially increased since that time and is no longer threatened with annihilation.[51]

There can be no doubt that the supply of furs of some species may be enormously increased by fur farming. Vast tracts of waste lands of various kinds, now unprofitable, may be profitably utilized in raising a number of species of valuable fur-bearers. Muskrat raising in swamp lands has proved highly profitable in some localities, and on uplands other species are being raised in captivity or semi-captivity. What may be done also merely by strict legal protection and scientific control without further care is well shown by the rapid increase in the northern fur seal in recent years, and by the fact that beavers, re-introduced into the former haunts from which they were long ago driven, have soon re-established themselves and formed thriving colonies. There should be no trouble about indefinitely increasing the rabbit supply, and the raising of "Persian lambs" for their pelts is developing into a very important industry.

Many excellent books and pamphlets on fur farming,[52] give detailed information concerning the habits and care of various species, and the equipment and management of fur farms. Success with most of the species yet tried depends upon very thorough knowledge of the habits, the kind and quantity of food required, housing requirements, their diseases and so on, and upon constant and watchful care. Foxes, especially, are very sensitive, and easily worried by strange sights, noises or odors, particularly during the breeding season, and when worried or excited have been known to destroy their own offspring. It is not pleasant to see the life of fox pups, with a potential value of hundreds or thousands of dollars, snuffed out because of a little temporary carelessness, before they have had time to attain their possible high value. It is customary on some fox farms to exclude all visitors

[51] Laut, *The fur trade of America,* pp. 125-133, 1921. Preble, *N. Amer. Fauna,* No. 46, 1923. Bower and Aller, *Ann. Rept. U. S. Comm. Fish. for 1914,* Appendix x. Nelson, *Scientific Monthly,* XVI, 372-373, 1923.

[52] For example: Jones, *Fur farming in Canada,* pp. 39-40, 1913. Laut, *The fur trade of America,* p. 56, 1921. Ashbrook, *Fur farming for profit,* 1928; Fur farming, a growing industry, *Yearbook U. S. Dept. Agric. for 1926,* pp. 393-395; Recommendations for beginners in fur farming, *U. S. Biol. Surv., Leaflet No. 27,* 1928. Grinnell, Foxes in captivity, *Journ. Mammalogy,* IV, 184, 1923. Salvesen, *Pelsdyrboken: Handbok i Opdrett av Pelsdyr,* Oslo, 1928 (on fur farming). Allen and McLure, *Theory and practice in fox ranching,* Charlottetown, Pr. Edw. Isl., 1926.

and keep all domestic animals from the vicinity of the pens during the breeding season, and in some places laws prohibit strangers from approaching fox farms without permission of the owners.

Though there are vicissitudes that make fur farming uncertain, many such enterprises, carefully conducted, under favorable circumstances, have yielded very large profits. In 1918 one Prince Edward Island fur farmer sold $14,000 worth of pelts from his farm.[53] In 1924, six fox farms sold 1541 skins for $215,740 (average price $140) and in 1925 they sold 4089 pelts at an average price of $132, the highest price for a single skin being $520.[54] There are now about 2500 fur farmers in the United States and Alaska, mostly silver or blue fox, with a total investment of $15,000,000 to $18,000,000, and 2130 in Canada, with an investment of $13,240,245.[55] It was estimated that in 1923 there were 15,000 silver foxes in captivity,[56] an estimate now much too low.

Prior to 1910 there were very few fox farms and few breeding foxes were for sale. Then the breeders discovered that they could get much larger prices for the well-bred live foxes for breeding purposes than for the pelts, and began to place breeding stock on the market. Within two years they rose in price from $3,000 to $15,000; one pair sold in 1912 for $20,000 and others were quoted at a value of $35,000 a pair, while one fine skin sold in London for $2,817.[57] During the World War there was a slump, but a few years later "pure-blood, registered silver foxes" were selling alive for from $10,000 to $35,000 a pair, and breeding stock of Persian lambs were quoted at from $500 to $10,000 a pair.[58] It is no wonder that some fur-farm breeding stocks "get the care of millionaire babies," as Miss Laut picturesquely puts it.

In 1921 blue foxes were selling at $20 a pair and skins ran from $75 up, while white fox pelts did not exceed $60. Breeding mink stock at the same time was selling for $30 to $300 a pair.[59]

[53] Laut, *The fur trade of America,* p. 65, 1921.
[54] Ashbrook, *Fur farming for profit,* p. 19, 1928.
[55] Ashbrook, *Fur farming for profit,* p. 24, 1928; Silver fox farming, *U. S. Dept. Agric. Bull.* No. 1151, 1923; *Journ. Mammalogy,* III, 1-7, 1922. See also Ashbrook and Earnshaw, *Farmers' Bull.,* No. 1469, pp. 3-4, 1925. Ashbrook and Walker, Blue fox farming in Alaska, *U. S. Dept. Agric. Bull.* No. 1350, 1925. Dearborn, Silver fox farming in eastern United States, *ibid., No. 301,* 1915. Osgood, Silver fox farming, *Farmers' Bull.,* No. 328, 1909. *California Fish and Game,* III, 80, 1917; VII, 164-165, 1920.
[56] Ashbrook, address quoted in *California Fish and Game,* IX, 161, 1923.
[57] Jones, *Fur farming in Canada,* pp. 14-15, 49, 111, 1913.
[58] Laut, *The fur trade of America,* Foreword, p. ix; also pp. 52, 54, 55, 1921.
[59] Laut, *The fur trade of America,* pp. 63, 102, 1921.

With all the phenomenal profits made by highly successful fox farmers, we must not overlook the fact that there have also been many and sometimes heavy losses, due to unfavorable locality, poor management, ignorance or failure to understand the necessity of constant watchfulness. The failures are not so likely to be published as the successes. Vendors of capital stock of fur-farm companies see to it that success is duly and thoroughly advertised, but no one is specially interested in advertising failures. As in most lines of business, it is a great success under proper management and favorable conditions, otherwise only a moderate success or a failure.

In addition to fox farming, mink and skunk farming have been successfully accomplished, minks have been bred in captivity for sixty years, breeding stock during the American Civil War having sold at $30 a pair, while in 1916 it was said that there were more skunk breeders than all other breeders of fur-bearers combined.[60] Other species have been tried with more or less success. Muskrat farming consists mostly of utilizing swamp lands of little value for other purposes, as the most economical method, and beaver farming is largely a matter of re-introducing the animals into favorable territory from which they had been exterminated, and carefully protecting them from poachers. Fur farming of some sorts may be profitably carried on in connection with general agriculture in some localities. A fair income may often be derived from simply trapping the wild fur-bearers about the farms during the right season, protecting them from molestation during the remainder of the year when the skins are not prime and the animals are breeding, thus "turning pests into profits." It may not be out of place here to suggest that deer farming and the raising of other wild non-fur-bearing mammals under control may be profitably carried on, perhaps in connection with some kinds of fur farming, in suitable localities.[61]

The so-called "Persian lambs," broadtails and karakuls are domesticated animals and so, of course, the whole supply of their pelts, so much used in the fur trade, is the result of fur farming. The raising of these animals is already well started in the United States and will

[60] Dearborn, Fur farming as a side issue, *Yearbook U. S. Dept. Agric. for 1916*, pp. 489-506. Ashbrook, Mink raising, *U. S. Biol. Surv. Leaflet* No. 8, 1928. See also books by Laut, Jones, and Ashbrook cited in other footnotes to this chapter.

[61] Lantz, Raising deer and other large game animals in the United States, *U. S. Biol. Surv. Bull.* No. 36, 1910; Deer farming in the United States, *Farmers' Bull.*, No. 330, 1908. Roseberry, Experience in raising Virginia deer, in Jones, *Fur farming in Canada*, pp. 118-119, 1913.

continue to expand.[62] The native home of these sheep is not Persia, but Turkestan. The current belief that the skins are obtained from the unborn lambs by killing their mothers is without foundation, but it has been said that to get the pelt with the curl and luster in its best condition it must be taken within three or four days after birth. To kill the high-priced ewe and thus stop further reproduction, in order to get the tiny lambskin, would make these furs even very much more expensive then they now are. The United States is a heavy importer of these pelts from Turkestan, 1,500,000 per annum, worth $14,000,000, as reported in 1921, while a few years ago Leipzig alone was importing 2,900,000 per annum. Prices of pelts advanced 180 per cent from 1895 to 1913, brought $12 during the World War and thereafter again advanced 140 per cent.[63]

The chinchilla rabbit has been greatly exaggerated as a profitable fur-farm animal, perhaps because of confusion with the wild chinchilla of South America, whose fur is much more valuable, but which does not belong to the rabbit family. "As with all domestic rabbits, chinchillas must be bred for both meat and fur to combine the returns from the two commodities and thus derive the maximum profit on the labor and capital invested."[64]

Turning now to hides and skins of animals other than fur-bearers, and to leather and leather goods manufactured therefrom, we find another vast industry based upon mammals. The great majority of Americans and Europeans, as well as inhabitants of some other lands, wear boots or shoes made of leather, which also provides the indispensible material for great belts that transmit power to machinery in our factories, the best material for gloves, saddles, harness, suitcases, some sorts of upholstery and very numerous other articles. For many purposes no satisfactory substitute is known. So important is this widely-used material that one may be excused for speculating on how different the course of development of modern civilization, or how it might have been retarded, had there been no mammals to provide leather for boots and shoes, to say nothing of the many other articles so very convenient and useful as to be considered essential.

The following statistics concerning the leather, hide and skin (ex-

[62] Marshall, Heller and McWhorter, Karakul sheep, *Yearbook U. S. Dept. Agric. for 1915*, pp. 249-262. Ashbrook, *Fur farming for profit*, pp. 239-262, 1928.

[63] Laut. *The fur trade of America*, pp. 66-77, 1921.

[64] Green, Chinchilla rabbits for food and fur, *U. S. Biol. Surv. Leaflet* No. 22, 1928.

cept furs) industries in the United States are culled from the statistical abstract of the United States for 1925:[65]

| | | |
|---|---|---|
| Manufactures of leather and its finished products in the United States in 1923: | | |
| Leather, tanned, curried and finished | | $ 488,898,000 |
| Total value finished products of leather | | 1,391,183,000 |
| Boots and shoes, excluding rubber | $1,000,078,000 | |
| Boot and shoe cut-stock and findings not made in shoe factories | 137,303,000 | |
| Belting for machinery, etc. | 37,723,000 | |
| Leather gloves and mittens | 38,081,000 | |
| Pocketbooks, purses and cardcases | 32,732,000 | |
| Saddlery and harness | 42,113,000 | |
| Trunks, suitcases and bags | 63,023,000 | |
| Miscellaneous leather goods | 40,130,000 | |
| Hides and skins produced in 1923, except furs | | $ 91,226,000 |
| Imports of hides and skins in 1925 | | $ 96,754,000 |
| Cattle hides | $ 26,695,000 | |
| Buffalo hides (India, etc.) | 705,000 | |
| Kip and calf skins | 8,599,000 | |
| Horse, colt and mule skins | 1,490,000 | |
| Sheep and lamb skins | 23,458,000 | |
| Goat and kid skins | 33,197,000 | |
| Kangaroo and wallaby skins | 561,000 | |
| All other skins except furs | 2,049,000 | |
| Imports of leather | | $ 22,413,000 |
| Imports of leather manufactures | | 13,858,000 |
| | | $ 133,025,000 |
| Exports of hides and skins in 1925, except furs | | $ 12,031,000 |
| Exports of leather | | 52,127,000 |
| Exports of leather manufactures | | 20,562,000 |
| | | $ 84,720,000 |

According to Holmes the production of hides and skins in the United States in 1915 was as follows:[66] calf skins, 5,424,000; goat skins, 432,000; cattle hides 12,645,000; sheep skins 15,865,000; total 34,366,000 skins.

In 1914 the boot-and-shoe manufactures of the United States were placed at $445,000,000 (which may be compared with the $1,000,000,000 for 1923), distributed as follows:[67]

| | | | |
|---|---|---|---|
| Massachusetts | $200,000,000 | Ohio | $ 38,000,000 |
| New York | 54,000,000 | Pennsylvania | 25,000,000 |
| Missouri | 40,000,000 | Other states | 50,000,000 |
| New Hampshire | 38,000,000 | | |

[65] *Statistical abstracts of the United States for 1925,* U. S. Bureau of Foreign and Domestic Commerce, 1926.
[66] Holmes, Hides and skins, *Yearbook U. S. Dept. Agric. for 1917,* pp. 425-446.
[67] Allen, *Shoe industry,* pp. 33-37, 1922, citing U. S. Census for 1914, *The leather industry,* Table 24.

More leather is used in the manufacture of boots and shoes, which are prime necessities, than for any other class of articles, their manufacture giving employment to a large number of men and women. In 1910 the United States exported $13,216,237 worth of shoes and boots and in the same year the United Kingdom exported $14,729,936 worth.[68]

A bulletin of the United States Department of Agriculture, giving directions for skinning, curing and marketing hides and skins, contains the following table of hides and skins used in the United States in 1914:[69]

| | *Domestic* | *Imported* | *Total* | *Total Value* |
|---|---|---|---|---|
| Cattle and horse hides | 10,354,600 | 8,477,200 | 18,831,800 | $152,862,800 |
| Calf and kip skins | 7,615,800 | 8,452,000 | 16,067,800 | 33,117,700 |
| Goat and kid skins | 860,700 | 36,895,200 | 37,755,900 | 23,917,000 |
| Sheep and lamb skins | 13,554,900 | 26,535,300 | 40,090,200 | 19,257,700 |
| Miscellaneous skins | | | 1,328,500 | 4,377,500 |
| | | | 114,074,200 | $233,532,700 |

We have at hand no complete, up-to-date statistics of the hide and leather trades of other countries, but the exports and imports from and to three of the important countries of Europe for 1909, 1910 and 1919 respectively are as follows:[70]

| Germany, 1909-10: | *Exports* | *Imports* |
|---|---|---|
| Cattle hides and calf skins | $20,268,080 | $ 77,878,836 |
| Horse hides | 1,904,832 | 2,906,498 |
| Buffalo hides | | 479,808 |
| Lamb and sheep skins | 916,062 | 6,320,714 |
| Goat and kid skins | 1,355,648 | 6,902,952 |
| Other skins (not furs) | 69,734 | 502,560 |
| Total | $24,514,356 | $ 94,991,368 |

| | |
|---|---|
| United Kingdom, Imports of hides, 1910 | $10,793,718 |
| United Kingdom, Exports of hides 1910 | 2,686,415 |
| France, Imports of hides, 1919 | $20,253,000 |
| France, Exports of hides, 1919 | 55,110,600 |

Besides the skins specifically enumerated, skins of many other mammals are used in the leather industry, among which may be mentioned

[68] *U. S. Bureau of Manufactures, Special Agent Series, No. 49,* 1912.

[69] Whalen, Frey, Veitch and Hickman, Country hides and skins, *Farmers' Bull.,* No. 1055, 1919. For tanning see also Frey, Clarke and Veitch, Home tanning of leather and small fur skins, *Farmers' Bull.,* No. 1334.

[70] The reader will find much information on this subject in the Special Agent Series of the U. S. Bureau of Manufactures, especially Nos. 49, 50, and 200, with other countries treated in other numbers.

the pig, hair seals, porpoises, etc. Many thousands of deer skins are marketed annually in the United States and used in making buckskin. Before game laws for Alaska were enacted thousands of deer were killed there for their skins alone.[71] In Texas, from 1844 to 1853, 75,000 deer skins were handled at one trading post.[72] Reindeer skins are much used for clothing in Alaska, Labrador and some northern European countries. American bison skins were sold by hundreds of thousands from 1865 to 1885, many of them for a dollar or two each, for robes and other purposes, but they are not now in the market. One railroad handled 1,378,369 in three years, from 1872 to 1874, and 75,000 were shipped from Bismarck alone in 1881.[73] The buffalo skins mentioned in recent statistics of imports and exports of various countries are not American bison, but the buffaloes of Asia, Philippines and perhaps Africa.

The armadillo, an interesting and useful animal, is being rapidly exterminated from Texas and northern Mexico for its skin, which is used in the manufacture of ornamental baskets.[74] Marine mammals furnish large quantities of excellent leather. In 1902 the seal leather (not fur seal) production was estimated at $1,500,000 per annum, beluga or white whale (sold as porpoise leather) at $200,000, and tanned walrus leather at $100,000; about 30,000 pounds of tanned walrus hides, worth $25,000, imported to the United States annually; the largest Atlantic Coast catch of porpoises for leather up to that time, 20,000 skins in 1887, the green skins then worth $2 a side; manatee and dugong skins also used for leather, but the production too small to be of much consequence.[75]

[71] Osgood, The game resources of Alaska, *Yearbook U. S. Dept. Agric. for 1907*, p. 478.

[72] Strecker, The trade in deer skins in early Texas, *Journ. Mammalogy*, VIII, 106-110, 1927.

[73] Nelson, *Scientific Monthly*, XVI, 369, 1923. Bailey, *N. Amer. Fauna*, No. 49, p. 22, 1926.

[74] [Jackson], *Journ. Mammalogy*, X, 89, 1929, criticizing McDaniel, *Amer. Forests and Forest Life*, XXXV, 44-45, 1929.

[75] Stevenson, Utilization of the skins of aquatic animals, *Rept. U. S. Fish Comm. for 1902*, pp. 327, 337-340.

## X

## DOMESTICATED MAMMALS

At a very remote period primitive man began the subjugation of certain species of mammals, and before the dawn of written history some species of cattle, horses, sheep, dogs, cats and perhaps others had been brought completely under his dominion. It is asserted that in Europe various mammals had been domesticated at least as early as the Lake Dweller period. At the beginning of the historic period animals under domestication were widely distributed in Europe, Asia and Africa. Cats were undoubtedly domesticated in ancient Egypt. Egyptian monuments show that hump-backed cattle were domesticated as early as 2100 B.C., and pigs are believed to have been domesticated in China about 5,000 years ago.[1] Dogs were living under domestication among the American Indians when Europeans first began to explore the two continents, and undoubtedly had been for a long time previously. Mummified dogs are found among the very ancient relics of prehistoric cultures in southwestern United States, and several breeds of dogs were distributed over the Americas before the arrival of Columbus. A very large amount of research has been devoted to the origin of various domesticated mammals, with rather definite results in some cases, but many of the origins are still very obscure.[2]

It is not always easy to determine just what should be included in the term domesticated. The word is incapable of very exact definition, but means to become wholly adapted to life in close association with human beings and about human habitations, with the approval of the owner of the premises. Thus house cats and dogs, and the ordinary farm cattle, sheep, goats, horses and hogs are clearly domesticated. However, house cats often leave home and may be found living far out in forests in a feral state. Cattle on western North American plains and in portions of South America, derived from unquestionable domestic stock, owned by men, who catch and market them, but do not have them under constant control, are sometimes very wild and may

[1] Hewitt, *The conservation of the wild life of Canada,* p. 310, 1921.

[2] As examples consult: Keller, The derivation of European domestic animals, *Ann. Rept. Smithsonian Inst. for 1912,* pp. 483-491; Ewart, The principles of breeding and the origin of domesticated breeds of animals, *27th Ann. Rept. U. S. Bureau of Animal Industry,* pp. 125-186; Morse, The ancestry of domesticated cattle, *ibid.,* pp. 187-239.

scarcely claim a position with domesticated animals. They may be more appropriately said to be semi-domesticated. This would apply also to the "wild" horses of the western United States. House rats and mice, more intimately associated with human habitations than any cattle or horses, cannot be considered domesticated. They are unwelcome intruders.

The fact that individual animals have been caught or even bred in capitivity, tamed and trained for various purposes or kept as pets, does not make of them domesticated animals. Thus deer, kept in enclosures, often become very tame, just as squirrels and wild birds in parks learn to feed out of one's hands, but are not domesticated. Canadian moose have on several occasions been captured while young, tamed and used as draft animals, but were not bred in captivity and only an occasional animal was so used, consequently they would not be included in the term, while the European moose was in northern Europe long used as a draft animal, in considerable numbers, and might have been considered at least semi-domesticated.[3] The reindeer is usually considered a domesticated animal, as it has for centuries been intimately associated with human beings and kept in controlled herds. Zebras are often driven in harness, especially in circus parades, but they are not domesticated.[4] The cheetah, or hunting leopard of Asia, caught and trained to hunt game for its captors, is not domesticated. It is said that for the best results it must not be caught until it has acquired hunting experience. The ferret, kept in captivity and used in catching rats, is not domesticated. Neither are bears, lions and many other wild animals that must be kept confined, but are taught to perform many acts for exhibition purposes, nor are squirrels and other pets kept in cages.

The great value of cattle, sheep and goats to the human race has been discussed in other chapters, in connection with the supply of meat, milk, hides, furs and other products. Further information concerning these and the other domesticated mammals may be found in the systematic part of this volume (Part II). The flesh of horses is used as food in some lands and the skins are used in making excellent leather. In addition, horses and their relatives (mules, burros, donkeys, etc.) have for many centuries been used in all lands as draft and saddle animals and beasts of burden, the horse being the most valuable and most extensively used of all animals, for those purposes.

[3] Jones, *Fur farming in Canada*, p. 95, 1913. Shields, *Forest and Stream*, XLI, 316, 1893.
[4] *Forest and Stream*, LVII, 24, 1901.

The number and value of the more important domesticated mammals in the United States in 1925 was estimated by the Department of Agriculture as follows:[5]

| | *Number* | *Value* |
|---|---|---|
| Cattle | 61,572,000 | $3,651,970,000 |
| Horses, mules, etc. | 22,267,000 | 2,569,570,000 |
| Sheep | 35,251,000 | 395,401,000 |
| Goats | 3,459,000 | 17,565,000 |
| Swine | 51,842,000 | 988,582,000 |
| Total | 174,391,000 | $7,623,088,000 |

In 1927 there were 1,499,000 Angora goats in the Union of South Africa, 3,162,000 in Turkey and 3,159,000 in six of the United States —Arizona, California, Missouri, New Mexico, Oregon and Texas.[6]

The following is an estimate of the number of cattle, swine and sheep in some of the principal countries of the world, based partly upon census reports, not including Central America and large portions of Asia, South America and Africa, which would very much swell the total:[7]

| | *Cattle* | *Swine* | *Sheep* |
|---|---|---|---|
| Europe | 133,001,000 | 74,224,000 | 183,299,000 |
| United States | 59,829,000 | 51,223,000 | 40,748,000 |
| Canada | 9,307,000 | 4,426,000 | 2,756,000 |
| Australia | 13,358,000 | 898,000 | 80,110,000 |
| New Zealand | 3,504,000 | 440,000 | 24,548,000 |
| Asiatic Russia | 10,247,000 | 2,196,000 | 14,558,000 |
| India | 143,403,000 | | 33,539,000 |
| Japan | 1,469,000 | 668,000 | 15,000 |
| Korea | 1,605,000 | 1,130,000 | 3,000 |
| Formosa | 3,000 | 1,000 | |
| Argentina | 37,065,000 | 1,437,000 | 36,209,000 |
| Brazil | 34,271,000 | 16,169,000 | 7,933,000 |
| Total for the countries included | 447,062,000 | 152,821,000 | 423,718,000 |

Exports from and imports to the United States in 1925:[8]

| | *Exports* | *Imports* |
|---|---|---|
| Cattle | $2,388,000 | $5,173,000 |
| Sheep | 370,000 | 498,000 |
| Hogs, about | 1,000,000 | |
| Horses, mules, burros, etc. | 4,141,000 | 1,640,000 |
| Total | $7,899,000 | $7,311,000 |

[5] *Statistical abstract of the United States for 1925,* U. S. Bureau of Commerce, 1926. See also an interesting paper by Senator Warren, *National Geographic Magazine,* XVII, 511-524, 1906. Estimates of numbers and values vary considerable from year to year; compare statistics of farm animals and animal products, *Yearbook U. S. Dept. Agric. for 1927,* pp. 980-1060 (Separate No. 976).

[6] The Angora goat and mohair industry, *Interdepartmental Committee of U. S. Dept. Agric. and Dept. Commerce, Miscell. Circular No. 50,* 1929.

[7] *New York World Almanac for 1929,* p. 376.

[8] *Statistical Abstract of the United States for 1925,* U. S. Bureau of Commerce, pp. 466, 504.

The cattle, swine and sheep for all other countries are estimated as follows: cattle, 402,564,000; swine, 103,278,000; sheep, 240,003,000.[9] It was also estimated by the Agricultural Department that in 1926 there were 7,000,000 dogs in the United States.[10] In 1917 it was estimated that there were 35,000,000 horses in Russia, 3,000,000 in Canada and 8,000,000 in Argentina.[11]

Though the horse is the most important draft animal and beast of burden in the world, it is by no means the only important one. Austin in 1917 estimated that there were in the world 100,000,000 horses, 80 per cent in the temperate zone and 20 per cent in the tropics; and in tropical and oriental countries 3,000,000 camels, 10,000,000 donkeys and 20,000,000 carabao (water buffalo); that the pound-loads various animals would carry on their backs are as follows:[12] man, 75 to 150; llama, 50-200; donkey, 100-200; horse, 200-250; camel, 350-500; elephant, 1800-2500.

The llamas and alpacas of South America have been domesticated for many centuries, and provide the natives with milk, meat, wool and leather. The latter is also a beast of burden. Everyone is familiar with the pictures of great caravans of camels in Asia and Africa, carrying passengers and loads of merchandise, sometimes hitched to wheeled vehicles, and furnishing meat, milk, leather and hair for the weaving of cloth.

The carabao, or water buffalo, is said to be the "strongest beast of draft in the world except the elephant."[13] It is extensively used in India, the Philippines, Hawaiian Islands and other localities, and is particularly useful in rice fields and other places where the ground is soft and muddy. The yak, another member of the ox family, has been domesticated on the high plains of Thibet, for its flesh and milk, and is used as a beast of burden. The humped oxen of India are seen drawing all sorts of vehicles. The American bison is now being bred in a domesticated or semi-domesticated state in various localities, but, though it possesses great strength, is not being used as a work animal.

The Asiatic elephant has long been used for hauling heavy loads,

[9] *World Almanac for 1928,* p. 376.
[10] *Ibid.,* p. 435.
[11] Holmes, Hides and skins, *Yearbook U. S. Dept. Agric. for 1917,* pp. 425-446.
[12] Austin, Queer methods of travel in curious corners of the world, *Natl. Geog. Mag.,* XVIII, 688, 1907.
[13] The wanderings of the water buffalo, *Ann. Rept. Smithsonian Inst. for 1901,* pp. 679-682; reprinted from *London Spectator,* Aug. 31, 1901.

carrying passengers and for other heavy work. Though it has been supposed by many people that the African elephants could not be tamed and trained to work, it has been done. Experiments with them in the Belgian Congo show that in plowing they are "fourteen times less costly than plowing by tractor."[14]

Considering the world as a whole, the dog is more intimately associated with man and his domicile than any other domesticated animal. It is one of man's most faithful friends, and well deserves the place it holds in our esteem and affection. While some breeds are mere pets, others are very useful as shepherds, hunters, watchdogs and the like, and as guardians of children. Dogs were used by the American Indians as draft animals prior to the introduction of the horse by the Spaniards. Dogs are even now often hitched to carts by white men in various parts of the world, such not being an altogether unknown sight in some of our American cities. The finest and best known example of the kind is, of course, the sledge dogs of the Far North, which have in recent years been bred up until some of them have become splendid animals. In 1897 it was said that dogs were used more extensively as draft animals in Belgium than anywhere else except the Far North, and elaborate laws were in force relating to their use and care.[15] They have also been used to a considerable extent in several other European countries.

The domestic cat is of value chiefly as a pet, though many of them are good mousers and occasionally an exceptional one is a ratter. On the whole it probably does at least as much harm as good, in the destruction of useful birds and otherwise.[16]

Guinea pigs and some rabbits are raised under control and may perhaps be considered domesticated or semi-domesticated. Foxes, skunks, minks and some other fur-bearing animals are raised in captivity, but none of them can be called domesticated, though sometimes some of them become great pets.

[14] Phillips, Trained African elephants, *Journ. Mammalogy,* VI, 130-131, 1925. Science news supplement to *Science,* April 6, 1928, p. x.

[15] Johnson, *Forest and Stream,* XLIX, 491-492, 515, 1897; L, 13-14, 1898.

[16] For a full investigation of its economic status see Forbush, The domestic cat, *Massachusetts Board Agric., Econ. Biol. Bull.* No. 2, 1916.

## XI

## MAMMALS AND THE HUNTER

Hunting, as both a business and a pastime, is a very ancient form of sport or recreation. Primitive men lived largely upon the flesh of wild mammals long before they began to develop agricultural pursuits or to domesticate cattle and sheep. They still do in some parts of the world. As may be seen in another chapter, early white explorers and pioneer settlers of North America were often dependent for food and raiment upon their skill as hunters. A large army of Americans still get out for a season of hunting each year, but most of them not, as in case of their ancestors, because they are in need of meat, but because of the recreational urge—possibly in some cases because of a lust for blood.

Nearly everywhere in the United States market hunting is now prohibited. This meets with the approval of most hunters, as otherwise there would be very little game left. It was market hunting that exterminated the passenger pigeon and nearly led to the extinction of the American bison. As an additional protective measure, and also in order to obtain from the hunters and fishermen themselves part or all of the funds necessary for the propagation and protection of fish and game and the enforcement of the laws relating thereto, hunting licenses are required in most states and hunting without license is prohibited. About 4,000,000 such licenses were issued in the United States in 1921, 5,000,000 in 1924-1925 (fees $6,400,000), but as some states require no license, others require none for boys below a certain age or for owners of land who hunt only on their own premises, the total number of hunters afield each year is estimated at 6,000,000 to 7,000,000 or about 5 per cent of the population.[1]

The increase in the number of hunting licenses issued and fees therefor in the United States and Canada is shown by the following figures:[2]

| | *Licenses* | *Fees* |
|---|---|---|
| 1924 | 4,395,038 | $5,594,982 |
| 1925 | 4,904,740 | 6,190,863 |
| 1926 | 5,168,353 | 6,872,812 |
| 1927 | 5,750,000 | 7,800,000 |

[1] *Journ. Mammalogy*, III, 235, 1922. *California Fish and Game*, XII, 95-96, 1926. Compare Statistics of hunting licenses, *U. S. Biol. Surv. Circular* 54, 1906.
[2] *American Forests and Forest Life*, XXXIV, 511, 1928.

In 1927 New York headed the list, with 620,414 licenses, for which the fees paid totalled $822,415.

Although the value of the meat obtained by this army of hunters aggregates a very large sum, making wild game a real addition to the nation's resources, yet the cost of procuring it is probably much greater than its monetary value. Though not measurable in dollars, the recreational value of game is very much greater. It serves to get many men and some women out of their dingy, poorly-ventilated offices for a few days, into the open spaces, away from the cares and turmoil of modern civilization, and sends them back to their work refreshed in body, rested in mind and sweeter in disposition. The total amount of money represented by the activities of hunters is difficult to estimate. It includes such items as the original cost of the equipment (guns, hunting garments, hunting dogs, boats, etc.), the interest upon which would be a considerable sum; ammunition, transportation to and from the hunting grounds, hotel bills, guides and many other items of the sort. The nation's hunting bill also includes a considerable part of the support of manufacturers of and dealers in hunters' equipment and supplies, hunting resort hotels, sportsmen's clubs and the taxidermists who mount the hunters' trophies. However, if such recreations as attending the opera, visiting seaside resorts, going on camping trips and the like, with their attendant expenses, are justified, then also is the nation's hunting bill justified, regardless of the value of the meat obtained thereby.

It is estimated that 75,000 deer are killed in the United States annually, the flesh of which, at twenty cents a pound, would be worth $2,250,000,[3] in addition to the value of the skins. In about one-third of the states there is now no open season on deer, as they have been locally exterminated or have become very scarce, while in some states where adequately protected they are increasing in numbers. So few, relatively, of the other large mammals of the United States are killed that their meat is a negligible item in the national bill of fare, though affording considerable recreation. It is said that the game and fur-bearing mammals of New York bring to the state an annual income of $3,200,000, and if capitalized, would be worth $53,000,000 to the state, while game protection costs but $182,000.[4] It has been estimated that the game and other wild life of the whole United States, if capitalized

[3] Palmer, Game as a national resource, *U. S. Dept. Agric. Bull.* No. 1049, 1922. The value of game as a meat resource is more fully considered in another chapter.
[4] *California Fish and Game,* VII, 185, 1921.

on a basis of 6 per cent, would be worth $1,000,000,000, which led to the observation that "the conservation of wild animals and birds is not a mere fad, indulged in by those who have only a sentimental interest in the subject."[5]

Adams, in an elaborate table covering the years 1921 to 1925 inclusive for all the national forests of the United States, gives the following figures of mammals usually called game animals on all the national forests in 1925: Antelope, 7568; black bear, 44,326; grizzly, 5593; caribou, 143; deer, 605,964; elk, 72,165; moose, 6061; mountain goats, 17,887; mountain sheep, 12,052.[6] Of these animals, in most of the states only the bear and deer are now to be really considered game animals, as the hunting of the others is prohibited or they are not to be found in most of the states.

Of the smaller mammals in North America, rabbits are the only ones of great importance as part of our food supply, though many squirrels, raccoons, opossums and others are obtained. It is estimated that 25,000,000 rabbits are killed annually in the United States, worth, at twenty cents each, $5,000,000 for their meat,[7] while many of their skins find their way into the market and the hunting of these animals furnishes recreation to thousands of boys and men. In 1920 there were short open seasons on rabbits in twenty-three states, mostly eastern, with no restrictions elsewhere except the usual hunter's license requirements. England is said to produce 30,000,000 rabbits annually and imports a large number from Belgium, but these are largely raised in confinement, not wild. However, large shipments of wild rabbits are made to Europe from Australia and New Zealand, where they have become a serious pest.[8]

There are people who believe that hunting game animals should be entirely prohibited, but they are greatly in the minority, usually not entirely consistent in their views concerning the sacredness of the lives of the lower animals, and often very much mistaken concerning the facts of natural history. Without going too much into detail, we will say that hunting within reasonable limits is both economically and morally quite proper. If it is proper to kill cattle, hogs, sheep, chickens

[5] Nelson, *Scientific Monthly* (quoted in *California Fish and Game,* IX, 161, 1923); contains a lot of statistics on game and its value.

[6] Adams, The economic and social importance of animals in forestry, with special reference to wild life, *Roosevelt Wild Life Bull.,* III, opposite p. 558, 1926.

[7] Palmer, *U. S. Dept. Agric. Bull.* No. 1049, 1922.

[8] Dearborn, Rabbit growing to supplement the meat supply, *Yearbook U. S. Dept. Agric. for 1918,* pp. 145-152; Rabbit farming, *Farmers' Bull.,* No. 1090, 1920.

and fish for their flesh, skins and other by-products, it is equally right to kill wild game for the same purpose. Furthermore, since we have destroyed many of the natural enemies of game animals—predatory animals that prey upon the others—unless a certain amount of hunting be permitted the game animals in some regions, as has been shown by actual experience, would soon become so abundant as to do great damage to crops. In some cases they perhaps would speedily destroy their own food supply and possibly become exterminated locally or entirely extinct through starvation and the diseases that accompany under-nourishment and the crowding of too many animals into a given area. Consequently, the course that is approved by all naturalists, whose business it is to study and understand such matters, is midway between the two extremes of unrestricted hunting on the one hand and complete protection of wild animals on the other.

## XII

## DISEASES AND PARASITES OF MAMMALS, AND POISONING FROM PLANTS

Probably all species of mammals have various diseases and parasites. Hundreds of books, bulletins, pamphlets and articles in periodicals, discussing diseases of domesticated mammals, have been published—far too many to be even listed in this volume, and only a few of the principal diseases may be mentioned briefly. Also there is an extensive and much-scattered literature of the diseases and parasites of wild mammals, only a few items of which may be herein mentioned for purposes of illustration. Though diseases of domestic stock result in great economic loss, on the other hand, diseases of certain destructive wild mammals are sometimes distinctly beneficial to the human race, because they serve to keep injurious animals in check. The subject of mammals as disseminators of disease, especially of diseases which affect human beings, is discussed in the next chapter, including rabies, or hydrophobia, and tularemia, or rabbit fever.

Let us first turn briefly to some serious epidemic and non-epidemic diseases of domestic stock. In 1915 it was estimated that the total loss to stock raisers from livestock diseases in the United States amounted to $212,000,000 annually, the chief diseases being as follows:[1]

| | | | |
|---|---|---|---|
| Hog cholera | $75,000,000 | Contagious abortion | $20,000,000 |
| Texas fever | 40,000,000 | Scabies, cattle and sheep | 4,600,000 |
| Tuberculosis | 25,000,000 | Glanders | 5,000,000 |
| Black-leg | 6,000,000 | Other livestock diseases | 22,000,000 |
| Anthrax | 1,500,000 | Parasites | 5,000,000 |

To this must be added a large but unknown amount of indirect loss due to the expense of fighting disease, quarantine, etc. In the United States, in 1915, one per cent of all the cattle slaughtered under federal inspection were infected with tuberculosis, and the meat partly or wholly condemned. It will be noticed that the greatest loss in the foregoing list is from hog cholera, upon the study and control of which large sums of money have been expended for many years, with great ultimate success, hog-raising being far less hazardous than form-

[1] Mitchell, Animal diseases and our food supply, *Yearbook U. S. Dept. Agric. for 1915*, pp. 159-172.

erly.[2] The Texas tick-fever, against which quarantine has long been maintained by some states, is also very serious. Mitchell states that the suppression of the foot-and-mouth disease in 1914-1915 required the destruction of 168,158 head of live stock, valued at $5,676,000. It is difficult to compute or even estimate the large loss from minor diseases that affect all sorts of domesticated animals, reducing their efficiency or otherwise lessening their value. Angora goats are subject to the usual sheep and cattle diseases and to many parasites. In 1880 an epidemic of pleuro-pneumonia nearly destroyed the Angora goat and mohair industry of South Africa, with a loss of 40,000 goats before it was checked.[3] The annual loss in Scotland from domestic animal diseases is placed at nearly $5,000,000, and it is said to be four times as much in England and Wales.[4]

In 1912 about two hundred species of insect enemies of domestic stock were known.[5] Some of them cause the death of the animals they attack, others, though not fatal in their attacks, annoy, weaken and otherwise damage the stock. "Ticks and mites are among the foremost enemies of domestic animals" (Bishopp). For example, the North American cattle tick transmits splenic or Texas fever among cattle and one species of mite produces sheep scab, while another is responsible for mange in cattle.

Various species of gnats and flies are very troublesome to both domestic and wild mammals, some of them, in addition to direct attacks, being carriers of serious disorders. The damage caused by the ox-bot, or heel-fly, alone has been estimated at $173,596,895 in 1900.[6] Screwworms, tapeworms, lungworms, liver flukes, lice and many other invertebrate pests are named among the enemies of the stock-grower. A calendar showing what pests to guard against during the different months has been recently issued.[7]

It has been mentioned that better methods of combating and preventing disease have reduced the hazards of hog-raising. Various other examples are known. For instance, in 1903, eighteen states were

[2] See Hess, Less cholera—more hogs, *Yearbook U. S. Dept. Agric. for 1918*, pp. 191-194.

[3] Angora goat and mohair industry, *Interdepartmental Committee of U. S. Dept. Agric. and Dept. Commerce, Miscell. Circular* No. 50, p. 11, 1929.

[4] Loss from animal diseases, *Science*, LV, 507, 1922.

[5] Bishopp, Some important insect enemies of live stock in the United States, *Yearbook U. S. Dept. Agric. for 1912*, pp. 383-396.

[6] Bishopp, *ibid.*, p. 388.

[7] Hall, A calendar of livestock parasites, *U. S. Dept. Agric. Miscell. Pub.* No. 25, 1928.

quarantined for sheep scabies, but in 1915 all but one state and small portions of two others were free from quarantine. In 1905, ten states were quarantined for cattle scabies, but in 1915 all but a small portion of one state were free from quarantine.[8]

Considerable has been learned about the diseases and parasites of wild mammals in captivity, and, though "some of the morbid conditions described . . . are peculiar to captivity, yet it seems reasonable to assume that many of the diseases found in captive animals occur also in the wild."[9] There is increased activity among fish and game commissions in the investigation of diseases and parasites of wild animals *in ferae naturae,* at least one state commission, that of California, having employed for the purpose experts in pathology, parasitology and chemistry.[10]

Though diseases of wild mammals under natural conditions have not been so fully investigated as have those of domestic stock, it is known that many of the species are subject to serious diseases, and probably no species is entirely free from them. Some of the diseases of domestic stock also affect members of the deer family and wild species of goats and sheep. Diseases that attack the more useful wild mammals, as with those that affect domestic stock, may in a general way be considered detrimental to human interests, but this is not always or altogether true. Domestic stock, under human control, may be limited in reproduction and never become too numerous. It is not so easy to do this with wild mammals. Even useful wild animals, if entirely protected from natural enemies, disease and bad weather, might increase to such an extent as to become a menace. Deer, usually too scarce to be harmful, have been known to become so numerous under protection as to be somewhat destructive to garden and other crops. However, their numbers are easily reduced by removing restrictions upon hunting.

A few rabbits are not usually considered particularly destructive, but under favorable circumstances their natural high fecundity may be greatly increased and their mortality rate lowered, a larger percentage of the young reaching the adult stage, whereupon they become a serious pest. As though to exhibit her wisdom, nature has provided that in their natural haunts, when rabbits become overabundant, they are assailed by epidemics that destroy them in large numbers, thus keeping them within reasonable bounds, so that they do not become so

[8] Mitchell, *Yearbook U. S. Dept. Agric. for 1915,* Pl. 18, opp. p. 161.
[9] Fox, *Disease in captive wild mammals and birds,* Philadelphia, 1923.
[10] *California Fish and Game,* xv, 135, 1929.

numerous as to consume the entire food supply and thus possibly become exterminated through starvation. The varying hare in Alberta is said to thus limit its own increase by epidemics about every seven years, at the period of maximum abundance. The same sort of thing happens in case of voles and lemmings, whose periods of unusual abundance are usually ended by epidemics.[11] Such epidemics, affecting only injurious mammals, are of distinct benefit to the human race.

Among diseases of rabbits in captivity are mentioned mange, slobbers, snuffles, sore eyes, sore hocks, vent disease, ear canker, and warbles.[12] Tularemia is discussed at some length in the next chapter. In many wild rabbits are found cysts,[13] which injure the meat for food purposes. Some squirrels are infested with scabies.[14] A wildcat in captivity was infested with intestinal, muscular and pulmonary parasites, and a white rhinoceros was infested with round worms.[15] Foxes on fox farms are subject to a number of diseases, such as mange, diarrhoea, constipation, worms, indigestion, tuberculosis, kidney disease, intestinal abscesses,[16] "fox paratyphoid" and "epizootic fox encephalitis."[17] The best-conducted fox farms have hospital wards or pens for the occupancy of the sick foxes.[18] The western dog-tick infests not only dogs, but also sheep, cattle, horses, ground squirrels, and one dead deer was found to be covered with them.[19] One case of diseased tonsils in the wolf[20] is reported, and tuberculosis in marsupials.[21]

Various members of the deer family are subject to the foot-and-

[11] Henderson, A. D., Cycles of abundance and scarcity in certain mammals and birds, *Journ. Mammalogy,* IV, 264-265, 1923. Innis, *The Canada fur trade,* p. 90, 1927. Howell, Periodic fluctuations in the numbers of small mammals, *Journ. Mammalogy,* IV, 149-155, 1923. Elton, Periodic fluctuations in the number of animals: Their causes and effects, *British Journ. Exper. Biol.,* II, 1924 (quoted by Innis); Plague and the regulation of numbers of wild animals, *Journ. Hygiene,* XXIV, 138-163, 1925. Soper, Notes on the snowshoe rabbit, *Journ. Mammalogy,* II, 101-107, 1921.

[12] Dearborn, Rabbit raising, *U. S. Dept. Agric., Farmers' Bull.,* No. 1090, pp. 32-34, 1920. DeOng, Parasites which affect the food value of rabbits, *California Fish and Game,* I, 142-143, 1914. Schwartz and Snook, Rabbit parasites and diseases, *Farmer's Bull.* No. 1568, 1928. Marine, The cure and prevention of ear canker in rabbits, *Science,* LX, 158, 1924; see also same volume, pp. 429-430.

[13] See, for example, Crawley, *Proc. Acad. Nat. Sci. Phila.,* LXVI, 214-218, 432-436, 1914.

[14] Bryant, Tree squirrels infested with scabies, *California Fish and Game,* VII, 128, 1921. Shannon, Gray squirrel disease spreading, *Californa Fish and Game,* VIII, 52, 1922.

[15] Fox, *Disease in captive mammals and birds,* p. 3, 1923.

[16] Jones, *Fur farming in Canada,* pp. 41, 43, 45, 67, 1913.

[17] Fox distemper being investigated, *California Fish and Game,* XIV, 232-233, 1928.

[18] Ashbrook, *Fur farming for Profit,* pp. 62-65, 1928.

[19] Wright, *Yosemite Nature Notes,* VII, No. 5, p. 38; *California Fish and Game,* XIV, 252-253, 1928.

[20] Scott, Carcinoma of the tonsils in the common wolf (Canis lupus), *Proc. Zool. Soc. London,* 1928, Part I, pp. 43-47.

[21] Scott, Tuberculosis in marsupials, *Proc. Zool. Soc. London,* 1928, pp. 249-256.

mouth disease,[22] which is so disastrous to cattle and sheep, and also to other diseases.[23] Deer are subject to fatal *Cephanomyia* infestation,[24] fatal neck tumors, pinkeye, distemper and various diseases of domestic stock, in addition to the foot-and-mouth disease.[25] Along the California coast many deer are infested with lung-worms, in addition to at least three other serious parasites which are also found in the domestic stock of the region.[26] A white-tailed deer in captivity was infested with liver flukes.[27] The Yellowstone Park and Jackson Hole elk are subject to scabies, doubtless introduced by domestic sheep, and an epizootic disease.[28] Caribou are often seriously infested with warble-fly maggots.[29]

Skinner says that the pronghorn antelope in Yellowstone Park is much subject to disease and parasites. Lumpy jaw, which kills deer and elk, is especially virulent to the pronghorn, and in captivity it suffers with pneumonia, pyemia, congestion of the lungs and ulcers. It is also afflicted by internal parasites such as affect domesticated goats, sheep and cattle—tapeworms, stomach worms, whipworms and hair worms. The embryos of the tapeworm of the coyote, wolf and fox are found in the pronghorn.[30]

Diseases and parasites of the muskrat have been discussed by Johnson and Barker.[31]

Rush[32] reports mountain sheep to have been dying of disease in large numbers in Montana, a pronghorn antelope with ulcerated lungs and diseased kidneys (diagnosed as miliary tuberculosis), a porcupine and two muskrats with hearts partly atrophied, beaver, muskrats and mountain sheep with intestinal worms, and so on.

Hornaday discusses, among other things, the caribou disease in Quebec, mountain sheep scab, lumpy jaw among pronghorned antelope

[22] Adams, *Scientific Monthly,* XX, 581, 1925.
[23] *California Fish and Game,* II, 138, 1916.
[24] Walker, Cephenomyia sp. killing deer, *Science,* LXIX, 646-647, 1928.
[25] Hall, *California Fish and Game,* XII, 248-249, 1926. See also Bryant, Investigations of deer disease in Mendocino County, *California Fish and Game,* XII, 107-108, 1926.
[26] *California Fish and Game,* XV, 135, 164, 1929.
[27] Fox, *Disease in captive mammals and birds,* p. 3, 1923.
[28] Skinner, *Journ. Mammalogy,* IX, 309-317, 1928. Murie, An epizootic disease of elk, *Journ. Mammalogy,* XI, 214-222, 1930.
[29] Hewitt, *The conservation of the wild life of Canada,* p. 67, 1921.
[30] Skinner, *The American antelope in Yellowstone Park,* pp. 19-20.
[31] Johnson, *Roosevelt Wild Life Bulletin,* III, 292-294, 1925. Barker, *Journ. Parasitology,* I, 184-197, 1915; *Science,* XLII, 570, 1915; XLIII, 208, 1916; *Trans. Amer. Microscopical Soc.,* XXXV, 175-184, 1916.
[32] Rush, Notes on diseases of wild game mammals, *Journ. Mammalogy,* VIII, 163-165, 1927.

and mountain sheep, the rinderpest, one of Africa's great scourges, and other diseases.[33] According to Roosevelt the rinderpest about forty years ago almost exterminated the buffalo in Africa.[34] Many other diseases are known among African game mammals.[35]

A great many, if not all, wild mammals harbor internal parasites.[36] Intestinal and stomach worms are very much more common than is generally realized, even by naturalists who have not made special studies of the subject. In laboratory dissections of dogs and cats it is common to find many such organisms, and some wild mammals examined have been found with stomachs entirely filled with worms. In addition to the well-known tapeworms, human beings are subject to many other internal worms. Dixon, in examining many wild mammals, found that 7.5 per cent of the contents of stomachs of a considerable number of wildcats, and 10.4 per cent in case of skunks, consisted of parasitic worms.[37] Numerous large stomach worms were found in a sea-elephant.[38]

Many of the wild mammals, or all of them, are also afflicted by external parasites.[39] Some of them, such as lice, perhaps do little or no harm, but some of them, particularly the internal ones, are certainly very harmful. Some of the species of external parasites, such as certain ticks, are carriers of fatal diseases. Even those that are not carriers of disease organisms are very annoying. Roosevelt tells of the great number of ticks infesting zebras and various large game

[33] Hornaday, *Our vanishing wild life,* pp. 82-87, 1923.

[34] Roosevelt, *African game trails,* p. 288, 1910.

[35] Percival, Game and Disease, *Journ. East Africa and Uganda Nat. Hist. Soc.,* No. 13, pp. 302-315, 1918.

[36] See, for example: Hall, Nematode parasites of mammals of the orders Rodentia, Lagomorpha and Hyracoidea, *Proc. U. S. Natl. Museum,* L, 1-258, 1916; A new nematode, Rictularia splendida, from the coyote, with notes on other coyote parasites, *ibid.,* XLVI, 73-84, 1913; A new rabbit cestode, *ibid.,* XXXIV, 691-699, 1908; A new species of cestode parasite of the dog and the lynx, *ibid.,* XXXIX, 139-151, 1910. Schwartz, A new proliferating larval tapeworm from a porcupine, *ibid.,* LXVI, 1-4, 1924; A new parasitic nematode from an unknown species of bat, *ibid.,* LXXI, 1-4, 1921; Description of Ancylostoma pleuridentatum, a hookworm of the carnivores, *ibid.,* LXXII, 1-9, 1927. Stiles, A revision of the adult tapeworms of hares and rabbits, *ibid.,* XIX, 145-235, 1896. Price, A new nematode from the pronghorned antelope, *ibid.,* LXXI, 1-4, 1927. Ransom, The nematodes parasitic in the alimentary tract of cattle, sheep and other ruminants, *U. S. Bureau Animal Industry Bull.* No. 127, 1911 (includes parasites of deer, moose and other wild mammals); Hookworms of the genus Uncinaria of the dog, fox and badger, *Proc. U. S. Natl. Museum* LXV, 1-5, 1924. Wislocki, Nematode parasites of the ovaries of the ant-eater, *Journ. Mammalogy,* IX, 318-319, 1928. There are numerous other papers discussing parasites of wild mammals in various parts of the world. Seton, Lives of game animals, 4 vols., 2 parts each, 1929; discusses parasites of many species and diseases of some.

[37] Dixon, *Journ. Mammalogy,* VI, 34-46, 1925.

[38] Huey, *Journ. Mammalogy,* V, 241, 1924.

[39] Ferris, Concerning lice, *Journ. Mammalogy,* III, 16-18, 1922.

mammals of Africa. Flies, mosquitoes and other insects, though not parasites in the usual sense of the word, worry both wild and domesticated animals, sometimes to their decided detriment. The tsetse flies of Africa are disseminators of sleeping sickness, which has wrought great havoc to human life, as well as that of horses, cattle and other mammals.[40] "It is well known that the presence of certain biting flies *(Glossina)* that carry the trypanosome of the nagana disease, makes the use of horses nearly impossible in certain parts of Africa," and that "the accidental introduction of the Texas fever, a tick-borne disease, into South Africa, resulted at one time in the destruction of vast numbers of antelope and cattle."[41] Of 506 mammals, belonging to 29 species, in Nigeria, 126 were infested with a total of 1153 ticks and mites, as well as many external insect parasites.[42]

There are many native plants which are very poisonous to cattle, horses, sheep, goats and other domestic stock.[43] The animals usually avoid such plants to a great extent except when forage is short, even

[40] Roosevelt, *African game trails,* pp. 29, 52, 112, 1910.

[41] Allen, *Journ. Mammalogy,* IV, 267, 1923, reviewing Borradaile, *The Animal and its environment,* 1923.

[42] Pearse, Arachnids found on Nigerian rodents and insectivores, *Journ. Elisha Mitchell Sci. Soc.,* XLIII, 171-180, 1929; *Journ. Mammalogy,* X, 270, 1929; Ecology of the ectoparasites of Nigerian rodents and insectivores, *Journ. Mammalogy,* X, 229-239, 1929.

[43] Chestnut, The principal poisonous plants of the United States, *U. S. Dept. Agric., Division of Botany Bull.* No. 20, 1898; Thirty poisonous plants of the United States, *Farmers' Bull.* No. 86, 1898; Some poisonous plants of the northern stock ranges, *Yearbook U. S. Dept. Agric. for 1900,* pp. 305-324. Chestnut and Wilcox, The stock-poisoning plants of Montana, *U. S. Div. Bot. Bull.* No. 26, 1901. Crawford, The larkspurs as poisonous plants, *U. S. Bureau of Plant Industry Bull.* No. 111, Part 1, pp. 5-12, 1907; Barium, a cause of the loco-weed disease, *ibid.,* No. 129, 1908; The supposed relationship of white snakeroot to milksickness or "trembles," *ibid.,* Bull. No. 121, Part 1, pp. 5-20, 1908. Marsh, Stock poisoning due to scarcity of food, *Farmers' Bull.* No. 536, 1913; The loco-weed disease of the plains, *U. S. Bureau of Animal Industry Bull.* No. 112, 1909; The loco-weed disease, *Farmers' Bull.* No. 380, 1909; Stock-poisoning plants of the range, *U. S. Dept. Agric. Bull.* No. 1245, 1924. Marsh and Clawson, Poisonous properties of the whorled milkweeds, *ibid.,* No. 942, 1921; The death camas species as poisonous plants, *ibid.,* No. 1012, 1922; The woolly-pod milkweed as a poisonous plant, *ibid.,* No. 1212, 1924; The meadow death camas as a poisonous plant, *ibid.,* No. 1240, 1924; The stock-poisoning death camas, *Farmers' Bull.* No. 1273, 1922; Sleepy grass (Stipa vaseyi) as a stock-poisoning plant, *U. S. Dept. Agric., Technical Bull.,* No. 114, 1929. Marsh, Clawson and Marsh, Larkspur, or "poison weed," *Farmers' Bull.* No. 531, 1913; Zygadenus, or death camas, *U. S. Dept. Agric. Bull.* 125, 1915; Larkspur poisoning of livestock, *ibid.,* No. 365, 1916; Lupines as poisonous plants, *ibid.,* No. 405, 1916. Marsh, Clawson, Couch, and Marsh, Western sneezeweed (Helenium hoopesii) as a poisonous plant, *ibid.,* No. 947, 1921. Marsh, Roe and Clawson, Cockleburs as poisonous plants, *ibid.,* No. 1274, 1924; Coyotillo (Karwinskia humboldtiana) as a poisonous plant, *U. S. Dept. Agric., Technical Bull.,* No. 29, 1928. Marsh, Clawson, Couch and Eggleston, The whorled milkweed, *U. S. Dept. Agric. Bull.* No. 800, 1920. Poisonous plants injurious to goats, *U. S. Dept. Agric. and U. S. Dept. Commerce,* Interdepartmental Angora Goat and Mohair Committee, *Miscell. Circular* No. 50, 1929.

though all the domesticated animals are introduced, not native to the range in which the plants occur. It is possible that the native mammals, having developed side by side with the poisonous plants, may be even more careful to avoid them or in some instances may have established more or less complete immunity from the poison, but there is not very definite evidence bearing upon this subject. Some mammals appear to be immune from poisons which affect others. Thus some squirrels eat mushrooms which are quite poisonous to human beings.[44]

[44] Odell, *Canadian Field Naturalist,* xxxix, 180-181, 1925; xl, 184, 1926.

## XIII

## MAMMALS AS DISEASE CARRIERS AND DISSEMINATORS

It has long been known that certain species of mammals are active agents in the dissemination of serious diseases that afflict the human race, and that others may be. Sixteen years ago Jones[1] published a list of mammal (and other animal) distributors, with the number and names of the diseases each was known to disseminate, as follows (omitting the names of the diseases and of all animals but the mammals): dog, 9; cow, 12; African antelopes, 1; cat, 5; horse, 5; sheep, 2; rat, 3; swine, 5; goat, 2. Other species are now known as disseminators and much more is known about methods of transmission. Recently Hull,[2] with very much more information at his command, has published a detailed account of diseases of domesticated mammals which may be transmitted to man.

The various diseases are transmitted in different ways, such as by contact, by biting, through meat and milk. It will be noticed that most of the animals listed by Jones are domesticated species. Naturally the opportunities for animals that live about human habitations to carry diseases to human beings are much greater than those of wild animals that live far from homes and towns. Nevertheless some wild animals are definitely known to be disseminators and probably many others are, but of necessity much less is known about the wild animals than about the domesticated animals under constant observation.

The opportunities for pet dogs and cats to carry diseases are particularly numerous. They are often permitted to freely enter and leave the sick-room, are handled by the patient and afterwards perchance fondled by all the children of the neighborhood. The germs of many diseases may readily be carried in the hairy coats of household pets and thus spread through the community. Cats have greater opportunities to become carriers than have dogs, partly because they are more decidedly household pets and are more intimately fondled. Every effort should be made to keep both away from patients suffering from

[1] Jones, On certain relations of the lower animals to human diseases, *Science*, XLIV, 337-347, 1916.

[2] Hull, *Diseases transmitted from animals to man.* Springfield, Illinois, and Baltimore, Maryland, 1930.

diseases which may be transmitted in that way, or to quarantine them if they have been exposed.

Cats "have been accused or suspected of transmitting more than a score of infections to man or domestic animals. The diseases named range from scarlet fever, smallpox and bubonic plaque to whooping cough, mumps and foot-and-mouth disease. Science has already acquitted the cat in some cases, and future investigation may either confirm or deny other allegations. There are some infections, however, regarding which the evidence seems conclusive."[3] It is one of the chief carriers of ringworm, transmits various internal and external parasites, and often transmits various infections by its teeth and claws, including at least one case of the dreaded tetanus (Forbush). Dogs and cats have both been recognized as carriers of creeping eruptions.[4] Tapeworms are disseminated by wild Carnivora, and probably by domesticated species.[5]

Rabies, more popularly known as hydrophobia, though usually thought of as a disease of dogs, also affects wolves, foxes[6] and other members of the dog family, domestic cats, mountain lions and other members of the cat family,[7] and is, by their bites while infected, transmitted to cattle, sheep, horses and other domestic stock and to various wild animals, as well as to human beings. It frequently becomes epidemic locally, sometimes over large areas. Because of its terrible results and the fact that it has become much more prevalent than formerly in the western United States,[8] no effort to stamp it out should be spared. As dogs have long been the principal carriers of the disease, experience in Europe has shown that, where such is the case, muzzling all dogs for a few years would eradicate the disease, and all homeless, owner-

[3] Forbush, Is the cat a disseminator of disease?, in *The domestic cat, Economic Biology, Bull. No. 2,* 1916, Massachusetts State Board of Agriculture, pp. 82-87. See also Osborne, The cat, a neglected factor in sanitary science, *Pedagogical Seminary,* XIV, 439-459, 1907; The cat and the transmission of disease, *Chicago Medical Recorder,* May, 1912. Cohen, *System of physiol. therapeutics,* V, 144, 340, 1903. Fleming, *Animal plagues, their history, nature and prevention,* II, 15, 16, 74-77, 80, 89-91, 95, 99, 1882.

[4] White and Dove, Dogs and cats concerned in the causation of creeping eruption, Reprint from *Official Record, U. S. Dept. Agric.,* V, 3, 1926.

[5] Vergeer, Dissemination of the broad tapeworm by wild Carnivora, *Journ. Canadian Med. Assn.,* XIX, 692-694, 1929.

[6] Bryant, Rabies epidemic among gray foxes, *California Fish and Game,* X, 146-147, 1924.

[7] Forbush, *The domestic cat,* pp. 85-86, 1916.

[8] Buckley, Rabies becoming more prevalent in the United States, *Yearbook U. S. Dept. Agric. for 1926,* pp. 622-624. Salmon, Rabies: Its cause, frequency and treatment, *Yearbook for 1900,* pp. 211-246. Hart, Rabies and its increasing prevalence, *U. S. Bureau of Animal Industry Circular* No. 129, 1908.

less dogs should be destroyed as humanely as is reasonably possible, for this, as well as for other reasons.

In hydrophobia, prevention centers around the problem of muzzling the dogs. This has been known for decades, yet the American people prefer to have 5000 persons, mostly children, bitten each year and a hundred or more deaths, than to subject their dogs to the discomfort of muzzles and to destroy the stray and worthless curs of the streets.[9]

Unfortunately, especially in the western United States, coyotes and other wild animals have become infected, thus complicating the problem of the control of this disease. As coyotes are very important carriers in that region, and are also directly destructive to domestic stock even when not infected, extensive campaigns against them have often been necessary. It is reported that during the rabies epidemic among wild mammals in the West in 1914-1915, $5,000,000 worth of stock were killed by infected predatory mammals, chiefly coyotes, in one year in Nevada alone, one rabid coyote having attacked 27 steers in one feed lot, and 1500 people were bitten by rabid animals.[10]

Tularemia, or rabbit fever, which has been sometimes locally known as deer-fly fever, a "debilitating, disabling and frequently fatal disease," is serious enough to warrant very careful consideration. It is carried especially by rabbits, but also by various rodents and other mammals, as well as by some birds, and is easily transmitted by them to mankind. Human cases have been recognized in nearly all of the states of the United States, about five hundred definite cases having been already reported, 4 per cent of which have proved fatal. It is identical with the Japanese rabbit-borne "O'Hara's disease," and has been recognized also in Russia and Siberia.[11]

Most of the human cases were derived directly from handling diseased rabbits, and even the wearing of gloves does not appear to be an absolute protection, but usually only a small percentage of the rabbits in the market are infected. It is said that a sure test of the disease in rabbits is pin-head white specks on the liver and spleen.[12] In addition to rabbits and hares, several species of ground squirrels, pine squirrels,

[9] Jones, On certain relations of the lower animals to human diseases, *Science,* XLIV, 337-347, 1916.

[10] Bell, Hunting down stock killers, *Yearbook U. S. Dept. Agric. for 1920,* pp. 289-301.

[11] Simpson, *Tularemia,* N.Y., 1929 (technical, for physicians, etc.). *American Game (Bull. Amer. Game Protec. Assn.),* XVII, 4-5, 1928. *Science News Supplement* (in *Science*), March 8, 1929, p. x; March 22, 1929, p. xiv. *California Fish and Game,* XIV, 157-158, 1928; XV, 256, 1929.

[12] Barnes, Rabbit fever or tularemia, *Scientific Monthly,* Nov., 1928, pp. 463-469.

chipmunks, gophers, muskrats, opossums, cats, porcupines, mice, wood rats and coyotes have been found definitely susceptible to the disease in a fatal form, and it probably affects many other mammals, as well as birds, notably the grouse.[13] There seems to be no danger from eating the flesh of even the diseased rabbits if it be thoroughly cooked.

A mimeographed circular from the United States Biological Survey, dated January, 1928, says, among other things:

> Discovery of tularemia has cleared up many puzzling cases of illness that in the past have doubtless been wrongly diagnosed as "flu," septic infection, blood poisoning or other kindred diseases, because of a superficial resemblance of the symptoms at some stage of the disease. Human cases have been traced to rabbits or other animals in the locality or to shipments of diseased animals sold in the public markets. This specific knowledge lays the foundation for intelligent action in maintaining safeguards and in protecting the public in the use of important game animals.

The United States Public Health Service has been especially active in the investigation of tularemia and has published many important papers on the subject.[14] Many other papers not cited herein may be found scattered through the periodical literature of recent date.

Various other diseases are known to be disseminated by certain species of wild mammals. A notable example is the terrible bubonic plague, or "black death," which has ravaged various parts of the world at intervals from a remote date down to the present generation. The disease is transmitted by the bites of fleas that infest certain species of rodents, chief of which is the widely distributed brown house rat, though ground squirrels[15] and other rodents also are definitely known

[13] Mease, Tularemia from opossums, *Journ. Amer. Med. Assn.*, XCII, 1042, 1929. Schwartz, Tularemia from a muskrat, *ibid.*, pp. 1180-1181, 1929. Murray, The possibility of tularemia in the ruffed grouse, *The Auk*, XLVI, 110-111, 1929, citing Green and Wade, Tularemia in birds, *Journ. Amer. Med. Assn.*, May 26, 1928, and *Proc. Soc. Exper. Biol. and Med.*, April, 1928. Green, The problem of tularemia in game birds, *American Game*, XVII, 80, 1928.

[14] Dieter, A case of tularæmia in a laboratory worker, *Public Health Report*, July 2, 1926, pp. 1355-1357. Perry, Tularæmia among meadow mice (Microtus californicus aestuarinus) in California, *ibid.*, Feb. 3, 1928, pp. 260-263. Parker and Francis, The susceptibility of the coyote (Canis lestes) to tularæma, *ibid.*, July 9, 1926, pp. 1407-1410. Parker and Spencer, Hereditary transmission of tularæmia infection by the wood tick, Dermacenter andersoni Stiles, *ibid.*, July 9, 1926, pp. 1403-1407; Six additional cases of laboratory infection of tularæmia in man, *ibid.*, July 2, 1926, pp. 1341-1355. Francis and Evans, Agglutination, cross-agglutination and agglutinin absorption in tularæmia, *ibid.*, June 25, 1926, pp. 1273-1295. Freese, Lake and Francis, Four cases of tularæmia (three fatal) with conjunctivitis, *ibid.*, Feb. 26, 1926, pp. 367-372. Anonymous, Seasonal incidence of tularæmia and sources of infection, *ibid.*, Dec. 2, 1927, pp. 2948-2951. Francis, Mayne and Lake, Tularæmia Francis 1921, a new disease of man, eight papers, Hygienic Laboratory, *U. S. Pub. Health Serv. Bull.* No. 130, 1922.

[15] Merriam, The California ground squirrels, *U. S. Biol. Surv. Circular* No. 76, p. 6, 1910.

to be disseminators in some localities. It will be recalled that not many years ago this plague appeared at different times in New Orleans, Seattle and San Francisco, and was checked by prompt, effective campaigns against rats and in one case against ground squirrels also. In the San Francisco campaign 278,000 rats were captured in four months and it was estimated that 500,000 more were poisoned.[16] Lantz says that the house rat is responsible for more deaths among human beings than are all the wars of history, because of its relation to bubonic plague, which in the fourteenth century destroyed from two-thirds to three-fourths of the population of large areas in Europe—25,000,000 people—and since 1896 has killed 9,000,000 people in India alone, 1,200,000 in 1907.[17] So active is the rat as a disseminator of plague that it has been proposed to "build out the plague" by building out the rats through the use of concrete, metal and the like in the construction of buildings.[18]

The spotted fever, or "tick fever," of the Rocky Mountain region, especially virulent in portions of Wyoming, Montana and Idaho, rapidly increasing in Colorado, is transmitted to human beings by the bites of wood ticks which have become infected through first biting infected mammals of some sort. The adult ticks have been found on mountain goats, coyotes, badgers, wood rats, mice, woodchucks, snowshoe rabbits and bears, but are more frequently found on domestic stock;[19] hence many mammals aid in the spread of the disease by harboring the ticks. Domestic sheep are excellent collectors of ticks, which easily lodge in their wool. It has been thought by some that they could be used effectively to collect the ticks and make possible their destruction by frequently "dipping" the sheep. It does not seem to be very practicable, as some of the most favorable localities for ticks are not favorable to sheep and sheep cannot be long run in numbers over the same pasturage used for cattle and horses.[20]

It is generally known that trichiniasis is transmitted to human beings by means of under-cooked pork. The sleeping sickness in Africa is transmitted from antelopes, dogs and monkeys to man by the tsetse

[16] Forbush, Rats and rat riddance, *Massachusetts Board of Agric., Economic Biol. Bull.* No. 1, 1915.

[17] Lantz, The house rat: The most destructive animal in the world, *Yearbook U. S. Dept. Agric. for 1917,* pp. 235-251; The brown rat in the United States, *U. S. Biol. Surv. Bull.* No. 33, 1909. See also Taylor, *Science,* XLVI, 124-125, 1917.

[18] *Technical World Magazine,* Nov., 1912, pp. 269-273.

[19] Birdseye, Some common mammals of western Montana in relation to agriculture and spotted fever, *U. S. Dept. Agric., Farmers' Bull.* No. 484, 1912.

[20] See Wood, Experiments in the use of sheep in the eradication of the Rocky Mountain spotted fever tick, *U. S. Dept. Agric. Bull.* 45, 1913.

fly. Malta fever is spread by the milk of goats and other diseases by the milk of cows. These are but a few of many instances that might be mentioned of lower mammals that are carriers or hosts of diseases that attack human beings. Many are already known, and the investigation of this important and interesting subject is still in its infancy. Carrion-feeders, such as coyotes, are especially likely to spread diseases of livestock, but there is not as yet at hand as much definite evidence on that subject as is desirable. It seems almost needless to mention the obvious cases of transmission of disease from one mammal to another of the same species, this being the most common type of carrier. Rats and mice, running about in all sorts of places and "tracking" filth of various kinds over stores of human food, are potential carriers of many serious diseases, which adds another to the reasons for their control by rigorous methods.

## XIV

# MAMMALS DANGEROUS TO HUMAN BEINGS[1]

The inhabitants of Europe, America and Australasia are fortunate as compared with those of some portions of Asia and Africa, so far as dangerous mammals are concerned. We read that in one year (1910), in India alone, 2138 persons were killed by wild mammals, as follows: By tigers, 882; leopards, 366; wolves and bears, 428; elephants and hyaenas, 77; wild pigs, 51; buffaloes, 16; wild dogs, 24; unspecified, 220.[2] Other portions of Asia could add largely to the list.

We have at hand no figures for any part of Africa, but the literature of exploration, hunting trips and the settlement of Africa is filled with accounts of attacks of the larger mammals upon people, and the total mortality from this cause must be very large. Roosevelt lists four mammals of Africa as especially dangerous, and says: "During the last few decades, in Africa, hundreds of white hunters and thousands of native hunters have been killed or wounded by lions, buffaloes, elephants and rhinos" (rhinoceroses).[3] It must not be inferred from this statement that only hunters have been killed or that the animals named are the only ones that are dangerous. Such is far from the case. The hippopotamus often upsets boats and destroys the native occupants. Though the leopard does not often attack humans, it sometimes does, and Roosevelt mentions one that killed seven boys before the hunters could get it. Various writers assert that the hyaena enters native huts and kills children and even attacks sleeping adults.[4]

The lions and tigers are not all man-eaters, or the destruction of human life by them would be much greater, but their great size and strength and the uncertainty as to when one may acquire the taste for human blood make them all a potential menace. A remarkable account has been published of two man-eating lions in Africa that waged war upon a railroad construction gang for nine months before they were

[1] In this chapter we consider only those large mammals that directly attack human beings. Danger from mammalian disease carriers is considered in another chapter.

[2] *Science,* XXXVII, 938, 1913. See also *Amer. Nat.,* XXXI, 77-78, 1897.

[3] Roosevelt, *African game trails,* pp. 58-59, 62, 243, 1910.

[4] Roosevelt, *ibid.,* p. 59. Drake-Brockman, *The mammals of Somaliland,* p. 42, 1910. Ingersoll, *The life of animals,* p. 161, 1907.

killed. They stopped construction for three weeks, the workmen having fled from the scene in dismay. The two "devoured between them no less than twenty-eight Indian coolies, in addition to scores of unfortunate African natives of whom no official record was kept."[5]

The large mammals of North America are not ordinarily dangerous, and seldom is anyone injured except by a wounded individual or one that considers itself or its young in danger. However, as there are not wholly wanting rare instances of apparently unprovoked attacks, it is not safe to depend upon that general rule. There is considerable individuality in four-footed mammals, just as there is among men and women. Furthermore, they may sometimes imagine they are being attacked when they are not in any danger. Extreme hunger also may impel them to attack people.

It is very seldom that mountain lions have been known to attack human beings except when they were being pursued,[6] but there is at least one recent instance of one of these great cats killing a boy in eastern Washington, apparently without the slightest provocation, springing upon him unaware.[7] Concerning this case Bryant says: "Those seeking dependable information have sought authentic instances of the killing of human beings by mountain lions, with largely negative results. This is apparently one of the first instances to be recorded of an attack of this kind. This report should not lead people to believe that the mountain lion is a dangerous animal. It should be remembered that the common domestic dog claims many more victims annually than mountain lions, and one of the safest places to live is in mountain districts where mountain lions are abundant."[8] This is largely true, and yet the fact that such a thing did occur is sufficient evidence that such a powerful beast must not be considered harmless, especially to children. There is another report of the killing of a seven-year-old boy in California by a mountain lion. In another California case, a lion attacked and badly wounded a boy, as well as a girl who rushed to his rescue, and it was killed by a man who rushed to the scene with a rifle. Both victims died, the girl with a clear case of hydrophobia and the boy probably from the same cause.[9] It is well known that for years there has

[5] Patterson, The lions that stopped a railroad, *World's Work,* Nov., 1908, and Jan., 1909, pp. 10895-10906, 11147-11158.

[6] Howell, *N. Amer. Fauna,* No. 45, p. 42, 1921. Roosevelt, With the cougar hounds, *Scribner's Magazine,* xxx, 431-432, 1921.

[7] Finley, *Journ. Mammalogy,* vi, 197-199, 1925.

[8] Bryant, *California Fish and Game,* vi, 89-90, 1925.

[9] *Morgan Hill Times,* July 9, 1909. Storer, *California Fish and Game,* ix, 45-48, 1923.

been considerable hydrophobia among wild animals of the western states. A mountain lion in Venezuela started toward a man with every apparent intention of an attack, but was shot before he actually made the attack.[10]

There were many casualties among the hunters of the American bison when they were still roaming the plains in great herds, but those attacks were plainly due to the fact that the bison were being pursued and shot at. They were fighting in self defense. The African buffalo is said to be much more dangerous than the American bison. Domestic bulls injure and kill more people in North America than do all the beasts of prey. Occasionally a child is killed by a dog. The domestic horse has been called "the most dangerous animal." When horses were in more general use than now, there were annually many deaths and serious injuries to human beings caused by runaway and kicking horses. The high mortality rate was not due to the viciousness of horses in general, and seldom due to real viciousness of the particular animals that did the damage. It was due to the great number of horses being constantly handled by people, many of whom were careless or incompetent, and many horses are nervous and easily frightened by unusual sounds or sights that they cannot understand.

The members of the deer family, including the reindeer, are inclined to be vicious during the breeding season, and in captivity they have been known to attack and injure or kill their keepers.

Wolves in the United States have not been considered dangerous to human beings, but when hungry they would almost certainly attack a young, unprotected child, if they had a chance. In Siberia and some other countries they are said to often attack travelers, and as they hunt in packs they are dangerous.[11]

Our black bears seldom, if ever, attack men without provocation, but the grizzly is generally believed to sometimes attack without any good reason.[12] Many writers call it a dangerous animal, and stories are told of bold attacks upon men, most of which, however, were hunters who were attacking or attempting to kill the bears. Mr. Skinner, well-known Yellowstone Park naturalist, contends that even grizzlies are "harmless if let alone." Occasionally a park bear becomes cross and dangerous. He tells of a grizzly that killed a Montana rancher who had

[10] Osgood, *Journ. Mammalogy*, I, 240-241, 1920.
[11] Coupin, Animals that hunt, *Ann. Rept. Smithsonian Inst. for 1903*, pp. 567-573.
[12] See Henshaw, *Rept. Chief of Engineers, U. S. Dept. War*, 1876, Part 3, p. 528.

caught it in a trap and was trying to kill it.[13] An alleged "unprovoked" attack of a "brown" bear upon two hunters in Yukon Territory occurred when the hunters, with dogs, were approaching the carcass of a moose upon which the bear was feeding, and which the big animal naturally did not choose to give up without a struggle.[14] Baboons, gorillas and orang-outangs are accused of attacking and injuring or killing people, a subject discussed in a subsequent section on primates.

[13] Skinner, *Journ. Mammalogy,* IV, 53, 1923.
[14] Bonebrake, *Journ. Mammalogy,* III, 185-186, 1922. Grinnell, *ibid.,* IV, 52-53, 1923. Sheldon, *ibid.,* pp. 51-52.

## XV

## THE RELATION OF MAMMALS TO FIRE HAZARD

Fire chiefs and insurance adjusters agree that fires are not infrequently caused by the work of rodents, particularly the brown house rat. In many cases this is suspected, but there are not lacking instances in which the proof seems quite conclusive. Matches are often dipped in paraffin by the manufacturers to protect the phosphorus, before being placed on the market. Rats, attracted by the paraffin, carry the matches under the floors or to their nests and there gnaw them.[1] In a London museum was once exhibited a partly burned rat's nest in which the fire was caused by the rat gnawing a match that it was working into the nest, thus nearly setting fire to H.M.S. *Revenge*. A fire in the Sultan's palace at Scutari, Asia Minor, some years ago, had a similar origin, and there are many other known and a multitude of suspected instances.

Fires in mills and warehouses, particularly cotton mills, are said to have often resulted from spontaneous ignition of oily rags or waste carried into the walls or beneath the floors by rats. In some instances fires have been caused by the accidental ignition of gas from leaky lead gas mains, the leaks being the result of gnawing by rats. Many other leaks from the same cause have fortunately been discovered without the gas having ignited, showing that this is a real fire hazard where lead pipes are used in buildings to which rats have access. More numerous still are fires caused by rats in gnawing the insulation from electric light and power wires beneath floors and within partitions. The loss from fires attributed to defective insulation of electric wires in the United States has been estimated at $15,000,000 per annum, a great deal of which may have been the work of rats and mice.

As heaps of inflammable rubbish in non-fireproof buildings are everywhere recognized as a fire hazard, it is not at all impossible that fires in country and mountain homes may have been caused by the nest-building operations of wood rats, and especially the "pack rat" of the Rocky Mountains. Dead timber, especially where there are accumulations of the finer twigs and small branches, is a fire hazard in forest areas, as

[1] See Lantz, The brown rat in the United States, *U. S. Biol. Surv. Bull.* No. 33, pp. 27-28, 1909.

it is much easier for fires to originate from lightning or from the careless handling of matches and cigarette stubs in such places than in clean, open forests, free from dead brush and wood. Nests of rodents provide such accumulations of twigs, grass and other débris.

While some mammals may increase fire hazards in forest areas, on the other hand Angora goats lessen fire hazard by clearing out underbrush. In California they have been utilized in keeping clear of weeds the "fire-breaks" or long lanes from which the timber has been removed along the crests of ridges in order to prevent the spread of forest fires, and to make it easier to bring the fires under control. The cost of keeping the lanes free from weeds and grasses which in dry seasons become very inflammable is considerable.[2]

[2] Heller, The Angora goat, *Farmers' Bull.* No. 573, p. 4, 1914.

## XVI

## THE RELATION OF MAMMALS TO SOIL TURNOVER, EROSION, DAMS, DIKES, RESERVOIRS, CANALS

The activity of earthworms in moving soil, continually bringing fresh soil to the surface, has long been known and much discussed. That burrowing mammals move considerable soil is also very apparent to the most casual observer of outdoor phenomena, but it has not been so much discussed, and the enormity of mammalian activity in this direction and its results are but little realized. It affects soil fertility, water conservation, water run-off, growth of vegetation and erosion. Grinnell[1] estimates that a single group of rodents, the gophers, in Yosemite Park alone raise 8000 tons of earth an average height of eight inches per annum. Extend this to include the whole world and add to it the quantity moved by all other burrowing animals the world over, such as moles, rats, mice, squirrels, rabbits, prairie-dogs, badgers and a multitude of others, then multiply the result by the thousands of years during which such burrowing has been in progress, and the total would run far up into millions of tons. Moles observed in captivity made 1252 pits in 65 days, a daily average of 19.[2] White-footed mouse (*Peromyscus polionotus*) mounds are very large for so small a species, some of the burrows being a foot deep and some of the mounds containing several cupfuls of soil.[3]

The burrowing helps to aërate the soil, and the soil brought to the surface is subjected to more rapid weathering, thus releasing minerals needed by the plants. The freshly exposed soil buries portions of the surface vegetation, which decomposes and helps to enrich and mellow the soil. The loosening of the soil on pasture ground that is not stirred by the plow to some extent serves to counteract the packing of soil due to the trampling of livestock, admitting to the soil the air essential to plant growth. The loosened soil more readily absorbs moisture from

[1] Grinnell, The burrowing rodents of California as agents in soil formation, *Journ. Mammalogy*, IV, 137-149, 1923; reprinted in *Ann. Rept. Smithsonian Inst. for 1923*, pp. 339-350. Henderson, *Geology in its relation to landscape*, pp. 135-137, 1925.

[2] Hisaw, Observations on the burrowing habits of moles (Scalopus aquaticus machrinoides), *Journ. Mammalogy*, IV, 79-88, 1923.

[3] Sumner and Karol, Notes on the burrowing habits of Peromyscus polionotus *Journ. Mammalogy*, X, 213-215, 1929.

rainfall, which is very important in arid and semi-arid regions. In this way the work of burrowing mammals compensates for some of the damage they do to crops. On the other hand, the burrows of some of the larger species, such as prairie-dogs, badgers and the like often cause injuries to horses and riders on the western cattle and sheep ranges, and the ridges and mounds of moles and gophers are a serious detriment to lawns, gardens and some fields. Furthermore, the loosening of the soil promotes erosion, which may be serious on steep slopes but little protected by vegetation.

The burrows of rats, muskrats, beavers, gophers and other mammals often damage earthen embankments, reservoir dams, dikes and canal banks, weakening them, causing leaks and sometimes resulting in flooding the adjacent lands. It is said that the American muskrat, introduced into Europe, is endangering whole systems of waterways.[4] Beavers often flood fields and roads by building their dams across streams, thus backing up the water until it overflows. This is usually detrimental to human interests, but not always so. By turning waste lands into ponds, lakes and swamps, they may sometimes provide reservoirs to detain storm waters, retard run-off, and thus lessen damage by floods, as well as providing quiet pools where trout and other fish fry may acquire sufficient size and strength to enable them to safely enter swift streams.

The biological and environmental interrelations in nature are extremely complicated. It may be that the stirring and aëration of the soil by burrowing mammals are very important, if not necessary, to the thrift of certain kinds of plants. It is well known that some species of plants are at their best only on soil which has been recently disturbed by the plow or otherwise. It is also certain that chemical and bacterial characteristics of the soil have a large influence upon plant growth. A thorough study of the influence of the disturbance and aëration of the soil by burrowing animals upon soil bacteria and chemical reactions might prove very fascinating and perhaps fruitful.

The erosion and destruction that follows forest fires and excessive lumbering operations[5] is observed also to follow overgrazing. In regions where slopes are steep, covered with loose soil, rainfall light, but consisting of occasional heavy downpours, the destruction of the scant vegetation in many localities has resulted in very rapid erosion and

[4] Aherns, Muskrats in central Europe, *Journ. Mammalogy*, II, 236-237, 1921.
[5] Glenn, Denudation and erosion in the southern Appalachian Region and the Monongahela Basin, *U. S. Geol. Surv. Professional Paper* No. 72, 1911.

denudation of the hillsides, the transported débris covering and injuring or destroying fields and pastures in the valleys. The storm waters, no longer held in check by the loose soil and vegetation, rush down the slopes and produce disastrous floods where they were formerly unknown. The partial restoration of original range conditions by the removal of sheep has resulted soon in lessening the violence of floods. Erosion and floods due to overgrazing in the Manti Forest before it was made a national forest, caused damage to the extent of $225,000, while on Sevier River, Utah, sediments derived from erosion due to overgrazing covered and were estimated in 1916 to have damaged farm lands to the extent of $150,000.[6] These are but illustrative examples out of many such instances now known.

Botanists observe that when the virgin prairie surface is disturbed by plowing, or in the construction of roads and the like, weeds at once spring up in the loosened soil, where only grass grew when it was compact. Thus on western plains the graded roadsides are often soon lined with a thick growth of sunflowers, "snow-on-the-mountain" and other plants that do not ordinarily invade the undisturbed soil except here and there as single plants or small clusters. Where prairie sod has been plowed and the fields then abandoned they are soon covered with a dense growth of sunflowers and other weeds. A similar result has been observed to follow the destruction of the original vegetative cover by overgrazing and excessive trampling of the soil by large flocks of sheep or herds of cattle, even on slopes not steep enough for serious erosion to occur, "useless weeds" being substituted for the original vegetation.[7] The inevitable result of excessive overgrazing on the plains of the Rocky Mountain states is so to reduce the forage that the range will not support even sheep. In the national forests of the mountains, where precipitation is much greater and consequently the effects of overgrazing not so extreme, it has been found necessary to provide, in

[6] Reynolds, Grazing and floods: A study of conditions in the Manti National Forest, *U. S. Forest Service Bull.* No. 9, 1911. Dana, Farms, floods and erosion, *Yearbook U. S. Dept. Agric. for 1916,* pp. 107-134. Cottam, Man as a biotic factor illustrated by recent floristic and physiographic changes at the Mountain Meadows, Washington County, Utah, *Ecology,* x, 361-363, 1929. Forsling, A study of the influence of herbaceous plant cover on surface run-off and soil erosion in relation to grazing on the Wasatch Plateau in Utah, *U. S. Dept. Agric. Technical Bull.* No. 220, 1931.

[7] Colville, Forest growth and sheep grazing in the Cascade Mountains of Oregon, *U. S. Div. Forestry Bull.* No. 15, 1898. Shreve, Changes in desert vegetation, *Ecology,* x, 364-373, 1929. Campbell, Vegetative succession in the Prosopis sand dunes of southern New Mexico, *Ecology,* x, 393-398, 1929. Jardine and Forsling, Range and cattle management during drought, *U. S. Dept. Agric. Bull.* No. 1031, 1922.

the grazing permits, for the restriction of the number of animals allowed in each area, and for the more or less continual movement of sheep, so that they may not be grazed and bedded too long in one locality.

In the semi-arid southwestern states many streams which flowed in very shallow channels when settlers first entered the region, have since become deeply entrenched in the alluvium, with vertical walls. Large cottonwoods and willows which lined some of the streams have died because they were left on the high, dry banks where their shallow roots no longer reach the water line. Swamps and ponds which occupied some of the valleys and aided in retarding run-off have been destroyed by the establishment of more complete drainage through the deep, narrow channels. These changes have by some writers been attributed to a very recent change in climate, which is not consistent with the facts. The evidence seems to point to more rapid run-off of storm waters, resulting from the removal of the vegetative cover by overgrazing, as the probable cause in many or most cases.[8] Run-off has been accelerated by trails worn by cattle and sheep in going to and from water and feeding grounds, the trails providing small channels of least resistance and thus concentrating the sheet flow during and after storms into numerous tiny rivulets. However, the trails of themselves could not have produced such general and pronounced trenching as is found in the Southwest. There were numerous bison trails on the Great Plains when white settlers arrived, which had been traveled by those animals for centuries, and they had produced only very local erosion, but the bison herds moved about freely and made long migrations, not grazing in one locality long enough to seriously reduce the vegetative cover.

[8] Rich, Recent stream trenching in the desert of southwestern New Mexico—a result of removal of vegetative cover, *Amer. Journ. Sci.*, 4th series, XXXII, 237-245, 1911; abstract, *Ann. Assn. Amer. Geographers*, I, 135, 1911. Duce, The effect of cattle on the erosion of canyon bottoms, *Science*, XL, 450-452, 1918. Reagan, Recent changes in the plateau region, *Science*, LX, 283-285, 1924. Bryan, Date of channel trenching (arroya cutting) in the arid Southwest, *Science*, LXII, 338-344, 1925; with a great deal of evidence as to dates of cutting and citation of numerous publications.

## XVII

## THE INFLUENCE OF WILD MAMMALS IN THE EXPLORATION AND SETTLEMENT OF NORTH AMERICA AND UPON HISTORY

Probably wild mammals have figured largely in the early human occupancy and exploration of many lands, but perhaps nowhere has that influence been more profound and obvious than in North America, especially that portion lying north of the latitude of St. Louis. The value of wild mammals as a source of food for exploring expeditions was brought to fleeting public attention by the popular accounts of a somewhat recent expedition to Africa, when an ex-president of the United States and his son furnished a large part of the food of the entire safari of more than one hundred men from the game that fell before their rifles.[1] How many readers of those accounts connected that idea with the early history of the United States and Canada? Thoughout this vast region, the meat of wild animals of the virgin forests, plains and mountains provided the trappers, traders and explorers with abundant food, the skins furnished them with warm clothing and temporary shelter to protect them from storms until they could establish habitations. The stories brought back by the explorers and trappers stimulated permanent settlers to push back the frontiers, and mammals furnished them, too, with food, raiment and shelter until they could build cabins, clear land and plant and harvest their first crops.

It has been said that "the most important fact in American history is the beaver." In a certain sense this is true. Until rather recently the beaver, because of its size, excellence, general distribution, abundance and gregarious habits, was the center of the fur trade of America, and the trappers and traders connected with that ancient industry led the way into the wilderness and "blazed the trails" for the settlers who followed far behind.[2] A large number of other fur-bearing mammals contributed to the lure that led the trappers and traders to leave the established settlements and proceed, alone or in small groups, into the unknown wilderness, confident that the game of the solitudes would

[1] Roosevelt, *African game trails,* 1910.

[2] Vandiver, *The fur trade and early exploration,* Cleveland, 1929. Dale, *Ashley-Smith Exploration,* Cleveland, 1918. See also books cited in footnotes of Chap. IX.

provide them with sufficient food. There were no places in the unexplored regions where they could purchase food, clothing and ammunition, no railroads or other transportation systems to carry their supplies far from their base for long trips or lengthy stays. The earliest settlements in the West and Northwest were built up about the fur-trading posts, some of which finally developed into large and important cities.

Fur traders are believed to have visited the present site of St. Paul as early as 1658. LaSalle mentioned the place in 1682 and Carver described it in 1766. French traders founded St. Louis in 1764, and for a century it was one of the great centers of the fur trade. In 1804, when the first government exploring expedition, under Captains Lewis and Clark, started up the Missouri River, that stream was already known to the trappers and traders as far northwest as the present state of Montana, where tributary streams and other topographic features of the country had been named by French voyageurs. Astoria, near the mouth of the Columbia River, was founded as a fur-trading post in 1811.

The early history of the vast plains and rugged mountains of western and central North America is almost entirely a history of the fur trade. The trappers of the various St. Louis companies preceded Fremont, Long, and all other explorers into the Rocky Mountains. Before Fremont crossed the continental divide a trapper's rendezvous had been held at Bear Lake, in southern Idaho, trappers coming in from various directions to trade their pelts for supplies. Through battles between rival groups of trappers and traders, occasional hostilities of Indians and other hazards of life in the wild, unsettled region, some companies are said to have lost 40 per cent of their men in a single year.

Various exploring expeditions in western United States were also partly dependent upon wild animals for food and clothing. Some of them employed hunters, whose business it was each day to set forth in the search for game. This is true to some extent of all the early expeditions—Lewis and Clark, Fremont, Long, Pacific Railway, King, Powell, Wheeler and Hayden Surveys.

In British America the early fur trade was as important as in the territory now constituting the United States, if not more important. The Hudson Bay Company was given almost absolute jurisdiction over the vast Hudson Bay region, and for two centuries dominated a territory as large as the United States in the interests of the fur trade. Its agents reached the Arctic Circle thirty years before anyone had crossed the territory now embraced within the United States. MacKenzie in 1789 reached the river that bears his name and explored it from Great Slave Lake to the Arctic Ocean. He was the first white man to cross the Rocky Mountains, and reached the Pacific Ocean in 1793.

Alaska, too, owed its early exploration and settlement to the fur trade, which is still a very important industry in that region. Early Arctic expeditions were dependent upon the walrus, polar bear and other Arctic mammals for food, before the modern development of the art of condensing and preserving food made it possible for expeditions to carry provisions for a long voyage. Wherever one turns in the early history of the northern two-thirds of the continent, one sees in game and fur-bearing mammals two of the very important factors in its exploration and settlement.

Whales and the whaling and related industries also played a prominent part in the early exploration and history of North America, a subject discussed more at length in Chapter VI. Whaling vessels explored the then unknown coasts of the continent, discovered many bays, inlets, harbors, rivers and islands, carried the American flag for the first time into various foreign ports, and furnished hardy, experienced seamen for our naval vessels, notably in the War of 1812. The fur trade was mixed up in the Oregon boundary dispute which led to talk of war between the United States and Great Britain during the "54° 40′ or fight" campaign, but the trouble was settled by the treaty of 1846. Again the fur trade caused war clouds to float on the political horizon during the dispute over the North Pacific fur-seal fishery, finally settled by arbitration and treaties between the United States, Great Britain and Japan.

## XVIII

## MAMMALS AS SCAVENGERS

Many mammals live to some extent upon carrion and other waste and decomposing material, and are therefore somewhat beneficial because of that repulsive habit, but it is doubtful whether the total result of their activities in that line is of much consequence, though the aggregate amount of refuse consumed by all the species must be large. Among birds, such species as the gulls, gathering in great flocks about harbors, garbage dumps, salmon canneries, etc., and feeding upon the refuse, doubtless do much good. Perhaps there is among mammals no parallel to this example. Vultures, crows and other birds feed upon carcasses and pick up much other material which, if unconsumed, would putrify, and they probably do some good in that way, but no more than is done by various mammals of like habit.

Every western rancher is well aware that coyotes consume great quantities of carrion, and they take advantage of this knowledge by inserting poison into the carcasses of cattle, horses and sheep in order to destroy the coyotes. The scarcity of vultures ("buzzards") in many localities where they were once abundant is due to the eating of poisoned meat prepared for coyotes. Dixon examined many coyote stomachs and discovered that 50 per cent of all the flesh of livestock contained therein, 25 per cent of the flesh of game and 12.5 per cent of the flesh of rodents was carrion.

Visitors to Yellowstone Park watch the bears gather about the garbage dumps, feeding upon the refuse from the camps and hotel kitchens and poking around the garbage cans in the camps to see what they can find that is eatable, however unsavory it may seem to the human occupants of the camps. They are sometimes found eating carcasses of deer or livestock killed by mountain lions or wolves, and wrongfully accused of having themselves killed the victims, though they do not hesitate about killing animals when they are hungry and have the opportunity. This is especially true of the grizzly.

The house rats and mice and many other species of rodents feed to a considerable extent upon refuse and garbage. Hyaenas are notorious scavengers, even entering the villages in search of garbage, though they also kill other animals and even children.[1] The wolverene is both hunter and scavenger, a great scourge to the trapper, following the trap lines and voraciously devouring the animals caught therein, for which reason it is often called the glutton.[2]

[1] Drake-Brockman, *The mammals of Somaliland,* p. 39, 1910.
[2] Fry, The wolverene, *California Fish and Game,* IX, 129-134, 1923. Bailey, *N. Amer. Fauna,* No. 49, p. 178, 1926.

## XIX

## MAMMALS AS ENEMIES OF OTHER MAMMALS

That certain species of mammals habitually prey upon other mammals is a matter of common knowledge, reflected in the popular group apellation of the larger species—"beasts of prey." The mammalian enemies of domestic stock have been considered in Chapter VII, in relation to Damage to the Human Food Supply by Mammals.

All members of the cat family (Felidae) are flesh-eaters, many of them almost exclusively so, and mostly subsisting upon the flesh of mammals and birds killed by themselves. They destroy a vast number of mammals of many kinds. Domestic cats kill many house mice, a few of them attack rats, and they often destroy squirrels and other small mammals. Mountain lions are special enemies of deer and also kill many of the small mammals, as well as domestic stock, particularly colts. Jaguars kill many mammals, big and little, including men. Lynxes and wildcats (bobcats) destroy many rabbits and other small mammals, chiefly rodents.[1] There are very few large African mammals that the lion will not attack and conquer, but, where available, the zebra is its favorite prey. Tigers and leopards destroy many kinds of mammals, large and small.

The members of the dog family (Canidae) also subsist largely upon flesh, but take a larger average percentage of other food than do the Felidae. Coyotes destroy large numbers of rabbits, prairie-dogs, ground squirrels, mice and so forth, but unfortunately raid sheep and calf pens. The larger wolves are destructive to livestock and deer, but do not disdain various smaller wild mammals, even consuming many mice where those rodents are abundant.[2] Their size and habit of hunting in packs, especially in northern Europe, make them formidable foes. Damage by predacious mammals to domestic stock in the United States is estimated at $20,000,000 to $30,000,000 annually, chiefly cattle and sheep.[3]

[1] Merriam, *N. Amer. Fauna,* No. 3, p. 79, 1890. Bailey, *ibid.,* No. 49, p. 149, 1926; *Farmers' Bull.,* No. 335, 1908. Dixon, *Journ. Mammalogy,* VI, 36-38, 1925.

[2] Johnson, A note on the habits of the timber wolf, *Journ. Mammalogy,* II, 11-15, 1921. Bailey, Destruction of deer by the northern timber wolf, *U. S. Biol. Surv., Circular,* No. 58, 1907. Bell, Wolves, coyotes, take big toll from stockmen, *Yearbook U. S. Dept. Agric. for 1926,* pp. 774-776.

[3] Bell, Hunting down stock killers, *Yearbook U. S. Dept. Agric. for 1920,* pp. 289-301.

Foxes live very largely upon small rodents. Seton says that 90 per cent of the pellets of the red fox consists of mouse fur.[4] Sheep-killing dogs have been discussed in another chapter, and they are only occasional, but many dogs kill rabbits and other small mammals. Hyaenas kill sheep and small wild mammals.[5]

Bears are not as habitual killers as are the Felidae and Canidae, but they do destroy many wild mammals, as well as livestock. The mongoose is an active enemy of all the smaller mammals and is a very successful ratter. Some squirrels eat mice and other very small mammals. The killer whale not only kills other whales, but is an enemy of seals. The stomach of one from Pribilof Islands contained 18, and another 24, young fur seals.[5a] Baboons are said to do a vast amount of havoc among young lambs and kids, not for their flesh, but for the milk they contain, which is obtained by tearing the young animals asunder.[6] During years when mice are abundant in Labrador they form a large part of the food of bears, foxes, wolves, wolverenes and other carnivorous mammals.[7] Innis emphasizes the fact that the supply of certain fur-bearing mammals is affected by the abundance or scarcity of the mice upon which the fur-bearers feed so largely.[8]

The Mustelidae are chiefly carnivorous and the food of many of them consists partly, sometimes largely, of injurious rodents. The badger, for example, lives mostly upon rodents, such as prairie-dogs, ground squirrels, gophers, rats and mice, all of which it is able to easily dig out of their holes.[9] The black-footed ferret of the western plains lives almost entirely upon prairie-dogs and is often called the prairie-dog ferret.[10] Minks eat mice, rats, squirrels, muskrats, chipmunks, rabbits and other mammals, as well as a great variety of other animal life.[11] Weasels are great enemies of ground squirrels and pocket gophers, being able to enter the burrows of these rodents, but also

[4] Seton, *Journ. Mammalogy,* I, 140, 1920.

[5] Drake-Brockman, *The mammals of Somaliland,* p. 39, 1910.

[5a] Evermann, *Scientific Monthly,* XV, 310, 1922. Hanna, *Journ. Mammalogy,* IV, 209-220, 1923.

[6] Roosevelt, *African game trails,* pp. 218-219, 1910. Ingersoll, *The life of animals,* pp. 24-25, 1907.

[7] Cabot, *Labrador,* 1921. Allen, *Journ. Mammalogy,* III, 56-57, 1922.

[8] Innis, *The fur trade of Canada,* pp. 89-91, 1927.

[9] Bailey, *Farmers' Bull.,* No. 335, 1908; *N. Amer. Fauna,* No. 49, p. 184, 1926; *Animal life of Carlsbad Cavern,* p. 102, 1928. Birdseye, *Farmers' Bull.,* No. 484, 1912. Sawyer, *Journ. Mammalogy,* VI, 125-126, 1924. Silver, *ibid.,* IX, 63, 1928.

[10] Cary, *N. Amer. Fauna,* No. 33, p. 184, 1911. Bailey, *ibid.,* No. 49, p. 171, 1926.

[11] Howell, *N. Amer. Fauna,* No. 45, 1921. Bailey, *ibid.,* No. 49, p. 173, 1926. Ashbrook, *U. S. Biol. Surv. Leaflet* No. 8, 1928.

destroy large numbers of mice, chipmunks and other rodents.[12] Skunks kill many mice, gophers and other small mammals, and even rabbits.[13] The fisher and pine marten also feed largely upon small rodents.[14] The wolverene is more ambitious. In addition to taking many of the smaller mammals, there are accounts of its attacking those much larger than itself, such as moose and caribou.[15] Squirrels sometimes eat smaller mammals. A Franklin ground squirrel attacked and ate a young rabbit and another was seen chasing a striped ground squirrel.[16]

Although shrews are chiefly insectivorous, they are fond of meat and some species destroy mice of various kinds.[17] There is an account of a rat eating a mole.[18] Grasshopper mice kill and eat a great many injurious mice of various species.[19]

[12] Bailey, *Farmers' Bull.*, No. 335, p. 30, 1908; *N. Amer. Fauna*, No. 49, pp. 166, 169, 170, 1926. Carey, *ibid.*, No. 33, p. 186, 1911. Howell, *ibid.*, No. 45, p. 35, 1921.

[13] Merriam, *N. Amer. Fauna*, No. 3, p. 83, 1890. Howell, *ibid.*, No. 20, p. 11, 1901; No. 26, p. 8, 1906; No. 45, 1921. Bailey, *Farmers' Bull.*, No. 335, p. 28, 1908. Lantz, *ibid.*, No. 587, 1914. Cuyler, *Journ. Mammalogy*, v, 180-189, 1924. Dixon, *ibid.*, vi, 34-46, 1925.

[14] Bailey, *N. Amer. Fauna*, No. 49, pp. 176-177, 1926.

[15] Keele, *Forest and Stream*, LXXI, 971. Hunter, *Canadian Indian wilds*, p. 150, 1907. Grinnell, *Journ. Mammalogy*, I, 182-185, 1919.

[16] Johnson, *Journ. Mammalogy*, III, 187, 1922.

[17] Howell, *N. Amer. Fauna*, No. 45, p. 21, 1921.

[18] Garrett, Rat-eating mole, *The Field* (London), vol. 148, p. 205, 1926; cited in *Journ. Mammalogy*, VII, 340, 1927.

[19] Bailey and Sperry, *U. S. Dept. Agric. Technical Bull.*, No. 145, 1929.

## XX

## THE ECONOMIC RELATIONS OF MAMMALS AND BIRDS

It is probable that all mammals that eat flesh of any sort will devour birds when they are hungry, if they have the opportunity. They are of course more destructive to ground-nesting species, but also easily get young birds of tree-nesting species just after they leave the nest and have not yet achieved dexterity on the wing, and occasionally succeed in capturing adult tree-nesting birds that feed upon the ground, such as robins.

Swine eat the eggs of both wild birds and poultry and sometimes kill the birds. In cities and about farms the mammals most destructive to wild birds are domestic cats, many of which, though not usually attempting to catch adult birds, feel an irresistible impulse to spring upon every young bird seen fluttering on the ground in the effort to fly. The domestic dog also sometimes catches wild birds and an occasional well fed individual acquires the habit of killing chickens and turkeys, not for food, but from sheer blood-lust, just as others acquire the sheep-killing habit.

Other members of the cat and dog families (Canidae and Felidae) are definitely known to kill birds and probably all do so to some extent. Audubon and Bachman long ago remarked that the wildcat "makes great havoc among the chickens, turkeys and ducks of the planter."[1] Dixon found that bird remains constituted 3.1 per cent of the contents of 118 wildcat stomachs examined by him.[2] Foxes sometimes kill birds, though their preference is for rodents. In the lair of one were found the remains of 76 short-eared owls (8 adults) and a number of grouse, ducks, plover and curlew, besides rats and voles.[3]

The brown house rat eats wild birds and their eggs and is said to "kill more young chickens than any other animal."[4] Some species of squirrels and chipmunks, especially the red squirrels, are known to kill young birds, but do more damage by eating the eggs of both tree-nesting and ground-nesting species.[5] Muskrats take some wild birds,

[1] Quoted in Howell, *N. Amer. Fauna,* No. 45, p. 42, 1921.
[2] Dixon, *Journ. Mammalogy,* VI, 36-38, 1925.
[3] Fisher, *Yearbook U. S. Dept. Agric. for 1894,* p. 225, citing Adair, *Annals Scottish Nat. Hist.,* Oct., 1893.
[4] Fisher, *Yearbook U. S. Dept. Agric. for 1908,* p. 193.
[5] Thoms, Are squirrels bird enemies? *Bird-Lore,* XXIV, 206-207, 1922. Stoddard,

particularly water and shore-birds and other birds that nest near the water.[6] The ring-tailed cat (*Bassariscus*) also feeds upon birds to some extent.[7] Raccoons and opossums not only prey partly upon wild birds, but also raid the poultry yards.[8] The Indian mongoose, in some regions to which it has been imported, has wrought great damage to ground-nesting wild birds and poultry.[9]

Skunks eat some wild birds and their eggs and occasionally poultry, though their food is chiefly insects and partly rodents.[10] Of 353 stomachs examined under the direction of Dixon, only 27 contained bird remains.[11] Lantz says that of 62 stomachs only one contained bird remains, consisting of a few feathers.[12] Minks and weasels kill some wild birds and rob their nests and are very destructive to poultry when they have a chance, killing more than they can possibly use, but in other ways probably do more good than harm. The mink is particularly injurious to ducks and marsh birds.[13] Though the land otter lives chiefly on fish, one stomach contained the head of a mallard.[14] The fisher sometimes kills wild birds.[15] The badger occasionally takes poultry[16] and one was detected digging into bank swallows' nests.[17] There are reports of bears searching lake shores for wild ducks' eggs,[18] climbing trees for hawks' eggs[19] and gnawing into a woodpecker's nest.[20] Oriental bats of the genus *Megadermus* feed largely on small birds.[21]

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Flying squirrel as a bird killer, *Journ. Mammalogy*, I, 95-96, 1919. Klugh, Ecology of the red squirrel, *ibid.*, VIII, 1-32, 1927. Bailey, *N. Amer. Fauna*, No. 49, pp. 46-55, 1926; *Journ. Mammalogy*, IV, 129, 1923. There are very numerous other references on this subject. Warren, *Mammals of Colorado*, p. 168, 1910. Howell, *N. Amer. Fauna*, No. 52, pp. 9-11, 1929.

[6] Johnson, The muskrat: Its natural history and economics, *Roosevelt Wild Life Bull.*, III, 205-320, 1925.

[7] Bailey, *Animal life of Carlsbad Cavern*, p. 105, 1928.

[8] Howell, *N. Amer. Fauna*, No. 45, pp. 18, 35, 1921. Bailey, *ibid.*, No. 49, p. 187, 1926. Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Nat. Resources*, p. 451, 1909.

[9] Wetmore, *U. S. Dept. Agric. Bull.* No. 326, pp. 38, 67, etc., 1916. Palmer, *Yearbook, U. S. Dept. Agric. for 1898*, pp. 87-100. *Amer. Naturalist*, XVII, 299, 1883. Morris, *The mongoose on sugar estates in the West Indies*, 1883.

[10] Bailey, *N. Amer. Fauna*, No. 49, p. 181, 1926.

[11] Dixon, *Journ. Mammalogy*, VI, 34-46, 1925.

[12] Lantz, *Farmers' Bull.*, No. 587, 1914.

[13] Bailey, *Farmers' Bull.*, No. 335, p. 30, 1908; *N. Amer. Fauna*, No. 49, p. 173, 1926. Howell, *N. Amer. Fauna*, No. 45, pp. 35, 37, 1921. Fisher, *Yearbook U. S. Dept. Agric. for 1908*, p. 190. Ashbrook, *U. S. Biol. Surv. Leaflet* No. 8, 1928.

[14] Merriam, *N. Amer. Fauna*, No. 5, p. 82, 1891.

[15] Bailey, *N. Amer. Fauna*, No. 49, p. 177, 1926.

[16] Bailey, *N. Amer. Fauna*, No. 49, p. 184, 1926; *Farmers' Bull.*, No. 335, p. 29, 1908.

[17] Potter, Badger digs for bank swallows, *The Condor*, XXVI, 191, 1924.

[18] Rowen, Bears and birds' eggs, *The Condor*, XXX, 246, 1928.

[19] Taverner, Bears and hawks, *The Condor*, XXX, 157, 1928.

[20] Dixon, Black bear tries to gnaw into a woodpecker's nest, *The Condor*, XXIX, 271-272, 1927.

[21] Poulton, *Proc. Zool. Soc. London for 1929*, p. 300.

Having seen that the Felidae, Canidae, many of the Mustelidae, Rodentia and other mammals indulge more or less in the destruction of birds, we find that, on the other hand, many birds are persistent destroyers of mammals. This subject has been very much discussed in the literature of economic ornithology and elsewhere.[22] Eagles and the larger hawks and owls destroy many rabbits, squirrels, prairie-dogs, gophers and other rodents, eagles even attacking coyotes, badgers, antelope, wild sheep, wild goats, deer and domestic stock, while many hawks and owls live largely upon mice and other small injurious rodents. Of the hawks and owls, fifteen species in the United States are listed as enemies of ground squirrels, five as enemies of pocket gophers, seventeen as enemies of rabbits and eleven as enemies of brown house rats.[23]

In 571 pellets of the barn owl there were remains of 1131 meadow mice, 240 white-footed mice, 153 harvest mice, 85 pocket gophers and a number of other small mammals.[24] Another lot of pellets contained one shrew, 84 pocket gophers, 4 pocket mice, 26 harvest mice, 52 white-footed mice, 276 meadow mice, 2 house rats, 37 house mice, 2 rabbits, 1 song sparrow and 3 Jerusalem crickets.[25]

Besides the so-called birds of prey, gulls, ibises, storks, spoonbills, cranes, herons, ravens, crows, magpies, jays, shrikes and many other species of birds destroy multitudes of mice and other small mammals. One species of hawk in Africa is especially adapted to feeding upon bats and is consequently called the bat hawk.[26]

[22] See Henderson, *The practical value of birds,* pp. 76-78, 189-204, etc., 1927, with numerous references to other publications in footnotes.

[23] Grinnell, G. B., Eagles' prey, *Journ., Mammalogy,* x, 183, 1929. Fisher, The hawks and owls of the United States in relation to agriculture, *U. S. Div. Orn. and Mamm. Bull.* No. 3, 1893; *Yearbook U. S. Dept. Agric. for 1907,* pp. 329-342; *ibid.* for 1894, pp. 219-225. Oberholser, The North American eagles and their economic relations, *U. S. Biol. Surv., Bull. No. 27,* 1906. Bailey, *U. S. Div. Orn. and Mamm. Bull.* No. 4, 1893; *ibid.,* No. 5, 1894; *Animal life of Carlsbad Cavern,* pp. 76-92, 141-147, 1928. Piper, *Yearbook U. S. Dept. Agric. for 1908,* pp. 301-310; *Farmers' Bull.,* No. 352, 1909. Lantz, *Yearbook for 1905,* pp. 363-376; same for 1909, pp. 209-218; *U. S. Biol. Surv.,* Bull. No. 31, 1907; *ibid.,* No. 33, 1909; *Farmers' Bull.,* No. 896, 1917.

[24] Foster, A note on the dietary habits of the barn owl, *The Condor,* xxix, 246, 1927.

[25] Hall, The barn owl in its relation to the rodent population at Berkeley, California, *The Condor,* xxix, 274, 1927.

[26] *Bull. Amer. Mus. Nat. Hist.,* xxxvii, 551-552, 1917.

# XXI

# THE ECONOMIC RELATION OF MAMMALS TO FISHES, REPTILES AND AMPHIBIANS

Many mammals are fond of fish, which constitute a large part of the diet of a few species. Perhaps all flesh-eaters will take fish, if available when they are hungry. As would be expected, marine mammals, specially adapted to a strictly or partly aquatic existence, feed partly upon fish, though it is very doubtful whether all the fish taken by the strictly aquatic forms, such as whales and porpoises, which wander freely far and wide through the ocean, has an appreciable effect upon the total number of fishes, if, indeed, the activity of the semi-aquatic forms, such as seals and sea-lions has. The diminished supply of fishes must be attributed chiefly to the fishing activities of commercial fishermen, who, with their nets and traps, catch fish annually by the million.

All the species of seals and sea-lions are accused by fishermen of feeding chiefly upon fish, and of being very destructive to the marine fisheries, their plea being sometimes for the complete extermination of these animals. Most of the published statements to this effect are vague, general and inclusive, without indicating any evidence upon which they are based. On the other hand, in many cases actual examination of the contents of the stomachs of individuals killed by the fishermen has failed to disclose any fish remains therein. However, there is some very definite evidence that they do sometimes eat fish. This is especially true during the short season of the salmon run, when the fish are entering the rivers in great schools to spawn, affording for the time being an abundant supply of easily-obtained food—the very time when the fishermen are catching as many as possible, thus preventing them from going up the rivers, which they must do to spawn. The evidence and the reasons for believing the seals and sea-lions on the whole are not a serious menace to the fisheries are set forth and discussed at some length under the order Pinnipedia in the systematic portion of this book, and need not be repeated here.

As it is customary for all animals of mixed diet to take the suitable food most easily obtained, when whales happen upon schools of fishes they will abandon the search for the less easily obtained crustaceans and mollusks and devote their attention for a time to fish. One humpbacked whale contained about a ton of sardines, with some smelt and anchovies, and a sperm whale contained a ten-foot shark.[1] As a general rule, fishes taken by whales are of small, abundant species, whose commercial value is not very high. We have not happened upon very definite information concerning the food habits of other cetaceans, though probably it exists somewhere in the much-scattered literature of mammalogy. Various writers do say in a very general way that the porpoises and dolphins feed chiefly upon fish, though the Risso dolphin is said probably to subsist upon squid and cuttlefish.[2] Porpoises may often be seen following ships and eating the waste food thrown overboard.

Several species of fur-bearers (Mustelidae) are very fond of fish and enter water after them, and fish is extensively and successfully used for bait by trappers. The land otter is said to live chiefly upon fish, but also to take frogs, etc.[3] Coues says that the sea otter undoubtedly eats fish, though its diet is chiefly mollusks and sea-urchins.[4] The mink is very fond of fish and haunts the banks of streams and lakes, taking also reptiles and amphibians, with other food.[5] The diet of the pine marten is similar to that of the mink, but the Pennant marten, or "fisher," notwithstanding its name, does not habitually fish, though it takes fish as bait in traps.[6]

Raccoons and muskrats are known to sometimes eat fish and frogs, and the latter also eat caddis larvae and other food of fishes, thus to a slight degree affecting the fish fauna.[7] La Valette mentions the aquatic shrew, weasel, polecat, domestic cat, otter and bear as enemies of fish.[8] Haack says that shrew-mice ("wasserspitzmausen") in brooks are "well-known enemies of fish."[9]

[1] Evermann, *Scientific Monthly,* xv, 309-310, 1922.

[2] Aflalo, *Nature Lovers' Library,* v, 299, 1917; *Standard natural history,* II, 335, 1908. Hornaday, *American natural history,* II, 154, 1914. Stone and Cram, *American animals,* p. 21, 1902.

[3] Merriam, *N. Amer. Fauna,* No. 5, p. 82, 1891. Bailey, *N. Amer. Fauna,* No. 49, p. 179, 1912. Audubon, as quoted by Coues, *N. Amer. Mustelidae,* p. 315, 1877.

[4] Coues, *N. Amer. Mustelidae,* p. 345, 1877.

[5] Howell, *N. Amer. Fauna,* No. 45, p. 37, 1921. Bailey, *N. Amer. Fauna,* No. 49, p. 173, 1926. Ashbrook, Mink raising, *U. S. Biol. Surv. Leaflet* No. 8, 1928.

[6] Coues, *N. Amer. Mustelidae,* pp. 66-68, 92, 1877. Bailey, *N. Amer. Fauna,* No. 49, p. 177, 1926.

[7] Lantz, The muskrat, *U. S. Biol. Surv. Bull.* No. 396, p. 21, 1910. Annin, Carpenter, Elliott and Hessel. *Bull. U. S. Bureau of Fisheries,* IV, 85-86, 295-298, 470, 579-584, 1884. Sturr, *Bull. Bur. Fish.,* v, 342, 1885. Johnson, *Roosevelt Wild Life Bull.,* III, 247, 1925. Howell, *N. Amer. Fauna,* No. 45, p. 35, 1921. Bailey, *N. Amer. Fauna,* No. 49, p. 187, 1926.

[8] La Valette, The enemies of fish, *Rept. U. S. Fish Comm. for 1878,* pp. 509-516.

[9] Haack, *Bull. U. S. Fish Comm.,* IV, 375-376, 1884.

During the salmon run in Alaskan rivers bears gorge themselves with fish.[10] Dogs also eat spawning salmon in streams of the Northwest and contract the "salmon disease," an intestinal trematode disease, the salmon from salt water not thus affecting them.[11] The domestic cat sometimes catches fish close to shore in shallow water.[12] Wildcats eat both fish and frogs, and in 118 stomachs 6 per cent of the contents consisted of fish, probably bait used in the traps.[13] Coyotes sometimes eat both fish and reptiles, three horned lizards having been found in one stomach.[14] The name of the South American rat genus *Ichthyomys*[15] seems to have been derived from its fish-eating proclivity. There is one genus of fish-eating bats (*Noctilio*) in the Caribbean region, some stomachs examined containing fish exclusively.[16] Several instances are mentioned of deer eating fish,[17] a habit perhaps acquired through the eating of refuse about camps.

Beaver, though semi-aquatic, are vegetarians and do not indulge very much, if at all, in a fish diet. However, they do affect the fish population of beaver streams in other important ways. Their dams form quiet pools, ponds and lakes whose somewhat complex effect upon fishes has been partly investigated and much discussed. There seems good reason for the belief that in regions where the summer temperature of the water is high and the flooded areas contain much vegetation that decomposes in the ponds, they may be decidedly detrimental to fish life, especially for some time after the ponds are freshly formed. In rapid streams of high, cool mountain areas, beaver ponds are often very beneficial to fishes, affording protection to young trout and equalizing the flow of water, keeping the streams running during dry seasons. Often in such regions the old, well-established beaver pools afford the best fishing.[18]

Though many mammals, as we have seen, eat fish, many species of

[10] Osgood, *N. Amer. Fauna,* No. 24, p. 43, 1904.
[11] Donham, *Science,* LXI, 341, 1925.
[12] Dimmock, *Amer. Naturalist,* XVIII, 941-943, 1884.
[13] Dixon, *Journ. Mammalogy,* VI, 36-38, 1925. Howell, *N. Amer. Fauna,* No. 45, p. 42, 1921.
[14] Lantz, *U. S. Biol. Surv. Bull.* No. 20, 1905.
[15] Thomas, On a new fish-eating rat from Bogota, *Ann. and Mag. Nat. Hist.,* Ser. 9, XIII, 164, 1924; A new fish-eating rat from Equador, *ibid.,* p. 541; *Journ. Mammalogy,* V, 215, 1924.
[16] Goodwin, *Journ. Mammalogy,* IX, 104-112, 1928. Benedict, *Journ. Mammalogy,* IX, 58-59, 1928.
[17] Burgess, *Journ. Mammalogy,* V, 64-65, 1924.
[18] Bailey, *U. S. Dept. Agric. Tech. Bull.* No. 21, 1927 (replacing Dept. Bull. No. 1078, 1922). Dearborn, *U. S. Dept. Agric. Circular* No. 135, p. 10, 1920. Kendall, *Roosevelt Wild Life Bull.,* II, 205-351, 1924; IV, 286-491, 1927. Knight, *Science,* LXII, 590-591, 1925; LXIII, 209-210, 1926.

fish eat the flesh of mammals. Indeed, fisherman often use mammal meat for bait. Fishes often catch small mammals along the edge of the water or in it. Cabot tells us that during a season of overabundance of mice in Labrador the trout fed chiefly upon mice and acquired a mousy flavor, all trout over half a pound in weight then containing mice.[19] White-footed mice are part of the usual food of Kern River trout in California. "Scarcely one of the trout was taken that one or more of these mice was not found in its stomach, while from one fish of unusual size no fewer than five were taken."[20] Pickerel, gar-pike and perhaps other fishes catch young muskrats as they are swimming in the water.[21] Schools of small fishes of the genus *Serrosalmo* in tropical America even attack men in the water and inflict serious injuries.[22] It is said that sometimes they almost literally eat men alive, as they do any other mammal that enters or falls into the water when they are about. The larger sharks, individuals of which are sometimes called man-eaters, are formidable antagonists, feared by swimmers and divers.

We have noted that the mink, otter and coyote eat reptiles and frogs, but other mammals do also. The European hedgehog eats frogs, toads and snakes, as well as birds, mice and various invertebrates.[23] Solitary instances are reported of a salamander, a frog and a snake having been eaten by chipmunks.[24] Lizards and salamanders are known to have been eaten by grasshopper mice.[25] A muskrat was observed catching a salamander.[26] Rattlesnakes have been killed by brown house rats and bush rats.[27] A mouse is reported to have attacked and eaten lizards in captivity.[28] A white-footed mouse in captivity killed and partly ate a snake large enough to have eaten the mouse.[29] True, these two instances occurred in captivity, under artificial conditions, and do not prove that under natural conditions mice would attack either snakes or lizards.

Reptiles are better known as the enemies of mammals than as the

[19] Cabot, *Labrador,* 1921. Allen, *Journ. Mammalogy,* III, 56, 1922.
[20] Henshaw, *Rept. Chief of U. S. Engineers,* 1876, Part 3, p. 529.
[21] Lantz, *Farmers' Bull.,* No. 396, p. 35, 1910. Arthur, *Louisiana Dept. Conservation Bull.* No. 18, p. 174, 1928.
[22] Jordan, *Guide to the study of fishes,* II, 161, 1905.
[23] Ingersoll, *The life of animals,* pp. 68-77, 1907.
[24] Howell, *N. Amer. Fauna,* No. 52, pp. 9-11, 1929.
[25] Bailey, *N. Amer. Fauna,* No. 25, pp. 93-94, 1915. Bailey and Sperry, *U. S. Dept. Agric. Technical Bull.,* No. 145, 1929.
[26] Warren, *Mammals of Colorado,* p. 106, 1910.
[27] Hartman, *Journ. Mammalogy,* III, 116-117, 1922.
[28] Burt, A note on the mouse as an enemy to lizards, *Copeia,* No. 162, pp. 15-16, 1927.
[29] Hatt, *Journ. Mammalogy,* IV, 186-187, 1923.

victims. Many well-known species of snakes habitually eat mice, and the bull snake is often called the gopher snake, because of its fondness for gophers. The rodent-eating snakes doubtless do some good in this way, but their digestion is slow, they require little food and often go for long periods without food, so the total number of rodents eaten by one snake in a year is probably not large.[30] However, experiments with captive snakes indicate that a bull snake would be able to consume one pocket gopher a month. In Kansas it was estimated that a moderate infestation of an alfalfa field would be about eight gophers an acre. Consequently one snake would be able to keep an acre of ground free from gophers.[31] As mice are much smaller, the snakes could of course consume a much larger number of them. The senior author of this book once found three full-grown field mice in one small gartersnake. One bull snake contained thirty-five mice,[32] mostly young, and another contained four full-grown gophers.[33] Many young muskrats are eaten by snakes.[34] Snakes eat their prey by swallowing the creatures whole, instead of biting off pieces and chewing them. They will take almost any animal not too large to be swallowed, which, in case of a boa constrictor or python, means a rather large animal.

Morse has described the way a bull snake captures a gopher.[35] The rattlesnake is listed as one of the enemies of ground squirrels[36] and one contained a wood rat.[37] A python attacked a spaniel,[38] another swallowed a 70-pound buck,[39] and a cobra killed a tiger.[40] Poisonous snakes are well known as a menace to human beings as well as to other mammals. In British India in 1910 there were 22,478 deaths of human beings and in 1909 there were 21,364 because of snake bites.[41] In 1895 only 1646 persons were reported killed by venomous snakes[42] but statistics were much less complete then than now.

Alligators and crocodiles will kill almost any small mammal up to

[30] Burnett, *Office Colorado State Entom. Circular* No. 18, 1916.

[31] Hisaw and Gloyd, The bull snake as a natural enemy of injurious rodents, *Journ. Mammalogy,* VII, 200-205, 1926.

[32] Pack, *Copeia,* No. 68, p. 16, 1918.

[33] Ruthling, *Copeia,* No. 37, p. 91, 1916.

[34] Arthur, *Louisiana Dept. Conservation, Bull.* No. 18, p. 269, 1928.

[35] Morse, The way of a snake with a gopher, *Copeia,* No. 164, pp. 71-72, 1927.

[36] Merriam, *U. S. Biol. Surv. Circular* No. 76, p. 7, 1910.

[37] Mearns, *U. S. Natl. Museum Bull.* No. 56, p. 479, 1907.

[38] Smith, Python attacking a spaniel, *Journ. Bombay Nat. Hist. Soc.,* XXX, 485, 1925; *Journ. Mammalogy,* VIII, 325, 1927.

[39] Holland, Pythons and their prey, *The Field* (London), CL, 395, 1927; *Journ. Mammalogy,* IX, 81, 1928.

[40] Spence, Sanderson and Prater, Tiger killed by a cobra, *Journ. Bombay Nat. Hist. Soc.,* XXX, 705, 1925.

[41] *Science,* XXXVII, 938, 1913.

[42] *Amer. Naturalist,* XXXI, 77-78, 1897.

the size of pigs and young calves, and are often very dangerous to men. A Florida alligator seized a 50-pound dog, crunched its bones and swallowed it whole. The dangerous "man-eating" crocodiles live in Africa and India, where "old examples will rush from the water, seize a human—adult or child—then drag the prey into the water to drown."[43] In 1910, 244 deaths of human beings in India were caused by alligators and crocodiles.[44] In Louisiana alligators are considered by trappers great enemies of muskrats, but forty-four stomachs were examined and "not a trace of muskrat was found in any of them,"[45] possibly because in Louisiana, owing to the menace of alligators, the muskrats have developed more terrestrial habits than in most regions.

Two bats were found in one black snake, and four shed skins found in the bat roost indicated the reason that the number of bats had diminished by over 50 per cent in one year.[46]

A full-grown mole was found in the stomach of a 14-ounce frog.[47]

[43] Ditmar, *The reptile book,* p. 89, 1907; *Reptiles of the world,* pp. 65, 67, 78-81, 1910.

[44] *Science,* XXXVII, 938, 1913.

[45] Arthur, The fur animals of Louisiana, *Louisiana Dept. Conserv. Bull.* No. 18, p. 164, 1928.

[46] Silver, Pilot black snake feeding on the big brown bat, *Journ. Mammalogy,* IX, 149, 1928.

[47] Heller, Brewer's mole as food of the bullfrog, *Copeia,* No. 165, p. 116, 1927.

## XXII

## THE ECONOMIC RELATION OF MAMMALS TO INSECTS

Some groups of mammals almost deserve to rank with insectivorous birds as insect destroyers, helping to keep the insect hordes within reasonable bounds. This is particularly true of the Insectivora (moles and shrews) and Edentata (anteaters and armadillos), which destroy insects that live on and beneath the ground, and the Chiroptera (bats), which feed upon the flying insects, though many other mammals are also highly insectivorous and others take some insects.

The food of the bats of the United States and Great Britain consists almost exclusively of nocturnal flying insects of many kinds, thus supplementing the work of insectivorous birds, which live chiefly upon diurnal insects. The total amount of insect life annually destroyed by these flying mammals is enormous. Stomachs of bats shot in the early evening, after only twenty minutes of flight, have been found packed with insects, and they probably take several such meals each twenty-four hours. Great deposits of bat guano in caverns are composed of insect remains.[1] "Bat towers" have been erected in Texas for the purpose of controlling mosquitoes and accumulating commercial deposits of guano, but though the bats doubtless take some mosquitoes, they by no means take as many of these pests as some people suppose. Mosquito remains are not conspicuous in the guano from either the towers or caves, and in most regions bat towers would not produce enough guano to pay for their erection.[2] Nevertheless, it is significant that, according to Fargo, on Bird Key, Florida, there are bats and no mosquitoes, while on neighboring keys there are mosquitoes and no bats,[3] unless the presence and absence of mosquito-eating birds may

[1] Bailey, *Farmers' Bull.*, No. 335, p. 31, 1908; Bats of Carlsbad Cavern, *Natl. Geog. Mag.*, XLVIII, 321-330, 1925; *Animal life of Carlsbad Cavern*, pp. 108-129, 1928. Nelson, *U. S. Dept. Agric. Bull.* No. 1395, 1926. Huey, *Journ. Mammalogy*, VI, 196-197, 1925. Hatt, *ibid.*, IV, 260-261, 1923. Seton, *ibid.*, III, 52, 1922. Pittman, *ibid.*, V, 231-233, 1924. Goodwin, *ibid.*, IX, 104-112, 1928. Grinnell, *California Fish and Game Comm. Teachers' Bull.*, No. 6, 1916. Poulton, British insectivorous bats and their prey, *Proc. Zool. Soc. London for 1929*, pp. 277-303.

[2] Campbell, *Bats, mosquitoes and dollars*, 1925. Storer, *Journ. Mammalogy*, VII, 85-90, 1926; *Science*, LXIII, 337-338, 1928. McAtee, *Ann. Rept. Smithsonian Inst. for 1925*, p. 416. Goldman, *Journ. Mammalogy*, VII, 136-138, 1926. Hall, *California Fish and Game*, XII, 136-137, 1926.

[3] Fargo, *Journ. Mammalogy*, X, 203-205, 1929.

account for the phenomenon. We may add that bats do not harbor bedbugs, as they are popularly supposed to do.

While the bats are busy ridding the air of insects, most species of moles and shrews are battling the insects that swarm upon and beneath the ground. They get a great many ants, wireworms, cutworms, white grubs and other destructive insects, thus doing much more good than harm.[4] The short-tailed shrew is one of the principal enemies of the larch sawfly in New Brunswick, destroying 40 per cent of the cocoons.[5] One captive shrew ate from four to seven large meal worms a day.[6] The hedgehog of Europe, related to the shrews and moles, eats many insects, but also takes other invertebrates and vertebrates.[7]

A captive mole in ten hours ate 7 cutworms and 48 earthworms.[8] Another captive in twenty-four hours devoured 50 large white grubs, 45 rosebug larvae, 1 cicada, 1 "chestnut worm," 1 wireworm and 13 earthworms.[9] However, it should be remembered that experiments upon animals in captivity are not at all conclusive as to habits under natural conditions. Moles are known to destroy both eggs and nests of wasps.[10] Of the food of 56 moles, 62 per cent was insects.[11] The principal food in 200 stomachs of the common mole was earthworms and white grubs, one containing 171 white grubs and another 250 ant pupae.[12] In 34 stomachs, 23 per cent of the contents was adult insects and 29 per cent insect larvae.[13] In 67 stomachs, 42.25 per cent of the contents was earthworms, 22.7 per cent ground beetles, 27 per cent grubs and larvae, 3.7 per cent vegetable matter.[14]

The armadillo of the southern United States is a "voracious consumer of insects, especially white grubs and their adults, caterpillars and ants."[15] The giant armadillo of the Amazon is said to live mainly on ants and termites and the giant anteater of Brazil lives wholly on ants.[16] The African antbear "lives entirely on termites."[17] The spiny

[4] Dunnam, *Iowa State Agric. Exper. Sta. Circular* No. 88, 1924. Wight, *Journ. Mammalogy,* IX, 19-33, 1928. Bailey, *N. Amer. Fauna,* No. 49, pp. 200, 203, 205, 1926. Howell, *ibid.,* No. 45, pp. 20-21, 1921. Klugh, *Journ. Mammalogy,* II, 35, 1921.

[5] McAtee, *Ann. Rept. Smithsonian Inst. for 1925,* p. 416.

[6] Dixon, *Journ. Mammalogy,* V, 1-6, 1924.

[7] Ingersoll, *The life of animals,* pp. 68-77, 1907.

[8] Howell, *Journ. Mammalogy,* IV, 253, 1923.

[9] Brooks, *Univ. West Virginia Agric. Exper. Sta. Bull.* No. 113, 1908.

[10] Brooks, *Journ. Mammalogy,* IV, 183, 1923.

[11] West, *Bull. Illinois State Lab. Nat. Hist.,* IX, 1910.

[12] Scheffer, *Farmers' Bull.,* No. 1247, 1922.

[13] Hisaw, *Journ. Mammalogy,* IV, 9-20, 1923.

[14] Dyche, *Trans. Kansas Acad. Sci.,* XVIII, 183-186, 1903.

[15] McAtee, *Ann. Rept. Smithsonian Inst. for 1925,* p. 416.

[16] Ingersoll, *The life of animals,* pp. 469, 476-477, 1907.

[17] Drake-Brockman, *The mammals of Somaliland,* p. 175, 1910.

anteater of Australia, whose diet is suggested by its name, is a member of the Monotremata, not the Edentata. The Australian duckbill, another monotreme, also feeds upon insects, with other invertebrates. The banded anteater of Australia is a marsupial. The American opossum, another member of the Marsupialia, includes insects in its bill of fare,[18] and the South American marsupialian, *Caenolestes,* lives chiefly upon insects.[19] Some of the Australasian phalangers feed partly upon insects.[19a]

Some species of Mustelidae (fur-bearers), such as the badger,[20] pine-marten,[21] mink[22] and weasel,[23] eat insects to some extent. Skunks are particularly insectivorous, especially useful in the destruction of grasshoppers, crickets and white grubs.[24] The contents of ten skunk stomachs examined by Dixon averaged 26.3 per cent insects, mostly injurious species, and of 353 examined by others under his direction, 207 contained insects.[25] Of 62 stomachs, grasshoppers and crickets formed a large percentage of the food in half of them, while beetles and their larvae were found in two-thirds of them, in many cases being the only food.[26] The "largest part of the food of skunks consists of grasshoppers, beetles, crickets and other insects and insect larvae."[27] In Manitoba it was estimated that on an 8-acre tract skunks destroyed 14,520 white grubs to the acre, and they have elsewhere proved active enemies of cutworms, army worms, tobacco worms, potato beetles, grasshoppers, hop grubs, range caterpillars and many other harmful insects.[28] Plath considers skunks to be quite destructive to both wild bees and honeybees.[29]

[18] Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Nat. Res.,* p. 451, 1909.
[19] Gregory, *Journ. Mammalogy,* III,. 106-114, 1922.
[19a] Ingersoll, *The life of animals,* pp. 495, 500-504, 1907.
[20] Merriam, *N. Amer. Fauna,* No. 5, p. 85, 1891. McAtee, *Ann. Rept. Smithsonian Inst. for 1925,* p. 416. Bailey, *Farmers' Bull.,* No. 335, p. 27, 1908.
[21] Coues, *N. Amer. Mustelidae,* p. 92, 1877. Bailey, *N. Amer. Fauna,* No. 49, p. 176, 1926.
[22] Ashbrook, Mink farming, *U. S. Biol. Surv. Leaflet* No. 8, 1928.
[23] Howell, *N. Amer. Fauna,* No. 45, p. 35, 1921. Stone and Cram, *American animals,* pp. 236-237, 1902.
[24] Dearborn, *U. S. Dept. Agric. Circular* No. 135, p. 11, 1920. Cuyler, *Journ. Mammalogy,* V, 181-189, 1924. Bailey, *Farmers' Bull.,* No. 335, p. 28, 1908. Howell, *N. Amer. Fauna,* No. 45, 1921.
[25] Dixon, *Journ. Mammalogy,* VI, 34-46, 1925.
[26] Lantz, Economic value of North American skunks, *Farmers' Bull.,* No. 587, 1914.
[27] Bailey, *N. Amer. Fauna,* No. 49, p. 181, 1926.
[28] McAtee, The rôle of vertebrates in the control of insect pests, *Ann. Rept. Smithsonian Inst. for 1925,* pp. 415-437.
[29] Plath, The bee-eating proclivity of the skunk, *Amer. Naturalist,* LVII, 570-574, 1923.

Many of the Rodentia include insects in their diet,[30] some species to a marked degree. Along the foothills in Colorado the striped ground squirrel is said to "feed upon grasshoppers and other injurious insects, almost to the exclusion of all other food."[31] Of 46 stomachs, 13 were nearly or quite full of insects and 15 contained none.[32] Of 22 Iowa stomachs, 46 per cent of the contents was insects, almost exclusively injurious species,[33] while in 15 South Dakota stomachs a larger percentage of the insect contents consisted of harmless or useful species.[34] Of the contents of Franklin and Richardson ground squirrel stomachs, 50 per cent consisted of insects, according to Bailey's report of 1892, but later reports do not seem so favorable, possibly due to different conditions.[35] Of 35 stomachs of the chestnut-tailed squirrel of Utah (*Callospermophilus castanurus*), 25 contained grasshoppers, beetles, flies and larvae.[36] "Arboreal squirrels sometimes feed freely on scale insects and other tree pests."[37] Gray squirrels are reported as having destroyed oak apple galls.[38] Red squirrels are known to eat many insects,[39] as probably all the other species do.

Some of the wild mice are very much more highly insectivorous than is generally supposed. In Michigan, of 4519 open cocoons of the larch sawfly, more than 60 per cent had been opened by mice and only a very small percentage had been parasitized by insect enemies or attacked by fungi.[40] Much of the food of grasshopper mice consists of soft-bodied insects such as grasshoppers and crickets, and the name "scorpion mice" is sometimes applied to them because of their fondness for scorpions.[41] The food of the harvest mice resembles that of the

[30] Klugh, *Journ. Mammalogy,* VIII, 1-32, 1927. Howell, *N. Amer. Fauna,* No. 45, p. 62, 1921.

[31] Burnett, *Office Colorado State Entom. Circular* No. 18, p. 6, 1916. See also Bailey, *N. Amer. Fauna,* No. 49, p. 52, 1926; *U. S. Div. Orn. and Mam. Bull.* No. 4, 1893. Hisaw and Emery, *Journ. Mammalogy,* VIII, 41-44, 1927.

[32] Burnett, *Office Colorado State Entom. Circular* No. 14, 1914.

[33] Gillette, *Iowa Agric. Exper. Sta. Bull.* No. 6, 1888.

[34] Aldrich, *South Dakota Agric. Exper. Sta. Bull.* No. 30, 1892.

[35] Bailey, *Ann. Rept. U. S. Dept. Agric. for 1892,* pp. 185-192; *N. Amer. Fauna,* No. 49, pp. 55, 59, 1926.

[36] Merriam, *N. Amer. Fauna,* No. 4, p. 19, 1890.

[37] McAtee, *Ann. Rept. Smithsonian Inst. for 1925,* p. 416.

[38] Davis, Oak apple galls destroyed by gray squirrels, *Bull. Brooklyn Entom. Soc.,* XIX, 91-93, 1924. *Journ. Mammalogy,* V, 274, 1924.

[39] Hatt, *Roosevelt Wild Life Bull.,* II, 109-110, 1929. See also Insects as the food of squirrels, *Canadian Entomologist,* XXXIX, No. 1, p. 16, 1907.

[40] Graham, The larch sawfly as an indicator of mouse abundance, *Journ. Mammalogy,* X, 189-196, 1929.

[41] Cary, *N. Amer. Fauna,* No. 33, 1911. Merriam, *ibid.,* No. 3, 1890. Bailey, *ibid.,* No. 49, p. 81, 1926; *Farmers' Bull.,* No. 335, p. 13, 1908; *Animal life of Carlsbad Cavern,* 1928. Burnett, *Office Colo. State Entom. Circular* No. 25, p. 7, 1918. Bailey and Sperry, *U. S. Dept. Agric. Technical Bull.* No. 145, 1929.

grasshopper mice.[42] The pocket mice destroy some grasshoppers,[43] and these insects were found in stomachs of an Arizona form of white-footed mouse.[44]

Bears are very fond of insects, and may be seen tearing open nests of bees, wasps and other insects and turning over logs in search of beetles, ants and larvae. Stomachs have been found filled with May-flies and shad-flies.[45] Coyotes often eat locusts and other insects.[46] Foxes on Santa Cruz Island were found to be feeding principally on insects.[47] One badger's stomach contained bumblebees and their honeycomb.[48] Woodchucks have been known to eat quantities of June beetles.[49] Cottontail rabbits are reported to eat cocoons of cecropia moths.[50] The house cat, ring-tailed cat, jackal, aardwolf, lemur, and various species of monkeys are known to sometimes eat insects.[51] The skunk, raccoon, mole, coyote, fox, opossum, ground squirrel, short-tailed shrew, badger and domestic pig are all listed as enemies of the troublesome white grubs.[52]

The mammalian enemies of ants have been discussed at some length by Bequaert, especially certain species of monotremes, marsupials, edentates, mongooses, bears and chimpanzees,[53] but he does not mention the smaller Rodentia, Mustelidae and other well-known insect eaters, which perhaps do not relish ants particularly.

The best summary we have seen of the economic relations of mammals to insects is that of McAtee, as follows:[54]

> Among mammals we have some highly insectivorous groups, as the bats, shrews and moles. The exact nature of the food of bats is little known, but it includes all sorts of flying insects of sizes these animals can swallow, including mosquitoes, but the latter certainly to no such extent as has sometimes been

[42] Burnett, *ibid.*, p. 8, 1918.
[43] Bailey, *N. Amer. Fauna,* No. 49, p. 119, 1926.
[44] Merriam, *N. Amer. Fauna,* No. 3, p. 64, 1890.
[45] Hewitt, *The conservation of the wild life of Canada,* pp. 108-110, 1921. Bailey, *N. Amer. Fauna,* No. 49, p. 191, 1926.
[46] Hewitt, *ibid.*, p. 225.
[47] Henshaw, *Ann. Rept. Chief of Engineers, U. S. Dept. War, for 1876,* Part 3, p. 526.
[48] Merriam, *N. Amer. Fauna,* No. 5, p. 85, 1891.
[49] Gianini, *Journ. Mammalogy,* VI, 281-282, 1925.
[50] Bird, Cottontail rabbits are insectivorous, *Journ. Mammalogy,* XI, 240, 1930.
[51] Dimmock, *Amer. Naturalist,* XVIII, pp. 941-942, 1884. Bailey, *Animal life in Carlsbad Cavern,* p. 105, 1928. Lantz, *U. S. Biol. Surv. Bull.* No. 20, 1905. Drake-Brockman, *The mammals of Somaliland,* pp. 7, 38, 46, 1910.
[52] Davis, *Bull. Illinois State Lab. Nat. Hist.,* XIII, 53-138, 1919; *Journ. Mammalogy,* I, 44, 1919.
[53] Bequaert, The predacious enemies of ants, *Bull. Amer. Mus. Nat. Hist.,* XLV, 1922; mammalian enemies on pp. 315-331.
[54] McAtee, The rôle of vertebrates in the control of insect pests, *Ann. Rept. Smithsonian Institution for 1925,* pp. 416-417.

claimed. Shrews and moles get numerous ants, wireworms, cutworms and white grubs, and doubtless do more good than harm. The short-tailed shrew has proved to be one of the principal enemies of the larch sawfly and in New Brunswick it has been ascertained that 40 per cent of the cocoons are destroyed by this shrew. Arboreal squirrels sometimes feed freely on scale insects and other tree pests; the western ground squirrels eat quantities of injurious insects, such as cutworms, wireworms and grasshoppers; and the so-called grasshopper mice perhaps deserve their name, and undoubtedly are more highly insectivorous than the majority of their tribe. The armadillo, which occurs in the United States only in Texas, is a voracious consumer of insects, especially white grubs and their adults, caterpillars and ants, and the badger occasionally makes a hearty meal of grasshoppers, immature cicadas, or beetles. Of our larger mammals, skunks certainly are the greatest enemies of insects. Army worms, tobacco worms and white grubs are favorite prey of these animals. In Manitoba, Mr. Norman Criddle, field officer, Canadian Entomological Service, estimated that on one 8-acre tract skunks destroyed 14,520 white grubs to the acre. Cutworms, the potato beetle and grasshoppers are other insect pests eaten by skunks, and the common eastern skunk once proved so efficient an enemy of the hop grub in New York, that the first legislation protecting the animal in that state was passed at the demand of the hop growers. Investigations in New Mexico by the Biological Survey showed skunks also to be most important natural enemies of the range caterpillar."

Not only are many mammals enemies of insects, but some insects are annoying, injurious, and in some cases very destructive to mammals, a subject discussed in Chapter XII, on Diseases and Parasites of Mammals.

## XXIII

# THE ECONOMIC RELATIONS OF MAMMALS TO INVERTEBRATES OTHER THAN INSECTS

Probably most of the mammals that eat insects also indulge in other arthropods, worms and non-shell-bearing mollusks, and some of them take shell-bearing mollusks also. A few examples only need be given. The duckbill of Australia takes crustaceans and worms. Coyotes, wildcats and raccoons have been known to eat crustaceans.[1] A considerable part of the food of moles and some of the food of shrews consists of earthworms.[2] In 306 mole stomachs the contents averaged 72.5 per cent earthworms, with some insects and slugs.[3] In 56 other stomachs the average was 26 per cent earthworms, 1 per cent arachnids.[4] In 91 stomachs earthworms and beetle larvae formed the bulk of the food, with a few millipedes and centipedes.[5] One captive mole ate 48 earthworms and 7 cutworms in 10 hours.[6] One California stomach was "filled with angleworms."[7]

Minks, skunks and otters sometimes eat crustaceans, the mink, at least, including also mussels.[8] Muskrats are especially fond of fresh-water mussels and eat also snails and crustaceans.[9] Rats have been known to eat fresh-water snails of the genus *Lymnaea*.[10] Short-tailed shrews are very fond of land snails, one having eaten 130 *Polygyras* in

[1] Lantz, *U. S. Biol. Surv. Bull.* No. 20, 1905. Howell, *N. Amer. Fauna,* No. 45, pp. 35, 42, 1921.

[2] Hisaw, *Journ. Mammalogy,* IV, 9-20, 1923. Scheffer, *Farmers' Bull.,* No. 1247, 1922. Howell, *N. Amer. Fauna,* No. 45, pp. 20, 21, 1921. Bailey, *ibid.,* No. 49, pp. 200, 205, 1926.

[3] Wight, *Journ. Mammalogy,* IX, 19-33, 1928.

[4] West, *Bull. Illinois State Lab. Nat. Hist.,* IX, 1910.

[5] Dunnam, *Iowa Agric. Exper. Sta. Circular* No. 88, 1924.

[6] Howell, *Journ. Mammalogy,* IV, 253, 1923.

[7] Dirks, *California Fish and Game,* V, 99, 1919.

[8] Howell, *N. Amer. Fauna,* No. 45, p. 37, 1921. Bailey, *ibid.,* No. 49, pp. 173, 179, 1926. Johnson, *Roosevelt Wild Life Bull.,* III, 247, 1925. Lantz, *Farmers' Bull.,* No. 587, 1914. Ashbrook, *U. S. Biol. Surv. Leaflet* No. 8, 1928.

[9] Lantz, The muskrat, *Farmers' Bull.,* No. 396, 1910. Johnson, *Roosevelt Wild Life Bull.,* III, 240, 247, 1925. Howell, *N. Amer. Fauna,* No. 45, p. 35, 1921. Bailey, *N. Amer. Fauna,* No. 49, p. 187, 1926. Lee, *Journ. Trenton Nat. Hist. Soc.,* No. 1, p. 8, 1886. Apgar, *ibid.,* No. 2, pp. 58-59, 1887. Butler, *Amer. Naturalist,* XIX, 1044-1055, 1885. Headlee, *Biol. Bull.,* XI, 305-318, 1906. Baker, *Biol. Bull.,* (2), VII, p. 18, 1922.

[10] Smith, *Limnaea stagnalis* destroyed by rats, *Journ. Conch.,* XVI, 141, 1920.

two months.[11] Squirrels, chipmunks, mice, mongooses, European hedgehogs and rabbits all eat land snails.[12] The food of the sea otter is said to consist of clams, mussels and sea urchins.[13] Opossums eat some crustaceans and mollusks.[14] Seals, walruses and whales consume large quantities of mollusks, crustaceans and other invertebrates.[15] Probably many arachnids, crustaceans and slugs are eaten by various species of mice. The grasshopper mouse becomes the "scorpion mouse" in regions where scorpions are abundant, because of its fondness for the scorpions as part of its diet.[16]

[11] Shull, *Amer. Nat.*, XLI, 495-522, 1907. Hamilton, *Journ. Mammalogy,* XI, 27-30, 33, 1930. Clench, *Nautilus,* XXXIX, 28, 1925. Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Nat. Res.,* for 1908, p. 601, 1909. Babcock, *Science,* XL, 526, 530, 1914.

[12] Elrod, *Univ. Montana Bull.* No. 10, p. 114, 1902; *Nautilus,* XVII, 4, 1903. Van Hyning, *Nautilus,* XVIII, 23, 1904. Bailey, *N. Amer. Fauna,* No. 49, p. 205, 1926. Howell, *N. Amer. Fauna,* No. 45, p. 21, 1921; No. 52, pp. 9-11, 1929. Ingersoll, *The life of animals,* 1907. Pilsbry and Bequaert, *Bull. Amer. Mus. Nat. Hist.,* LIII, 479, 539-540, 1927. Wright, *Journ. Conch.,* XII, 268, 1922. Oldham, *Journ. Conch.,* XVIII, 335, 1929. Lawson, *Journ. Conch.,* XVIII, 327-328, 1929. Taylor, *Monog. land and freshwater Mollusca British Isles,* III, 281.

[13] Elliott, The sea otter and its hunting, *Rept. on Condition of Affairs in the Terr. of Alaska,* Washington, 1875, pp. 54-62. Coues, *N. Amer. Mustelidae,* p. 345, 1877.

[14] Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Nat. Res.,* 1908, p. 451.

[15] Bartlett, *Journ. Mammalogy,* VIII, 207-212, 1927. Dice, *California Fish and Game,* XIV, 1-16, 1928; VIII, 135, 1922. Huey, *Journ. Mammalogy,* V, 237-243, 1924; VI, 126, 1925. Dall. *Ann. Rept. Smithsonian Inst. for 1901,* pp. 687-688. Evermann, *Scientific Monthly,* XV, 309-310, 1922; XVI, 526-527, 1923. Dyche, *Trans. Kansas Acad. Sci.,* XVIII, 179-182, 1902. Merriam, *Science,* XIII, 777-779, 1901.

[16] Merriam, *N. Amer. Fauna,* No. 3, pp. 59, 61, 1890. Cary, *ibid.,* No. 33, p. 100, 1911. Bailey, *Animal life of Carlsbad Cavern,* 1928.

## XXIV

# THE EXTINCTION OF CERTAIN SPECIES OF MAMMALS AND THE APPROACHING EXTINCTION OF OTHERS

Throughout the long geological ages, species, genera, families and orders of plants and animals have developed, flourished and passed away, leaving their recognizable remains in the rocks to tell the story of their former existence. Whole groups of organisms once occupying a prominent position in nature are long since extinct, such, for example, as the trilobites, calamites, lepidodendrons and sigillarias of the Paleozoic Era; the ammonites, dinosaurs, ichthyosaurs, plesiosaurs and pterodactyles of the Mesozoic Era; the gigantic mammals, Dinocerata, of the early Cenozoic Era, and many others. Some groups, once highly important, still exist, but in insignificant numbers as compared with the past, as, for example, the brachiopods.

The Tertiary Age is often called the Age of Mammals. Though primitive forms of mammals appear to have existed very far back in the Mesozoic Era, as shown by small fossil jaws, they did not become at all important until the beginning of Tertiary time. Then they suddenly expanded, spread over most of the earth's surface, and developed a vast assemblage of distinct types, in this respect reaching their zenith and beginning their decline. Before the close of the Tertiary all the higher mammalian types appeared. Many of the groups that flourished during early and middle Tertiary time became extinct before the end of that period. Others dwindled rapidly during the Pleistocene or Glacial Age. Hence the present or "Psychozoic" Epoch presents to us in living form only a remnant of the rich mammalian life of the Tertiary.

Ancestral camels, horses and rhinoceroses roamed the western plains of the United States during Tertiary time, but dwindled away and disappeared before the dawn of the Recent Epoch, their development to modern types having been continued on other continents. During Pleistocene time mammoths, distinct from but closely related to living species of elephants, ranged almost throughout North America and Europe. Their teeth, tusks and bones are especially plentiful in Alaska and Yukon Territory, and even more abundant in the frozen wastes of Siberia, where their flesh has been found intact, frozen in the permanent ice of that inhospitable region. Now the whole group of elephants is entirely extinct over the greater part of its former range. The sloth family, once represented by gigantic ground sloths in portions of the United States, is now represented only by the much smaller tree sloths of South America. These are but a few of the multitude of examples that might be cited to show that mammalian life has long been dwindling, large groups becoming extinct and no new ones developing to replace them. Quite possibly there are just as many species and individuals still living as at any time in the past, but that would be because of the small rodents, such as mice and their allies, of which there are very numerous species and vast hordes of individuals.

Probably under natural conditions of the past the development and extinction of species and higher groups proceeded in a slow and orderly fashion. It is very probable that at no time during the past ages have such faunal changes been wrought within a short time as within the past century or two. This is due to the rapid development and spread of civilization and the rapid increase in human population. A large amount of destruction of wild life was unavoidable, as agriculture and stock-raising on a large scale developed, but much that was unnecessary was made possible by the invention of more efficient modern weapons, placed in the hands of thoughtless and selfish human beings. In ordinary times under natural conditions the mortality of all species of mammals just about balances the birth rate. If the mortality of a species much exceeded the birth rate, it would not long be able to maintain its existence, but would dwindle away to extinction. If the mortality fell very far below the birth rate, in time the species would become so abundant as to be self-destructive through competition for food. Modern man, having stepped in and changed the face of nature by wholesale and widespread agricultural operations and the destruction of forests, and invented deadly, rapid-fire guns, placing all these in the balance on the side of destruction, the larger animals have little chance for survival unless something equally effective be done to even up the balance, and this has not yet been done.

It has been said that man, who complains of the destructiveness of certain species of rodents, is himself the most destructive animal. No other animal has exterminated so many species of other animals or been so generally destructive to nature in its various aspects. Dr. Osborne, in his Foreword to Hornaday's timely book, *Our Vanishing Wild Life,* says, among other things:

We no longer destroy great works of art. They are treasured, and regarded as of priceless value; but we have yet to attain the state of civilization where the destruction of a glorious work of Nature, whether it be a cliff, a forest, or a species of mammal or bird, is regarded with equal abhorrence. . . . Travels through Europe, as well as over a large part of the North American continent, have convinced me that nowhere is Nature being destroyed so rapidly as in the United States. Except within our conservation areas, an earthly Paradise is being turned into an earthly Hades; and it is not savages nor primitive men who are doing this, but men and women who boast of their civilization. Air and water are polluted, rivers and streams serve as sewers and dumping grounds, forests are swept away and fishes are driven from the streams. Many birds are becoming extinct, and certain mammals are on the verge of extermination. Vulgar advertisements hide the landscape, and in all that disfigures the wonderful heritage of the beauty of Nature today, we Americans are in the lead.

All things that minister to the pleasure of the people, relieve the drab monotony of earning a living and inspire in children a love for nature, are well worth while. The animals in zoological parks and the menageries of circuses are a great attraction to both old and young, but many of the animals therein exhibited are approaching extinction and some that were exhibited or to be seen in a wild state within the memory of men now living are already extinct. Others, having now become rare, are doomed, or must be preserved, if at all, by rigid protection in their natural environment, as they will not breed in captivity, and, even if they did so, close inbreeding would weaken and eventually destroy them. "The lovers of nature . . . cannot contemplate such a state of affairs with equanimity. . . . The day when circuses are shorn of their attendant menageries will sensibly diminish the gayety of nations and deprive the youthful of a most cherished source of amusement and instruction" (Dall).

A noble tree that required nature's forces centuries to grow is laid low by the woodman's axe, a perfectly proper procedure if properly done for a proper purpose, but who can replace it, except by the same slow process that brought it into existence? It should not be wasted. Most of the deforestation of our formerly wooded areas has been done in a shockingly wasteful manner. In travelling through some of the logged areas one is appalled at the immense quantities of good logs and timbers left behind to decay on the ground. A species of bird or mammal has required ages for nature to develop and bring to perfection, yet men ruthlessly exterminate them with no thought of the rights of future generations.

Surely no one can object to the use of our forests, streams, fish and game, within reasonable and proper limits, but no one has a right wastefully or needlessly to destroy any of them. A very small percentage of the people hunt, yet the laws concerning game birds and mammals have always been mostly dictated by and their enforcement placed in the hands of the men who hunt. The millions who wish to see deer and other game running wild and do not care to kill any of them, have seldom had a voice in the matter.

It is said that civilized man is more destructive than the savage, but that may be merely because his inventions have increased his powers for destruction, while commerce has provided stronger motives for the exercise of that power. The savage, with simple needs and tastes and with primitive weapons, usually killed only enough to provide him with food, raiment and shelter of very simple sorts. He could use no more, had no market for the surplus, and the exertion of getting game with his primitive weapons was sufficient to deter him. Civilized man, with the arteries of commerce and the development of more luxuriant taste, could easily dispose of his surplus for cash with which to buy the luxuries he craved, and his weapons made it easy for him to obtain a much greater supply of game and furs that he himself could use. Hence the slaughter began.

Nevertheless, savages, as well as enlightened people, have been known, when the lust for blood possessed them, to ruthlessly destroy large numbers of animals, many more than they could in any way dispose of, leaving the carcasses to putrify and foul the air about them. Most of the carnivorous mammals kill only that they may eat, but some individuals kill far beyond their power of disposal. Thus sheep-killing dogs often kill a considerable number of sheep in a single night and eat none. Weasels and minks go on killing sprees and destroy a number of chickens in a single raid. Other examples are not wanting.

Man's destruction of wild life began with the dawn of human life. He sought the flesh of mammals for food, the skins for raiment and later for shelter, the bones and horns for tools, the fat for his crude lamp, the ivory of mammoths for his primitive art. But in a primitive state, when few in numbers, armed with crude weapons, the toll he took was perhaps no greater than that of the sabre-toothed tiger or other large beasts of prey. It was not until the human race had greatly increased in numbers and reached an advanced state of civilization, within the past century or so, that his depredations began to get really serious and to threaten the very existence of many species. In North

America within the past century the bison (buffalo), elk (wapiti), various species and subspecies of deer, woodland caribou, moose, prong-horned antelope, mountain sheep, mountain goat, bear (especially the grizzly), jaguar, puma (mountain lion), beaver and some other species have been entirely exterminated over a very large part of their former range, and the musk-ox is threatened with extinction. The rapid destruction of fur-bearing mammals has led most states at least to enact laws for their protection. The slaughter of birds has been even greater, the passenger pigeon and great auk having been entirely exterminated and the ducks, geese and shore-birds, as well as many species of song birds, greatly reduced from their former abundance.[1] The wild turkey, one of our largest, most handsome and majestic American game birds, once abundant almost throughout the eastern part of the United States, is now extinct over a large part of its former range, and elsewhere much less abundant than formerly. The various species of the grouse family, water-fowl and shore-birds are everywhere greatly reduced in numbers and some species have disappeared from their former haunts in large areas. The following species of American birds have been entirely exterminated since 1840, according to Hornaday: Great auk, Pallas cormorant, passenger pigeon, Eskimo curlew, Cuban tricolored macaw, Gosse's macaw, Guadaloupe macaw, yellow-winged green parrot, purple Guadaloupe parakeet, Carolina parakeet. Does that record increase our pride in our boasted civilization?

All students of the subject agree that the situation as to the most interesting and valuable of our mammals is critical and calls for heroic efforts to save our mammals. The situation in other lands is no better than in America. In Europe various species have disappeared over most of their range and become scarce in other regions. Among these may be mentioned the beaver, European bison, deer and others. In Africa the seriousness of the situation is much more striking. Many students of African mammals agree that some of the large species of Africa's interesting and unique mammalian fauna are threatened with very early extermination. Two species, the quagga and blauwbok, are said to have

[1] Consult especially: Hornaday, *Our vanishing wild life,* New York; The destruction of our birds and mammals *2nd Ann Rept. N. Y. Zool. Soc.,* pp. 77-108. Osborne and Anthony, Close of the age of mammals, *Journ. Mammalogy,* III, 219-237, 1922, with comments by several other naturalists; Can we save the mammals, *Natural History,* XXII, 389-405, 1922. Lucas, Animals recently extinct or threatened with extermination, as represented in the collections of the U. S. National Museum, *Ann. Rept. U. S. Natl. Mus. for 1889,* pp. 609-650. Dall, On the preservation of the marine animals of the Northwest Coast, *Ann. Rept. Smithsonian Institution for 1901,* pp. 683-688.

become wholly extinct, while the range of many others has been greatly restricted and their numbers much reduced. The giraffe, zebra and various species of the remarkable African antelope group have been destroyed in great numbers everywhere and exterminated over large areas. The reduction in the number of elephants is explained by the fact that, according to Lucas (1889) about 100,000 elephants, a "procession 180 miles long," were annually killed to supply the world with ivory. The time seems near when many animals that now give pleasure to thousands of people may no longer be seen.

Carl Akeley, just before his tragic death, wrote: "I have just come in from a two days' trip down the Tana, through a region I have known only as swarming with game, but I now find it a complete waste. There is only a pitiful remnant of the great buffalo herds of the past, and of the other game almost nothing. This is the condition we have found everywhere we have been in the Kenya colony."

Some writers, visiting certain regions in Africa and finding game still abundant, make the mistake of assuming that it is not in danger, but abundance is not the test. There are three questions to be considered in all such problems: 1. What is the relative abundance or scarcity of the animals as compared with conditions a few years or many years before? 2. From how much of the range of each species has it been within recent years exterminated or nearly so? 3. How effectively are the animals of the region now being protected? Judging from the accounts published by the men in best position to judge as to these questions, many large African animals are in serious danger of extinction.[2] While the American bison was being exterminated, many observers, passing through its range and seeing large herds, but knowing nothing of the vast numbers that had occupied the territory a short time before, declared that they needed no legislative protection, as it would be impossible to exterminate them, yet in a very few years they were gone. Though killing elephants for their tusks is prohibited in certain districts of Africa, yet $250,000 worth of tusks so obtained are annually smuggled out of the districts.

It is of course unavoidable that as civilization advances in Africa,

[2] Compare Friedman, Notes on the big game of Africa and its preservation, *Journ. Mammalogy,* VII, 73-85, 1926. Carey, Saving the animal life of Africa—a new method, *Journ. Mammalogy,* VII, 73-85, 1926; African game conservation through the League of Nations—a reply to Dr. Herbert Friedman, *ibid.,* pp. 311-313; Carl Akeley's last words about Africa, *ibid.,* VIII, 172, 1927. Hubbard, Big game in Rhodesia, *Journ. Mammalogy,* IV, 228-230, 1923. Lang, The vanishing wild life of Africa, *Natural History,* XXIV, 313-327, 1924.

with its attendant increase of population and the devotion of much larger areas to agriculture, the larger mammals must give way to a great extent, as they have in North America. The present big herds of buffalo and various species of antelope, wild elephants, rhinoceroses and the like are quite incompatible with fields of grain and fruit-raising on a large scale, and cannot be permitted where there is a dense human population. The great beasts of prey such as lions, and leopards, which annually take a considerable toll from human life on that continent, would destroy many more human lives, as well as livestock, if they were allowed to exist in present numbers amid a much more dense population. Roosevelt says that "the dangerous game of Africa are the lion, buffalo, elephant, rhinoceros and leopard."[3] The hippopotamus also sometimes attacks and overturns boats and kills or injures their occupants. Inevitable as the depletion of the large mammals of Africa may be, that does not excuse their wanton slaughter in the wilderness.

Wild life in India also is being rapidly reduced.[4]

Australia's unique fauna of marsupials exhibits the inroads of civilization, with its changing conditions in large areas. They were once abundant, and, being rapid breeders, were for a long time unaffected by civilization, but they have recently been greatly reduced except where protected. Thousands of skins of kangaroos are annually marketed. Introduced rabbits have destroyed the food supply of the native animals in many places, foxes and domestic cats have preyed upon the young, and the clearing of scrub and bush lands has had detrimental effect. Bush fires have destroyed many, and poisons put out for rabbits are said to have done more harm to native animals than to the rabbits.[5] Brush, forest and prairie fires, usually resulting from human activities of one sort or another, have also been very destructive to mammals in the United States, not only directly, but indirectly by destroying their food and haunts and thus preventing the rapid natural restocking of the burned-over areas.[6]

When white men first penetrated the American wilderness they found the bison, or buffalo, as it is more commonly called, ranging over

[3] Roosevelt, *Game trails in Africa,* p. 58, 1910.

[4] Faunthrope, The disappearance of wild life in India, *Natural History,* XXIV, 570-574, 1923.

[5] Hoy, The present status of the Australian mammal fauna, *Journ. Mammalogy,* IV, 164-166, 1923.

[6] Brown, Fire and its effect on wild life, *Journ. Mammalogy,* IV, 195-196, 1923. Mills, Deadly effect of forest fires on fur-bearers, *Parks and Recreation,* VII, 636-638, 1924. Hewitt, *The conservation of the wild life of Canada,* p. 22, 1921. Stivers, Forest fires destroy game, *California Fish and Game,* VI, 36-37, 1920.

a large part of what is now the United States and British America. It was inevitable that the settlement of a large part of their range by agriculturists and stock-growers would deplete the herds and restrict their range. Their gregarious habits made them peculiarly susceptible to attack. Slowly they were exterminated all over the eastern part of their range. When the westward march of white men reached the Great Plains extending from British America to Texas and from the Missouri River to the Rocky Mountains, they found the bison roaming in vast hordes. The total number has been variously estimated, even as high as 30,000,000 to 60,000,000, which latter figure is probably extravagant, but the numbers must have run well up into millions.

For many centuries these herds had been the chief dependence of the Plains Indians for meat, the skins furnishing raiment and shelter. With the advent of white hunters, trappers and pioneer settlers, the caravans of immigrants and government exploring and surveying expeditions, they also found the bison an abundant source of food. The workmen engaged in the construction of railroads over the plains were fed largely on buffalo meat while in the neighborhood of the herds. The coming of the railroads made available the eastern markets and the slaughter of these noble animals began. Theretofore it had been difficult to get the bulky skins to the market and in the absence of refrigeration the meat could not be marketed at all, except locally. Within a few years after opening the railroads the vast herds had ceased to exist, and this species, once so abundant over so large a territory, was reduced to a mere remnant, divided into a few small, widely scattered herds. "The buffalo hunters paved the prairies of Texas and Colorado with festering carcasses" (Hornaday). This sudden and appalling destruction and the unpardonable waste that attended it are a lasting disgrace to civilization, but such has ever been the history of the contact of advancing civilization with wild animals, especially with the larger species. It was estimated that in 1870 there were still 5,500,000 of them left, but in 1885 one could travel almost all over the former range of the species in the United States and never see one.[7]

It is said that 50,000 were killed for their tongues alone, the meat

[7] See Nelson, *Nat. Geog. Mag.* xxx, 389, 1916. Allen, History of the American bison, *9th Ann. Rept. Hayden's U. S. Geol. Surv. Terr.* (for 1875), pp. 443-547, (reprinted from *Mem. Kentucky Geol. Surv.* and *Mem. Museum Comp. Zool.* at Harvard College). Hornaday, The extermination of the American bison, *Ann. Rept. U. S. Natl. Mus. for 1887,* pp. 367-547. McAllister, California's large game animals, *California Fish and Game,* IX, 11-15, 1923; Canada leads in buffalo conservation, *California Fish and Game,* XIV, 155-156, 1928.

and skins being left to decompose on the ground. The figures for 1872, 1873 and 1874, partly from actual statistics and partly estimated, are enlightening. One railroad in the three years carried out 459,453 skins, 10,793,350 pounds of bones (gathered partly from the "kills" of former years) and only 2,250,400 pounds of meat. Inasmuch as the animals mostly weighed from 800 to 1,400 pounds each, it is seen that less than 1 per cent of the meat was utilized. It is estimated that the total kill of bison by whites during the three years was 3,158,730, the kill by Indians for the same period being only 390,000. Most of those killed by the whites were destroyed for the skins alone, which so glutted the markets that for some time the largest, fine bull skins brought only $1.00 each at the railroad station, smaller cow skins bringing only 40 to 50 cents. Long after the great herds had been destroyed their bleaching bones were gathered from the plains and shipped to market in large quantities.

On the Great Plains the pronghorn antelope was also very abundant. Some observers declared that it was even more numerous than the bison, though not so noticeable because of its less conspicuous colors and smaller size. Like the bison, it has been so persistently hunted that it has entirely disappeared over most of the vast region where it was formerly so abundant, and where it still survives, its numbers are insignificant as compared with its former abundance. As it does not thrive or breed in captivity, and for its existence seems to require its natural environment more than most animals do, the prospects for its future do not seem very bright.[8]

Mountain sheep and mountain goats in the United States, except in a few areas where all hunting is entirely prohibited, are now confined to localities very difficult of access, and even where theoretically fully protected by law they are often illegally and surreptitiously killed by men who seem unable to resist the temptation to kill any wild animal that comes within range of the rifles.

When white men began the task of wresting North America from the possession of its Indian inhabitants, deer were almost everywhere common and in many regions plentiful. Now they have entirely disappeared from vast areas, even where the land has not been broken by the plow, and in very few localities are they as abundant as they once were. The elk, once widely and generally distributed over a large part

[8] Nelson, Status of the pronghorned antelope in 1922-1924, *U. S. Dept. Agric. Bull.* No. 1346, 1925.

of the continent and very abundant in many localities, is now exterminated over much the greater part of its former range and greatly reduced in numbers almost everywhere. Hundreds of elk have been illegally killed just for the two teeth worn as emblems by members of a fraternal organization, and the slaughter is still going on.[9] Before the enactment of game laws, Alaska deer were killed by the thousands merely for their hides, which sold for a few cents each, the venison being shamelessly wasted.

The musk-ox of the Far North, a gregarious animal, had developed habits that enabled it to successfully resist the attacks of wolves and other natural enemies, but those habits were fatal when its home was invaded by men carrying powerful, rapid-fire rifles. Like the antelope, it will not thrive if removed from its natural habitat. Thus far the musk-ox has been rather well protected by its isolation and the difficulties of transportation that discouraged most men from attempting the penetration of the inhospitable region, but as it is now reduced almost to the point of extermination, and those difficulties are being overcome, only the most rigorous protection can save these unique animals from annihilation.

The beaver, another exceedingly interesting animal, was once very abundant throughout the greater part of the United States and British America. Because of its abundance, the ease with which large numbers could be captured and the excellence of its pelt, it was for a great many years the backbone of the world's fur trade. As a result it was some time ago exterminated from a large part of its range in America, as it was in Europe, and in nearly every region where it survives the living animals are a small remnant of the former beaver population. Recognizing its value as a fur-bearer, serious and successful efforts are now being made to re-establish it in favorable localities where it should be able to thrive and where its operations will do little harm to agricultural or other private or public interests.

Hunting and trapping has wrought great havoc also among other groups of fur-bearing animals all over the world. Published records show that 107,689,927 skins of 23 kinds of fur-bearers passed through the principal fur-trade markets in 1921. This does not include all the wild animals that are used extensively in the fur trade or the millions of furs that do not pass through the centers of the trade and consequently are unreported. So serious has become the destruction of fur-

[9] Leek, Elk tusk hunting, *Outdoor Life,* XXXV, 149-151, 1915.

bearers that some nations and most of the states of the United States of America have enacted laws requiring licenses and otherwise regulating trapping, and providing close seasons for certain species. One Boston fur-buyer reported that in three years, 1918-1920, the offerings of muskrat skins fell off 50 per cent per annum, while in Wisconsin 800,000 were marketed in 1917, 300,000 in 1918 and only 150,000 in 1919, though each year there was an increase of about 10 per cent in the number of licensed trappers.[10]

Though hunting game animals for the market, which was one of the principal causes of their wholesale destruction, has now been prohibited in most states, that, of course, is impracticable in case of the trapping of fur-bearers. In 1921 there were about 4,000,000 hunting licenses issued in the United States. In addition, many men hunted in isolated localities without licenses, and in some states boys beneath a certain age and men hunting on their own land are not required to procure licenses.

The animals structurally so modified as to adapt them to a more or less complete marine existence have been as vigorously persecuted, chiefly for the oil they yield. In the American Antarctic, 5500 whales were taken from one whaling station in a single season. They were relentlessly pursued in all the seas for years until in most regions they became so scarce that whaling was no longer profitable. As they became scarce the whalers turned their attention more energetically to the pursuit of other oil-yielding animals. The sea-elephant, once abundant in some localities along the Pacific Coast of America, was soon brought by hunters to the verge of extinction. The Arctic sea-cow, once locally abundant but of very limited range in the Far Northwest, was discovered in 1742, and about twenty-five years later, in 1767 or 1768, the last one is said to have been killed. Sea-lions have been killed in large numbers along the Pacific Coast, sometimes under bounty acts, under the apparently mistaken notion that they are very destructive to fish. The walrus, both European and American, has been destructively hunted for its oil and ivory. In Europe it soon became too scarce for profitable hunting. In one rookery of Norway 600 were killed in six hours. On the northwest coast of America the walrus was depended upon by natives for food, while its skin was used in the construction of boats and for other purposes, its blubber furnished them with oil, and its ivory was found useful and later on salable. When

[10] Bailey, *U. S. Dept. Agric. Circular* No. 135, pp. 6-7, 1920.

whalers turned their attention to this animal, their numbers were reduced 50 per cent in ten years. From 1870 to 1880 100,000 were killed. Sea otters, once abundant, are approaching extinction.

The fur seal of the North Atlantic was at one time threatened with extinction for its fur. Its rapid destruction led to a serious crisis in the amicable relations between the United States and Great Britain, but fine statesmanship finally averted disruption and resulted in the protection of the seals by laws and international treaties. Even the hair seal, not valuable as a fur-bearer, has long been the subject of constant assault for its oil and leather. In 1889 it was estimated that 875,000 were killed annually. Unlike rodents and some other animals, the marine mammals are not rapid breeders and cannot long survive destruction in large numbers.

While all this destruction of useful mammals was in progress, apparently with little thought of the future, useful birds and fishes and extensive forests were also being wastefully destroyed. It is only within comparatively few years that the seriousness of the situation, long apparent to naturalists, began to impress the general public and make itself felt in legislative halls. With wider diffusion of a knowledge of the facts, public sentiment is beginning to crystallize into better laws and better enforcement, but very much remains yet to be done if some of our useful species of mammals are to be preserved from total extermination. No effort should be spared to get the exact facts before all people in such form that they may realize the urgent need of conservation of the more useful forms of wild life.

Unfortunately, while the general assault on useful animals all along the line has been going on, but little systematic, wide-spread, concerted effort has been made to prevent the dissemination and increase of destructive animals, except the large predatory species. During a century and a half the brown rat, said to be the most destructive mammalian pest in the world, and the house mouse, also very destructive and a great nuisance, have been allowed to spread from Europe almost over the whole civilized part of the globe, and to multiply enormously. Predacious birds and mammals that feed largely upon rats, mice, gophers and other harmful rodents, have been destroyed by the thousands, leaving these prolific animals to increase without the hindrance of their natural enemies. In some cases man has deliberately introduced harmful species into new territory, with disastrous results, as witness the European house sparrow in America, the rabbit in Australia, the mongoose in Jamaica, the goat on St. Helena, and many other instances. It is strange that civilized man, with his boasted scientific attainments and partial conquest of nature, should do so many things detrimental to the interests of the human race—things that every student of natural science knows are foolish. This is largely because of the difficulty of getting accurate information to the general public.

The foregoing is the dark side of the picture. The destruction of useful animals has been due to ignorance and thoughtlessness, not to viciousness. Lest one get the idea that the human race is altogether depraved, let us turn now to the bright side. Man has entered into great waste spaces and made them blossom and bring forth food and other products in abundance. He has carried water in canals to irrigate arid tracts, where now are fields of waving grain. He has planted orchards and shade trees, surrounded his home with flowers and shrubbery and given to the world much of beauty to partly compensate for beauty he has ruthlessly destroyed. He has developed and introduced many improved varieties of fruits, vegetables and animals and in many ways bettered living conditions for the race. In other words, though some of his activities have been destructive, others have been constructive. He need only be properly and convincingly informed, to demand that needless destruction of useful wild life shall cease.

## XXV

## THE PROTECTION OF USEFUL MAMMALS

We have seen that, through the intervention of man, with his death-dealing weapons and his sweeping and rapid environmental transformations, many useful mammals, as well as birds and other organisms, have been greatly reduced, brought to the verge of extinction or entirely exterminated. Some of the destruction was practically unpreventable, as great herds of bison and elk, large numbers of deer and so on, were wholly incompatible with dense population centers, but a great deal of it could have been prevented. Except for the uncontrolled greed of hide-hunters, small, picturesque herds of bison would still be scattered about, to the delight of travellers, an attraction to many pleasure resorts and a source of occasional meat for settlers. A few deer, left in some of the vast areas from which they have been totally destroyed, would now be a source of profit to thousands and of pleasure to millions of people. Had the people soon enough awakened to the seriousness of the onslaught, the pronghorned antelope would still be seen in small numbers over much of its former range, and people who wish a sight of these beautiful animals would not have to travel into remote and almost inaccessible regions for a bare chance of seeing them.

Fortunately the dissemination of accurate knowledge upon the subject is slowly developing a strong public sentiment in favor of better protection of our useful wild animals and their re-establishment in regions from which they have long since disappeared. One of the first fruits of aroused public opinion was the enactment of better protective laws and their more thorough enforcement. Much yet remains to be done in this direction, but this whole subject is discussed at some length in a special chapter on legislation, and need not be discussed here. Several other movements have been inaugurated that promise important results.

There is more serious consideration of the biological facts in framing and enforcing bird, mammal and fish laws, than formerly. There is need of much research as a basis for such laws, as many of them are scientifically unsound, based upon hunters' traditions, rather than upon demonstrated truth. For example, there is a serious question as to the soundness of a permanent close season on does. Many students of the subject are coming to the belief that the unbalancing of the sexes, arising from an annual open season on bucks and complete close season on does, is producing undesirable results,[1] and the tendency now is drifting toward some sort of an open season for does. Also it is now well known that it is quite possible to give a species too much protection. Consequently game commissioners are in some states being given greater discretionary power. This is a good thing where such commissioners are careful to get the facts and principles involved straight before acting, not acting hastily or unadvisedly. Deer have become too plentiful for their food supply in some localities, the most acute situation in this respect being in Kaibab Forest, Arizona.[2] Larger animals in some of the game reserves have become so abundant that the surplus animals are being offered for sale.[3]

The possibility of re-stocking a region with game by proper protection is exhibited by Vermont, where deer were practically exterminated in 1870. In 1875 thirty were introduced and protected until 1897; thereafter, with a short open season, they continued to increase. In 1901, 211 were killed, 561 in 1902, 791 in 1905, 1600 in 1907, 5261 in 1909, computed to have furnished for the latter year 716,358 pounds of meat worth $85,962; damages paid to farmers in 1908-1909 for injury to crops, only $4,865.90; value of meat, hides and horns obtained for those two years, $107,790.[4]

One of the most important steps in the protection of mammals is a campaign of education—getting full and reliable information to the general public. The vast store of knowledge of the habits and economic status of various species laboriously accumulated by naturalists, working independently or under state or federal departments or bureaus, will accomplish little unless the more important facts and conclusions become generally known outside the small technical groups that gather the information. To this end there are now established a considerable number of periodicals devoted wholly or partly to the protection of wild life. Some of these are published privately, but they are mostly the

[1] The Pennsylvania deer problem, *Pennsylvania Game Comm. Bull.* No. 12; *California Fish and Game,* XV, 138-139, 1929. Schierbeck, Is it right to protect the female of the species at the cost of the male?, *Canadian Field. Nat.*, XLIII, 6-9, 1929.

[2] Grinnell, The starving deer of the Kaibab Forest, *Outlook,* CXXXVI, 186-187, 1924.

[3] *California Fish and Game,* XV, 155-156, 1929. *American Forests and Forest Life,* XXXIV, 123, 1928. Goldman, Game surpluses perplex wild-life guardians, *Yearbook U. S. Dept. Agric. for 1926,* pp. 397-399.

[4] Hewitt, *The conservation of the wild life of Canada,* p. 9, 1921. Hornaday, *Wild life conservation,* p. 106.

TABLE OF NATIONAL WILD-LIFE RESERVATIONS

| State or Territory | Under direction of Department of Agriculture | | Under direction of Department of Commerce | |
|---|---|---|---|---|
| | Acres | Type of life protected | Acres | Type of life protected |
| Alabama | 635 | Water Birds. +All forms of wild life. | | |
| Arizona | 21,120<br>886,200<br>907,320 | Mule deer, mountain sheep, Kaibab squirrel, cormorant, pelican, game birds. All wild life. | | |
| Arkansas | 9,000<br>21,500<br>30,500 | White-tailed deer, ducks, quail, and turkey. +All other wild life. | | |
| California | 44,140<br>15,770<br>59,910 | Mule deer, bear, fur animals, water birds; all other wild life. | 120+ | Sea lions—any other form of life found there. |
| Colorado | | | | |
| Florida | 254+ | Water and shore birds, all kinds of wild life. | | |
| Georgia | 600<br>14,000<br>14,600 | White-tailed deer, raccoon, opossum, birds +all other wild life. | | |
| Idaho | 15,540 | All types of wild life. Water, game, and shore birds. | | |
| Illinois | No acreage given | Muskrat, mink, raccoon, fox, beaver, and other animals. | | |
| Iowa | No acreage given | Muskrat, mink, raccoon, fox, beaver, and other animals. | | |
| Louisiana | 63+ | Water birds mainly—all wild life. | 5,640 | All forms of life—mainly birds. |
| Maine | | | | |
| Michigan | 92 | Water birds mainly; all wild life. | | |
| Minnesota | 7+ | Muskrat, mink, raccoon, fox, beaver, and other animals. | | |
| Mississippi | | | | |
| Montana | 81,882+ | Buffalo, elk, deer, mountain sheep, and birds and other wild life. | | |
| Nebraska | 21,232 | Buffalo, elk, and antelope; and birds; and other wild life. | | |
| Nevada | 248 | Birds; all wild life. | | |
| New Mexico | 74,360 | Birds—all wild life. | | |

TABLE OF NATIONAL WILD-LIFE RESERVATIONS (CONTINUED)

| Under direction of Department of Interior | | Under direction of Department of Navy | | Under direction of Department of War | |
|---|---|---|---|---|---|
| Acres | Type of life protected | Acres | Type of life protected | Acres | Type of life protected |
| | | | | | |
| 673,608 | Mountain sheep, mule deer, antelope, beaver, squirrel—all other wild life. | | | | |
| 928 | All forms of wild life, but non-game birds especially. | | | | |
| 1,213,984 | Mule deer, bear, elk, all birds, all other wild life. | | | | |
| 304,614 | Mule deer, elk, bear, mountain sheep, beaver, and all other wild life. | | | | |
| | | | | | |
| | | | | 6,542 | Deer, rabbits, gray squirrel; all forms of life. |
| 23,040 | Buffalo, mountain sheep, elk, antelope, mule deer, white-tailed deer, moose, bear—all other wild life. | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| 9,600 | White-tailed deer, beaver—all other wild life. | | | | |
| | | | | 2,680 | Deer, squirrels; all forms of wild life. |
| | | | | | |
| | | | | 1,323 | Deer, squirrels, opossums, rabbits, raccoons, foxes—all forms of wild life. |
| 1,108,401 | Deer, elk, moose, mountain sheep, mountain goat, bear, buffalo, antelope, and all other forms of wild life. | | | | |
| | | | | | |
| | | | | | |
| | | | | 45,423 | Deer, squirrels, all other wild life. |

TABLE OF NATIONAL WILD-LIFE RESERVATIONS (CONTINUED)

| State or Territory | Under direction of Department of Agriculture | | Under direction of Department of Commerce | |
|---|---|---|---|---|
| | Acres | Special type of life | Acres | Special type of life |
| North Carolina | 89,513 | Elk, white-tailed deer, gray squirrel; other wild life. | | |
| North Dakota | 3,567 | Buffalo, elk, antelope, white-tailed deer; and other wild life. | | |
| Oklahoma | 60,800 | Buffalo, antelope, elk, white-tailed deer; other wild life. | | |
| Oregon | 183,052 | All wild life; mainly all types of aquatic birds. | | |
| South Carolina | 2,352 | All wild life; mainly avian. | | |
| South Dakota | 17,840<br>44,360<br>62,200 | Mountain goat, mountain sheep, deer, elk, buffalo, antelope; all wild life. | | |
| Tennessee | 30,000 | White-tailed deer; other wild life. | | |
| Utah | 14,080+ | All types of wild life; mainly avian. | | |
| Virginia | | | | |
| Washington | 7,229<br>299,370<br>306,599 | Olympic elk, black-tailed deer, bear; other wild life. | | |
| Wisconsin | No acreage given | Muskrat, mink, raccoon, fox, and other wild life. | | |
| Wyoming | 39,509<br>28,318<br>67,827 | Elk, mule deer; other wild life. Winter feeding grounds. | | |
| Alaska | 13,120 | Muskrat, beaver, sea otter, sea lion, red fox, blue fox, caribou, brown bear, black bear, lynx, mink, ermine, reindeer; other wild life. | 561,000 | Fur seal, sea otter, sea lion; all other wild life. |
| Hawaii | | | | |
| Porto Rico | No acreage given | All wild life—mainly all types of water birds. | | |

All forms of wild life found on the reservations are protected, excepting such species as are a menace to those forms for which the reservations have been established.

All wild life in National Parks, National Monuments, and Lighthouse Reservations is protected, although such areas are not strictly game preserves.

Certain areas within National Forests administered by the Forest Service have been set aside to afford protection particularly to big-game animals.

TABLE OF NATIONAL WILD-LIFE RESERVATIONS (CONTINUED)

| Under the direction of the Department of the Interior | | Under the direction of the Department of the Navy | | Under the direction of the Department of War | |
|---|---|---|---|---|---|
| Acres | Special type of life | Acres | Special type of life | Acres | Special type of life |
| | | | | | |
| 780 | Buffalo, elk, white-tailed deer, antelope, and other wild life. | | | | |
| 849 | Buffalo, elk, white-tailed deer, and other wild life. | | | | |
| 159,360 | Black-tailed deer, elk, bear, marten, all fur-bearers, and other wild life. | | | | |
| | | | | | |
| 10,900 | Buffalo, elk, antelope, and other wild life. | | | 5,548 | Deer, squirrels; all forms of wild life. |
| | | | | 3,546+ | Deer, fox, raccoon, mink, opossum, squirrel, muskrat, rabbit, skunk, and other wild life. |
| 90,880 | Mule deer, other wild life. | | | | |
| | | 13,995 | Rabbits; game birds, and other wild life. | | |
| 208,000 | Black-tailed deer, mountain goat, bear; other wild life. | | | | |
| | | | | | |
| 2,088,960 | Buffalo, mountain sheep, antelope, mule deer, moose, bear, and other wild life. | | | 56,132 | Antelope; all forms of wild life. |
| 3,945,590 | Mountain goat, mountain sheep, bear, fox, caribou, moose, and other wild life. | | | | |
| 158,720 | All forms of wild life, particularly non-game birds. | No acreage given. | All forms of wild life; mainly aquatic birds. | | |
| | | | | | |

TABLE OF STATE WILD-LIFE RESERVATIONS

| State | Acreage—Preserves | Type of life |
|---|---|---|
| Alabama | 16,000+ | Deer, game birds. |
| Arkansas | 13,695+ | Squirrel, deer, game birds. |
| Arizona | 866,500± | All game. Predatory animals not protected. |
| California | Had 15 or more reserves in 1925 | |
| Colorado | 3,324,480 | All game |
| Connecticut | 167,423 | All game. |
| Delaware | No state-controlled game preserves | Hunting prohibited in all parks and estates; also in strip of land in Sussex County. |
| Florida | 3,819,840 | Game mammals and game birds. |
| Georgia | 14,000 | All game and wild life. |
| Idaho | 3,000,000 | All forms of game. Predatory animals not protected. |
| Illinois | 3,403+ | All game. |
| Indiana | 12,924 | Game mammals, fur-bearers, game birds. |
| Iowa | 2,334 | All game birds—all hunting prohibited. |
| Kentucky | One refuge; acreage not given | Deer, turkey, smaller game mammals and birds. |
| Kansas | 6,757 | All game. |
| Louisiana | 512,013+ | Muskrat, raccoon, mink, otter, opossum, deer, bear, squirrel, rabbit, wildcat, wolves, foxes, game birds, migratory water fowl. |
| Maine | 268,577 | Deer, rabbit, moose, fox, skunk, squirrel, porcupine, raccoon, game birds. |
| Maryland | 32,525 | Deer, rabbits. All hunting prohibited. |
| Massachusetts | 110,328.26 | All forms of game. |
| Michigan | 280,000 | Deer, bear, and associated game. (163+ private dedications) |
| Minnesota | 1,521,331 | Beaver, deer, muskrat, otter, badger, squirrel, game birds. |
| Mississippi | No data | Has no fish and game commission. |
| Missouri | 49,365.54 | Deer, bear, beaver. |
| Montana | 3,471,151.82+ | All game. |
| Nebraska | 277,730 | Game bird preserves only. |
| Nevada | 3,414,472+ | All wild life. |

TABLE OF STATE WILD-LIFE RESERVATIONS (CONTINUED)

| State | Acreage—Preserves | Type of life |
|---|---|---|
| New Hampshire | 9,610 | All game. |
| New Jersey | 59,775—no hunting<br>16,587—under game laws<br>76,362 | Rabbit, deer, fox, raccoon, squirrel, skunk, muskrat, weasel, game birds. |
| New Mexico | 2,323,591 | Deer, bear, beaver, small mammals. |
| New York | 14,440—private<br>8,687—state<br>23,127 | Deer, bear, beaver, small mammals. |
| North Carolina | 671,330 | Deer, bear, squirrel, rabbit, opossum, raccoon, fox. |
| North Dakota | 1,760+ | Hundreds of refuges set aside on privately owned ground. Buffalo, elk, deer, game birds. |
| Ohio | No data | |
| Oklahoma | 135,000+ | Buffalo, deer, squirrels, other small game. |
| Oregon | 1,887,640 | Sheep, deer, game birds. All hunting prohibited in many preserves. |
| Pennsylvania | 106,394.7 | Deer, cottontail rabbit, black, gray, and fox squirrels, black bear, raccoon, opossum, varying hare, elk. |
| Rhode Island | 17,170 | Gray squirrel, rabbit. |
| South Carolina | 61,086<br>(31 sanctuaries) | All game. |
| South Dakota | 13,160 | Deer, elk, buffalo, mountain sheep, and mountain goats, antelope. |
| Tennessee | 36,500 | Deer, bear, fur animals. |
| Texas | 3,000,000<br>(64 preserves) | All game. |
| Utah | No data | |
| Vermont | 900+ 12 game refuges (area not given) | Deer, rabbits. |
| Virginia | 217,765<br>(195 sanctuaries) | No hunting. |
| Washington | 12,613,129 | All game. 29.36% of State in game preserves. |
| West Virginia | 140,000 | All game. |
| Wisconsin | 96,640+ | All wild life. |
| Wyoming | 3,464,280 | Deer, moose, elk, antelope, mt. sheep. |

publications of organizations composed of sportsmen of the better class (the real sportsmen), naturalists and other nature lovers. A few periodicals of importance are published by state fish and game commissions. Many special bulletins and circulars upon the same subject are issued by state and government departments and bureaus, especially the United States Biological Survey, and by several state fish and game commissions, for free distribution. The aggregate number of people reached by all these publications is very large, but there are still millions of people in this country who never see such literature and are thoroughly ignorant of the whole subject—sometimes even men and women who are reasonably well-informed in a general way.

In recent years there have been many successful efforts, both public and private, to re-stock certain areas with elk, deer, beaver and other animals that had long ago been destroyed or driven therefrom. The results will doubtless encourage other experiments of the sort.

A great many private and public bird and mammal refuges have been established in which hunting is entirely prohibited, and the idea of dedicating large tracts of public and private land to the protection of wild life is rapidly growing in favor. Some of the refuges are fenced and under more or less complete control. Others, including the national parks and most of the state and national refuges are open, affording breeding grounds from which the surplus animals, as they increase in numbers, may overflow into the surrounding regions. There are now several hundred such refuges in the United States, most of the states and Canadian provinces having some within their boundaries.[5]

The accompanying tables of refuges have been compiled from information furnished by the United States Department of Agriculture and the game officials of the various states.

[5] Palmer, Private game preserves and their future in the United States, *U. S. Biol. Surv. Circular* No. 72, 1910; National reservations for the protection of wild life, *ibid.*, No. 87, 1912; Game as a national resource, *U. S. Biol. Surv. Bull.* No. 1049, 1922 (game refuges on pp. 28-49). Phillips, Pennsylvania's game refuge system and what it is doing to bring back our game, *Pennsylvania State Board Agric.*, 1923. *California Fish and Game*, x, 95, 1924; xi, 119-120, 1925; ix, 175, 1923. Nelson, *U. S. Dept. Agric. Bull.* No. 1346, p. 14, 1925. *Bird-Lore*, 157-158, 1928. Lantz, Deer farming in the United States, *Farmers' Bull.*, No. 330, 1908; Deer farming, *U. S. Biol. Surv. Bull.* No. 36, 1910. National wild life reservations, *U. S. Dept. Agric. Miscell. Pub.* No. 51, 1929. National bird and mammal reservations in Alaska in charge of the U. S. Department of Agriculture, *U. S. Biol. Surv. Circular* No. 71, 1910. Hewitt, *The conservation of the wild life of Canada*, pp. 235-257, 1921. Ligon, *Wild life of New Mexico*, pp. 171-184, 1927. *Amer. Forests and Forest Life*, xxxiv, 114, 1928.

## XXVI

## THE CONTROL AND DESTRUCTION OF INJURIOUS MAMMALS

As many species of mammals are exceedingly destructive, it is not surprising to find an extensive literature concerning methods of destroying them and otherwise preventing their depredations. Methods of destruction mostly in use are by firearms, traps, poisons and fumigants. Protecting property from damage by mammals without destroying them is accomplished chiefly by proper construction of buildings and the erection of woven-wire fences. Formulae for poisons and directions for fence and building construction, trapping and otherwise fighting the pests are contained in many of the publications cited in the footnotes, but cannot be set forth in detail here. The bounty system of controlling mammalian pests, which has not proved very effective, is discussed in the chapter on legislation. Better results could probably be obtained by using the money appropriated for the payment of bounties in financing sustained, systematic campaigns in large areas. Especially is this true of the smaller pests.

One thing that should be emphasized in all campaigns for the control of noxious mammals is the need of coöperation of landowners over large areas. This may be accomplished by volunteer organization, but if some refuse to join in the organized effort they reap the benefit of the expenditure of time and money by their neighbors, without contributing their share toward the campaign. This may be obviated by laws permitting the organization of pest districts, with power to compel contribution from all within the district, as provided, for example, by the Colorado pest law.[1] Unless the campaign covers a reasonably large area, the lands where the pests are uncontrolled remain breeding grounds from which surplus animals overflow upon the lands from which the campaign has eliminated them. Furthermore, such campaigns should be under the direction of experts who are perfectly familiar with the habits of the animals and methods of attacking them. Small local organizations cannot, of course, afford to maintain such experts, but fortunately the United States Biological Survey has them

[1] Burnett, *Office Colorado State Entom. Circular* No. 8, p. 13, 1913.

and provides them in coöperative work in various regions as they are needed. There are also some men of experience in such work in the employment of various states, as well as some "unattached" individuals.

Some species so useful that their protection is very desirable, under certain circumstances become locally so destructive that some method must be adopted to prevent their depredations or to minimize the damage resulting therefrom. There are often means of controlling their pernicious activities without resorting to their wholesale destruction. For example, the beaver is a valuable fur-bearer, and most of the trees it cuts for food and for use in the construction of its houses and dams are of little value, but sometimes, where such trees are scarce and others are accessible, it attacks fruit, shade or other valuable trees. These may be protected by woven-wire cylinders placed about them at a distance of a few inches, 3 feet high, supported by substantial stakes. Woven wire also makes good beaver fences. Their building dams so high as to flood valuable adjacent land may be prevented by placing drain pipes in the dams, directions for which have been published.[2]

Woven wire may also be used to prevent muskrats and other useful animals from damaging gardens and burrowing into embankments,[3] and to protect poultry from weasels and skunks,[4] which are very useful as enemies of rodents and insects. Nests of some small species of birds may be protected from cats by woven wire of mesh large enough to admit the birds but too small to admit cats, set far enough away to prevent cats from reaching the nests with their paws. Cat-proof poultry-yard fences are difficult to construct on account of the climbing ability of the house cat, which will surmount a woven-wire fence, or, if there is a tree near-by, it will climb the tree and drop into the enclosure from a limb. Forbush says that an effective fence may be made by use of six-foot woven wire set close to the ground at the bottom, with a three-foot twine net above, fastened at the lower edge to the top of the woven wire, making a fence nine feet high. The net baffles the cat by giving beneath its weight.[5]

Deer and elk, though classed among the useful species, sometimes do some damage to gardens, which may be prevented by good fences. Lantz says that an elk-proof fence should be five or six feet high, but

[2] Bailey, Beaver habits and experiments in beaver culture, *U. S. Dept. Agric. Tech. Bull.* No. 21, pp. 13-14, 30-31, 1927; Beaver habits, beaver control and possibilities in beaver farming, *U. S. Dept. Agric. Bull.* No. 1078, pp. 11-12, 1922.

[3] Lantz, The muskrat, *Farmers' Bull* No. 396, pp. 34-35, 1920.

[4] Bailey, *Farmers' Bull.* No. 335, p. 28, 1908.

[5] Forbush, The domestic cat, *Massachusetts State Board of Agric., Econ. Biol., Bull.* No. 2, p. 88, 1916.

a foot or two higher would be better.[6] Woolen cloths soaked in sheep dip, hung in the trees by means of wires, so as not to come in contact with the bark, are said to keep deer away from orchard trees.[7]

The two most destructive groups of mammals are the "beasts of prey," especially the Canidae and Felidae, and the Rodentia and their allies. In the control of these groups the United States Biological Survey coöperates with farmers and stockmen, placing the government experts in charge of the work. In such coöperative work in the western United States from 1914 to 1923, the hunters and trappers killed 186,172 coyotes, 4916 wolves, 999 mountain lions, 83 lynxes, 23,274 bobcats and 579 bears, the skins of which were sold for $310,306 to repay the government for part of the expenses of the work.[8] There is a growing belief among naturalists that the campaign against coyotes may be carried too far, a subject discussed in another chapter. Poisons are extensively used in such work, especially against coyotes, and many of the animals are shot, but a much larger number are caught in traps than are shot. Trained dogs have been found very effective in hunting mountain lions.[9] In California 3627 of these big cats were killed under the bounty system from 1907 to 1919, then the California Fish and Game Commission decided that a better way is to employ one or more expert official hunters, with their dogs.[10] The big cats of other lands, such as the tiger, African lion, leopard and jaguar are usually taken by rifle or trap.

Sheep and other domesticated animals may be protected from coyotes, wolves and sheep-killing dogs by a fence of three-foot woven wire, five-inch mesh, with one barbed wire stretched close to the ground, the woven wire set three inches above it, and above the woven wire two barbed wires set six inches apart, all tightly stretched. In regions where snowfall is heavy other barbed wires may be added at the top or wider woven wire used.[11]

In the control of rats, mice and some other rodent pests, the first

[6] Lantz, Deer farming in the United States, *Farmers' Bull.* No. 330, p. 12, 1908; Raising deer and other large game animals in the United States, *U. S. Biol. Surv. Bull.* No. 36, p. 37, 1910.

[7] Dondero, Protecting orchards from deer, *California Fish and Game,* XIV, 221, 1928. True, *ibid.,* XVIII, 136-147, 156-165, 1932.

[8] Adams, *Roosevelt Wild Life Bull.,* III, 582-583, 1926. See also Bell, Hunting down stock killers, *Yearbook U. S. Dept. Agric. for 1920,* pp. 289-301.

[9] Roosevelt. With the couger hounds, *Scribner's Magazine,* XXX, 417-435, 1901.

[10] Hunter, The control of the mountain lion, *California Fish and Game,* VII, 99-101, 1921. Bruce, The how and why of mountain lion hunting, *ibid.,* VIII, 108-114, 1922; The problem of mountain lion hunting in California, *ibid.,* XI, 1-17, 1925.

[11] Bailey, Directions for the destruction of wolves and coyotes, *U. S. Biol. Surv. Circular* No. 55, p. 5, 1907; *ibid.,* No. 63, 1908; *Farmers' Bull.,* No. 335, 1908; Wolves

step should be to eliminate their hiding places, such as piles of old lumber, brush heaps and weed patches. Their burrows should be plugged. All foodstuffs should be kept in rat-proof rooms or containers. As soon as crops are removed from fields and gardens there should be a general clean-up.[12] Buildings should be rat-proofed by the free use of cement, with tin or sheetiron re-enforcement of the bottoms of doors and other places where gnawing is likely to occur.[13] All openings should be closed so far as practicable, and necessary openings such as drain-pipes and ventilators should be screened. Rats and mice may often be cleared from infested buildings by fumigation, and trapping by experts is an excellent method of disposing of them. For poisoning rats, barium carbonate is preferred to strychnine by many, as rats are said to have acquired remarkable resistance to the latter and perhaps to other poisons. In the use of poison great care should of course always be exercised to place it where it cannot be reached by children, or by dogs or other valuable animals for which it is not intended. All animals are more easily caught or poisoned when food is scarce and they are consequently hungry, hence another reason for keeping foodstuffs, as well as garbage, where mice and rats cannot get them.[14]

Silver recommends deterrent odors (where no foods can be affected thereby), such as flake napthaline in quantity, creosote, carbolic acid, kerosene, oils of peppermint and wintergreen, sulphur, lime, lye and copperas; and for deodorizing when rats and mice have died in buildings he recommends, as best, a few teaspoonfuls of lysol, dropped into their holes or other suspected places, though zinc chloride is also good.[15] As in campaigns against other pests, community coöperation is often desirable, in order to get rid of sources of infestation.

In western states where woodchucks are not overly abundant they have been successfully controlled by use of poisons placed in their

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in relation to stock, game and national forest reserves, *U. S. Forest Service Bull.* No. 20, 1905. Lantz, Coyotes in their economic relations, *U. S. Biol. Surv. Bull.* No. 20, 1905; The relations of coyotes to stock raising in the West, *Farmers' Bull.* No. 226, 1905. Simmons, Sheep-killing dogs, *Farmers' Bull.* No. 1268, 1929.

[12] Birdseye, *Farmers' Bull.*, No. 484, 1912. Burnett, *Office Colorado State Entom. Circular* No. 18, 1916.

[13] Lantz, House rats and mice, *Farmers' Bull.*, No. 896, 1917; The house rat: The most destructive animal in the world, *Yearbook U. S. Dept. Agric. for 1917*, pp. 335-351. Use of concrete on the farm, *Farmers' Bull.*, No. 461.

[14] Silver, How to get rid of rats, *Farmers' Bull.*, No. 1302, 1923. Lantz, Methods of destroying rats, *Farmers' Bull.*, No. 297, 1907; *U. S. Biol. Surv. Bull.* No. 33, 1909. Forbush, Rats and rat riddance, *Massachusetts State Board of Agric., Econ. Biol., Bull.* No. 1, 1915; also in 62nd Ann. Rept. Dice, *Journ. Mammalogy*, IV, 188-189, 1923.

[15] Silver, Rat control, *Farmers' Bull.*, No. 1533, 1927.

dens. In the eastern states fumigation has been found more effective, carbon disulphide being the cheapest and best, three teaspoonfuls being placed on cotton or other absorbent material and dropped into the burrow, then the burrow closed to retain the fumes. It is inflammable and explosive, hence smoking should not be indulged in when handling it. Calcium cyanide is also used. It is a dangerous poison and should be handled with great care. The exhaust fumes from an automobile engine are sometimes used effectively.[16]

In the war against the destructive rodents of the fields and pastures, the U. S. Biological Survey is coöperating with farmers and stockmen as it does in the eradication of coyotes and other predaceous animals. In one year its agents directed campaigns against prairie-dogs and ground squirrels over 18,000,000 acres of farm and range lands, with the help of 132,000 farmers, thus saving in one season $11,000,000 worth of crops.[17] The smaller rodents that live in burrows may be destroyed as woodchucks are, by the fumes of carbon disulphide, cotton containing a teaspoonful of the fluid being dropped into the hole, which should then be covered to confine the fumes for several hours, but the cheapest and most effective method is to drop poisoned grain into the burrows. There are formulæ for preparing poisons, directions for trapping and other pertinent information in most of the publications on economic mammalogy.[18] Pellett says that the best repellant

[16] Silver, Woodchuck control in the eastern states, *U. S. Dept. Agric. Leaflet* No. 21, 1928.

[17] Bell, Death to rodents, *Yearbook U. S. Dept. Agric. for 1920,* pp. 421-438.

[18] Lantz, Use of poisons for destroying noxious animals, *Yearbook U. S. Dept. Agric. for 1908,* pp. 421-432; Destroying rodent pests on the farm, *ibid.,* for 1916, pp. 381-398; Pocket gophers as enemies of trees, *ibid.,* for 1909, pp. 209-218; Meadow mice in relation to agriculture and horticulture, *ibid.,* for 1905, pp. 363-373; An economic study of field mice, *U. S. Biol. Surv. Bull.* No. 31, 1907; Directions for destroying pocket gophers, *ibid.,* Circular No. 52, 1908; Rodent pests of the farm, *Farmers' Bull.,* No. 932, 1918. Bailey, *N. Amer. Fauna,* No. 49, pp. 51-52, 1926. Piper, The Nevada mouse plague of 1907-8, *Farmers' Bull.,* No. 352, 1909; Mouse plagues: Their control and prevention, *Yearbook U. S. Dept. Agric. for 1908,* pp. 301-310. Dearborn, Trapping on the farm, *ibid.,* for 1919, pp. 451-484. Burnett, The Wyoming spermophile or ground squirrel, *Office Colorado State Entom. Circular* No. 9, 1913; Meadow mice, *ibid.,* No. 18, 1916; The Wyoming ground squirrel in Colorado, with suggestions for control, *ibid.,* No. 20, 1917; Suggestions for combating prairie-dogs and ground squirrels, *ibid.,* No. 24, 1917. Dixon, Rodents and reclamation in the Imperial Valley, *Journ. Mammalogy,* III, 136-146, 1922; Control of the California ground squirrel, *California Agric. Exper. Sta. Circular* No. 181, 1917. Dixon and deOng, Control of the pocket gopher in California, *California Agric. Exper. Sta. Bull.* No. 281, 1917. Merriam, The California ground squirrels, *U. S. Biol. Surv. Circular* No. 76, 1910. Birdseye, Some common mammals of western Montana in relation to agriculture and spotted fever, *Farmers' Bull.* No. 481, 1912. Scheffer, American moles as agricultural pests and fur producers, *Farmers' Bull.,* No. 1247, 1922 (superceding Nos. 583 and 833). Bruner, Pocket gophers, *Univ. Nebraska Agric. Exper. Sta. Press Bull.,* No. 29, 1908. Silver, Mouse control in field and orchard, *Farmers' Bull.,* No. 1397, 1924.

wash to protect trees from rabbits is fresh blood, which of course, would have to be frequently renewed. As a better protection he recommends wire screens.[19] Wagner recommends, as the best repellant wash to protect trees from both deer and rabbits, one pound of blood-meal to three gallons of water, repeated every two weeks.[20]

Though rabbits are partially protected by legal close seasons in many parts of eastern United States, they often do great damage locally to garden and field crops and orchard trees. Especially destructive are the abundant jack rabbits in some parts of the West. Lime-sulphur and other washes about the lower parts of the trunks of trees are sometimes helpful. Trees may also be protected by woven-wire cylinders, as in case of the beaver, and properly constructed fences of the same material will protect gardens. Rabbits are easily shot, trapped or poisoned. In the West, organized "drives" of jack rabbits are often conducted, when numbers of men, women and children, without firearms, surround a large area and drive all the rabbits toward a central point, where they are destroyed. In California 25,000 rabbits were killed in three months on a tract of 48 square miles, 8000 on a small ranch in nine days and 40,000 in drives near Bakersfield in two months. Seven drives in one Idaho county netted 15,728 rabbits, and drives in five other counties resulted in 5500, 17,800, 20,000, 19,000 and 10,000 rabbits respectively. A big hunt in South Dakota resulted in 7550 white-tailed jack-rabbits in one pile.[21]

Most of the publications cited in the footnotes to this chapter emphasize the importance of the natural enemies of injurious mammals and the need of encouraging such enemies. As this subject is discussed somewhat in two of the preceding chapters, it need be mentioned only briefly here. Among the active enemies of rodents are many species of hawks and owls, crows, gulls, coyotes, bobcats, foxes, weasels, skunks and snakes. Notwithstanding all the information concerning the usefulness of most species of hawks and owls that has for years been disseminated among farmers and hunters by the United States

[19] Pellett, The cottontail, *Forest and Stream,* Feb. 25, 1911, p. 291, cited by Seton, *Lives of game animals.*

[20] Wagner, A spray for preventing damage by deer, *California Fish and Game,* I, 241, 1915.

[21] Palmer, The jack rabbits of the United States, *U. S. Biol. Surv. Bull.,* No. 8, 1897. Bell, Death to the rodents, *Yearbook U. S. Dept. Agric. for 1920,* pp. 421-438. Bailey, *N. Amer. Fauna,* No. 49, pp. 134-144, 1926. Lantz, Cottontail rabbits in relation to trees and farm crops, *Farmers' Bull.,* No. 702, 1912. Silver, The European hare (Lepus europaeus Pallas) in North America, *Jour. Agric. Research,* XXVIII, 1133-1137, 1924.

Department of Agriculture and other agencies, by means of bulletins, circulars and magazine and newspaper articles, the great majority of them still persist in shooting these birds at every opportunity. The wholesale destruction of the natural enemies of rodents has made the control of these pests much more difficult and expensive, and costs the farmers far more than the possible losses of poultry would have amounted to, and most of the poultry losses could be prevented by proper precautions, without destroying useful birds and mammals that prey upon the rodents.

# XXVII

## LEGISLATION CONCERNING MAMMALS

Laws concerning mammals, both wild and domesticated, are of very ancient origin. In the Old Testament we find laws concerning horses (Deut., XVII:16), asses (Ex., XIII:13; XXIII:4; Deut., XXII:10), cattle, goats and sheep for the sacrifice, and forbidding the eating of camels, conies, hares, swine, weasels, ferrets, mice, moles, and, by implication, bats and flying foxes, "flying creeping things, which have four feet" (Lev., XI).

In England laws relating to wild animals developed at a very early date, including a fundamental principle that lies at the root of all fish and game laws, to wit, that all wild animals belong to the state, based upon the fact that they move freely from one man's property to that of another and are not in actual possession of anyone until they are either caught or killed. The recognition of this principle led to various problems which had to be solved by legislation or court decisions, and precedents established by courts soon became recognized as law of equal force with legislative enactments. Such, for instance, was the question as to who owns the carcass of an animal that is shot on one man's property and dies on another's.

On the theory that wild animals belong to the state, the American states have always exercised the right to decide, through the legislatures, just how problems of wild life should be disposed of, when, how, by whom, in what quantity and in what manner wild animals may be caught, killed, used and sold. The federal government, under its constitutional authority over interstate affairs, has assumed jurisdiction over migratory birds, which pass regularly from state to state and into other countries, has enacted laws and regulations concerning hunting such birds and negotiated treaties in relation thereto with other powers. It would doubtless do the same with mammals if they were sufficiently migratory to make it advisable. Indeed, the government long ago established the status of the North Pacific fur seal by treaties with Great Britain and Japan, after a long and serious controversy. In a single chapter we may only very briefly refer to a few general features of the numerous wild animal laws in force in the United States.

The United States leads the world in the bulk of its legislation concerning mammals, a fact not altogether to our credit, but to some extent unavoidable. This is partly because there are forty-eight separate states each having distinct jurisdiction over its own mammals, each making its own laws and each changing its laws at almost every legislative session. One reason for the constantly changing laws and lack of uniformity in various states is that the legislators and in some cases the game commissioners have very little technical knowledge of natural history, no training or experience in the rigid investigation of its difficulties, and are disposed to seek the advice of hunters whose knowledge is rather haphazard, instead of consulting experts whose lives are devoted to the investigation of the habits of animals and their intricate economic relations. Add to this the fact that there is much yet to be discovered even by the naturalists, and one may understand why much of the legislation is not based upon sound principles or adequate knowledge. However, the laws are on the whole constantly being improved.

If we could be sure that only persons of high personal character and ability and accurate knowledge of nature would be appointed, a permanent commission having jurisdiction over all wild life, its powers defined in very general terms, leaving it with great latitude in making regulations, would bring very much better results than the present system. Conditions affecting wild life often change rapidly, so that laws perfectly proper today may be quite improper a year hence. Fortunately some states now have fish and game commissions fully worthy of the name, directed by men who are competent and who have surrounded themselves with advisers and investigators expert in their various lines of work, and the results of their investigations and suggestions are being felt in other states.

The whole subject of legislation relating to wild animals is very difficult—much more so than the average legislator with little knowledge of nature as a whole can possibly comprehend—because nature itself is highly complex, as we have seen in various preceding chapters. To obtain ultimately the wisest laws three ideas must at all times be kept prominently in the foreground: (1) Any disturbance of the status of one species, by its increase or decrease in numbers, its destruction, its introduction into a new region, the introduction of another species that becomes an enemy or a competitor for food or shelter, or any change in the environment, inevitably affects other species either to their advantage or disadvantage, sometimes with far-reaching and disastrous results. Hence legislation regarding one species should be devised with as full knowledge as possible of its relation to the whole environment, including all other species of the region, food supply, enemies, and other factors. This idea is usually ignored by legislators and game commissioners unfamiliar with the complexities of nature. (2) Local conditions may require regulations of a certain sort in one place, while conditions in another locality not far distant may require very different treatment. Therefore conditions within the whole area of the jurisdiction and often even beyond its confines should be studied in devising the regulations. (3) Natural conditions often change rapidly in limited districts and sometimes over large areas. Epidemic diseases and changing food supplies often seriously affect wild life. A harmful species may suddenly become so abundant in a favorable season that it is advisable to give special encouragement to its natural enemies which are usually kept in check. Many other possible changes that would make changes in regulations necessary will occur to every thoughtful reader. All these matters could be handled more efficiently by a properly-constituted permanent commission, studying the whole subject from year to year, than by any ordinary legislative assembly, meeting occasionally, and whose personnel is constantly changing.

The development of game laws in the United States during the past 300 years[1] has been marked by great differences in the definition of game birds and mammals in various states and at various times. Among the earliest American game laws were those providing special hunting privileges and concessions in New Netherlands, Massachusetts and New Jersey, in 1629, 1647 and 1678. At the end of the colonial period twelve of the thirteen colonies had game laws of some sort. Georgia had close season on deer, New York on turkeys, heath hens, partridges and quail, but the first close season on deer was in Massachusetts in 1694. Several colonies prohibited fire-hunting at night, and Massachusetts in 1710 prohibited hunting waterfowl in camouflaged boats or canoes. Several had laws restricting the exportation of deer skins,

[1] Palmer, Chronology and index of the more important events in American game protection, 1776-1911, *U. S. Biol. Surv. Bull.*, No. 41, 1912, with summary of laws on pp. 20-46. Summaries of state and federal game laws have been issued either annually or biennially by the U. S. Dept. Agric. for many years, the one for 1927-1928 being *Farmers' Bull.*, No. 1550; for 1928-1929, No. 1575; for 1929-1930, No. 1616. The same department also issues directories of organizations and officials connected with protection of game. For Alaska, Laws and regulations relating to game, land fur-bearing animals and birds, *U. S. Biol. Surv. Circular* No. 5, 1928.

and Massachusetts and New Hampshire had warden systems in colonial days. After colonial times comparatively few states enacted game laws up to 1850, but in 1860 thirty-one states had such laws of one kind or another. In 1880 all states and territories of the Union had game laws (sometimes only county laws). From 1901 to 1910, there were enacted 1324 game laws, not including numerous bounty and appropriation bills. In 1902 Virginia provided for the payment for damages to crops caused by deer, a rule now in force in some other states.

Laws designed for the protection of the bison were in force in Idaho in 1864, Wyoming in 1871, Colorado in 1877, North and South Dakota in 1883, New Mexico in 1880, and Nebraska in 1875, but there was little enforcement against the big business of hide-hunting and the laws did not protect the bison from practical extermination. Kansas and Texas, regions of great abundance, afforded no protection. A somewhat parallel case is that of the passenger pigeon. In 1857 an Ohio legislative committee declared that "the passenger pigeon needs no protection . . . no ordinary destruction can lessen them or be missed from the myraids that are yearly produced," language very similar to that used by the opponents of bison protection. New York in 1862, Michigan in 1869, and Pennsylvania in 1878 prohibited hunting at their nesting places or roosts, and Pennsylvania established a close season in 1870, but market-hunting was not forbidden, and this splendid and once abundant bird is now extinct, to the lasting disgrace of modern civilization.

The various states of the Union and Canadian provinces all have close and open seasons on various kinds of game mammals, and these vary from state to state and from province to province, in their length of time and time of year, as well as in the species to which they apply, though some of the latter differences are due to the presence of species in certain areas which are absent from other districts. The laws also differ in the bag limits, and these limits are subject to very frequent changes in many jurisdictions. In nearly all states the sale of game is now prohibited or much restricted and there are rigid provisions concerning the interstate transportation of game. Some states have special provisions that deer may be killed at any season when they are damaging crops, while others provide for compensation of the owner for such damage.

In addition to close seasons of a few months each year, sometimes

| State or Province | Open and Closed Seasons | | | | | | | | | | | | | | | Closed Seasons Only | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bear | Deer | Elk | Moose | Caribou | Mountain sheep | Mountain goat | Antelope | Squirrels, some species | Rabbits, some species | Opossum | Raccoon | Tapir | Paca | Anteater | Bear | Deer | Elk | Moose | Caribou | Mountain sheep | Mountain goat | Antelope | Peccary | Squirrels, some species | Sierra hare | Bison | Musk-ox |
| Alabama | x | x | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Alaska | x | x | – | x | x | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Arizona | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | – | – | x | – | x | x | – | – | – | – |
| Arkansas | – | x | – | – | – | – | – | – | x | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – | – |
| California | x | x | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | x | – | – | – | – | x | – | x | x | – | – |
| Colorado | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | – | – | – | – | x | – | x | – | – | – |
| Connecticut | – | x | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Delaware | – | – | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Florida | – | x | – | – | – | – | – | – | x | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Georgia | – | x | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | – | – | – |
| Hawaii | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Idaho | – | x | x | – | – | x | – | – | – | – | – | – | – | – | – | – | – | – | x | – | x | – | x | – | – | – | – | – |
| Illinois | – | – | – | – | – | – | – | – | x | x | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – |
| Indiana | – | – | – | – | – | – | – | – | x | x | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – |
| Iowa | – | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | – | – | – |
| Kansas | – | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | x | – | – | – | – | – | x | – | x | – | – | – |
| Kentucky | – | – | – | – | – | – | – | – | x | x | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | – | – | – |
| Louisiana | x | x | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – |
| Maine | x | x | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – |
| Maryland | – | x | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Massachusetts | – | x | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – |
| Michigan | – | x | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | x | x | x | – | – | – | – | – | – | – | – |
| Minnesota | – | x | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | x | x | x | – | – | – | – | x | – | – | – |
| Mississippi | x | x | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Missouri | – | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – |
| Montana | x | x | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | x | x | x | x | – | – | – | x | – |

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| Nebraska | – | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | x | x | – | – | x | – | x | – | – | – | – | – |
| Nevada | x | x | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | x | – | – | x | x | x | – | – | – | – | – |
| New Hampshire | – | x | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| New Jersey | – | x | – | – | – | – | – | – | – | x | – | x | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – |
| New Mexico | x | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | x | x | – | – | – | x | – |
| New York | x | x | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | x | x | x | – | – | x | – | x | – | – | – |
| North Carolina | – | x | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | x | – |
| North Dakota | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | x | x | – | – | – | x | – | – | – | – | – |
| Ohio | – | – | – | – | – | – | – | – | x | x | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – |
| Oklahoma | x | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | x | – | – | – | – | – | x | – | – | – | – | – |
| Oregon | x | x | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | x | x | – | x | x | x | – | – | – | – | – |
| Pennsylvania | x | x | x | – | – | – | – | – | x | x | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Rhode Island | – | – | – | – | – | – | – | – | x | x | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – |
| South Carolina | – | x | – | – | – | – | – | – | x | x | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| South Dakota | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | – | – | x | – | x | – | – | – | – | – |
| Tennessee | – | x | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Texas | x | x | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – | x | – | x | – | | – | – | – |
| Utah | x | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | – | – | x | x | x | – | – | – | – | – |
| Vermont | – | x | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | x | x | x | – | – | – | – | – | – | – | – |
| Virginia | – | x | x | – | – | – | – | – | x | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Washington | – | x | x | – | – | – | | – | – | – | – | – | – | – | – | – | – | – | x | x | x | x | x | – | – | – | – | – |
| West Virginia | – | x | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – |
| Wisconsin | – | x | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | x | x | – | – | – | – | – | – | – | – | – |
| Wyoming | – | x | x | x | – | x | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | – |
| Alberta | – | x | – | x | x | x | x | – | – | – | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | x | – |
| British Columbia | x | x | x | x | x | x | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | – |
| Manitoba | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | – | – | – | – | x | – | – | – | x | – |
| New Brunswick | – | x | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – |
| Newfoundland | – | – | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| N. W. Territories | – | x | – | x | x | x | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | x |
| Nova Scotia | – | x | – | x | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – |
| Ontario | – | x | – | x | x | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | – | – | – |
| Prince Edward Isl. | – | – | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Quebec | x | x | – | x | x | – | – | – | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Saskatchewan | – | x | x | – | x | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | x | – | – | – | x | – |
| Yukon | – | x | – | x | x | x | x | – | – | – | – | – | – | – | – | – | – | x | – | – | – | – | – | – | – | – | x | x |
| Mexico | x | x | – | – | – | – | – | – | – | x | – | – | x | x | x | – | – | – | – | – | x | – | x | – | – | – | – | – |

close terms of several years have been established. The following table showing the first close seasons, close terms and bag limits has been slightly modified from Palmer's compilation:[2]

| Species | First Close Season | | First Close Term | | First Bag Limit | |
|---|---|---|---|---|---|---|
| Antelope (Pronghorn) | Calif., | 1852, 1824 | Calif., | 1883 | Wyo., | 1890 |
| Buffalo (Bison)...... | Idaho, | 1864 | Colo., | 1887 | S. Dak., | 1901 |
| Caribou............ | Maine, | 1870 | N. Hamp., | 1878 | Maine, | 1883 |
| Deer............... | Mass., | 1694 | Mass., | 1718 | Maine, | 1883 |
| Elk (Wapiti)........ | Calif., | 1852, 1854 | Mich., | 1879 | Wyo., | 1880 |
| Moose............. | Maine, | 1830 | L. Island, | 1869 | Maine, | 1883 |
| Mountain goat...... | Nevada, | 1861 | Colo., | 1887 | Wash., | 1897 |
| Mountain sheep..... | Nevada, | 1861 | Colo., | 1885 | Wyo., | 1890 |
| Rabbit............. | N. J., | 1820 | None | | Wis., | 1903 |
| Squirrel............ | Penn., | 1841 | Neb., | 1905 | Ohio, Vt., | 1902 |

Laws prohibiting deer-hunting by firelight were first passed as follows: South Carolina, 1769; North Carolina, 1777; Georgia, 1790; Virginia, 1792; Mississippi, 1803; Alabama, 1822; Florida, 1828; Maryland, 1830.

The tabulation on pages 170-171 of open and close seasons has been compiled from *Game Laws for the Season 1927-1928*,[3] open seasons for members of the deer family (except caribou), mountain sheep and mountain goats usually applying only to adult males, and game commissions having power in some cases temporarily to open seasons on some completely protected species. (The bulletin for 1929-1930, received since the table was compiled, would make a few minor modifications.)

Hunters in nearly all civilized countries now are required to obtain licenses from the proper authorities. The chief purpose of this, in the United States at least, is to obtain funds for game protection and propagation, on the theory that the hunters should themselves pay for the protection of their game. That was not the purpose of the earliest license laws, which, in America, had their inception in a Virginia statute of 1691 in relation to "free trade with the Indians," forbidding hunting far from the English plantations without a "lycense and permission" from certain officers, in order to prevent "such mischeifes as have frequently happened at huntings, commonly called fire-huntings, and other huntings remote from the plantations."[4] In 1745 North

[2] Palmer, *U. S. Biol. Surv. Bull.* No. 41, p. 16, 1912.
[3] Game laws for the season 1927-1928, *Farmers' Bull.*, No. 1550.
[4] Palmer, Hunting licenses and their history, objects and limitations, *U. S. Biol. Surv. Bull.* No. 19, 1904; summary of laws by states on pp. 19-66; many changes

Carolina prohibited hunting by any person "not having a settled habitation in the" province, requiring each hunter to first obtain a certificate from officials of his county asserting "his having planted and tended five thousand corn-hills" during the preceding season or year. This was evidently aimed at hunting by irresponsible persons who were not taxpayers and at non-resident hunters. Possibly the germ of discrimination against non-resident hunters may be found in a New Jersey statute of 1719 prohibiting non-residents from "taking oysters or putting them on board a vessel not wholly owned by a resident." In most of the United States and Canadian provinces the license fee for non-residents is now much higher than that for residents. In some states non-residents are also required to employ resident guides. About 5,000,000 hunting licenses were issued in the United States in 1924, the fees for which amounted to over $6,000,000.

In many states the owner (and members of his family or his tenants) may hunt on his own property without license. Some states allow persons under a certain age to hunt without license, sometimes requiring consent of parents or guardians, and a few exempt veterans of the Civil War from the license requirement or require them to pay no fee therefor. Some states do not require a license for hunting rabbits and squirrels. In a few jurisdictions unnaturalized aliens are prohibited from hunting or the possession of firearms.

The game laws in most states contain various definite provisions relating to trespass by hunters,[5] such as requiring permission of the owner or lessee, which permission in some states must be in writing, while in a few states the owner who wishes to prevent hunting on his premises is expected to post notices to that effect. Laws against shooting from public highways and railroad rights of way are becoming more general.

Protective laws are not confined to game animals. Though it is generally known that many states have close seasons for or permanently protect beaver, many people do not seem to be aware that there are now in nearly all states close seasons for other fur-bearers, in addition to the bear and rabbit, which in some jurisdictions are protected

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since then. For summary of laws down to date see Game Laws [of the United States and Canadian provinces] for the season 1927-1928, *Farmers' Bull.*, No. 1550 1928; for 1928-1929, No. 1575; for 1929-1930, No. 1616.

[5] Palmer, Some benefits the farmer may derive from game protection, *Yearbook U. S. Dept. of Agric. for 1904*, pp. 509-520. *Farmers' Bull.*, No. 1550, 1928.

by the game laws.[6] The purpose of close seasons on fur-bearers is not only to conserve the fur supply, but also to insure a better average grade of furs, and to prevent unnecessary cruelty in trapping. Furs are in prime condition for only two or three months each year, the period varying slightly with different species and in different localities, but the extreme limits in North America being not earlier than November and not later than February, the best months being December and January. The laws should be based upon a more thorough study than yet has been made of the habits of the various species and the character of the furs coming to market from different regions.[7] That legislatures are struggling to improve the fur-animal laws is shown by the fact that changes were made in all except four states between the issuance of the summary for 1924-1925 and that of 1925-1926.

Laws for the protection of fur-bearing animals are not altogether a modern invention. The earliest of the sort that we have found was enacted in Massachusetts in 1791, prohibiting trapping during June, July, August and September. In 1821 New Hampshire provided a close season for beaver, mink, otter and muskrat from May 1 to November 1 of each year. In 1829 New Jersey and in 1830 Ohio provided a close season for muskrats.[8] The great difference of opinion among legislatures is shown by the fact that some states protect bears, muskrats, rabbits and some other species for the destruction of which bounties are paid in other states. The muskrat is protected throughout the year in a few states, with an open season of from two to five months in most states and no protection in a few. The skunk is subject to an open season of from one to three months in the great majority of states and is unprotected in the remainder, which applies also to the raccoon, except that the open season reaches five months in some states.

The laws are also extremely variable in other respects. Among other provisions of various state and provincial laws are: Provisions against poisoning fur-bearers (except such as coyotes, wolves, etc., sometimes

[6] Ashbrook, Earnshaw and Grimes, Laws relating to fur animals for the season 1927-28, *Farmers' Bull.*, No. 1552, 1928, one of a series of biennial summaries of fur laws published by the U. S. Dept. of Agric. Dearborn, Maintenance of the fur supply, *U. S. Dept. Agric. Circular* No. 135, 1920. Ashbrook, Trapping laws and the fur supply, *Journ. Mammalogy*, VI, 168-173, 1925; *Fur farming for profit*, pp. 289-292, 1928. Laut, *The fur trade of America*, pp. 151-186, 1921. Innis, *The fur trade of Canada*, pp. 49-66, 1927; *Fur farming in Canada*, pp. 135-138, 1913. Anti-steel trap legislation and the sportsman, *American Game* (*Bull. Amer. Game Protec. Assn.*), XVII, 96-97, 1928.

[7] Dearborn, *U. S. Dept. Agric. Circular* No. 135, p. 7, 1920. Lantz, The muskrat, *Farmers' Bull.*, No. 396, 1910.

[8] Lantz, The muskrat as a fur-bearer, with notes on its use as food, *Farmers' Bull.*, No. 869, 1923.

under direction of game protective officers); forbidding the use of smoke or chemicals to drive fur-bearers from their dens, or drowning them in their burrows; regulating the size and kinds of traps that may be used; forbidding the use of artificial lights in hunting them; prohibiting the destruction of the homes or runways of beaver or muskrat or the nests or lairs of any of the protected animals, or the setting of traps in or close to homes of certain animals; sometimes specifying the minimum distance, in other cases prescribing the distance traps must be placed *within* hollow logs or burrows, and frequency with which the traps must be visited, usually every 24 or 36 hours; forbidding the use of scented bait, or the flesh of game birds or mammals as bait, or explosives, spears, baited hooks, set guns, pits, deadfalls, ferrets (or firearms for certain specified animals); prohibiting the taking of muskrats during floods, when they are driven from their homes by the water, or of certain other animals when there is snow on the ground, or cutting down trees containing dens of animals (permitted for raccoons in some states); limiting the number of traps allowed to one trapper, and making it unlawful for anyone else to disturb, injure or remove his traps or remove any animal therefrom; requiring the owner to have his name and address on his traps, usually stamped on a metal tag or on the trap itself; prescribing bag limits on certain animals included among fur-bearers (bears, raccoons, etc.); regulating the shipment of furs and fur-bearing animals; provisions against shooting foxes when they are being chased by dogs; requiring trappers to procure licenses, and requiring them to make annual reports of their operations. Anti-steel trap propaganda and legislation have been discussed in the chapter on the Fur Trade.

Fur farming is now well established in nearly all the states, in most of which, as well as in Canadian provinces, there are regulatory laws. There are also federal laws concerning importation of wild animals, imposing a tariff tax therefor and regulating interstate commerce in animals, dead or alive.

We have compiled from the annual summary of the fur laws for the season of 1927-1928 a list of fur animals for which close seasons have been provided in different states and provinces.[9] It is impossible to show all the provisions exactly in the form of a simple table, as there are many exceptions to the general rules in some states. The inclusion of the bear complicates matters, as it is included among game animals

[9] Ashbrook, Earnshaw and Grimes, Fur laws for the season 1927-1928, *Farmers' Bull.*, No. 1552, 1928; for 1928-1929, see Bull. No. 1575; for 1929-1930, No. 1616.

| State or Province | Open and Close Seasons | | | | | | | | | | | | | | | | | | | | Close Season Only | | | | | | | Bag Limit | | Bounties | Trapping Licenses |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Armadillo | Bear, some species | Beaver | Fisher | Fox, some species | Kinkajou | Lynx | Marten or Sable | Mink | Muskrat | Opossum | Otter, land | Raccoon | Badger | Skunk | Ring-tailed cat | Weasel | Wolverene | Other fur animals | All fur animals | Bear | Beaver | Fisher | Marten or Sable | Mink | Otter | Raccoon | Raccoon | Bear | | |
| Alabama | | x | x | | x | | | | x | x | x | x | x | | | | | | | | | | | | | | | | | 0 | x |
| Alaska | | x | x | | x | | x | | x | x | | x | | | | | x | | | | | | | | | | | | x | x | x |
| Arizona | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | op | x |
| Arkansas | | | | | ? | | | | | | | | | | | | | | x | | x | x | | | | | | | | op | x |
| California | | x | x | x | x | | | x | | x | | x | x | | x | x | | x | | | | | | | | | | | | x | x |
| Colorado | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | op | x |
| Connecticut | | | | | x | | | | x | x | | x | x | | x | | x | | x | | | | | | | | | | | op | x |
| Delaware | | | | | x | | | | x | x | x | x | x | | x | | | | | | | | | | | | | | | 0 | x |
| Florida | | | x | | x | | | | | | | x | | | x | | | | x | | | | | | | | | | | 0 | x |
| Georgia | | x | x | | x | | | | x | x | | x | x | | | | | | | | | | | | | | | | | 0 | x |
| Idaho | | | x | x | x | | | x | x | x | | x | x | | | | | | | | | | | | | | | | | 0 | x |
| Illinois | | | | | x | | | | x | x | x | x | x | x | x | | | | | | | | | | | | | | | op | x |
| Indiana | | | | | x | | | | x | x | x | | x | | x | | | | | | | x | | | | x | | | | op | x |
| Iowa | | | x | | | | | | x | x | | x | x | | x | | | | | | | | | | | | | | | op | x |
| Kansas | | | | | | | | | x | x | x | | x | | x | | | | | | | x | | | | x | | | | x | x |
| Kentucky | | | x | | x | | | | x | | x | x | x | | x | | | | | | | | | | | | | | | 0 | x |
| Louisiana | | x | | | x | | | | x | x | x | x | x | | x | | x | | | | | x | | | | | | | x | 0 | x |
| Maine | | | | | x | | | | | x | | | | | | | | | | | | x | | | | | | | | x | x |
| Maryland | | | | | | | | | | x | x | x | x | | | | | | x | | | | | | | | | | | x | x |
| Massachusetts | | | | | | | | | x | x | | x | x | | x | | | | | | | | | | | | | x | | x | x |
| Michigan | | x | x | x | | | | x | | x | | x | x | | x | | | | | | | | | | | | | | x | 0 | x |
| Minnesota | | | | x | | | | | | x | | | | | x | | | | | | | x | | | | x | x | | | x | x |
| Mississippi | | x | | | | | | | x | x | x | x | x | | x | | x | | | | | x | | | | | | | x | 0 | x |
| Missouri | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | 0 | x |
| Montana | | | | x | x | | | | x | x | | | | | | | | | | | | x | | x | | x | x | | | op | x |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nebraska | | | x | | x | | | | x | x | x | x | x | | | | | | | | | | | | | | | | | x | x |
| Nevada | | x | x | x | x | | | x | x | | | x | x | | x | | | | | | | | | | | | | | | x | x |
| New Hampshire | | | | x | | | | x | x | x | | x | | | x | | | | | | | x | | | | | | | | x | x |
| New Jersey | | | | | | | | | x | x | | x | x | | x | | | | | | | x | | | | | | | | x | x |
| New Mexico | | x | | | | | | | | | | | | | | | | | | | | x | | | | | | | x | 0 | x |
| New York | | x | | | | | | x | x | x | | | x | | x | | | | | | | x | | | | | | | x | 0 | x |
| North Carolina | | x | | | | | | | x | x | x | x | x | | x | | | | | | | x | | | | | | | | 0 | x |
| North Dakota | | | | | x | | | | x | x | | | x | | | | x | | | | | x | | | | x | | | | x | x |
| Ohio | | | | | x | | | | x | x | x | | x | | x | | | | | | | | | | | | | | | x | x |
| Oklahoma | | | | | x | | | | | x | x | | x | x | x | | | | | | | x | | x | x | x | | | | op | x |
| Oregon | | x | x | x | | | | x | x | x | | x | x | | x | | | | | | | | | | | | | | | op | x |
| Pennsylvania | | x | | | | | | | x | x | x | x | x | | x | | | | | | | x | | | | | | | x | x | x |
| Rhode Island | | | | | | | | | x | x | | x | x | | x | | | | | | | | | | | | | | | x | x |
| South Carolina | | | | | x | | | | x | x | x | x | x | | x | | | | x | | | | | | | | | | | 0 | x |
| South Dakota | | | | | | | | | x | x | x | | x | | x | | | | | | | x | | | | x | | | x | op | x |
| Tennessee | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | x | x |
| Texas | | x | | | | | | | | x | | | | | | | | | | | | x | | | | x | | | x | op | x |
| Utah | | x | | | | | | x | x | x | | | x | | | | | | | | | x | | | | x | | | | x | x |
| Vermont | | | | x | x | | | x | x | x | | x | x | | x | | | | | | | x | | | | | | | | x | x |
| Virginia | | x | | | | | | | | | | | | | | | | | | x | | | | | | | | | | x | x |
| Washington | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | x | x |
| West Virginia | | | | | x | | | | | x | x | | x | | x | | | | | | | x | | | | x | | | | x | x |
| Wisconsin | | | | | | | | | x | x | | x | x | | x | | | | | | | x | x | x | | | | | | x | x |
| Wyoming | | | | x | x | | | x | x | x | | x | x | | | | | | | | | x | | | | | | | | 0 | x |
| Alberta | | | | x | x | | | x | x | x | | | | | | | | | | | | x | | | | | | | | x | x |
| British Columbia | | x | x | | | | | | | x | | | | | | | | | x | | | | | | | | | | x | x | x |
| Manitoba | | | | x | x | | x | x | x | x | | x | | | | | | | | | | x | | | | | | | | x | x |
| New Brunswick | | | | x | x | | | x | x | x | | x | | | | | | | | | | x | | | | | | | | x | x |
| Newfoundland | | | | | x | | x | x | | x | | x | | | | | | | | | | x | | | | | | | | x | x |
| N. W. Territories | | | x | x | x | | | x | x | x | | x | | | | | | | | | | | | | | | | | | x | x |
| Nova Scotia | | | | | | | | | | | | | | | | | | | x | | | x | x | x | | | | | | 0 | x |
| Ontario | | | x | x | x | | | x | x | x | | x | x | | | | | | | | | | | | | | | | | x | x |
| Pr. Edward Isl. | | | | x | | | | x | x | x | | x | x | | x | | | | | | | x | | | | | | | | 0 | x |
| Quebec | | x | x | | x | | | | | | | x | | | | | | | x | | | | | | | | | | | x | x |
| Saskatchewan | | | | x | x | | x | x | x | x | | x | | | | | | | | | | x | | | | | | | | x | x |
| Yukon | | | | | x | | x | x | x | x | | x | | | | | | | | | | | | | | | | | | 0 | x |
| Mexico | x | x | x | | | x | | | | | | | | | | | | | | | | | | | | | | | | 0 | x |

op = optional with county authorities.
0 = no bounty law.

also, and in New Mexico the license required seems to be only the usual hunting license required for hunting bears. In many instances close seasons apply only to certain counties, and in case of foxes and bears the law in some states applies only to certain species, not to all. In Newfoundland the governor may open the season on beaver, with a bag limit of twenty. Various other exceptions will be found by an examination of the laws themselves or the annual summary thereof.

The payment of bounties for the destruction of noxious animals has been on trial in North America for several centuries, and there are very serious doubts as to whether this method has accomplished much. There are a number of objections to it. Certainly it has not resulted in the extermination of any injurious animals, and as a result of much experience bounty laws have lost a great deal of their former popularity, though such laws still exist in one form or another in a majority of the states.[10] There were bounty acts in force in some of the American colonies nearly four centuries ago, and nearly every state in the Union has at some time had bounty laws on the statute books. In 1905 all but eight states had such acts, including in their scope, in one state or another, the following mammals: Puma (mountain lion), lynx, wolf, coyote, fox, bear, woodchuck, prairie-dog, squirrel, rabbit, raccoon, weasel, skunk, mink, seal and sea-lion. Bounty laws in some states still include the same mammals, together with ground squirrels, pocket gophers and even muskrats. There is great lack of uniformity in the laws, some species being destroyed as pernicious animals in one state and protected as useful animals in another. The modern tendency is especially in the direction of removing all fur-bearers (weasels, skunks, minks, muskrats, etc.) from the bounty list. Bears are protected in many states and a subject of bounty in one or two.

Nearly all experienced writers on the subject question the efficacy of bounties, especially as to the abundant rodents, and believe that better results would come from the expenditure of bounty funds in systematic, wide-spread campaigns under the direction of men of special training and experience in that line of work, a subject more fully discussed in a preceding chapter. In order to do much good bounties must be high, making that method very expensive, and resulting in much fraud. For example, when bounties on coyotes are high, unscru-

[10] Palmer, Extermination of noxious animals by bounties, *Yearbook U. S. Dept. Agric. for 1896*, pp. 55-68. Lantz, Bounty laws in force in the United States, *ibid.*, for 1907, pp. 260-265.

pulous individuals raise them for the bounty market, coyote-raising, according to Palmer, having at times been more profitable in some states than sheep-raising. Others take the scalps, skins and other parts required to support claims for bounties, from a county or state where the bounty is low to one where it is higher, and obtain the higher bounty by misrepresenting the locality in which the animals were obtained. Bailey says that sometimes trappers have taken parent coyotes from the den, leaving the pups to grow up, in order to obtain the higher bounty paid for adults than for pups.[11] Lantz says that bounties on coyotes and wolves have been tried for many years and on the whole have not materially reduced the numbers of these animals.[12]

Dixon condemns the bounty on coyotes as very expensive, productive of endless fraud and failing to give general or permanent relief, but approves coyote-proof fences under favorable circumstances, and considers the most effective methods to be trapping, poisoning with strychnine, digging out dens of the young, and shooting in coöperative campaigns between state and federal authorities.[13] In Minnesota bounties have been paid on wolves for half a century, to a total of over \$1,000,000, and since 1903 the annual expenditure has slowly increased.[14] One may well wonder whether there may not be a more effective and less costly method. In 1916 bounties were paid in British Columbia on 210 wolves, 221 mountain lions and 17,352 coyotes, and in Saskatchewan, from 1907 to 1917, bounties were paid on 204,421 coyotes and 1200 gray wolves, to the amount of \$310,000, but it is admitted that the effort to control these animals by means of bounties is not a success there.[15] Lucas says that in Kansas a \$2.00 bounty on coyotes and five cent bounty on rabbits caused the destruction of coyotes, natural enemies of rabbits, and consequently an increase in the number of rabbits, instead of reducing the rabbits.[16] California for years tried the bounty system on mountain lions, the bounty in 1917 being from \$20 to \$30 and in thirteen years paid bounty on 3627 lions,

[11] Bailey, Wolves in relation to stock, game and forest reserves, *U. S. Forest Service Bull.* No. 72, 1907.

[12] Lantz, The relation of coyotes to stock raising in the west, U. S. Dept. Agric., *Farmers' Bull.*, No. 226, 1906.

[13] Dixon, Control of the coyote in California, *California College of Agric. Bull.* No. 20, pp. 379-397, 1920; *Journ. Mammalogy,* II, 176, 1921. As to fraud, see *Bird Lore,* XXXII, 247-248, 1930; citing Official Record, U. S. Dept. Agric., March 27, 1930.

[14] *Journ. Mammalogy,* IX, 89, 1928.

[15] Hewitt, *The conservation of the wild life of Canada,* pp. 198-204, 1921.

[16] Lucas, *Ann. Rept., U. S. Nat. Museum for 1889,* p. 612.

an average of 280 per annum, and then employed a trained lion hunter with his dogs.[17] In a campaign against rabid coyotes in two California counties in 1916 by the United States Forest Service, United States Biological Survey and California Board of Health, 2707 coyotes were killed, while in the same period bounties were paid on 1474.[18]

Bounties are particularly ineffective and wasteful in dealing with the abundant rodent pests. Dixon says that, with such abundant animals, if the bounty is high enough to do any good the cost is prohibitive. If too low, trapping is indulged in only until their numbers are reduced to the point where it becomes unprofitable,[19] then they are allowed to multiply until trapping again becomes profitable, which is not long with such prolific animals, thus giving trappers almost continuous employment and resulting in no permanent reduction in the rodent population. Bell, Bailey and Barrows all comment on the inefficiency of bounties in fighting such animals as ground squirrels, prairie-dogs, pocket gophers, rabbits, etc.[20] Palmer says that after paying bounties on jack rabbits in one county for fifteen years they were still so abundant that the annual bounty expense was greater than at the beginning.[21] At least one very recent writer[22] has defended the bounty system for the control of predacious mammals, but that does not necessarily carry with it the approval of bounties on prolific rodents.

Several other classes of laws concerning mammals are closely related to bounty laws, as their purpose is the control or destruction of animals that may for any reason be detrimental to human interests. Such, for example, are: (1) Laws designed to prevent the importation of noxious animals of any sort and giving the Department of Agriculture jurisdiction, with power to make and enforce regulations for that purpose. (2) Quarantine laws, to prevent taking diseased animals from an infected area to an uninfected one. (3) Laws providing for the destruction of domesticated animals afflicted with communicable diseases. (4) Laws requiring the muzzling of dogs during rabies epi-

[17] Hunter, *California Fish and Game,* VII, 99-101, 1921. Bruce, *California Fish and Game,* VIII, 108-114, 1922; XI, 1-17, 1925. *California Fish and Game,* III, 120, 1917.

[18] *California Fish and Game,* III, 120-121, 1917.

[19] Dixon, Control of the California ground squirrel, *California Agric. Exper. Sta. Circular* No. 181, 1917.

[20] Bell, *Yearbook U. S. Dept. Agric. for 1917,* pp. 225-233. Bailey, *U. S. Div. Ornith. and Mam. Bull.* No. 4, pp. 18-24, 1893; No. 5, pp. 25-26, 1895. Barrows, *ibid.,* No. 3, pp. 161-162.

[21] Palmer, The jack rabbits of the United States, *U. S. Biol. Surv. Bull.* No 8, 1897.

[22] Avery, Bounties or government trappers, *Field and Stream,* Dec. 1930, p. 8.

demics and the confinement of vicious dogs at other times. (5) Laws prohibiting owners from permitting their stock to run at large on highways or public lands, and concerning responsibility for damage done by stock to crops or other property. (6) Laws in some of western states providing for the destruction of wild horses, which have become a nuisance in some localities.[23]

Dog license laws are in force in many states and municipalities for the purpose of fixing ownership of dogs valued by their owners, in order that strays and homeless dogs may be disposed of, and many thousands of worthless strays are destroyed each year by the authorities. The total amount of fees collected from dog licenses in the United States is considerable. As dogs sometimes acquire the habit of killing sheep and poultry and worrying other stock, the loss from this cause being large in some localities, many states now have laws explicitly fixing responsibility for damage to livestock by dogs and defining the right of the owner of stock to destroy dogs found at large on his premises.[24] Because of their destructiveness to poultry and wild birds, cat laws have been adopted in some jurisdictions and proposed in others.[25] There is no good reason why the provisions of the dog laws, with some possible modifications, should not be applied also to cats, hundreds of thousands of which, homeless and ownerless, are running at large in this country. It must be remembered, however, as Forbush has pointed out, that even cats and dogs have some legal rights, and especially should those who contemplate setting out poison for these domesticated animals remember that there are in many jurisdictions stringent laws concerning the use of poisons.

Because rats greatly increase the fire hazard, as well as because of their general destructiveness and their activity as disease carriers, it has been suggested that the building laws of cities should require the rat-proofing of buildings.[26]

[23] Palmer, The danger of introducing noxious animals and birds, *Yearbook U. S. Dept. Agric. for 1898*, p. 88.

[24] Coll, Sheep-killing dogs, *Farmers' Bull.*, No. 1268, 1922; revision, by Simmons, *Farmers' Bull.*, No. 1268, 1924.

[25] *California Fish and Game*, I, 42, 1914. *Bird Lore*, XIX, 178, 1917; XXI, 330, 1919. *Wilson Bull.*, No. 105, p. 118, 1918. Henderson, *The practical value of birds*, pp. 32, 33, 77-78, 100-103, 111. Forbush, The domestic cat, *Massachusetts State Board of Agric., Econ. Biol., Bull.* No. 2, pp. 97-108, 1916.

[26] Silver, *Farmers' Bull.*, No. 1533, p. 20, 1927.

## XXVIII

## METHODS OF INVESTIGATION IN ECONOMIC MAMMALOGY

As in the much more highly developed science of economic ornithology, in economic mammalogy there are three different lines of evidence, of unequal importance, upon which to base conclusions: Purely circumstantial evidence, direct observation or the testimony of eye witnesses, and the examination of the contents of stomachs. In a general way, circumstantial evidence is the least reliable and most likely to be misleading of the three. A mountain lion may kill a calf. After it has fed, a rain may descend and obliterate the tracks of the big cat. Then a bear comes along and feeds upon the carcass, leaving his tracks to prove his guilt to the satisfaction of the owner of the calf, who promptly begins a round-up of the bears of the vicinity, and the guilty party escapes punishment because of the lack of evidence against him. However, as in human courts of justice, some kinds of circumstantial evidence, under some circumstances, may be the very strongest sort, conclusive and incontrovertible.

Direct observation, though usually more satisfactory, is not always so. It depends upon several things, such as the powers of observation of the observer, his opportunity for accurate observation, his complete freedom from prejudice or pre-conceived notions, and so on. In observations of this sort one is likely to be influenced by what he expects to see, and thus to reach a very definite conclusion based upon a very flimsy foundation of real fact. Many mistakes have been made in exactly this way in both ornithology and mammalogy. Yet in some instances careful observation by competent, unprejudiced observers, under favorable conditions, may afford as definite and conclusive proof as any other possible means.

The well-preserved contents of the stomach is conclusive as to at least that portion of the last meal eaten by the individual. Therefore, if a sufficient number of stomachs be examined and their contents are well enough preserved to be recognized with certainty, they would be the most reliable evidence of the diet of the species in the particular locality at the particular season of the year. If enough stomachs were available, taken at various seasons of the year at many localities, one could closely approximate the average food of the species as a whole. Just this has been done with many species of birds. Some progress has been made along this line with mammals, but the work is now in its infancy. We must face one difference that handicaps the mammalogist. Birds do not chew their food, but mammals do. In the stomachs of insectivorous birds many insects may be found in condition for positive identification. In the stomachs of bats the insects are usually finely comminuted, often making only very general identifications possible. Hawks and owls swallow mice whole. Weasels do not swallow their prey whole, except the smaller kinds. This difficulty, however, is not as great as has often been supposed, and the future should see progress along this line of investigation accelerated. Dixon says:

> Of course, we recognize at once that fur-bearing mammals have series of sharp teeth with which to rend and cut their prey, while hawks and owls have only hooked beaks. People have assured me that it would be impossible to identify stomach contents of fur-bearing mammals because, they were confident, the food would be too well masticated. This has not proved to be the case. I have found the contents of wild-cats' stomachs to be quite similar to the stomach contents of horned owls. From my own experience I know that there are relatively few carnivorous mammals in which the identification of food remains is not feasible. I have found the food of the otter chewed the finest and hence most difficult to identify. Minks are much easier than otter. Bobcats and mountain lions just chop up their food and swallow it in chunks, as do also coyotes and foxes. Even beavers and muskrats do not chew their food as finely as we might suppose, and identification is, even in their cases, not usually difficult. I have found the following to be the best clues by which stomach contents of fur-bearers may be identified. Mammal remains can be identified by the presence of teeth, feet, claws and hair. Birds may be best told by feet, claws and bills. Feathers are sometimes difficult to identify. The hard parts of insects, particularly mouth parts, wings and legs, assist in identification. Fortunately in insects the species involved are for the most part of large size, well known, and hence easily identified. The skin and feet of toads and frogs help in identification, as do also the scales of fishes.[1]

Having determined the facts concerning the food of a given species, in order to reach a safe conclusion concerning the economic status of the species under investigation, its food habits must be considered in the light of all that is known of the intricate interrelations of the various organisms in its diet, their respective food habits, their usefulness or harmfulness, their abundance and so forth. A balance must also be struck between its economic status arising from its food habits

[1] Dixon, Food predilections of predatory and fur-bearing mammals, *Journ. Mammalogy*, VI, 34, 1925.

and its possible status as a source of meat, fur or other useful commodities. All this requires an extensive and accurate knowledge of natural history, common sense, good judgment, open mind and conscientious devotion to truth.

Another difficulty that must be squarely faced is that, unless one be constantly on guard and fully informed, the contents of the stomachs may be misleading as to the habits of their former possessors. Certain predatory animals are also scavengers, and feed upon carcasses of animals they have found already dead. Thus the hair of a horse or cow or the wool of sheep may be found in the stomach of a coyote, which would not necessarily prove that it killed the sheep, and almost certainly would not prove that it killed the horse or cow. All evidence in scientific investigations should be carefully scrutinized and used with sound discretion.

# *Part II*

# *Systematic Discussion*

## SYSTEMATIC DISCUSSION

We have not considered it necessary, in a work of this sort, to enter into all the refinements of modern zoological classification and nomenclature, as the names of orders, families and other groups are herein used only for the purpose of bringing certain groups of species together and discussing their economic status, not for the purpose of exhibiting their physical relationships. Indeed, it would be impossible to conform exactly to all the modern systems of classification, as there is too much difference of opinion among the various authorities. The relationship of organisms is not end on end, but rather, in a general sense, in the form of a tree, hence strictly accurate and logical classification and arrangement end on end in a book or a list is impossible. Furthermore, too much yet remains to be learned for anyone to say the final word as to classification or nomenclature. We hope to be pardoned if in some instances we have used terms familiar to those not engaged in technical taxonomy, but not approved by some taxonomists. It has not been our intention to include all known families or other groups of mammals, but we have endeavored to include all groups of economic importance in North America north of Mexico, with many from foreign countries.

### Order MONOTREMATA—Primitive Egg-laying Mammals

This, the lowest order of mammals, is confined to the Australasian region, where it is represented by about four living species. Though of but little economic consequence, it is of very great scientific interest. The food of the duck-billed platypus (*Ornithorhynchus anatinus*) is said to consist of aquatic insects, small crustaceans, worms and the like. The spiny anteaters (*Echidna,* 3 species) feed chiefly upon termites ("white ants"), for which their long snouts and longer, slender, glutinous tongues are specially adapted.

### Order MARSUPIALIA—Oppossums, Kangaroos and Their Allies

This order, much more generally distributed in the geological past, is now greatly restricted in range and reduced in number of species, yet the economic importance of the order is considerable, not only because of the food habits of the various species, but also because the flesh of some of them is prized and their pelts find a ready market. The actual reported sales of marsupial skins during the seasons of 1919, 1920 and 1921 were as follows:[1]

| | |
|---|---|
| American opossum | 9,987,742 |
| Australian opossum | 4,265,621 |
| Wallaby (kangaroo) | 1,722,588 |
| Ring-tailed opossum (phalanger) | 1,321,625 |
| Wombat | 208,977 |
| Kangaroo | 41,238 |
| Kolinsky (Koala) | 1,151,553 |

The American opossum is found in 29 states of the United States. It is partially protected by law in 20 states, with close seasons of from two to four and one-half months each year.[2] Its combined value because of its fur and highly prized flesh makes it worthy of protection elsewhere. Kansas produced 350,286 opossum skins during the trapping season of 1927-1928 for which dealers paid $350,000.[3] It is nearly omnivorous, its diet including eggs, young birds, young rabbits, mice, rats, and other rodents, all sorts of small game, many kinds of insects, crustaceans, mollusks, frogs, salamanders, mushrooms, muskmelons, vegetables and fruits of many kinds, bacon, carrion and whatever else is conveniently at hand.[4] One stomach of the Florida opossum (*Didelphis virginiana pigra* Bangs) contained a horned lizard and bird feathers, besides meat used for trap bait; two stomachs were filled with crayfish, one was full of carrion from a dead hog, and in another were traces of maggots and carrion. It feeds extensively on crayfish and other crustaceans. The Virginia opossum (*D. virginiana virginiana* Kerr) is especially fond of chickens and eggs and in summer feeds extensively on fruit.[5] An opossum in captivity ate a blacksnake three feet and eight inches long.[6] Such damage as they do in occasional raids upon smokehouses and henhouses may be prevented by proper precautions in the construction and care of the buildings, and their destruction of wild birds is not anywhere serious enough to balance the value of their flesh and skins.

[1] Osborn and Anthony, *Journ. Mammalogy,* III, 226, 1922; *Natural History,* XXII, 393, 1922. Compare Innis, *The fur trade of Canada,* table opp. p. 76, 1927.

[2] Ashbrook, *Journ. Mammalogy,* VI, 168-173, 1925.

[3] Dose, *Kansas Fish and Game,* No. 2, p. 67, 1928.

[4] Lincecum, The opossum, *Amer. Naturalist,* VI, 555-557, 1872. Howell, *N. Amer. Fauna,* No. 45, p. 18, 1921. Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Natural Resources,* p. 451, 1909.

[5] Bailey, *N. Amer. Fauna,* No. 25, pp. 56-57, 1905.

[6] Lewis, Opossum in captivity, *Journ. Mammalogy,* x, 167-168, 1929.

At the present time marsupials are more diverse in character and more numerous in Australasia than anywhere else. Probably the kangaroo is better known to the people of the world than any other Australian mammal, and known to more people than is any other marsupial except possibly the American opossum. It is so characteristic of that region that a picture of it appears on a series of Australian postage stamps. The flesh of kangaroos is eaten with relish and the skins find their way to the world's markets in large numbers.

The following items concerning Australasian marsupials have been abstracted from Jennison:[7] Wombats (Phascolomyidae), entirely herbivorous, feeding upon grass, roots and vegetables. Bandicoot (Paramelidae), "food—fallen fruit, berries, corn, worms and insects"; "the commonest carnivorous animals of Papua, Australia and Tasmania"; "nocturnal burrowing animals that do much damage and are persecuted accordingly." Thylacine (Dasyuridae), "the largest carnivorous marsupial," "so destructive to sheep that a price is set on its head and its numbers are fast decreasing." Tasmanian devil (Dasyuridae), "very strong, murderous beasts that kill everything in their power, even sheep which are many times their size," "but tamable and amusing." Common dasyure, "catch and kill cockatoos and are as efficient as cats in catching rats and mice"; "at times do damage to poultry, though the birds are in general too large game."

Koala, or tree bear (Phalangeridae), feeds on leaves and vegetables; "is now very rare; disease carried off thousands in 1887-1889 and again in 1900-1903." It is not a member even of the same order as the true bears, but is an arboreal, nocturnal marsupial—a very unique and interesting animal whose extinction is imminent unless every reasonable effort is made to preserve it. Its extermination would be deplorable. The figures given on a preceding page for the sales of koala skins may be misleading, as in the fur trade the name "koala" is often applied to sheared and dyed skins of the wallaby, which is a different animal.[8] However, since the taking of koalas was made illegal throughout Australia, we are informed that over 600,000 pounds of koala skins have been shipped from Queensland under the name "wombat."[9]

*Caenolestes,* South American marsupials, "examination of three

[7] Jennison, *Natural history—animals,* pp. 329-334, 1927.
[8] Ashbrook, Trade names in the fur industry, *Journ. Mammalogy,* IV, 216-220, 1923.
[9] *Sydney Evening News,* July 6, 1929, quoted in *Journ. Mammalogy,* X, 374, 1929.

stomach contents reveals remains of weevils, caterpillars, lepidopterous pupa, adult lepidopteran, leg fragments of orthopteran, tipulid larva, centipede, spider. Dipterous and lepidopterous remains form the major portion (in one case 60 per cent). Animals caught in traps showed preference for meat bait."[10] Anatomically adapted to feeding upon insects.

## Order INSECTIVORA—Moles, Shrews, Hedgehogs

### Family TALPIDAE—Moles

Moles are accused of damaging newly planted corn and injuring potatoes and other field and garden crops and bulbs, but they usually simply push the bulbs, tubers and other roots aside without much injury as they burrow their tunnels, mice entering the tunnels and doing most of the damage by eating the roots, the diet of the moles being "composed largely of insects and earthworms."[1] One month after Townsend's moles were released in a newly planted garden, 30 out of 70 of their tunnels were in possession of field mice and one each possessed by rats, gophers and ground squirrels, the rodents destroying the seeds, but "seeds and vegetables were never found in the stomachs of moles taken from newly planted or growing gardens."[2] Their tunnels and mounds, however, do certainly disfigure lawns and do some damage to pastures, gardens and fields, in addition to providing runways which enable mice to get at the roots, though on the other hand the resulting soil turnover is of some advantage to the land in certain places.[3] In 65 days a captive mole made 1252 pits, an average of 19 daily.[4] In discussing the large amount of food eaten by moles, Hisaw says:

> When the amount of work that a mole is capable of doing in a single night is considered, one can readily see the necessity for such stupendous amounts of food. Lydekker (1901) mentions the formation of a burrow about 100 yards long during a single night. If a man weighing 160 pounds were to do

[10] Gregory, On the "habitus" and "heritage" of Caenolestes, *Journ. Mammalogy,* III, 106-114, 1922.

[1] Howell, *N. Amer. Fauna,* No. 45, p. 20, 1921. Couch, Mice and moles, *Journ. Mammalogy,* v, 264, 1924. Scheffer, The common mole of the eastern United States, *Farmers' Bull.,* No. 583, 1914; *Farmers' Bull.,* No. 1247, p. 12, 1922.

[2] Wight, Food habits of Townsend's mole, Scapanus townsendii (Bachman), *Journ. Mammalogy,* IX, 19-33, 1928.

[3] Grinnell, The burrowing rodents of California as agents in soil formation, *Journ. Mammalogy,* IV, 137-149, 1923; *Ann. Rept. Smithsonian Inst. for 1923,* pp. 339-350. See also a preceding chapter on relation of mammals to soil turnover, etc.

[4] Hisaw, Observations on the burrowing habits of moles (Scalopus aquaticus machrinoides), *Journ. Mammalogy,* IV, 79-88, 1923.

a proportionate amount of work in the same time, he would have to dig a hole about 47.9 miles long and large enough in diameter to admit his body freely. The fossorial habit of the mole demands a great expenditure of physical effort in the pursuit of food. Ordinarily the animal has to remove earth equal to several times its own body weight for each morsel.[5]

When it becomes necessary to get rid of moles or to thin them out, poisoning is not very practicable and trapping must be resorted to, for which purpose special mole traps have been designed and are on the market.[6]

Hisaw,[7] citing West, Dyche and Scheffer, has reported on the food habits of several subspecies of the common American mole (*Scalopus aquaticus*), as follows: 34 stomachs—earthworms, 31 per cent; adult insects, 23 per cent; insect larvae, 29 per cent; vegetable matter, 13 per cent (citing West, 1910, but a paper by West, cited in the footnote herewith, says 56 stomachs—insects and larvae, 62 per cent; earthworms, 26 per cent; spiders, myriapods, etc., 1 per cent; corn, 8 per cent; other vegetable matter, 3 per cent); 67 stomachs, 17 empty—in remaining 50, earthworms, 42.2 per cent; ground beetles, 22.7 per cent; grubs and larvae, 27 per cent; vegetable matter, 3.7 per cent (citing Dyche); 200 stomachs—one contained 171 white grubs; one contained 250 ant puparia; 10 cutworms in one; 12 earthworms in one; seeds and grain in a few; earthworms and white grubs their principal food; in the Northwest chiefly earthworms (citing Scheffer). In Hisaw's own experiments, 6 moles daily ate 32.08 per cent of their own weight in food for from 28 to 36 days; one, after being deprived of food for twelve hours, ate 66.6 per cent of its own weight in food. One might be excused for supposing, from these figures, that a 160-pound man, in order to equal the mole in feeding capacity, would have to eat 51.32 pounds of food a day, as Hisaw figures it, but it must be remembered that most of the food eaten by men is more concentrated than that of moles, hence the man would require proportionately less of it in weight.

In 100 stomachs of the star-nosed mole (*Condylura cristata* Linn) taken throughout the year, 2.2 per cent of the food consisted of verte-

[5] Hisaw, Feeding habits of moles, *Journ. Mammalogy,* IV, 9-20, 1923.

[6] Scheffer, American moles as agricultural pests and as fur producers, *Farmers' Bull.,* No. 1247, pp. 17-19, 1922.

[7] Hisaw, Feeding habits of moles, *Journ. Mammalogy,* IV, 9-20, 1923. West, A study of the food of moles in Illinois, *Bull. Illinois Lab. Nat. Hist.,* IX, 14-22, 1910. Dyche, Food habits of the common garden mole, *Trans. Kansas Acad. Sci.,* XVIII, 183-186, 1903. Scheffer, *Farmers' Bull.,* No. 147, 1922, superceding Bulls. No. 583 and 833. Wilson, The economic status of the mole (Scalops and Condylura), *Pennsylvania Dept. Agric. Bull.* No. 30, 1898.

brate remains, 2.2 per cent Mollusca, 6.5 per cent Crustacea, 30 per cent Insecta, 49 per cent Annelida, 8 per cent extraneous matter.[7a]

In 91 stomachs, earthworms and beetle larvae formed the bulk of the contents, with some slugs, grasshopper eggs, beetles, millipedes and centipedes, and a few contained a little vegetation.[8] Of 36 stomachs, 27 contained earthworms (7 only earthworms), 27 contained insects, mostly injurious (9 insects only), 10 contained a little vegetation, in all but 2 evidently taken accidentally.[9] In 306 Townsend's moles (*Scapanus townsendii*), 72.5 per cent of the contents was earthworms, a much larger percentage than in the common mole, and the balance was mostly insects, with some slugs and centipedes.[10] The earthworm item may not be altogether to the mole's credit, but in their destruction it probably seldom, if ever, does much damage, and sometimes it does some good, where the worms become too plentiful in gardens and pastures. One California mole stomach was "filled with angleworms."[11] A captive mole in ten hours ate 7 cutworms and 48 earthworms, and a four-hour fast during the day produced definite weakening.[12] A Brewer's mole (*Parascalops breweri*), in captivity, in 24 hours ate "50 large white grubs, one chestnut worm, one wireworm, one cicada nymph, 45 larvae of rose bugs and 13 earthworms," leading to the conclusion that in one year one mole would eat 40,000 insects and worms, weighing over 50 pounds.[13] Moles have been known to destroy wasps' nests in the ground and to eat the larvae and pupae,[14] and we are told of a rat-eating mole.[15]

Nature is very complex, and there may be biological interrelations which make it unwise to destroy all the moles in gardens and lawns, even when they appear to be doing some damage. Seton[16] repeats a story, for which he does not vouch, of a Holland gardener whose lilacs and other flowering bushes were all blighted after he had trapped

[7a] Hamilton, "Habits of the star-nosed mole, *Condylura cristata*," *Journ. Mammalogy,* XII, 245-255, 1931.

[8] Dunnan, The common garden mole of Iowa, *Iowa State Exper. Sta. Circular* No. 88, 1924.

[9] Rhoads, *Mammals of Pennsylvania and New Jersey,* p. 201, 1903; citing Wilson, The economic status of the mole (Scalops and Condylura), *Pennsylvania Dept. Agric. Bull.* No. 30, 1898.

[10] Wight, Food habits of Townsend's mole, Scapanus townsendii (Bachman), *Journ. Mammalogy,* IX, 19-33, 1928.

[11] Dirks, Mole eats angleworms, *California Fish and Game,* V, 99, 1919.

[12] Howell, Mole notes, *Journ. Mammalogy,* IV, 253, 1923.

[13] Brooks, Notes on the habits of mice, moles and shrews, *West Virginia Univ. Agric. Exper. Sta. Bull.* No. 113, 1908; cited in *Journ. Mammalogy,* IX, 21, 1928.

[14] Brooks, Moles destroy wasps' nest, *Journ. Mammalogy,* IV, 183, 1923.

[15] Garrett, Rat-eating mole, *The Field* (London), CXLVIII, 205, 1926; *Journ. Mammalogy,* VII, 340, 1926.

[16] Seton, The value of moles, *Journ. Mammalogy,* IV, 51, 1923.

all the moles from his walled-in garden. "Experts" told him that the "trouble is you have no moles." Thereupon "he restored the moles and the blight disappeared." The fact that lilacs and most of the usual flowering shrubs of gardens thrive where there are no moles seems to be a serious objection to the truthfulness of the story. However, if it be true it suggests an interesting and important subject for serious investigation. It is known that some plants thrive only on soil which has been recently disturbed. It is not at all impossible that the stirring and aeration of the soil through the operations of burrowing animals may be decidedly beneficial, if not necessary, to some kinds of useful or ornamental plants.

Scheffer says: "In periods when moleskin garments were in fashion, or when the skins were to be obtained at all, the volume of American business in furs of this class sometimes reached between $2,000,000 and $3,000,000 annually. The Biological Survey has found that the skins of the common mole of the eastern United States are well within the class of the imported product . . . while the skins of the common large mole of western Washington and Oregon are larger and have better texture and fur than those of Europe. . . . About $50,000 worth of American moleskins were marketed in 1918, and in 1919 the business increased by nearly 25 per cent. This does not take into account the value of moleskins utilized at home. Furthermore, values of the manufactured products—moleskin garments, fur sets and fur trimmings—will approximate at least five times that of the raw peltry."[17]

In 1921 it was estimated that the world's production of moleskins was 6,000,000 per annum, and, according to Laut, 600 are required for a short evening wrap and 1000 for a long one.[18] Actual reported sales of moleskins for the world in 1919-1921 amounted to 23,801,908 skins,[19] and the estimate for 1923-1924 was 10,000,000 from Europe and 500,000 from North America.[20]

### Family SORICIDAE—Shrews

Shrews are too small for their skins to have much value, but they live to a great extent upon insects and are very useful animals. Anthony says: "Although living largely on insect food which cannot put

[17] Scheffer, *Farmers' Bull.*, No. 1247, p. 20, 1922.
[18] Laut, *The fur trade of America*, p. 142, 1921.
[19] Osborn and Anthony, *Journ. Mammalogy*, III, 226, 1922; *Natural History*, XXII, 393, 1922.
[20] Innis, *The fur trade of Canada*, table opp. p. 76, 1927.

up much resistance, shrews undoubtedly kill and eat mice whenever the rodents are encountered under circumstances which allow the shrew to close in a rough-and-tumble fight. Mice put into cages with shrews are dispatched with a celerity that indicates this is by no means a new experience for the shrew."[21] While shrews will eat white-footed and field mice in traps, it is said that they will not eat trapped weasels; but, on the other hand, "it is well known that most animals, both wild and domestic, will not eat the short-tailed shrew" (*Blarina brevicauda*).[22] Nevertheless, two weasel stomachs contained remains of this shrew and weasels have often been seen carrying dead shrews.[23]

"On the whole, shrews are among the most beneficial mammals," in proportion to their size and numbers, "of considerable economic value in holding down certain pests of agriculture;" the stomachs of *Sorex* examined containing "Hymenoptera, Coleoptera, Diptera, caterpillars, crickets, spiders, hair and flesh of shrews and mice, moss, seeds and other vegetable material," and they eat rolled oats used for bait in traps, and earthworms; water shrews (subgenus *Neosorex*) eat also small fish and perhaps fish eggs, but are not common enough to do much harm in fish ponds and trout streams; 35 per cent of the contents of one marsh shrew (subgenus *Atophyrax*) stomach was snails, but otherwise it did not differ much from other shrews; and "nothing is known of the food of the members of the genus *Microsorex*" (the pigmy shrews).[24]

"While many of our small mammals must be considered enemies and destroyed in every possible way, fortunately some, as the shrews, may be classed as wholly beneficial and their presence welcomed on the farm," according to Bailey, who discusses the North Dakota species.[25] Hayden masked shrew (*Sorex cinereus haydeni*)—"The principal part of their food, as shown by the stomach contents, consists of insects, earthworms and the small animal life found over the surface of the ground." Short-tailed shrew (*Blarina brevicauda brevicauda*)—Food about the same as the preceding, including mollusks. Water shrew

[21] Anthony, *Field book of North American mammals,* p. 34, 1928. Plummer, *Amer. Journ. Sci,* XLVI, 237-241, 1844. Merriam, *Mammals of the Adirondacks,* 1884. Shull, *Amer. Nat.,* XLI, 495-522, 1907. Hamilton, *Journ. Mammalogy,* XI, 27-33, 1930. Babcock, *Science,* XL, 526-553, 1914. Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Nat. Res.,* p. 601, 1908 (1909).

[22] Kirk, Shrews and weasels, *Journ. Mammalogy,* II, 111, 1921.

[23] Hamilton, Weasels eat shrews, *Journ. Mammalogy,* IX, 249, 1928; citing Adams, *Mem. and Proc. Manchester Lit. and Phil. Soc.,* LIV, No. 10, p. 2, 1910.

[24] Jackson, A taxonomic review of the long-tailed shrews, U. S. Biol. Survey, *N. Amer. Fauna,* No. 51, pp. 10-11, 1928.

[25] Bailey, A biological survey of North Dakota, U. S. Biol. Surv., *N. Amer. Fauna,* No. 49, pp. 200-207, 1926. See Babcock, Some observations on the food habits of the short-tailed shrew (Blarina brevicauda, *Science,* XL, 526-530, 1914, for summary of literature.

(*Neosorex palustris*)—"The stomachs and intestines of those taken are usually found to contain particles of insects and small animals so well masticated that the species are not easily recognized."

Shrews and moles "get numerous ants, wireworms, cutworms and white grubs, and undoubtedly do more good than harm. The short-tailed shrew has proved to be one of the principal enemies of the larch sawfly, and in New Brunswick it has been ascertained that 40 per cent of the cocoons are destroyed by this shrew."[26] It is quite fond of land snails, one having eaten 130 *Polygyras* in two months, and 15 per cent of the food of the specimens under observation by Shull was snails, 40 per cent meadow mice and 5 per cent earthworms.[27] Others took crickets and moths and "ate with avidity anything of an animal nature, including pieces of salty chipped beef."[28] A captive gray shrew (*Notiosorex crawfordi*) was very fond of mealworms, from 4 to 7 large ones constituting a day's ration, but it refused a salamander and earthworms.[29] La Valette listed the water shrew (*Crossopus,* or *Neomys*). with the enemies of fishes[30] and Haack says that "shrew-mice" (wasser-spitzmausen) in brooks are "well-known enemies of the eggs and young of fish."[31] It is very doubtful whether any shrews do much real damage to either fishes or their eggs.

One long-tailed shrew, of three in close confinement, killed and ate the other two in eight hours.[32] A short-tailed shrew in captivity is reported to have killed and partly eaten a two-foot water snake.[33] Others are said to have killed salamanders.[34] Dusky shrews (*Sorex obscurus obscurus*) in captivity ate grasshoppers, stinkbugs and other insects, earthworms and watermelon rinds.[35]

The following table, combining data furnished by Hamilton,[36] shows

[26] McAtee, The rôle of vertebrates in the control of insect pests, *Ann. Rept. Smithsonian Inst. for 1925,* pp. 416.

[27] Shull, Habits of the short-tailed shrew, Blarina brevicauda (Say), *Amer. Naturalist,* XLI, 495-522, 1907. Howell, *N. Amer. Fauna,* No. 45, p. 21, 1921. Hamilton, *Journ. Mammalogy,* XI, 27-30, 33, 1930. Clench, *Nautilus,* XXXIX, 28, 1925. Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Nat. Hist.* (for 1908), p. 601. Babcock, *Science,* XL, 526-530, 1914.

[28] Klugh, Notes on habits of Blarina brevicauda, *Journ. Mammalogy,* II, 35, 1921.

[29] Dixon, Notes on the life history of the gray shrew, *Journ. Mammalogy,* V, 1-6, 1924.

[30] La Valette, The enemies of fish, *Rept. U. S. Fish Comm. for 1878,* pp. 509-516.

[31] Haack, Trapping kingfishers, rodents and other enemies of trout, *Bull. U. S. Fish. Comm.,* IV, 375-376, 1884.

[32] Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Nat. Res.,* p. 606, 1908 (1909), quoting Merriam.

[33] Cope, On the habits of a species of Blarina, *Amer. Nat.,* VII, 490-491, 1873.

[34] Hamilton, *Journ. Mammalogy,* XI, 33, 1930.

[35] Miller, A note on the dusky shrew in captivity, *Journ. Mammalogy,* XI, 311-312, 1930.

[36] Hamilton, The food of the Soricidae, *Journ. Mammalogy,* XI, 26-39, 1930.

the number of shrew stomachs of various species which contained food of the various sorts mentioned, and the percentage that each kind of food contained bears to the total contents.

| Food | *Blarina brevicauda* | | *Sorex cinereus* | | *Sorex fumeus* | | *Sorex albibaris* | |
|---|---|---|---|---|---|---|---|---|
| Total number of stomachs | 244 | | 62 | | 31 | | 13 | |
| | Number | Per cent food | Number | Per cent food | Number | Per cent food | Number | Per cent food |
| Insects | 212 | 47.8 | 54 | 65.3 | 30 | 70.4 | 13 | 78 |
| Worms | 44 | 7.2 | 2 | 4.3 | 4 | 3.4 | 1 | 4.4 |
| Mollusks | 26 | 5.4 | 2 | 1.4 | | | 1 | |
| Centipedes | 19 | 3.8 | 8 | 6.8 | 8 | 4.9 | | |
| Millipedes | 9 | 1.7 | 2 | | | | | |
| Crustaceans | 25 | 6.7 | 4 | 1.2 | 2 | 2.8 | | |
| Arachnids | 11 | 2 | 4 | .9 | | | | |
| Vegetable | 48 | 11.4 | 6 | 1.1 | 4 | 3.6 | 2 | 3.1 |
| Vertebrates | 21 | 4.1 | 6 | 7.1 | 2 | 3.6 | | |
| Inorganic | 24 | 2.3 | 4 | .9 | 1 | | 1 | 1.5 |
| Empty | 6 | | | | | | | |

### Family TUPAIIDAE—Tree Shrews

This family is found from India and China to the Philippines, Java and Sumatra. Their cheek teeth show that their food "must be largely insects. Many observers say they naturally eat fruit as well." All the evidence seems to show that their food is chiefly insects, with some fruit buds, fish and eggs, and one species is said by natives to kill small birds, mice, etc.[37] They are closely related to an African terrestrial family of Insectivora, the Macroscelididae.

### Family ERINACEIDAE—European Hedgehogs

The hedgehogs are largely insectivorous, but take also any invertebrates and small vertebrates they can obtain, and even carrion. They are included among the enemies of land snails.[38] "Hedgehog pie is accounted very appetizing by the gypsies, who bake it in clay, the bristles coming away with the clay covering. Porcupines are cooked the same way."[39]

## Order CHIROPTERA—Bats and Flying Foxes

Nearly all of the species of North American bats are very useful creatures. Their food consists almost entirely of night-flying insects,

[37] Lyon, Tree shrews: An account of the mammalian family Tupaiidae, *Proc. U. S. Natl. Museum,* XLV, 1-188, 1913.
[38] Pilsbry and Bequaert, *Bull. Amer. Museum Nat. Hist.*, LIII, 479, 1927.
[39] Jennison, *Natural history—animals,* p. 141, 1927.

including many kinds of injurious moths and beetles not often taken by insectivorous birds of diurnal habit.[1] In the dusk of early evening and on moonlight nights they may be seen flying about seeking and catching their prey, their erratic flight being the result of the search for and pursuit of insects.

Though they certainly perform a great service to mankind in keeping many troublesome and harmful insects within bounds, their value as destroyers of mosquitoes may not be so great as many people have supposed. Several years ago much newspaper publicity was given a book based upon the theory that the encouragement of bats by the erection of "bat towers" would not only rid the adjacent region of mosquitoes, but would also provide a revenue from the guano they would deposit,[2] this being simply the waste from the insects eaten by the bats. The experiment described was very interesting, but in most regions the accumulation of guano would be too slow to yield much revenue, and a study of the flight habits of bats, together with an examination of their pellets and guano, do not support the belief that they are very large consumers of mosquitoes.[3] This is not because of any aversion to mosquitoes as a diet, but probably because the usual flight of the bats is too high to catch the swarms of mosquitoes, especially the malaria mosquitoes, which fly not far above the ground. Consequently the supposed efficacy of bats in preventing mosquitoes from spreading malaria is not well founded. Localities where bats are very numerous are often afflicted with malaria and clouds of mosquitoes. However, bats do sometimes fly near the ground, even capturing beetles and other insects on the ground, and doubtless do take some mosquitoes. Fargo attributed the absence of mosquitoes from Bird Key, Florida, to the presence of bats, mosquitoes being numerous on neighboring keys, where there were no bats,[4] a rather strong case based upon circumstantial evidence. In this connection we might say that the popular notion that bats harbor and distribute bedbugs seems to be without foundation.

[1] Grinnell, Bats as desirable citizens, *California Fish and Game Comm. Teachers' Bull.*, No. 6, 1916.

[2] Campbell, *Bats, mosquitoes and dollars,* 1925.

[3] Storer, Bats, bat towers and mosquitoes, *Journ. Mammalogy,* VII, 85-90, 136-138, 1926; *Science,* LXIII, 337-338, 1926. Goldman, *Journ. Mammalogy,* VII, 136-138, 1926. McAtee, The rôle of vertebrates in the control of insect pests, *Ann. Rept. Smithsonian Inst. for 1925,* p. 416. Nelson, Bats in relation to the production of guano and the destruction of mosquitoes, *U. S. Dept. Agric. Bull.* No. 1395, 1926. Howard, Mosquitoes and bats, *U. S. Public Health Reports,* XXXV, pp. 1789-1795, 1920. Hall, Economic value of the Mexican free-tailed bat, *California Fish and Game,* XII, 136-137, 1926.

[4] Fargo, Bats of Indian Key, Tampa Bay, Florida, *Journ. Mammalogy,* X, 203-205, 1929.

As the activity of bats during flight demands a great deal of food and there is not much nourishment in most flying insects, the quantities of insects consumed by a large colony of bats is enormous. The Pipistrelle bats (*Pipistrellus subflavus subflavus*) are found with stomachs "distended with small dipterus and coleopterus remains."[5] The stomachs of little canyon bats (*Pipistrellus hesperus*) taken early in the evening, after twenty minutes of flight, were invariably found to be gorged with freshly eaten insects,[6] and probably they usually take several such meals each night when insects are abundant. It has been estimated that at such times each free-tailed bat (*Tadarida cyanocephala*) will nightly eat enough insects to equal its own weight or more.[7]

Two little brown bats (*Myotis lucifugus*) in captivity preferred noctuid moths and took from eight to ten at a meal, with meals half an hour apart, handling moths as large as the red underwing.[8] Pellets of the California leaf-nosed bat (*Macrotus californicus*) contained two species of grasshoppers, four of moths, with harvest flies, beetles and the gorged viscera of an insect, probably a grasshopper.[9] Pellets of Say's bat (*Myotis subulatus*) contained remains of numerous Diptera, spiders, a scarabaeoid beetle and a cuckoo-fly.[10] Pellets of the Pacific pallid bat (*Antrozous pallidus pacificus*) contained remains of Jerusalem crickets, scorpions, a beetle and fragments of other insects, including grasshoppers.[11] It is said that the destruction of bats in Germany in 1800 caused an increase of processional moths which ruined the trees of a large region.[12]

Bats sometimes, in the daytime, hang from the walls of caverns and similar places in prodigious numbers, emerging in the evening in swarms and scattering over the surrounding country in search of insects. The accumulation of guano in the roosting caverns in the course of centuries forms deposits of commercial importance. It was estimated that on one May evening 100,000 bats emerged from the great Carlsbad Cavern

[5] Hamilton, *Journ. Mammalogy*, XI, 307, 1930.

[6] Bailey, Biological survey of Texas, *N. Amer. Fauna*, No. 25, pp. 210-211, 1905; Harmful and beneficial mammals of the arid interior, with special reference to Carson and Humboldt Valleys, Nevada, *Farmers' Bull.*, No. 335, p. 31, 1908.

[7] Nelson, *U. S. Dept. Agric. Bull.* No. 1395, 1926.

[8] Pittman, Notes on the feeding habits of the little brown bat, *Journ. Mammalogy*, V, 231-233, 1924.

[9] Huey, Food of the California leaf-nosed bat, *Journ. Mammalogy*, VI, 196-197, 1925.

[10] Seton, A roving band of Say's bats, *Journ. Mammalogy*, III, 52, 1922.

[11] Hatt, Food habits of the Pacific pallid bat, *Journ. Mammalogy*, IV, 260-261, 1923. See also Grinnell (Hilda Wood), A synopsis of the bats of California, *Univ. California Pub. Zool.*, XVII, 235-255, 1918. Nelson, *Nat. Geog. Mag.*, XXXIII, 493, 1918.

[12] Schmeil, *Textbook of Zoology*, p. 66.

in southern New Mexico. When this cavern was discovered years ago, guano filled some of the largest rooms to a depth of 100 feet, coming up nearly to the openings, and sloping away for hundreds of yards over the cave floor, representing a great many centuries of deposition. It is estimated that 100,000 tons of it have been removed and marketed at from $20 to $75 per ton, or a total of much more than $2,000,000.[13]

The food of British insectivorous bats consists chiefly of injurious moths and beetles. Leisler's bat (*Nyctalus leisleri*) one hour after sunset was found crammed full of insects. The water bat (*Myotis daubentoni*) feeds largely on caddis-flies. A mouse-eared bat ate 1500 house-flies in one night, and another ate 80 grasshoppers in one night.[14] The oriental bats of the genus *Megadermus* feed largely on small birds and even on other bats.[15]

One group of bats (*Noctilio*), found in Porto Rico, Trinidad, and Virgin Islands, has formed the habit of eating fishes. There have been many observations of their scooping the surface of the water, apparently for food, and there is some direct evidence of their eating fish. A number of stomachs examined contained nothing but fish, though many contained insects, such as beetles, ants, mole-crickets, with some spiders.[16] They probably do little or no harm and much good.

A small family of South American bats, which reach much greater size than the North American bats, sometimes with a wing expanse up to 28 inches, have acquired the name vampires from their habits of sucking the blood of other mammals, including human beings. Two species have been said to subsist entirely upon a diet of blood.

The flying foxes, or fruit bats (Pteropodidae), ranging from Africa to Japan, Australia and Polynesia, reaching a large size and feeding chiefly upon fruit, are abundant in some places and very destructive to tree fruits. One Malay species is said to have a body eighteen inches long, with a wing expanse of five feet from tip to tip. The United States government is constantly on guard to prevent their introduction into the United States.[17]

[13] Bailey, Bats of the Carlsbad Cavern, *Natl. Geog. Mag.*, XLVIII, 321-330, 1925; *Animal Life of the Carlsbad Cavern*, pp. 108-129, 1928. Nelson, *U. S. Dept. Agric. Bull.* No. 1395, 1926.

[14] Poulton, British insectivorous bats and their prey, *Proc. Zool. Soc. London for 1929*, pp. 277-303.

[15] Poulton, *Proc. Zool. Soc. London for 1929*, p. 300.

[16] Benedict, Notes on the feeding habits of Noctilio, *Journ. Mammalogy*, IX, 58-59, 1928. Goodwin, Observations on Noctilio, *Journ. Mammalogy*, IX, 104-112, 1928.

[17] Palmer, The danger of introducing noxious animals and birds, *Yearbook U. S. Dept. Agric. for 1898*, pp. 96-98.

## Order CARNIVORA—Flesh-Eating Mammals

### Family URSIDAE—Bears

The flesh of bears is used for food, but they are not plentiful enough to make a notable contribution to the world's meat supply. However, in some sparsely settled regions and where protected from hunters, as in our national parks, they are still fairly common. The bears of Yellowstone National Park afford a great deal of amusement to many thousands of tourists each year. They are also common in some of the other parks. It was reported that in 1925 there were 44,326 black bears and 5593 grizzlies in the areas set aside in the United States as national forests.[1] Bears also furnish entertainment to both children and adults in zoological parks and menageries.

Bear skins are in demand for the manufacture of rugs and coats. From 1889 to 1892 about 11,000 bear skins were annually obtained by the Hudson Bay Company, but since 1900 the season's catch has declined, and in 1915 the company reported only 4500 skins.[2] The decrease in the United States has been as great, and over a large portion of their former range bears have been exterminated. However, it has been estimated that the total production of bear skins in North America in 1923-1924 was 25,000.[3] In 1919, 472 bears were killed in Pennsylvania.[4]

As a general thing, wild American bears are not dangerous to human beings if unmolested. Of course, if we act in such a manner as to indicate that we intend to interfere with its actions or to endanger it or its young, we can scarcely blame the bear for attacking, but instances of unprovoked attacks of bears upon men and women in America are rare. When the circumstances of the reported cases are carefully analyzed it is usually found that there is some provocative condition.[5] For example, the grizzly that killed a rancher in Montana had been caught in a trap, from which it had broken loose, and consequently it was in an angry mood.[6] Henshaw once said that though the grizzlies of the Rocky

[1] Adams, *Roosevelt Wild Life Bulletin,* III, opp. p. 558, 1926.
[2] Hewitt, *The conservation of the wild life of Canada,* p. 108, 1921.
[3] Innis, *The fur trade of Canada,* table opp. p. 76, 1927.
[4] *California Fish and Game,* VII, 65, 1921.
[5] Bonebrake, An instance of an unprovoked attack by a brown bear, *Journ. Mammalogy,* III, 185, 186, 1922. Sheldon, The "unprovoked" attack by a brown bear, *Journ. Mammalogy,* IV, 51-52, 1923. Grinnell (G.B.), The "unprovoked" attack by a bear, *Journ. Mammalogy,* IV, 52-53, 1923. Seton, *Lives of game animals,* II, Part 1, pp. 46-54, 108-111, 167-169, 217-218, 1929; citing also Bruette, *Forest and Stream,* June 22, 1907, p. 974.
[6] Skinner, Rancher killed by a grizzly bear in Montana, *Journ. Mammalogy,* IV, 53, 1923.

Mountains seldom attack human beings, in the Sierras "stories of unprovoked attacks by grizzlies are frequent, and not few are the lives lost in such encounters."[7] Perhaps he was not careful in ascertaining and analyzing the facts. Nevertheless, it should be remembered that any carnivorous animal of such size and strength is potentially a dangerous creature, for it may imagine itself or its young in danger when such is not actually the case. In 1895 bears killed twelve persons in India, mostly natives.[8]

Much has been written about the destructiveness of bears to game and domestic stock. There can be no doubt that they do kill both, but probably they do not quite live up to their reputation in this respect.[9] It may be, too, that only an occasional individual acquires this habit, as in the case of "man-eating" lions. It must be admitted that if bears were more abundant, resulting in greater competition for food, they would likely destroy more stock and game. If other food were easily obtained, they would probably not go to the trouble of killing large animals, but an animal pressed by hunger will go to almost any extent to obtain food. An occasional "killer" may do great damage, just as a sheep-killing dog does. A famous grizzly is believed by stockmen to have killed one cow every other day during the active season for fifteen years, a total of over 1200 cows, one daily during the fourteenth season and 34 in one ten-day period.[10]

Possibly the stock-killing and game-killing reputation of bears is partly due to the fact that they are seen feeding upon carcasses or their tracks seen about carcasses of animals which have died natural or accidental deaths or been killed by mountain lions. The latter are strictly carnivorous, requiring fresh meat and doing their own killing, but bears are omnivorous and carrion-feeders. Bruce, a state lion hunter in California, who has had much experience with bears and mountain lions, says that "the black bear is not by nature a killer," and that in every case investigated by him the bear was found to be innocent.[11] Anthony says he has often investigated accusations of bears killing sheep

[7] Henshaw, *Rept. Chief of Engineers, U. S. Dept. War,* for 1876, Part 3, p. 528.

[8] F.C.K., Deaths from wild animals and snakes in India, *Amer. Nat.,* XXXI, 77-78, 1897.

[9] See Seton, *Lives of game animals,* II, Part I, pp. 27-31, 160-162.

[10] Mills, Grizzly's high-power nose, *Atlantic Monthly,* CXXIX, pp. 36-40, 1922.

[11] Bruce, The black bear in relation to stock, *California Fish and Game,* IX, 16-18, 1923. See also Which is the outlaw, the sheepman or the bear, *Outdoor Life,* LXVI, May, 1930. Armijo, The sheepman's fight against wild life, *Outdoor Life,* LXVI, 40, 1930. Spencer, New light on bear protection and overgrazing, *Outdoor Life,* LXVI, 40-41, 1930.

and has "never yet found a clear case of killing by the bear."[12] On the other hand, Lorenzen says he saw a bear kill a sheep, but does not believe they are all killers.[13] A. H. Howell reports the killing of an elk calf by a black bear[14] and A. B. Howell charges the Florida black bear with the destruction of calves and hogs.[15] Seton reports their having killed deer and moose.[16]

Bailey says the grizzy kills cattle, deer and other large mammals.[17] Bell estimates the damage done by a stock-killing bear at $500 per annum, much higher than that done by any other animal except the wolf and mountain lion.[18]

That bears are omnivorous is well known and may be easily observed about the camps and garbage dumps in our western national parks. They eat all sorts of fresh meat, carrion, insects, plants, roots, nuts, etc. They may often be seen turning over logs and rocks in the search for worms, insects and other invertebrates. Like all omnivorous animals, they take the food that is most readily obtained when they are hungry, selecting their food only when not very hungry. Two men with bear hounds killed 182 bears within a radius of 10 miles from their ranches, in order to protect their hogs, which were feeding upon acorns in the oak thickets, but when the acorns were falling in sufficient quantity the bears would leave the hogs alone and eat acorns.[19] Ligon says bears in New Mexico are "unexcelled" in locating remote or isolated areas which are favored with an acorn, juniper or pinyon mast, and in California they frequent oak groves to "feast upon the rich harvest of acorns."[20]

Bears are particularly fond of bees and their honey, and one destroyed about fifty hives of honey bees in a few nights.[21] One Vermont bear stomach contained no animal matter, but was filled with vegetable matter, chiefly Indian turnip.[22] An Oregon bear ate the berries from a small

[12] Anthony, *California Fish and Game,* IX, 59, 1923.
[13] Lorenzen, A sheep-killing bear, *California Fish and Game,* IX, 151-152, 1923.
[14] Howell, A. B., The black bear as a destroyer of game, *Journ. Mammalogy,* II, 36, 1921.
[15] Howell, A. H., *N. Amer. Fauna,* No. 45, p. 29, 1921.
[16] Seton, *Lives of game animals,* II, Part I, pp. 163, 1929.
[17] Bailey, *N. Amer. Fauna,* No. 49, p. 193, 1926.
[18] Bell, Hunting down stock killers, *Yearbook U. S. Dept. Agric. for 1920,* pp. 289-300.
[19] Bailey, Biological survey of Texas, *N. Amer. Fauna,* No. 25, pp. 186-192, 1905. Brooks, *Forest and Stream,* January 10, 1914, p. 17, as cited by Seton, *Lives of game animals,* II, Part I, pp. 160-162, 1929.
[20] Ligon, *Wild life of New Mexico,* p. 95, 1927. Henshaw, *Ann. Rept. Chief of Engineers, U. S. Dept. War,* for 1876, Part 3, p. 528.
[21] Bailey, *N. Amer. Fauna,* No. 25, pp. 188-192, 1905; No. 49, p. 191, 1926.
[22] Sanborn, The food of the black bear, *Amer. Naturalist,* VI, 493, 1872.

cascara tree, with the usual strongly cathartic result.[23] In Mount Ranier National Park bears were found in autumn feeding upon "nearly all kinds of fleshy fungi," and their excreta "was composed almost wholly of huckleberry leaves, seeds and entire berries," with some "unidentified leaves and grasses."[24] According to Hewitt, insects constitute a large part of the diet of black bears, stomachs having been found filled with May-flies and shad-flies, while they also rob nests of bees, wasps and ants, and are fond of fish. He adds: "I have seen orchards bordering the woods assiduously robbed by bears."[25] Dixon reports one that tried to gnaw into a woodpecker's nest.[26] Rowan says they may be seen searching lake shores for eggs of wild ducks.[27] Taverner tells of circumstantial evidence indicating that bears climb trees after eggs of hawks.[28] Allen says that in Labrador, during periods of great abundance of mice, bears feed largely upon these rodents, and feed upon berries when mice are scarce.[29] In Alaska, during the salmon run, bears feed very extensively upon fish, which they catch in the water, but also take berries, squirrels and all sorts of other food.[30] La Valette long ago listed bears among the enemies of fish,[31] but they probably do no serious damage to the fisheries, unless it be where bears are rather numerous and fishes are going up the streams in large schools so that they may be rather easily caught. It would require a large number of bears to catch as many salmon as one fish trap or seine takes in one day. According to Seton, the food of the polar bear (*Thalarctos maritimus*) consists of fish, flesh, grass, etc.[32]

Protests are now being urged against an alleged plan to exterminate the bears of Kodiak Island, Alaska, though at least one writer thinks the brown bears of that territory are adequately protected and in no danger of annihilation.[33]

[23] Bailey, Bears and cascara berries, *Journ. Mammalogy,* IV, 53-54, 1923.
[24] Taylor and Shaw, Mammals and birds of Mount Rainier National Park, pp. 38-39, 1927.
[25] Hewitt, *The conservation of the wild life of Canada,* pp. 108-110, 1921. On insect eating, see Seton, *Lives of game animals,* II, Part 3, pp. 157-158, 1929.
[26] Dixon, Black bear tries to gnaw into a woodpecker's nest, *The Condor,* XXIX, 271-272, 1927.
[27] Rowan, Bears and birds' eggs, *The Condor,* XXX, 246, 1928.
[28] Taverner, Bears and hawks, *The Condor,* XXX, 157, 1928.
[29] Allen, review of Cabot's Labrador, in *Journ. Mammalogy,* III, 56-57, 1922.
[30] Osgood, *N. Amer. Fauna,* No. 24, 1904. On fish-eating, see Seton, *Lives of game animals,* II, Part 1, pp. 158-159, 1929.
[31] La Valette, The enemies of fish, *Rept. U. S. Fish Comm.* for 1878, pp. 509-516 (translated from the German).
[32] Seton, *Lives of game animals,* II, Part 1, pp. 217-218, 1929.
[33] Compare McGuire, The last stand of the bear, *Outdoor Life,* LXVI, 4-7, 1930, with Pegues, Alaska's brownies, *Field and Stream,* Dec., 1930, pp. 36-37, 62.

## Family PROCYONIDAE—Raccoons

The common American raccoons (*Procyon lotor* and various subspecies) are omnivorous, feeding upon fish, frogs, small mammals, birds and their eggs, mollusks, crustaceans, fruits, nuts, and sometimes killing poultry.[1] Their flesh is wholesome and highly esteemed by many people, and their fat furnished early American settlers with oil for domestic purposes. Their fur is also in great demand. In 1913 it was estimated that 600,000 raccoon skins were marketed annually at about $4.50 each.[2] The reported sales in 1919-1921 totalled 1,713,700 skins.[3] Raccoons are protected by law in 37 states, with open seasons of from one to five months. According to Bailey, they seem to be capable of opening the shells of such heavy-shelled Unionidae as *Quadrula* and *Lampsilis,* and one stomach contained a meadowlark.[4]

The coati or coatimundi (*Nasua*) is said to feed chiefly upon fruit and insects, but is omnivorous, taking also small mammals, birds, lizards, etc., and playing "havoc among the poultry." Stomachs examined by Goldman contained fruit pulp only.[5] The kinkajou (*Cercoleptes*) of the same region eats birds, mammals, and fruit, and its fondness for sweet fruits is said to be responsible for the name given it by the natives, meaning honey bear.[6]

## Family BASSARISCIDAE—Bassarisks

The bassarisks, cacomistles or ring-tailed cats (*Bassariscus*), of which several subspecies are found in the southwestern United States, have a variable diet, including "any small animal life, mammals, birds, insects, centipedes and fruit."[7] "Most of the stomachs of *Bassariscus* examined have been found to contain the bones and hair of small rodents, which make up also most of the excrement found along ledges and in caves where the animals live." They have been reported as eating

[1] Bailey, *N. Amer. Fauna,* No. 49, p. 187, 1926. Howell, *N. Amer. Fauna,* No. 45, p. 35, 1921. Seton, *Lives of game animals,* II, Part I, pp. 242-245, 1929.

[2] Jones, *Fur farming in Canada,* p. 70, 1913. Laut, *The fur trade of America,* p. 84, 1921. Innis, *The fur trade of Canada,* table opp. p. 76, 1927. Seton, *Lives of game animals,* II, Part I, pp. 230-256, 1929, places the average annual catch from 1821 to 1891 at 385,000.

[3] Osborn and Anthony, *Natural History,* XXII, p. 393, 1922

[4] Bailey, *N. Amer. Fauna,* No. 25, pp. 192-195, 1905.

[5] Seton, *Lives of game animals,* II, Part I, pp. 258-269, 1929, citing Azara, *Quadrupeds of Paraguay,* pp. 318-319, 1801. Belt, *The naturalist in Nicaragua,* edition of 1888, pp. 120-121. Goldman, Mammals of Panama, *Smithsonian Miscell. Coll.,* LXIX, No. 5, p. 154, 1920.

[6] Jennison, *Natural history—animals,* pp. 119, 120, 1927.

[7] Bailey, *Animal life of Carlsbad Cavern,* p. 105, 1928. Anthony, *Field Book of North American mammals,* p. 91, 1928.

fruit and one stomach contained a large centipede.[8] As summed up by Nelson, their food consists of almost anything, especially insects, rodents and fruit, and they rob chicken roosts.[9]

The name civet cat is often applied to the bassarisk, which is unfortunate, as that term is also applied to the spotted skunks, and should be confined to the true civet cats of Asia and Africa. This misuse of the name by trappers and fur traders makes it impossible to ascertain how many bassarisk skins may be included in reports and estimates of civet cat fur production. Innis definitely estimates that 40,000 bassarisk skins were marketed from America in 1913.[10]

### Family VIVERRIDAE—Mongooses and Civet Cats

The mongooses, sometimes spelled "mungooses" (*Herpestes*), eat almost any small animals, both vertebrate and invertebrate, and sometimes fruit and vegetables, and are listed among the enemies of poisonous reptiles.[11] Of nine stomachs, one contained termites and two were filled with driver ants.[12] In Africa they are known to eat snails.[13] They are rated as excellent mousers and ratters, and for that reason were introduced into Jamaica, Cuba, Porto Rico, Barbados, Santa Cruz and the Hawaiian Islands. After reducing the rats so that they no longer furnished them sufficient food, they naturally turned their attention to other small animal life, and have done much damage by the destruction of young pigs and lambs, poultry, eggs, wild birds and small mammals, almost or quite exterminating some species of birds.[14] A difference of opinion concerning the economic status of mongooses in Barbados is indicated by the fact that in 1917 a committee of the House of Assemblies recommended that their legal destruction be continued, while in 1911 a commission recommended that the law providing for their destruction be repealed, because of their value as rat catchers.[15] The re-

[8] Bailey, *North Amer. Fauna,* No. 25, pp. 182-184, 1905.

[9] Seton, *Lives of game animals,* II, Part 1, p. 581, 1929, citing Nelson, *Wild animals of North America,* p. 587.

[10] Innis, *The fur trade of Canada,* table opp. p. 76, 1927.

[11] Jennison, *Natural history—animals,* pp. 82-83, 1927. Ingersoll, *The life of animals,* pp. 152, 154, 1907.

[12] Bequaert, The predacious enemies of ants, *Bull. Amer. Museum Nat. Hist.,* XLV, 328, 1922.

[13] Pilsbry and Bequaert, The aquatic mollusks of the Belgian Congo, *Bull. Amer. Museum Nat. Hist.,* LIII, 479, 1927.

[14] Morris, The mungoose on sugar plantations in the West Indies, 1883, reviewed in *Amer. Naturalist,* XVII, 299, 1883. Earle, The mungoose in Jamaica, *Forest and Stream,* XXXIX, 69, 1892. Wetmore, Birds of Porto Rico, *U. S. Dept. Agric. Bull.* No. 326, pp. 38, 67, 1916. Palmer, The danger of introducing noxious animals and birds, *Yearbook U. S. Dept. Agric. for 1898,* pp. 87-100.

[15] Ballou, Rats in the West Indies, *Agricultural News,* Barbados, XVIII, 406-407, 1919; *Journ. Mammalogy,* I, 192-193, 1919.

port showed that the number of rats killed and paid for under the rat law from 1908 to 1911 was 56,578, while the number of mongooses killed under the mongoose law during the same period was 33,974. Great precautions are being taken to prevent the introduction of mongooses into the United States and some other countries where they have not yet obtained a foothold.

The food habits of the true civet cats of Asia and Africa are similar to those of the mongooses. In the fur trade, 80,000 civet cat skins were credited to Asia for 1923-1924.[16] The 600,000 from America for the same period were doubtless mostly skunk skins, with perhaps a few bassarisks.

### Family MUSTELIDAE—Weasels, Martens, Wolverenes, Minks, Otters, Skunks, Badgers

Though a vast number of excellent furs come from the order Rodentia, and from Canidae, Phocidae and other families, the family Mustelidae is considered pre-eminently the family of fur-bearers. Nearly all of the species furnish furs of considerable value in proportion to their size. Though some of them do considerable damage in raids upon poultry roosts and in the destruction of wild birds, yet they more than compensate for it by the destruction of rodents and insect pests and by their furs. The damage to poultry may be prevented by properly constructed poultry-yard fences and poultry houses. The flesh of Mustelidae is not considered valuable as food for human beings.

In 1902 the sale of furs of three semi-aquatic species was reported as follows:[1]

| | *United States* | *World* | *Value* |
|---|---|---|---|
| Mink | 578,000 | 728,000 | $1,140,000 |
| Otter | 14,000 | 33,640 | 264,110 |
| Sea otter | 330 | 590 | 239,540 |

In 1921 the following estimate was made of the number of mustelid skins produced annually in the world:[2]

| | | | |
|---|---|---|---|
| Ermine | 1,000,000 to 1,100,000 | Sable | 175,000 to 235,000 |
| Marten | 150,000 to 210,000 | Skunk | 1,200,000 to 1,500,000 |
| Stone marten | 250,000 to 380,000 | Fisher | 10,000 |
| Fitch (polecat) | 300,000 to 350,000 | Otter | 90,000 to 124,000 |
| Mink | 640,000 to 1,000,000 | Badger | 160,000 to 180,000 |

[16] Innis, *The fur trade of Canada,* table opp. p. 76, 1927.
[1] Stevenson, Utilization of the skins of aquatic animals, *Rept. U. S. Fish Comm. for 1902,* pp. 283-353.
[2] Laut, *The fur trade of America,* p. 84, 1921.

Actual sales for 1919-1921 were reported as follows:[3]

| | | | |
|---|---|---|---|
| Skunk | 6,895,674 | Fisher | 32,014 |
| Weasel or ermine | 3,492,412 | Marten | 309,808 |
| Mink | 1,683,900 | Stone marten | 107,075 |
| Sea otter | 76 | Sable | 57,908 |
| Land otter | 111,059 | European polecat | 1,094,411 |

The following fur table has been compiled from statistics furnished by Seton:[4]

Average Annual Catch of Skins

| | Hudson Bay Fur Co. | | Other American Companies | | Canadian | |
|---|---|---|---|---|---|---|
| | Year | Catch | Year | Catch | Year | Catch |
| Badger | 1842–1905<br>1895–1905 | 1278<br>2445 | 1858–1891 | 2000 | 1919–1924 | 3469 |
| Skunk | 1848–1905<br>1895–1905 | 5216<br>9425 | 1858–1891 | 287281 | 1919–1924 | 109462 |
| Land Otter | 1821–1905<br>1895–1905 | 10481<br>8898 | 1821–1891 | 6285 | 1919–1924 | 12089 |
| Weasel (Ermine) | | | | | 1919–1924 | 407593 |
| Mink | 1821–1905<br>1895–1905 | 41219<br>57729 | 1821–1891 | 112587 | 1919–1924 | 165681 |
| Pine Marten | 1821–1905 | 82418 | 1821–1891 | 36781 | 1919–1924 | 51086 |
| Fisher (Pennant's Marten) | 1821–1905 | 4493 | 1821–1891 | 4424 | 1919–1924 | 3953 |
| Wolverene | 1821–1905<br>1895–1905 | 1192<br>726 | 1821–1891 | 149 | 1919–1924 | 1145 |

In 1927 the following estimate of world production for 1923-24 was published:[5]

Ermine, 1,000,000 from Asia, 300,000 from Europe, 1,000,000 from North America.

Badger, 30,000 from Europe (100,000 in 1913), 20,000 from North America, 25,000 from Asia and Africa.

Mink, 300,000 from North America.

Otter, 40,000 from Europe, 30,000 from North America, 10,000 from South America, 5,000 from Africa.

[3] Osborn and Anthony, *Journ. Mammalogy,* III, 226, 1922; *Natural History,* XXII, 393, 1922; in the first paper the number of mink is given as 1,683,900, in the second as 2,540,000.

[4] Seton, *Lives of game animals,* II, 1929.

[5] Innis, *The fur trade of Canada,* table opp. p. 76, 1927.

Sable, 6,000 from Asia, 400,000 (marten) from North America.
Skunk, 3,500,000 from North America, 100,000 from South America.
Siberian polecat, 600,000 from Asia.
Civet (probably spotted skunk), 600,000 from North America.

The civet cat items is a good illustration of the confusion arising from use of trade names by trappers and furriers, which prevent one from obtaining accurate statistics in some cases. That name is applied to the North American spotted skunks, the bassarisks, and the true civet cats of Asia and Africa. Osborn and Anthony, in their first list, give the number of civet cat skins sold in 1919-1921 as 2,114,535, perhaps including several distinct species and families, but omit that item from their second list.

*Subfamily Mustelinae*—MARTENS, FISHERS, WEASELS, FERRETS, MINKS, ETC.

The food of the American pine martens (*Martes americana* and subspecies) consists chiefly of small mice and insectivores, but they take also rabbits, squirrels, birds and their eggs, insects, reptiles, toads, frogs, lizards, fish, berries, and various other food.[6] They are very fond of mountain ash berries.[7] Their fur has long been in demand, 15,000 having been handled by the Hudson Bay Company as far back as 1743. The Pennant marten or fisher (*Martes pennanti* and subspecies), notwithstanding its popular name, is not aquatic and is not known to catch fish, though it takes fish as bait in traps. Its food is about the same as that of the pine marten, and porcupine quills were found in one stomach.[8] Comeau says that he found one with 200 porcupine quills in its body, and has since killed 40 fishers, each one of which had such quills in its body.[9] Other writers testify to the porcupine-attacking habit of the fisher, and one is reported to have attacked a deer, while another defeated a dog.[10]

In 1906, twenty-four very fine marten pelts sold in London for $70 each, but in the fur boom year of 1920 the best pelts brought $210 each.[11] Skins of the Pennant marten in 1912 brought from $75

[6] Coues, *N. Amer. Mustelidae,* p. 92, 1877. Bailey, *N. Amer. Fauna,* No. 49, p. 176, 1926. Seton, *Lives of game animals,* II, Part 2, pp. 482-515, 1929.
[7] Hardy, A fall hunt in Maine, *Forest and Stream,* May 21, 1910, p. 810; Hunter, *Canadian wilds,* p. 138, 1907; as cited by Seton.
[8] Coues, *North American Mustelidae,* pp. 66-68, 1877. Bailey, *N. Amer. Fauna,* No. 49, p. 177, 1926.
[9] Comeau, *Life and sport on the North Shore,* pp. 80-84, 1909, as cited by Seton.
[10] Hardy, *Shooting and fishing,* April 13, 1899, p. 526; *Forest and Stream,* June 4, 1910, pp. 888-889; Merriam, *Mammals of the Adirondacks,* pp. 49-50; all quoted by Seton.
[11] Seton, *Lives of game animals,* II, Part 2, pp. 482-515, 1929.

to $100,[12] while in the Northwest in 1926 they were selling for from $20 to $125, and those of the pine marten for from $10 to $50.[13]

The term ermine is applied to the white winter pelage of northern weasels, long used in England as a symbol of rank, especially in the regalia of judges, and also recognized in heraldry, now frequently used in the manufacture of coats, or more commonly as trimming for garments.

The larger weasels feed chiefly upon mice, squirrels and the like, and are great enemies of ground squirrels and pocket gophers, whose burrows they are able to enter easily. They "kill every small animal that comes within their reach . . . far more than they can eat . . . killing for the sheer lust of it, as well as for a little blood, which they take from each individual," moving on when the rodents in the neighborhood are gone, occasionally raiding poorly-constructed henhouses, which may be prevented by proper construction.[14] Though their fur is valuable, the live weasels are probably worth much more as rodent destroyers. "In the winter the larger weasels kill a large number of gray rabbits. . . . In summer they catch grasshoppers, crickets and beetles of various sorts, and rob every bird's nest they can find."[15] Malloy found eleven dead rabbits killed by a weasel whose track in the snow he was following.[16] The destruction of poultry by the long-tailed weasels is only occasional, while its destruction of mice and other injurious rodents and insects is continual, and it is said to be the most important enemy of the prairie pocket gopher, yet Pennsylvania paid bounties for the killing of 422,457 of these valuable mousers from 1915 to 1924.[17]

The least weasel (*Mustela rixosa rixosa*) is too small to damage poultry very much, and is a very valuable agent in the control of field mice and other small rodents and insects.[18] A den in Manitoba contained six dead *Microtus*, two *Evotomys* and remnants of six or eight other rodents. All of the 27 vole communities (*Microtus minor*) examined had been raided by these weasels. "Thus from being an abundant ani-

[12] Jones, *Fur farming in Canada*, pp. 79-80, 1913.

[13] Taylor and Shaw, *Mammals of Mt. Rainier National Park*, pp. 47, 48, 50, 1927.

[14] Bailey, *Farmers' Bull.*, No. 335, p. 30, 1908; *N. Amer. Fauna*, No. 49, pp. 166, 169, 1926. Cary, *N. Amer. Fauna*, No. 33, p. 186, 1911.

[15] Howell, *N. Amer. Fauna*, No. 45, p. 35, 1921, quoting Stone and Cram, *American animals*, pp. 236-237, 1902.

[16] Rhoads, *Mammals of Pennsylvania and New Jersey*, p. 171, 1903.

[17] Criddle, *Journ. Mammalogy*, XI, 265-280, 1930. Seton, *Lives of game animals*, II, Part 2, pp. 612-632, 1929. One million golden weasels are exported annually from China, according to the *China Journal*, as cited in *Journ. Mammalogy*, XII, 173, 1931.

[18] Bailey, *N. Amer. Fauna*, No. 49, p. 169, 1926. Criddle, Weasels of Manitoba, Canada, *Field Nat.*, Sept., 1925. Seton, *Lives of game animals*, II, Part 2, pp. 634-639, 1929.

mal this vole was reduced to insignificance in the course of a few weeks, while all other kinds of mice had suffered severely from the same enemy. . . . All our weasels are eminently mousers, but it is the least weasel that is the natural enemy of *Microtus minor,* being so small it can readily follow the rodents through their runways into their homes."[19] A den of the least weasel examined by Winecoff contained "remains of mice only, not a hint of a feather."[20]

Streator weasels (*Mustela streatori streatori*) were found to be "living on conies [pikas] and different species of mice," and stomachs of Washington weasels (*M. washingtoni*) contained remains of gophers, red-backed mice, deer mice, pikas, squirrels and a junco.[21] The dwarf weasel (*Mustela streatori leptus*), confined mostly to high altitudes in the Rocky Mountains, is supposed to eat "conies" or pikas and mice.[22] La Valette says that weasels are enemies of fish,[23] but that enmity cannot be considered serious. Kirk says that weasels do not eat trapped shrews and shrews do not eat trapped weasels,[24] which does not necessarily mean that Coues was mistaken in listing Insectivora as part of the diet of weasels under natural conditions. Hamilton definitely reports two shrews contained in weasel stomachs and says weasels are often seen carrying dead shrews.[25]

The ticks carried by weasels are not known to be harmful to human beings, but, on the other hand, the weasels may do some good by killing rodents which are hosts of the spotted fever tick.[26]

The black-footed ferret (*Mustela nigripes*), found about prairie-dog "towns" or colonies on western plains, feeds mostly upon prairie-dogs, whose burrows it may easily enter, and is sometimes called the prairie-dog ferret, though it is too scarce to have much economic value.[27] European ferrets (*Mustela putorius*) eat many small rodents, and have been reared in captivity and trained to catch rats and rabbits by entering their burrows.

[19] Criddle, *Journ. Mammalogy,* VII, 199-200, 1926.
[20] Winecoff, Least weasel in captivity, *Journ. Mammalogy,* XI, 312-313, 1930.
[21] Taylor and Shaw, *Mammals and birds of Mount Rainier National Park,* pp. 52, 53, 1927.
[22] Cary, *N. Amer. Fauna,* No. 33, p. 187, 1911. Dixon, *Journ. Mammalogy,* XII, 72, 1931.
[23] LaValette, *Rept. U. S. Fish Comm. for 1878,* pp. 509-516.
[24] Kirk, Shrews and weasels, *Journ. Mammalogy,* II, 111, 1921.
[25] Hamilton, Weasels eat shrews, *Journ. Mammalogy,* IX, 249, 1928.
[26] Birdseye, *Farmers' Bull.,* No. 484, 1912.
[27] Cary, *N. Amer. Fauna,* No. 33, p. 184, 1911. Bailey, *N. Amer. Fauna,* No. 49, p. 171, 1926. Seton, *Lives of game animals,* II, Part 2, pp. 566-574, 1929. Nelson, *Wild animals of North America,* p. 571, 1918.

American minks (*Mustela vison* and various subspecies) furnish excellent furs, and were among the first mustelids to have been bred in captivity for their furs, over seventy years ago in New York. During the American Civil War breeding stock sold for $30 a pair.[28] "There have been hundreds of mink farms in America" (Jones). Some statistics of mink skin production have been given on a preceding page. We may add that there were 10,787 mink skins, worth $20,668 shipped from Alaska in 1923.[29]

As with weasels, minks eat any small animals obtainable, such as mice, rats, chipmunks, squirrels, muskrats, rabbits, birds and their eggs, frogs, salamanders, snakes, lizards, fish, insects, crustaceans, mussels, etc.; are sometimes destructive to ducks and marsh-dwelling birds, occasionally destroy many fish in fish ponds; and individuals that acquire the poultry habit and obtain access to poultry yards or buildings may kill thirty or forty chickens in one night,[30] which may be prevented by proper construction. One Texas mink stomach contained remains of a wood rat.[31] They are "inveterate and successful ratters and mousers," and also destroy the eggs of snapping turtles, which are enemies of wild ducks.[32]

## *Subfamily Guloninae*—The Wolverenes

The wolverenes (*Gulo*) are frequently called "gluttons," because of supposed greediness, but they are probably not more greedy than other carnivorous mammals when food is abundant. They are credited with following trappers in their rounds and killing every animal they find in the traps. They are rather scarce and their furs are valuable. They are bold hunters, as well as scavengers, eating carrion freely, breaking into provision caches, killing and eating marmots, gophers, rabbits, squirrels, rats, mice and any other small mammals or birds they can capture.[33]

[28] Dearborn, Fur farming as a side issue, *Yearbook U. S. Dept. Agric. for 1916*, pp. 489-506. Ashbrook, Mink raising, *U. S. Biol. Surv. Leaflet* No. 8, 1928; *Fur farming for profit*, pp. 137-147, 1928. Jones, *Fur farming in Canada*, pp. 72-78, 1913.

[29] *California Fish and Game*, x, 82, 1924.

[30] Howell, *N. Amer. Fauna*, No. 45, p. 37, 1921. Bailey, *N. Amer. Fauna*, No. 49, p. 173, 1926. Ashbrook, Mink raising, *U. S. Biol. Surv. Leaflet* No. 8, 1928. Annin, *Bull. U. S. Fish Comm.*, iv, 85-86, 1884. Fisher, *Yearbook U. S. Dept Agric. for 1908*, p. 190.

[31] Bailey, *N. Amer. Fauna*, No. 25, pp. 196-197, 1905.

[32] Seton, *Lives of game animals*, ii, Part 2, pp. 518-560, 1929, citing *Forest and Stream*, May 14, 1910, p. 770, and June 11, 1910, p. 934. Fisher, *Yearbook U. S. Dept. Agric. for 1908*, pp. 191-192.

[33] Bailey, *N. Amer. Fauna*, No. 49, p. 178, 1926. Fry, *California Fish and Game*, ix, 129-134, 1923.

Wolverenes have been known to kill deer and caribou and to attack even moose.[34] In Labrador they subsist largely upon mice, and during periods of mouse abundance they are found to be "full of mice."[35]

*Subfamily Lutrinae*—THE OTTERS.

The land otters (*Lutra*) are larger and their furs more valuable than most of the Mustelidae. In 1908 the pelts were worth from $10 to $20, in 1912 from $30 to $40. In 1923-1924 the average price in Canada was $30.70, but during the boom of 1920 the best skins brought $105.[36] They feed chiefly upon fish, mostly the more sluggish species, but also take crayfish, frogs and clams.[37] One stomach contained the head of a mallard.[38]

*Subfamily Enhydrinae*—SEA OTTERS.

The sea otter of the North Pacific (*Enhydra lutris lutris*) was once very abundant, but is now on the verge of extinction. Seton gives many details of the destruction of these animals, with a bibliography, and says that restrictions were placed upon killing them, on July 7, 1911, by treaty between the United States, Great Britain, Japan and Russia.[39] At the time of the discovery of Pribilof Islands these animals were there in great numbers. During the first year (1787) 5000 were taken on St. Paul Island by two sailors, the next year only 1000, and six years later they were practically gone, though there is one record for this island as recently as 1914.[40] Shellikou's first visit to Cook Inlet netted 3000 skins, next season 2000, third season 800, fourth season 600, and in 1812 only 100. Russians in 1794 took 2000 at the Gulf of Yakutat, and in 1799 less than 300. In 1804 Baranov had 15,000 sea otter skins from Alaska in one cargo, worth $1,500,000.[41]

During the palmy days of sea otter hunting the skins were sold by hundreds of thousands, according to Laut, one cargo having sold for

[34] Grinnell (G.B.), As to wolverenes, *Journ. Mammalogy,* I, 182-184, 1920. Keele, *Forest and Stream,* LXXI, 971. Hunter, *Canadian Indian wilds,* p. 150, 1907. Anthony, *Field book North American mammals,* pp. 113-114, 1928.

[35] Cabot, *Labrador,* as cited in *Journ. Mammalogy,* III, 56-57, 1922.

[36] Jones, *Fur farming in Canada,* pp. 80-85, 1913. Seton, *Lives of game animals,* II, Part 2, pp. 672-709, 1929.

[37] Bailey, *N. Amer. Fauna,* No. 49, p. 179, 1926. Seton, *Lives of game animals,* II, Part 2, pp. 672-709, 1929.

[38] Merriam, *North Amer. Fauna,* No. 5, p. 82, 1891.

[39] Seton, *Lives of game animals,* II, Part 2, pp. 641-670, 1929.

[40] Preble, Mammals of the Pribilof Islands, *N. Amer. Fauna,* No. 46, pp. 102-128, 1923.

[41] Elliott, the sea otter fishery. *The Fisheries and Fisheries Industries of the U.S.,* Sec. v, Vol. 2, pp. 483-491, 1887.

$50,000; 5000 sold in China in 1785 for $160,000 (at $32 each); 200,000 taken by Russians in fifty years; fifty years ago American fur companies were taking 3000 annually; 2369 reached the market in 1891, 202 in 1912, and only 25 reached the St. Louis, New York and London markets in 1920; several rather poor pelts in 1921 brought from $1,700 to $2,000.[42] Even up to 1880 skins sold for $80, while in 1910 the price had reached $1,700.[43] After 1883, when 5680 skins reached the market, production steadily declined, until in 1900 it was only 584, and at a sale in 1901 the average price of the best 145 skins was a little over $400, the average for the whole lot of 409 skins being a little over $300.[44]

The southern species (*E. l. nereis*) was once very numerous on the California and Lower California coasts, especially on the Farallone and Channel Islands, where "they were so abundant in 1812 that they were killed by the boatmen with their oars in passing through the kelp." In 1812 the Russian exploration of the region began, and they killed from 700 to 800 a week in San Francisco Bay, in five years took 50,000 and thereafter 5000 a year until 1831, the total number killed on these coasts probably having exceeded 200,000, but they are now seldom seen there.[45] "According to old Spanish records, 9729 sea otters had been taken on the California coast prior to 1790. The O'Kain expedition in 1803-1804 took 1100; the Winship expedition took 5000 in 1805-1806; and a party under a man named Campbell took 1230, all on the California coast."[46] It was estimated that 18,000 sea otter skins from California and the northwest coast were marketed in China in 1801, and 150,000 were taken from 1806 to 1813, but by 1820 they were no longer abundant.[47]

Of the sea otters Coues says: "Their food, as might be inferred from the flat molar dentition, is almost entirely composed of clams, mussels and sea-urchins. . . . They also undoubtedly eat crabs and the juicy, tender fronds of kelp, or seaweed, and fish."[48] Seton quotes Snow as

[42] Laut, *The fur trade of America,* pp. 113, 116, 1921. See When the sea otter flourished, *Forest and Stream,* xc, 46, 1920.

[43] *California Fish and Game,* III, 80, 1917.

[44] Stevenson, Utilization of the skins of aquatic animals, *Rept. U. S. Bureau Fisheries for 1902,* p. 323.

[45] Evermann, The conservation of the marine life of the Pacific, *Scientific Monthly,* XVI, 521-538, 1923.

[46] Evermann, The conservation and proper utilization of our natural resources, *Scientific Monthly,* XV, 289-312, 1922.

[47] O'Melveny, What the sea otter did for California, *The Masterkey,* III, No. 2, pp. 14-18, 1929.

[48] Coues, *Monograph of the Mustelidae,* p. 345, 1877, citing Elliott, The sea otter and its hunting, in *Report on the condition of affairs in Alaska,* pp. 54-62, 1875.

saying that he has examined hundreds of sea-otter stomachs which contained sea-urchins, sea-squirts and a substance resembling fish spawn, but no seaweeds, clams, limpets or mussels, and seldom fish.[49]

*Subfamily Mephitinae*—Skunks.

Since the general increase in the value of all furs, and the development of better methods of deodorizing and preparing skins for use, skunk skins, once considered undesirable, have come into extensive use, and the total value of the annual skunk catch has reached a considerable sum. Before 1912 the price had passed the $4 mark,[1] reached the peak in 1919, then suddenly dropped.[2] In 1911, 2,009,465 skunk skins were sold in London at an average price of $2 each, while in 1923 the raw skins sold for $3 in New York; in 1921 one American association alone dressed 824,599 skunk skins.[3] In 1923 it was estimated that skunk skins brought the trappers of the United States about $3,000,000 annually. In 1858 the reported sales of skunk skins in London amounted to only 18,255 pelts, increasing irregularly until in 1904 the number was 911,923; then averaged 1,300,708 for the ten years preceding the World War, after which the fur trade rapidly shifted to the United States and Canada. In 1918, 596,454 skunk skins were sold in New York and St. Louis, 1,276,913 in 1919, 1,205,910 in 1920, 918,675 in 1921, the price reaching the apex, from $4.65 to $5.30, in 1922.[4] The State of New York in 1918 produced $750,812 worth of skunk skins ("black muskrat"),[5] and in 1920 it was estimated that the catch was worth $1,000,000.[6] During the trapping season of 1927-1928 Kansas produced 279,647 skunk skins, for which the dealers paid over $560,000, and 107,277 "civit" skins.[7] Skunk farming has been popular at times. In 1916 it was said that skunk breeders were more numerous than breeders of all other fur-bearing mammals.[8] Though skunks do well in cap-

[49] Seton, *Lives of game animals*, II, Part 2, pp. 641-670, 1929.
[1] Jones, *Fur farming in Canada*, pp. 85-88, 1913.
[2] Innis, *The fur trade of Canada*, p. 39, 19?7.
[3] Bailey, *N. Amer. Fauna*, No. 49, p. 181, 1926. Lantz, *Farmers' Bull.*, No. 587, 1922.
[4] Lantz, The economic value of North American skunks, *Farmers' Bull.*, No. 587, pp. 16, 24, 1923.
[5] Johnson, *Roosevelt Wild Life Bull.*, III, 208-209, 1925.
[6] Dearborn, *U. S. Biol. Surv. Circular* No. 135, pp. 3-12, 1920.
[7] Dose, *Kansas Fish and Game*, No. 2, p. 67, 1928.
[8] Dearborn, Fur farming as a side issue, *Yearbook U. S. Dept. Agric. for 1916*, pp. 489-506. Ashbrook, Mink raising, *U. S. Biol. Surv. Leaflet* No. 8, 1928. Lantz, Economic value of North American skunks, *Farmers' Bull.*, No. 587, pp. 15-22, 1914. Seton, *Lives of Game Animals*, II, Part I, pp, 360-366, 1929.

tivity, skunk farming has not proved profitable except when prices are high,[9] and they fluctuate greatly.

It is difficult to obtain complete and reliable statistics as to skunk furs, owing to the fact that in many lists some skunk furs are included under the name civet cat, a name that is applied not only to the true civet cats of the Old World, but also to the American spotted skunks and the bassarisks, thus including members of three distinct families. Skunks were protected by law in 34 states, with open seasons of from one and one-half to six months each year, in certain counties in one state, and there was no protection in 14 states in 1925.[10]

It has been said that skunks are more valuable alive as rodent and insect destroyers, than dead for their furs. They "are among the most useful of our carnivorous mammals, though often destroyed in the belief that they are injurious;" the main part of their food is insects, but they take also mice and gophers; "when mice become excessively numerous, skunks feed upon them almost exclusively," and poultry may be protected from them by properly-built, skunk-proof poultry yards and buildings.[11]

"Of our larger mammals, skunks certainly are the greatest enemies of insects. Army worms, tobacco worms and white grubs are the favorite prey of these animals. In Manitoba, Mr. Norman Criddle, field officer, Canadian Entomological Service, estimated that on one eight-acre tract skunks destroyed 14,520 white grubs to the acre. Cutworms, the potato beetle and grasshoppers are other insect pests eaten by skunks, and the common eastern skunk once proved so efficient an enemy of the hop grub in New York that the first legislation protecting the animal in that state was passed at the demand of hop growers. Investigations in New Mexico by the U. S. Biological Survey showed skunks also to be the most important natural enemies of the range grasshopper."[12]

The food of the common striped skunks (*Mephitis*) is largely insects and small rodents, but they take also reptiles, amphibians or any small

[9] Bailey, *N. Amer. Fauna,* No. 49, p. 181, 1926. Howell, *N. Amer. Fauna,* No. 20, p. 11, 1901.

[10] Ashbrook, Trapping laws and the fur supply, *Journ. Mammalogy,* VI, 168-173, 1925.

[11] Bailey, *Farmers' Bull.,* No. 335, p. 28, 1908. Seton, *Lives of game animals,* II, Part 2, pp. 384-397, 1929, quoting Pellett, *Forest and Stream,* May 14, 1910, p. 772. Nelson, *Wild animals of North America,* p. 578, 1918. Brook, *Recreation,* 1899, p. 255.

[12] McAtee, The rôle of vertebrates in the control of insect pests, *Ann. Rept. Smithsonian Inst. for 1925,* p. 416.

animal life, and even carrion. "While occasional raids are made on the poultry yards or on the nests of wild birds, their destruction of insects and noxious mammals doubtless more than offsets any damage they may do to poultry or game." "When grasshoppers are abundant," skunks "feed extensively on these pests."[13]

Of 62 skunk stomachs (37 common skunks, 9 white-backed and 16 little spotted skunks), "grasshoppers and crickets formed a large percentage of the food of nearly half" of them; beetles and their larvae the most important item, found in two-thirds of the stomachs, in many cases the only food; 15 had eaten injurious rodents (mice, rats, ground squirrels and pocket gophers), carrion had been eaten by 3, lizards and salamanders by 3, crayfish by 3, fungi by 2, earthworms by 2, fruit by 6, centipedes by 2, sawflies by 1, 1 contained cicadas only, and 1 contained a feather. During an invasion of range caterpillars in New Mexico they made up from 60 to 95 per cent of the food of skunks examined.[14]

Of the contents of 10 skunk stomachs from California, examined in the laboratory, 30.5 per cent was mammal remains (harmful mammals 16.3 per cent, beneficial 1.4 per cent, neutral 12.8 per cent); 26.3 per cent insects (harmful 24.9 per cent); parasitic worms 10.4 per cent; in 353 stomachs examined by licensed trappers, insects were found in 207, rodents in 8, other mammals in 15, grass and roots in 100, fish in 5, reptile in 1, birds in 27, fruit in 6, game in 4, livestock in 14—beneficial habits 68 per cent, neutral 27 per cent, harmful 5 per cent.[15] The diet of the hog-nosed skunks (*Conepatus*) "is even more largely made up of insects than is that of the others, especially beetles, grubs and larvae, one containing 400 beetles."[16]

Three stomachs of non-captive skunks (*Mephitis m. nigra*) were found to be badly parasitized with threadworms. One captive specimen ate 134 field mice in one month, but was not fond of fish, frogs or snakes and refused shrews and moles.[17] Skunks eat both wild and domesticated bees and are accused of raiding apiaries, "which may

[13] Howell, *N. Amer. Fauna*, No. 45, p. 39, 1921.
[14] Lantz, Economic value of North American skunks, *Farmers' Bull.*, No. 587, 1914.
[15] Dixon, *Journ. Mammalogy*, VI, 34-46, 1925.
[16] Seton, *Lives of game animals*, II, Part 2, p. 378, 1929, citing Nelson, *Wild animals of North America*, p. 584, 1918.
[17] Shaw, The spring and summer activity of the dusky skunk in captivity, *New York State Museum Handbook*, No. 4, pp. 11-92, 1928.

be entirely avoided by placing the hives upon a high bench."[18] One skunk ate two kittens.[19]

The contents of seventeen stomachs of the spotted skunks (*Spilogale*) consisted mostly of insects, chiefly grasshoppers and beetles, with mice and other small mammals, lizards, salamanders, small birds and crayfish. One contained persimmons and fungi, another contained remains of three gray squirrels. They have proved valuable in destroying mice and rats in a house that was overrun with those rodents. They are sometimes destructive to small birds and poultry and occasionally to peanuts.[20] Two stomachs of *S. gracilis* from Arizona each contained remains of the desert mouse (*Peromyscus eremicus*).[21]

The following information concerning skunks is derived from Bailey's Texas report:[22] White-backed skunk (*Conepatus mesoleucus telmalestes*): three stomachs, filled with mostly beetles, but a few grubs, large brown flies and grasshoppers. Mearns hog-nosed skunk (*C. m. mearnsi*): in July found feeding on beetles, grasshoppers, crickets, and ripe cactus fruit. Long-tailed Texas skunk (*Mephitis mesomelas varians*): some stomachs filled with berries of zizyphus, but eats also cactus fruit, persimmons and berries, and favorite food is grasshoppers, cicadas, beetles and grub worms. The Gulf spotted skunk (*Spilogale indianola*): one stomach contained crayfish and a *Perognathus*, another contained beetles, another contained grasshoppers.

The spotted skunks are often called hydrophobia skunks, because of a popular belief that their bites usually or always produce rabies. Possibly the fact that the skunks attack men sleeping in camps, during "spells of temporary insanity" or "violent frenzy," has had something to do with their bad reputation, as has been suggested.[23] There do seem to be a few cases in which that dread disease has followed bites of skunks, just as it has followed the bites of dogs, coyotes and other mammals,[24] but in most cases nothing serious has resulted from skunk

[18] Lantz, *Farmers' Bull.*, No. 587, p. 11, 1923. Plath, The bee-eating proclivities of the skunk, *Amer. Naturalist*, LVII, 570-574, 1926.

[19] Dice, Skunk eats kittens, *Journ. Mammalogy*, VII, 131, 1926.

[20] Lantz, *Bull. Kansas Agric. College*, No. 129, pp. 389-390. Seton, *Lives of game animals*, II, Part 2, p. 393, 1929. Howell, Revision of the skunks of the genus Spilogale, *N. Amer. Fauna*, No. 26, pp. 8-9, 1906; *N. Amer. Fauna*, No. 45, p. 37, 1921.

[21] Merriam, *N. Amer. Fauna*, No. 3, p. 83, 1890.

[22] Bailey, *N. Amer. Fauna*, No. 25, pp. 200-205, 1905.

[23] Mitchell, "Mexican polecat," "hydrophobia cat," Spilogale indianola, of southern Texas, *Journ. Mammalogy*, IV, 49-51, 1923.

[24] Coues, *A monograph of North American Mustelidae*, pp. 223-235, 1877. Howell, *N. Amer. Fauna*, No. 26, p. 8, 1906.

bites. "There is no reason to suppose that they are more subject to it [rabies] than dogs or cats, nor more dangerous to human beings when they do have it."[25] Seton says he has been often bitten by skunks and has seen several skunk farmers bitten severely, without being infected with rabies.[26]

"Prof. Charles T. Vorhies, of the University of Arizona, has collected evidence which indicates that skunks are rather more apt to bite sleepers than are coyotes, wolves and dogs; also that perhaps a larger proportion of bites from skunks produces rabies than of the bites from any other animal. Statistics on over 3000 cases of rabies, however, indicate only 1 per cent infected from skunks, so that, after all, the total showing is not great. Doctor Vorhies concludes that in case of skunk bite the Pasteur treatment should be promptly taken."[27]

Various writers have declared that the flesh of skunks is good for the table, if properly prepared.[28]

*Subfamily Taxidiinae*—BADGERS.

"The badger feeds mainly on small rodents, varied with grasshoppers, beetles, scorpions, lizards or some large animal found dead. It is accused of killing poultry, but the accusation is so rarely substantiated that it may well be ignored. Pocket gophers, kangaroo rats, wood rats and various kinds of mice are always acceptable, but the badger lives mainly on prairie-dogs and ground squirrels." Yet they are killed by ranchers for fear that they might catch a chicken. Their burrows are a menace to horses and riders on the range, but not more so than the much more numerous holes of the prairie-dogs whose numbers the badgers help keep within bounds.[29] They cleared the prairie-dogs from an area a mile and a half long in a Colorado gulch, a large percentage of the prairie-dog burrows having been dug out by badgers.[30] They are powerful diggers, and easily dig all sorts of rodents out of their holes, taking two or three ground squirrels, a few gophers

[25] Bailey, *N. Amer. Fauna,* No. 25, p. 210, 1905; *Animal life of Carlsbad Cavern,* p. 102, 1928.

[26] Seton, *Lives of game animals,* II, Part 1, pp. 345-347, Part 2, pp. 384-397, 1929.

[27] Taylor and Shaw, *Mammals and birds of Mount Rainier National Park,* p. 55, 1927; citing Vorhies, *Univ. Arizona Agric. Exper. Sta. Bull.* No. 83, pp. 368-373, 1917.

[28] See, for example, Seton, *Lives of game animals,* II, Part 1, pp. 360-366, 1929. Merriam, *Mammals of the Adirondacks,* p. 76, 1884.

[29] Bailey, *N. Amer. Fauna,* No. 25, pp. 184-186, 1905. Seton, *Lives of game animals,* II, Part 1, pp. 282-294, 1929.

[30] Silver, Badger activities in prairie-dog control, *Journ. Mammalogy,* IX, 63, 1928.

or a dozen mice a day. Destruction of badgers in Nevada was followed by an increase in rodents.[31]

Badgers occasionally "make a hearty meal of grasshoppers, immature cicadas or beetles."[32] One stomach contained bumble bees and their honeycomb.[33] They are said to have dug out nests of bank swallows.[34] The badger is one of the hosts of the wood ticks that carry the spotted fever, which may make it a slight menace in the fever-infested districts, but there are so many other and much more abundant hosts that the badger is not a source of much additional danger.[35]

### Family CANIDAE—Dogs, Coyotes, Wolves, Foxes, etc.

Not only are fox skins among the most valuable of furs, but the pelts of coyotes, wolves and other members of this family also are prized. In 1906 the highest price paid for skins was $15.36 each for two fine ones, others bringing from 48 cents to $7.20. In 1921-1922 the average value of 9451 skins was $10.17. From 1901 to 1905, 498,000 pelts were taken in the United States and Canada.[1] In 1921 it was estimated that from 4300 to 6000 silver fox, and from 1,000,000 to 1,200,000 red fox, pelts were sold annually,[2] but actual sales for 1919-1921 were reported as follows: Red fox, 1,295,258; silver or black fox, 26,350; cross fox, 32,296; white fox, 166,071; wolf, doubtless including coyote, 1,094,502.[3] An Associated Press dispatch from St. Louis, dated May 3, 1919, announced that on that day 90,000 wolf skins were sold on the International Fur Exchange for a total of $904,450, the highest price for a choice pelt being $52, most of the timber wolves selling for from $18 to $27; and in 1921 155,000 wolf skins were sold in the spring sales of Europe and America.[4] In 1927 the following estimates were made for the years 1923-1924:[5]

[31] Bailey, *Farmers' Bull.*, No. 335, p. 29, 1908; *N. Amer. Fauna*, No. 49, p. 184, 1926; *Animal life of Carlsbad Cavern*, p. 102, 1928. Birdseye, *Farmers' Bull.*, No. 484, 1912. Sawyer, Badger runs down ground squirrels, *Journ. Mammalogy*, VI, 125-126, 1925. Cary, *N. Amer. Fauna*, No. 33, p. 181, 1911.

[32] McAtee, The rôle of vertebrates in the control of insect pests, *Ann. Rept. Smithsonian Inst. for 1925*, p. 416.

[33] Merriam, *N. Amer. Fauna*, No. 5, p. 85, 1891.

[34] Potter, Badger digs for bank swallows, *The Condor*, XXVI, 191, 1924.

[35] Birdseye, Some common mammals of western Montana in relation to agriculture and spotted fever, *Farmers' Bull.*, No. 484, 1912.

[1] Seton, *Lives of game animals*, I, Part 1, pp. 251-337, 1929.

[2] Laut, *The fur trade of America*, pp. 84, 149, 1921.

[3] Osborn and Anthony, *Journ. Mammalogy*, III, 226, 1922; *Natural History*, XXII, 393, 1922.

[4] Laut, *The fur trade of America*, p. 149, 1921.

[5] Innis, *The fur trade of Canada*, table opp. p. 76, 1927.

| | Asia | North America | Europe | Africa | Australia |
|---|---|---|---|---|---|
| Silver fox .......... | 500 | 20,000 | | | |
| Cross fox ........... | 5,000 | 20,000 | | | |
| Red fox ............ | 600,000 | 400,000 | 800,000 | | 400,000 |
| White fox .......... | 40,000 | 120,000 | | | |
| Blue fox ............ | 3,000 | 30,000 | | | |
| Kitt fox ............ | 300,000 | 10,000 | | | |
| Wolf ............... | 100,000 | 250,000 | | | |
| Jackal .............. | 10,000 | | | 20,000 | |

In 1923, 7939 white fox pelts, worth $297,476, and 10,787 red fox, worth $215,741, were shipped from Alaska.[6] Seton[7] gives the following figures on the catch of American red fox skins:

Hudson Bay Company, 1821-1905, averaged 18,075 skins per annum; 1895-1905, averaged 22,671 skins per annum; other American companies, 1821-1891, averaged 53,695 skins per annum.

The total loss in the United States because of the slaughter of domestic stock by wolves, coyotes, bobcats and mountain lions was in 1920 estimated at from $20,000,000 to $30,000,000. So serious was the loss that the United States Biological Survey, in coöperation with western stock growers, began a systematic campaign in which, from 1914 to 1920 inclusive, 109,346 coyotes and 2936 wolves were killed, while the total number from 1915 to 1923 inclusive is placed at 196,172 coyotes and 4916 wolves.[8] It was estimated that the annual damage by each mountain lion is $1,000, by each bear $500, by each wolf $500, by each bobcat and each coyote $50; but the coyote being far the most abundant, it is probably on the whole the most destructive western American carnivore, though also one of the most useful. These estimates of the damage done by individual animals are but little more than guesses. That they do considerable damage in some localities cannot be doubted. In other localities they do little or no harm, and they do some good wherever they occur. It depends upon local conditions, and a reasonable number of coyotes and bobcats, except perhaps in the vicinity of sheep and goat ranges, may even do much more good than harm. Consequently, generalized statements concerning the damage done are hazardous. The investigations have not been thorough enough to satisfy most mammalogists, who feel that the present government efforts for the control of predators by a general poisoning

[6] *California Fish and Game,* x, 82, 1924.
[7] Seton, *Lives of game animals,* I, Pt. 2, pp. 469-552, 1929.
[8] Bell, Hunting down stock-killers, *Yearbook U. S. Dept. Agric. for 1920,* pp. 289-301. Adams, *Roosevelt Wild Life Bull.,* III, 583, 1926. *Science,* LXIX, 378, 1929.

campaign are too intensive, extensive, indiscriminate, more or less harmful, and based upon too slight investigation of the facts and of local conditions. Many believe also that it is unwise to wholly exterminate any of the species. A year or two ago a committee was appointed by the American Society of Mammalogists to ascertain the facts concerning the Biological Survey's campaign of poisoning and to study the problems involved, in coöperation with the Survey and various organizations and institutions. It is quite probable that the recent criticisms and discussion may result in more thorough investigation of the whole subject, with some improvement in the methods used and a better understanding all around.[9]

The following table is based chiefly upon examinations of coyote stomachs by hunters, trappers and poisoners in the employment of the U. S. Biological Survey. Though an attempt is made to distinguish between carrion and the flesh of freshly-killed animals, this cannot be done with any degree of accuracy, especially in cold weather, when meat keeps without spoiling for a long time. Consequently, the coyote being to a considerable extent a carrion-eater, no one knows what proportion of the meat found in the stomachs is from animals killed by the coyotes themselves. Furthermore, one dead horse, sheep or cow, killed by a mountain lion, may conceivably furnish the meat found in a dozen coyote stomachs. Hence, no one can tell how many carcasses were fed upon by the coyotes whose stomachs were examined. This illustrates the difficulty of such investigations. The table is condensed from W. C. Henderson's defense of the Biological Survey poisoning campaign.[10]

[9] Consult: Howell, At the cross roads, *Journ. Mammalogy,* XI, 377-389, 1930; The poison brigade of the Biological Survey, *Outdoor Life,* LXVI, 30-33, 1930; The borgias of 1930, *Outdoor Life,* pp. 17, 85-87, Oct., 1930. Hall, Predatory mammal destruction, *Journ. Mammalogy,* XI, 362-372, 1930. Dixon, Furbearers caught in traps set for predatory animals, *Journ. Mammalogy,* XI, 373-377, 1930. Tooker, Sidelights on the poison brigade in Arizona, *Outdoor Life,* p. 37, Oct., 1930. Quinn, Facts about the poison brigade, *Outdoor Life,* pp. 26-27, 77-82, Nov., 1930. Petit, Howell, Huey, Moon and Walker, Discussion, pro and con, of the poisoning campaign, *Outdoor Life,* pp. 36-37, Nov., 1930. *Natural History,* XXX, 662-663, 1930. Avery, Bounties or government trappers, *Field and Stream,* p. 8, Dec., 1930. Henderson (W.C.), The other side of the poison case, *Outdoor Life,* pp. 22-23, 65-67, Dec., 1930; a strong defense of the activities of the Biological Survey by its Assistant Chief. Linsdale, Further facts concerning losses to wild life through pest control in California, *The Condor,* XXXIV, 121-135, 1932; summaries of reports from 285 observers on birds and mammals other than squirrels and coyotes killed by pest control. Kellogg, The California ground squirrel problem, *California Dept. Agric. Special Pub.* No. 109, 1931; a well-considered reply to criticisms of pest control operations in California.

[10] Henderson, W. C., The other side of the poison campaign, *Outdoor Life,* Dec., 1930, pp. 22-23, 65-67.

| *Nature of contents* | *No. of coyote stomachs* 1919-23 | 1924-28 | *Total* |
|---|---|---|---|
| Beef | 2,517 | 2,239 | 4,756 |
| Horse | 1,500 | 3,010 | 4,510 |
| Sheep or goat | 6,946 | 9,079 | 16,025 |
| Pork | 209 | 371 | 580 |
| Poultry | 1,306 | 2,705 | 4,111 |
| Grouse and quail | 1,268 | 2,571 | 3,839 |
| Waterfowl | 94 | 136 | 230 |
| Other birds | 805 | 982 | 1,787 |
| Deer | 399 | 1,209 | 1,608 |
| Elk | 20 | 72 | 92 |
| Antelope | 40 | 84 | 124 |
| Rabbit | 7,929 | 12,141 | 20,070 |
| Ground squirrel | 1,148 | 1,736 | 2,884 |
| Prairie-dog | 584 | 511 | 1,095 |
| Chipmunk | 65 | 100 | 165 |
| Marmot | 64 | 286 | 350 |
| Mouse or rat | 1,427 | 2,605 | 4,032 |
| Bait from traps | 5,293 | 11,663 | 16,966 |
| Carrion | 2,357 | 3,874 | 6,231 |
| Insects or worms | 669 | 542 | 1,211 |
| Fish, frog, reptile | 138 | 116 | 254 |
| Grass, sticks, berries | 2,211 | 3,138 | 5,349 |

Stock contained in 25,871, rodents in 27,596, poultry in 4111, deer, elk and antelope in 1824, wild birds in 5856.

The first important concerted effort to control the coyote and wolf in the West was the result of a serious outbreak of rabies, a subject discussed more at length in a preceding chapter on the relation of mammals to disease. In 1919 the Biological Survey, coöperating with the California Board of Health in a campaign against rabies, killed 2707 coyotes and 178 wildcats in Modoc and Lassen Counties alone, and during the same period bounties were paid on 1474 coyotes killed by others.[11] In 1917, 23,208 coyotes and 1723 wolves were killed in or near the national forests in 12 states.[12]

In addition to its rôle as a distributor of rabies, the coyote is one of the hosts of the spotted fever tick[13] and has been found susceptible to tularemia, or rabbit fever.[14] These diseases are serious in certain localities within the western range of the coyote, and the fact that such a widely roving animal as the coyote is an unquestionable carrier of one and an actual or potential carrier of the other two adds to the difficulty of control.

[11] *California Fish and Game*, III, 120, 1917.

[12] Bailey, Destruction of wolves and coyotes, *U. S. Biol. Surv. Circular* No. 63, 1908.

[13] Birdseye, Some common mammals of western Montana in relation to agriculture and spotted fever, *Farmers' Bull.*, No. 484, 1912.

[14] Parker and Francis, The susceptibility of the coyote (Canis lestes) to tularemia, *Public Health Repts.*, U. S. Public Health Service, July 9, 1926, pp. 1207-1410.

Methods of controlling coyotes and wolves have been discussed in two preceding chapters. The bounty system, which has been tried for many years in most states, is very expensive, productive of endless fraud and fails to give general or permanent relief. Coyote-proof fences help to prevent destruction of stock, but the most effective method of controlling these animals is by systematic trapping, poisoning, shooting and digging out dens of the young, in widespread co-operative campaigns of state and federal authorities and stock-growers.[15] In Minnesota, bounties have been paid on wolves for forty-nine years, to a total amount of $1,243,165.53, and for the last twenty-five years the annual expenditure for this purpose has slowly increased,[16] indicating that it is not a very effective method. This is typical of the experience of other states.

Though coyotes and wolves have much to their discredit in the destruction of useful animals, they have much to their credit in the destruction of harmful animals, as well as in the revenue derived from their pelts. Carey quotes a correspondent thus:

> I think that probably Sequoia National Park is the only place in the United States today where mountain lions, coyotes, skunks, wildcats, etc., are absolutely protected. I think I can see the effects of this in the keeping down of the smaller rodents, such as ground squirrels, rats, mice, etc., without any action by the government.[17]

Coyotes will eat almost any kind of an animal within their power to obtain. They take young deer and antelope, calves, colts, sheep, pigs, goats, cats, dogs (one killed a 100-pound dog), all sorts of rodents (rats, mice, gophers, prairie-dogs, rabbits, squirrels, etc.), weasels, poultry, wild birds, reptiles (3 horned lizards in one), fish, insects, crustaceans, etc.[18] They also eat melons and various kinds of fruit,

[15] Dixon, Control of the coyote in California, *California College Agric. Bull.* No. 320, pp. 379-397, 1920; *Journ. Mammalogy,* II, 176, 1921. Bailey, Wolves in relation to stock, game and national forests, *U. S. Forest Service Bull.* No. 72, 1907; Destruction of wolves and coyotes, *U. S. Biol. Surv. Bull.* No. 63, 1908. Lantz, *U. S. Biol. Surv. Bull.* No. 20, 1906; *Farmers' Bull.,* No. 226, 1906; Bounty laws in force in the United States, *Yearbook U. S. Dept. Agric. for 1907,* pp. 560-565. Lucas, *Ann. Rept. U. S. Natl. Museum for 1889,* p. 612. Palmer, Extermination of noxious animals by bounties, *Yearbook U. S. Dept. Agric. for 1896,* pp. 55-68. Bell, Wolf and coyote control, *The Producer,* Denver, VII, 3-4, 6-8, 1926. Young, Hints on wolf and coyote trapping, *U. S. Biol. Surv. Leaflet* No. 59-L, 1930.

[16] *Journ. Mammalogy,* IX, 89, 1928.

[17] Carey, *Journ. Mammalogy,* XI, 229, 1930.

[18] Lantz, Coyotes in their economic relations, *U. S. Biol. Surv. Bull.* No. 20, 1905; The relation of coyotes to stock-raising in the West, *Farmers' Bull.,* No. 226, 1905. Jotter, The coyote as a deer killer, *California Fish and Game,* I, 26-27, 1914. Hewitt, *The conservation of wild life of Canada,* p. 225, 1921. Seton, *Lives of game animals,* I, Part 2, pp. 355-417, 1929, with an excellent summary of the economic status of coyotes.

feed greedily upon figs and prunes that fall to the ground, and at certain times of the year feed "entirely upon grapes in one locality, melons in another, figs in another and prunes in another," damaging the date crop in the Imperial Valley, and using manzanita berries as their principal food where they abound.[19] "In one instance in the Morino Valley, Riverside County, these animals cleaned up the entire crop of melons. . . . Coyotes have frequently been known to take practically every bunch of grapes in small vineyards."[20] One stomach contained plums and another contained mesquite beans.[21] Many writers testify to their fruit-and-melon eating habit. A trapper informed us that coyotes are especially fond of green corn and demonstrated it the same evening by catching a coyote in a trap baited with an ear of corn, within 100 yards of a camp.

In balancing the evil and beneficial habits of the coyote one fact must not be overlooked. It is notably a carrion eater. Hence the discovery of a coyote eating a dead domestic animal or the finding of horse or cow hair or sheep wool in a coyote stomach does not prove that the coyote has killed one of those animals. After stating that carrion in a stomach may be distinguished from meat eaten while fresh, Dixon says: "After impartial study I have come to the conclusion that one-half of the domestic stock, one-fourth of the game and one-eighth of the rodents found in coyotes represent carrion and not animals the coyotes themselves killed." He reports that rodents were found in 47 stomachs, domestic stock in 70, game in 53, fruit in 10, fish in 1, insects in 5.[22]

Of the Texas coyote (*Canis nebrascensis texensis*) Bailey says:

> The bulk of his food the year round consists of rabbits, prairie-dogs, ground squirrels, wood rats, mice and all the small rodents that come his way. An unusual increase in jack rabbits in any region is always followed by a corresponding influx of coyotes, which probably accounts in part for the often observed fact that in the years following their maximum abundance jack rabbits are unusually scarce. At times the food of the coyote consists largely of fruit, including that of several species of cactus, juniper and forestieria berries, persimmons and the sugary pods of mesquite; but in times of scarcity

[19] Poole, Coyotes not strictly carnivorous, *California Fish and Game,* XIV, 151, 1928.

[20] Coyotes damage fruit crops in southern California, *California Fish and Game,* X, 94-95, 1924; *Weekly News Letter,* U. S. Dept. Agric., Jan. 26, 1924; Warren, *Mammals of Colorado,* p. 248, 1910.

[21] Lantz, *U. S. Biol. Surv. Bull.* No. 20, 1905.

[22] Dixon, Food predilections of predatory and fur-bearing mammals, *Journ. Mammalogy,* VI, 39-40, 1925.

a piece of rawhide, garnished with a few horned toads, lizards and some horse manure suffices for a meal.[23]

Many writers who have studied coyote habits agree upon its efficiency as a destroyer of rodents. Grinnell long ago noted that in Montana, jack rabbits were common only where coyotes and wolves were scarce, but others have observed that coyotes and wolves congregate where rabbits are abundant.[24] There can be no doubt that under natural conditions on western plains it did a great deal toward keeping such pests under control, but it was only one of numerous enemies of rodents, such as badgers, weasels, hawks, owls, etc. It is also certain that in many localities, following the wholesale destruction of these various enemies, the rodents greatly increased in numbers. However, we must remember that we are not now living under natural conditions. The advent of agriculture has furnished a more abundant food supply and better cover for rodents in many localities, probably increasing their fecundity and average length of life, and many of their enemies have been destroyed, so that the coyote could not keep them in check. Furthermore, the advent of stock-raising has made it necessary to thin out the coyotes. This was inevitable. As a result, having so radically disturbed the natural balance, we can no longer depend entirely upon natural agencies for protection of crops and stock from their enemies, but must control the situation by artificial means.[25]

While there can be no doubt that predatory mammals are a factor in controlling rodents, yet they play but a small part in maintaining the natural balance. Larger factors are involved, and these include seasonal conditions, fecundity of the species, the acts of man in providing abundant food and the presence of natural and other shelter. On the other hand, rodents the size of ground squirrels or smaller are more effectively decreased in numbers by raptorial birds than by predatory mammals. . . . For several years Grant County, Washington, had been let alone by government hunters, as the residents and land owners believed that coyotes were necessary to keep down jack rabbits; but when rabies appeared there among young coyotes and domestic dogs during August, 1921, it was necessary to clean out the coyotes. Hunters were concentrated in this and five adjacent counties and approximately 1800 coyotes were taken in the area during the year ending June 30, 1922. At the same time jack rabbits had increased along with the coyotes in such num-

[23] Bailey, *N. Amer. Fauna,* No. 25, pp. 175-177, 1905.

[24] Grinnell (G.B.), *Rept. Chief of Engineers, U. S. Dept. War, 1876,* Part 3, p. 639.

[25] Dixon, Control of the coyote in California, *Univ. California Coll. Agric. Bull.* No. 320, pp. 379-397, 1920; *Journ. Mammalogy,* II, 176-177, 1921. Goldman, The coyote—archpredator, *Journ. Mammalogy,* XI, 325-336, 1930. Henderson (W.C.), The control of the coyote, *Journ. Mammalogy,* XI, 336-362, 1930.

bers that organized campaigns were necessary to stop their depredations. During this same period 61,000 jack rabbits were killed in Grant County, and 94,000 in adjacent counties. During the fiscal year following 2062 coyotes were taken in the same district. Jack rabbits were practically at an ebb. Since that time jack rabbits and coyotes have not been troublesome except in a few local spots.[26]

The fluctuation in the numbers of such prolific species as rabbits, mice and some other rodents are somewhat periodic, depending upon various factors, especially weather, food and disease, and probably not so much as we are apt to suppose upon the presence or absence of predatory mammals and birds, though these birds and mammals undoubtedly do exercise a large influence in checking the increase of rodents under ordinary circumstances and aid in suppressing special rodent plagues.

The larger wolves are individually much more destructive than the coyotes, or prairie wolves, but fortunately are much less abundant. They are able to kill larger stock and game than the coyote can destroy. One was found feeding upon a dead moose, but circumstances did not indicate that it had killed the animal,[27] though they are known to destroy many deer.[28] One is said to have killed 125 cattle, worth $5,000, in ten months, and a famous South Dakota wolf is believed to have killed $25,000 worth of cattle in seven years.[29] One Colorado wolf is believed to have killed 75 horses and cattle.[30] The favorite food of the Arctic white wolf is said to be musk ox and caribou.[31] Wolves do not disdain small rodents. It is said that in Labrador when mice are very abundant the wolves leave caribou and other game alone and feed upon mice, returning to a diet of caribou and ptarmigan when mice become scarce.[32] The diet of the Brazilian red wolf (*Chrysocyon*) is chiefly fruit, but it takes many small armadillos, and one stomach contained seeds of the cumbaru tree.[33]

Where wolves are abundant and winters severe they have formed

[26] Couch, Relationship of predatory mammals and birds of prey to rodent life, *Journ. Mammalogy,* IX, 73-74, 1928.

[27] Johnson, Note on the habits of the timber wolf, *Journ. Mammalogy,* II, 11-15, 1921. See Criddle, The habits and importance of wolves, *Dept. Agric., Ottawa, Bull.* No. 13, 1925. Seton, *The lives of game animals,* I, Part 1, pp. 251-337, 1929.

[28] Bailey, Destruction of deer by the northern timber wolf, *U. S. Biol. Surv. Circular* No. 58, 1907.

[29] Bailey, *N. Amer. Fauna,* No. 49, p. 150, 1926; *U. S. Forest Service Bull.* No. 72, 1907. Bell, *U. S. Dept. Agric. Yearbook for 1920,* pp. 296-297. Seton, *Lives of game animals,* I, Part 1, pp. 251-337, 1929.

[30] Warren, *Mammals of Colorado,* p. 244, 1910.

[31] Seton, *Lives of game animals,* I, Part 2, pp. 340-351, 1929.

[32] Allen, *Journ. Mammalogy,* III, 56-57, 1922, reviewing Cabot's *Labrador.*

[33] Miller, *Journ. Mammalogy,* XI, 13, 1930.

the habit of hunting in packs, when even man is not safe from them. Especially from northern Europe come gruesome accounts of their attacks upon travellers, and wolves killed ten persons in India in 1895.[34]

Foxes do considerable good in the destruction of injurious rodents and some harm in the destruction of useful birds, occasional lambs and poultry. In one fox lair were found remains of 76 short-eared owls, several grouse, black-game, partridges, ducks, curlews, plovers, lambs, rats and voles,[35] all to the discredit of the fox except the rats and voles. Of the contents of four pellets of the red fox, 90 per cent was mouse fur, representing 10 or 12 field mice, with a small feather and the seeds and skin of an apple.[36] Bailey and Fisher say that the normal food of foxes consists chiefly of rodents.[37] In southern New Mexico the Arizona gray fox (*Urocyon cinereoargenteus scotti*) is very fond of juniper berries and pinyon nuts, which it obtains by climbing the trees.[38] "In choice of food the gray foxes are almost as omnivorous as the coon. Various fruits form the bulk of their food in summer and part of it in winter, while a great variety of small game, beetles, grasshoppers, maggots, mammals, birds and some poultry fall prey to them during the year. . . . Mice, wood rats, ground squirrels, rabbits and various small rodents are eaten when obtainable."[38-a] One stomach (*U. c. scotti*) contained a mockingbird and another contained *Perognathus.* Excreta of the Cascade Mountain red fox (*Vulpes cascadensis*) "indicated that the foxes were subsisting mainly on insects and fruit, the remains of huckleberries, leaves and other vegetation."[39] The fondness of foxes for grapes is proverbial. Henshaw reported that on Santa Cruz Island the foxes were feeding principally on insects, but were also attacking wild birds.[40] Introduced into Australia, a new environment, foxes are said to be destructive to native animals.[41]

Fox farming began in about 1887 in an experimental way. Prime furs of some kinds of foxes bring high prices, which, together with the comparative ease with which they may be handled in captivity, has

[34] F.C.K., *Amer. Naturalist,* XXXI, 77-78, 1897.
[35] Fisher, *Yearbook U. S. Dept. Agric. for 1894,* p. 225, citing Adair.
[36] Seton, Food of the red fox, *Journ. Mammalogy,* I, 140, 1920.
[37] Bailey, *Farmers' Bull.,* No. 335, 1908. Fisher, *Yearbook U. S. Dept. Agric. for 1908,* p. 190.
[38] Bailey, *Animal life of Carlsbad Cavern,* p. 95, 1928.
[38-a] Bailey, *N. Amer. Fauna,* No. 25, pp. 180-181, 1905.
[39] Taylor and Shaw, *Mammals and birds of Mount Rainier National Park,* p. 43, 1927.
[40] Henshaw, *Rept. of Chief of Engineers, U. S. Dept. War, 1876,* p. 526.
[41] LeSouef, The fox menace and its effect on our native animals, *Bull. Zool. Soc.,* XXVII, 69-71, 1924, as cited in *Journ. Mammalogy,* V, 272, 1924.

led to a great expansion in the industry during the last few years. From 1910 to 1912 the best breeding stock rose from $3,000 to $15,000 a pair, one live pair having sold for $20,000 in 1912, and some were quoted at from $18,000 to $35,000, while one silver fox skin sold in London for nearly $3,000.[42] Those sensational prices were inflated, but served to stimulate the industry. In 1914, 992 live adult foxes and some pelts from Prince Edward Island sold for $317,775,[43] and in 1918 one farmer on the island sold $14,000 worth of fox pelts from his farm.[44]

In 1923 it was stated that there were at least 15,000 silver foxes in captivity and over $8,000,000 invested in the business.[45] In 1928 it was said that there were 2500 fur farms in the United States and Alaska, mostly silver or blue fox, with a total investment of from $15,000,000 to $18,000,000, and 2130 fox farms in Canada, with an investment of $13,240,245. From six silver fox farms 1541 skins were sold for $215,740, average price $140; and 4089 were sold in 1925 at an average price of $132, the highest price for one pelt being $520.[46]

Such phenomenal profits of particular fox enterprises attract public attention. The failures or instances of small profits are not widely heralded. With expert care, based upon a thorough knowledge of fox habits, coupled with abundant good fortune, fox farms are often highly successful ventures, but there are many opportunities for failure, through accident, disease, ignorance of the habits of foxes, etc. Better methods are being devised to make the business safer and more profitable. Many people find the odor of foxes when in close confinement very disagreeable and dogs are said to dislike their flesh.[47]

The domesticated dogs are faithful friends, holding a high place in the esteem of mankind. Besides being prized as pets, many of them are useful as shepherds, hunters, watchdogs and protectors of children. The dogs of the Alps have been used in the rescue of mountain climbers who have been injured or lost in snowstorms. Many interesting stories are told about the intelligence and resourcefulness of dogs when human beings were in danger and needed help. They

[42] Jones, *Fur farming in Canada,* pp. 14, 15, 49, 111, 1913. See also Allen and McLure, *Theory and practice of fox ranching,* Charlottetown, Prince Edward Island, 1926.
[43] Innis, *The fur trade of Canada,* p. 73, 1927.
[44] Laut, *The fur trade of America,* p. 65, 1921.
[45] Ashbrook, *California Fish and Game,* IX, 161, 1923.
[46] Ashbrook, *Fur farming for profit,* pp. 19, 24, 1928.
[47] Ross, Dogs dislike fox flesh but relish that of wildcats, *Journ. Mammalogy,* IX, 250, 1928.

are also used in trailing and capturing criminals. Dogs were domesticated before the dawn of written history, various breeds having arisen in various parts of the world at remote periods.

The natives of America possessed several kinds of dogs before the advent of white men on the continent, and used them as food to a considerable extent.[48] White men in the wilderness on many occasions have been glad to get Indian dogs for food. The accounts of the De Soto expedition to the Mississippi and the Lewis and Clark expedition up the Missouri and across the mountains to the Pacific tell of various occasions when they were without food and were supplied with dogs by Indians. The Indians of the Northwest Coast possessed long-haired dogs with wool-like undercoats, which were sheared closely as sheep are and the product woven into blankets. Some of these blankets are preserved in museums, but the dogs seem to have disappeared.[49]

Before Europeans brought horses, dogs were the only beasts of burden and draft animals owned by the North American Indians. They were much used in harness to drag equipment on the western plains, in following herds of buffalo, and carried loads on their backs, as well, and are still used by both natives and white men in drawing sledges in the Far North. Dog sledges were quite indispensable in the exploration of the Arctic region. It has been but a few years since the whole civilized world was thrilled by a great run of sledge dogs carrying serum to an Alaskan town afflicted with a serious epidemic. Many dogs have also been used for drawing small carts in Belgium and other European countries and elaborate laws were devised to provide for their care and comfort.[50]

An occasional dog acquires vicious habits, kills sheep or game or even attacks human beings. This could be to a great extent avoided if so many dogs were not allowed to roam at will. Real dog-lovers do not claim the right to permit their dogs such liberty, nor would they allow them to run at large, especially at night. It is partly because of this occasional viciousness and partly because there are so many stray dogs, that many municipalities and some states have dog license laws, the license fees providing considerable revenue in the aggregate. For

[48] Henderson and Harrington, Ethnozoology of the Tewa Indians, *U. S. Bureau Amer. Ethnology Bull.* No. 56, pp. 25-28, 1914, and publications cited in footnotes therein. Allen, Dogs of the American aborigine, *Bull. Museum Comp. Zool.*, LXIII, 431-517, 1920.

[49] Leechman, Fleece-bearing dogs, *Nature Magazine*, XIV, 177-178, 1929.

[50] Johnson, Dogs as draft animals, *Forest and Stream*, XLIX, 491-492, 515, 1897; L, 13-14, 1898.

example, in Virginia the fees amounted to $237,762.70 in 1921,[51] and to $260,000 in 1927, when 17,000 homeless dogs were killed.[52] All or nearly all the states have laws fixing the responsibility of dog-owners for damages to livestock by their dogs, and a uniform dog law for all states has been proposed.[53] The loss of sheep through depredations of sheep-killing dogs in Ohio in 1901 was placed at $152,034 and in Missouri at $200,000.[54] In the old settled portions of the eastern United States the dog hazard in the sheep industry is considered as great as the coyote hazard is in the western states. Dogs also pursue and kill deer, which is made a subject of legislation in some states.[55] In 1926 it was estimated that there were 7,000,000 dogs in the United States.[56]

Dogs have always been the principal reservoir of rabies, which could probably have been entirely stamped out by rigorous action and care, but in the western United States coyotes, wolves and other carnivores have now become infected, greatly increasing the difficulty of control. A campaign against stray dogs is being conducted by the New York Department of Health, in order to reduce the incidence of rabies in the city. A recent report says:

> There is little doubt that the intensive collection of unwanted and stray dogs has been the main factor in reducing the number of animals found rabid by the Health Departments' laboratories. Despite the collection of enormous numbers of dogs (70,000), the number of dog bites reported (nearly 14,000) has continued to mount. An analysis of the dog bites reported during the first four months of this year furnishes the explanation. At present the stray dog is an infrequent source of dog bites; the chief offender is the dog whose careless owner allows the animal at large on streets or in other public places without being effectively muzzled as provided by law.[57]

The increase in the number of bites reported may not indicate a real increase in the actual number of bites, but may be the result of a greater disposition on the part of persons bitten to report the incidents to the proper authorities and to apply for medical treatment. It is very probable that dogs fondled by children and others who are

[51] *5th Ann. Rept. Virginia Dept. Game and Inland Fisheries for 1921,* p. 15.
[52] *California Fish and Game,* x, 95, 1927.
[53] Coll, Sheep-killing dogs, *Farmers' Bull.,* No. 1268, 1922. Revised by Simmons, 1929.
[54] Lantz, Coyotes in their economic relations, *U. S. Biol. Surv. Bull.* No. 20, p. 17, 1905.
[55] Russell, Menace of deer-killing dogs, *Oregon Sportsman,* I, 20-21, 1924; *Journ. Mammalogy,* VI, 66, 1925.
[56] *N. Y. World Almanac for 1928,* p. 435.
[57] New York Dept. of Health, *The Weekly Bulletin,* as quoted in *The Literary Digest,* July 23, 1932, p. 27. See also discussion of rabies in preceding chapters on disease and disease disseminators.

afflicted with infectious diseases, may carry the diseases to others if they are allowed to rove about.

There are many other members of the Canidae in other parts of the world, but the habits and economic relations of most of them probably closely coincide with those of their nearest relatives in North America. The jackals are said to be omnivorous, destructive to young goats and the like, and are sometimes seen "greedily catching and devouring insects."[58] In both Africa and Asia they sometimes haunt the outskirts of towns and feed upon refuse, also eating fruit and such vegetables as melons and pumpkins.

### FAMILY FELIDAE—CATS (LIONS, TIGERS, LYNXES, ETC.)

The Felidae are carnivorous, usually catching their prey alive; some of them are very destructive in proportion to their numbers. It is fortunate for the human race that they are not more abundant. It is a matter of common knowledge that lions, tigers and leopards are dangerous to human beings, though it is generally agreed, among those familiar with these great cats in a wild state, that only an occasional individual acquires a taste for human blood and becomes a "man-killer." Nevertheless, a wild carnivorous animal of such size and strength is always potentially dangerous, and when one does acquire the abnormal habit it may become a great scourge. Drake-Brockman says he has known of "man-eating" leopards in only one locality, where there are a number of graves of natives who were killed by two leopards.[1] One killed seven boys, who were herding sheep, before it was itself killed.[2] Two insatiable man-eating lions waged war on the construction gang engaged in building an African railroad, stopped work for three weeks and terrorized the community for nine months before they were stopped, after they had killed 28 Indian coolies and scores of African natives of whose death no official record was kept.[3] In one year (1910) 882 persons in India were killed by tigers and 366 by leopards,[4] and in 1895 in the same country 177 persons were killed by tigers and 64 by panthers and leopards.[5] The total toll of human lives taken by the big cats of Africa and Asia is large.

The jaguar of Central and South America, largest of American cats,

[58] Drake-Brockman, *The mammals of Somaliland,* p. 46, 1910.
[1] Drake-Brockman, *The mammals of Somaliland,* p. 16, 1910.
[2] Roosevelt, *African game trails,* p. 289, 1910.
[3] Patterson, The lions that stopped a railroad, *World's Work,* Nov. and Jan., 1908-09, pp. 10895-10909, 11147-11158. See also Patterson, The Man-eating lions of Tsavo, *Field Museum Nat. Hist. Zool. Leaflet,* No. 7, 1925.
[4] *Science,* XXXVII, 938, 1913.
[5] F.C.K., *Amer. Naturalist,* XXXI, 77-78, 1897.

"although usually inoffensive to man, occasionally works great havoc among the scattered population when the floods cut off the usual food and drive him a hungry maurauder to other pastures."[6] One at bay attacked four men at Santa Fe in 1825.[7] Stories are told of jaguars seizing and devouring boys who for just a moment have stepped beyond the circle of open fires maintained at night for protection. The food of the Ramsey jaguar (*F. ramseyi*) in Brazil is largely alligators, with an occasional calf, wild bull or swamp deer.[8] The large unspotted cats of America variously known as puma, cougar, panther and mountain lion (*Felis cougar,* etc.) have often been accused of attacking men, but usually it has been when they have been wounded or pursued, or for some reason imagine themselves or their young to be in danger.[9] A 13-year-old boy was killed by a mountain lion near Okanogan, Washington, in 1924, under circumstances indicating that the attack was unprovoked.[10] In 1890 a 7-year-old boy was killed by two mountain lions in California, in an apparently unprovoked attack.[11] In 1909 a boy and a girl died in California from rabies following bites from a rabid mountain lion.[12] While it is evident that mountain lions are potentially dangerous, the very few instances of unprovoked attacks, in proportion to the large number of people constantly travelling about alone where these animals are common, shows that the danger is slight.

In proportion to numbers, the mountain lion is the most destructive of our North American Felidae. Bell estimated the annual damage done to domestic stock by each one at $1,000, and says that in the co-operative campaign against predacious mammals by the United States Biological Survey and western stockmen, 540 lions were killed from 1914 to 1920.[13] The estimate of $1,000 to each cat per annum is not supported by very definite evidence. Dixon considers it too high, but shows that mountain lions are serious enemies of deer. He says that, of 43 lion stomachs examined, 80 per cent contained remains of deer and only 2 per cent contained remains of stock, and that, while 4000 lions have been killed under bounties from the California Fish and

[6] Jennison, *Natural history: animals,* p. 65, 1927.
[7] Seton, *Lives of game animals,* I, Part 1, pp. 4-33, 1929.
[8] Miller, *Journ. Mammalogy,* XI, 14, 1930.
[9] Osgood, Attacked by a cougar?, *Journ. Mammalogy,* I, 240, 1920. Seton, *Lives of game animals,* I, Part 1, pp. 37-136, 1929.
[10] Finley, Cougar kills a boy, *Journ. Mammalogy,* VI, 197-199, 1925; *California Fish and Game,* XI, 89-90, 1925. Hall, *The Murrelet,* May, 1925.
[11] *Outdoor Life,* XXXVI, 162-163, 1915. *California Fish and Game,* IX, 45, 1923.
[12] Storer, Rabies in a mountain lion, *California Fish and Game,* IX, 45-48, 1923.
[13] Bell, Hunting down stock killers, *Yearbook U. S. Dept. Agric. for 1920,* pp. 298-300.

Game Commission, because of their destructiveness to deer, the stockmen would only pay $20 bounty, as an indication of their estimate of its destructiveness to stock.[14] After continuous trapping for years, Bruce, California state lion hunter, estimated that there were, in 1919, 600 mountain lions in that state, that they killed 30,000 deer annually; in the next five years 165 lions were killed.[15] Hunter estimated that each lion in California kills an average of one deer a week, or 52 per annum.[16]

"One cougar killed five deer in a hundred-yard circle, all within a week. . . . I have examined the stomachs of many cougars killed in western Washington and never found anything but venison, although in some sections they are said to feed occasionally on mountain beaver. I know of only one instance of a cougar killing a mountain goat."[17] Roosevelt says that deer are the accustomed prey of the mountain lion and that it is also a dreaded enemy of sheep, pigs, calves, colts, etc., and has been known to attack human beings.[18] Howell, commenting on the latter statement, says that "authentic instances of such attacks are exceedingly rare."[19] "It is practically impossible to raise colts in the Shasta County hills on account of these pests. They destroy many hogs and cattle also, but do not present so serious an impediment to the keeping of these animals as in the case of horses."[20]

The American bobcats, wildcats and lynxes (genus *Lynx*) are much smaller than any of the preceding Felidae. Consequently they are not so destructive to the larger game and domesticated animals, but sometimes attack calves and colts, do much damage to lambs and sheep, prey upon small mammals and birds and make "great havoc among the chickens, turkeys and ducks of the planter," while "on a sheep range where cats are numerous the losses among newly-born lambs and kids are frequently enormous."[21] Bell estimated the damage done to domestic stock by each wildcat at $50 per annum (an estimate not

[14] Dixon, Food predilections of predatory and fur-bearing mammals, *Journ. Mammalogy,* VI, 40, 1925.

[15] Bruce, The why and how of mountain lion hunting in California, *California Fish and Game,* VIII, 108-114, 1922; The problem of mountain lion hunting in California, *California Fish and Game,* XI, 1-17, 1925.

[16] Hunter, The control of the mountain lion in California, *California Fish and Game,* VII, 99-101, 1921. See also Miller, *Journ. Mammalogy,* XI, 15, 1930.

[17] Taylor and Shaw, *Mammals and birds of Mount Rainier National Park,* p. 57, 1927.

[18] Roosevelt, With the cougar hounds, *Scribner's Magazine,* XXX, 431-432, 1901.

[19] Howell, *N. Amer. Fauna,* No. 45, p. 42, 1921.

[20] Merriam, *N. Amer. Fauna,* No. 16, p. 104, 1899.

[21] Howell, *N. Amer. Fauna,* No. 45, p. 42, 1921. Poole, The economic status of the bobcat, *California Dept. Agric. Monthly Bull.,* XVIII, 458-460, 1929.

supported by very definite evidence), and says that from 1914 to 1920 the U. S. Biological Survey, in coöperation with western stockmen, killed 15,374 of them.[22]

One bobcat stomach contained remains of a chicken, one contained remains of six robins, one contained a quail and another was seen to catch two quail.[23] One bobcat killed a 100-pound deer in Colorado, and another in Maine killed two deer in a few minutes and probably a third within a few hours before.[24]

To offset the harm they do, they feed largely upon destructive rodents, such as rabbits, ground squirrels, pocket gophers, mice, prairie-dogs and the like.[25] The stomach of the type specimen of the Bailey bobcat (*Lynx baileyi*) was distended with the remains of small mammals (one squirrel, one chipmunk, two gophers, one vole).[26] Pellets of this species showed that rabbits and wood rats preponderate in its diet, with many smaller rodents and an occasional bird.[27] It was said in 1905 that in portions of Texas "most of the ranchmen will not allow the wildcats to be killed for fear their ranches will be overrun with wood rats, mice and rabbits," but it is not usual for ranchmen to recognize the value of these cats as rodent destroyers. Two stomachs of the Texas bobcat (*L. rufus texensis*) contained wood rats, and one contained carrion venison.[28] The barred bobcat (*L. fasciatus*) was found feeding on grouse, rabbits, mice, pikas, chipmunks and mountain beaver.[29] Canada lynx (*L. canadensis*): "a study of the excreta showed that they were feeding on different kinds of rodents, including chipmunks, lemming-mice, white-footed mice, jumping mice, red-backed mice, large-footed meadow mice and mountain beavers."[30] It has been accused of killing several deer and is said to be an enemy of foxes. "Its staple diet consists of hares, but it also eats squirrels,

[22] Bell, Hunting down stock killers, *Yearbook U. S. Dept. Agric. for 1920,* pp. 289-300.

[23] Maxey, Wildcat eats chickens, *California Fish and Game,* VI, 37, 1920. Hunt, Food of the wildcat, *California Fish and Game,* VI, 37, 1920. McLean, Wildcat eats birds, *California Fish and Game,* V, 160, 1919.

[24] Young, Bobcat kills deer, *Journ. Mammalogy,* IX, 64-65, 1928. Newsom, The common bobcat a deer killer, *Amer. Game,* XIX, 42, 50, 1930.

[25] Bailey, *Farmers' Bull.,* No. 335, p. 26, 1908; *N. Amer. Fauna,* No. 49, p. 149, 1926.

[26] Merriam, *N. Amer. Fauna,* No. 3, p. 79, 1890.

[27] Bailey, *N. Amer. Fauna,* No. 25, pp. 170-171, 1905.

[28] Bailey, *N. Amer. Fauna,* No. 25, pp. 169-170, 1905.

[29] Taylor and Shaw, *Mammals and birds of Mount Ranier National Park,* pp. 60-61, 1927.

[30] Taylor and Shaw, *Mammals and birds of Mount Ranier National Park,* p. 59, 1927.

mice, birds, snakes and frogs, and has been known to kill even deer and caribou. Its numbers fluctuate markedly with the rise and fall in numbers of hares." The Hudson Bay Company exports from 4000 to 75,000 skins per annum; in 1906, 4 superb skins bringing $14.40 each, while in 1921-1922 the average price was $20.38.[31]

Dixon says that the food habits of the wildcats are 63 per cent beneficial to mankind, 27 per cent harmful and 10 per cent neutral, as shown by 118 stomachs, the contents of which consisted largely of rodents: Mammals, 65 per cent (harmful species 44.5 per cent, beneficial 20.5 per cent); waste material 19.6 per cent (vegetation, soil, etc., not food); undetermined, 3.1 per cent; parasitic worms, 7.5 per cent; birds, 3.1 per cent; fish, 6 per cent, probably bait from the traps.[32] One lynx is reported to have eaten a skunk.[33] A recent news-press item states that the Prussian government has placed wildcats on the list of protected mammals, because of their usefulness in the destruction of rodents.

Dogs are said to relish the flesh of wildcats, a trapper "regularly cooks wildcat flesh for the family table and claims it is most tender and agreeable," and lynx "flesh is a regular article of diet in the northwest," white and well flavored,[34] but it will not become popular.

Felidae not herein mentioned have pretty much the same habits as those of their nearest North American relatives. The cheetah, of India and Africa, possesses great speed for short distances and has been trained for hunting. "In semi-domestication, for which it is well fitted, it has been the plaything of princes, Asiatic, African, European (including our King William IV) for centuries. Cheetah hunting is a slothful sport, well suited to an indolent race."[35] Ocelots (*Felis pardalis* and subspecies) feed upon rodents, reptiles and birds, killing even the rhea, and the contents of one stomach consisted chiefly of spiny rats (*Proechimys*), with a few peccary hairs.[36] Various members of this family, particularly the lion, tiger and leopard, are favorite animals in circus menageries and zoological parks.

[31] Cross and Dymond, The mammals of Ontario, *Royal Ontario Museum of Zool. Handbook* No. 1, p. 20, 1929. Seton, *Lives of game animals,* I, Part I, pp. 162-209, 1929.

[32] Dixon, *Journ. Mammalogy,* VI, 36-38, 1925.

[33] Barton, The skunk eaten by the lynx, *Amer. Naturalist,* XII, 628, 1878.

[34] Ross, Dogs dislike fox flesh but relish that of bobcats, *Journ. Mammalogy,* IX, 250, 1928. Seton, *Lives of game animals,* I, Part I, pp. 162-209, 1929.

[35] Jennison, *Natural history: animals,* p. 74, 1927.

[36] Nelson, *Wild animals of North America,* p. 415, 1918, as cited by Seton. Miller, *Journ. Mammalogy,* XI, 15, 1930. Enders, *Journ. Mammalogy,* IX, 289-290, 1930.

The economic status of house cats has been the subject of much discussion. They have been domesticated house pets for many centuries.[37] Though perfectly proper as pets, cats should not be allowed at large. Though they catch some mice, they are not natural mousers—most of them not to be compared in this respect with some wild mammals and various birds, such as hawks and owls. House cats are natural bird-catchers. It is instinctive for them to catch birds. Especially will the fluttering young birds just out of the nest arouse that instinct into action. No amount of breeding or training succeeds in eradicating it, as some owners fondly suppose has been done with their particular pets. The very best-behaved, best-bred, well-fed cats, when closely watched, have been detected in catching wild birds, and where cats are abundant scarcely a young bird escapes them. One naturalist estimated that cats kill 1,500,000 birds annually in New England and another placed it at 3,500,000 for the whole United States.

Most cats catch a few mice and occasionally an individual is an excellent mouser, but the great majority are not, especially the well-fed pets. Fisher says he caught twelve mice in traps in one room of a ranch house, yet eight cats had access to the room.[38] Very few cats will catch rats, many being decidedly afraid of the common house rat, which, in proportion to its size, is a formidable antagonist.[39] Cats, placed in a rat-infested cellar, rushed out in great fright when the doors were opened in the morning and fought against being returned, but an owl, placed in the same cellar, killed nine rats the first night, and continued to kill some nightly until they were gone. Cats, petted and allowed freely to enter and leave the sick-room, transmit various diseases, a subject discussed in Chapter XIII, on Mammals as Disease Carriers.

Forbush made a very comprehensive study of the house cat problem, and from his report we have abstracted the following items: Cities are overrun by vagrant cats. The Animal Rescue League of Boston, during the ten years from 1905 to 1914 inclusive, received 215,449 homeless cats, an average of 21,000 per annum, placed 2908 in homes and destroyed 210,000. The American Society for the Prevention of Cruelty to Animals picked up and destroyed 257,403 stray cats in 1910 and 303,949 in 1911. Some game officials believe that cats destroy

[37] Keller, The derivation of the European domestic animals, *Ann. Rept. Smithsonian Inst. for 1912,* p. 491.

[38] Fisher, The economic value of predacious birds and mammals, *Yearbook U. S. Dept. Agric. for 1908,* p. 189.

[39] McAtee, Local suppression of agricultural pests by birds, *Ann. Rept. Smithsonian Inst. for 1920,* p. 433.

more small game than hunters do. In Connecticut, 28 stray cats were shot on one 20-acre tract in seven months. For one full day 226 observers watched 226 cats, which killed 624 birds during the day, an average of 2.7 each. For one week 33 observers watched one cat each, and the cats killed 239 birds, an average of 7.9 to the cat, more than one each daily. For one month 15 observers watched one cat each, and the cats killed 307 birds while under observation, or an average of 20.4 each. It is not known, of course, how many they may have destroyed when not observed. Stray cats are even much worse. Cats sometimes kill not to eat, but for sport, as sheep-killing dogs do. One killed 24 chickens in a day, another killed 25, another 34. Cats have exterminated or nearly exterminated more species of birds than has any other animal except man. Only one-third of the cats will kill rats at all.[40]

Cat-proof fences of woven wire placed close to the ground, especially if surmounted with twine fish net, to baffle them in attempts to climb over, have been tried with some success as a protection from marauding cats. Wire nets, of large enough mesh to permit the birds to pass through but too small for the cats, placed about nests of small birds at sufficient distance to prevent the cats from inserting their paws and reaching the nests, may be effectively used for the protection of some species of birds. Some attempts are being made to remedy matters by legislation, usually only to the extent of authorizing the killing of cats found straying beyond the limits of their owners' premises, or permitting hunters and requiring game wardens to destroy cats found hunting or killing protected species of birds or mammals or with such birds or mammals in their possession.[41] One municipal ordinance requires owners of cats to attach bells to them when they are allowed to run at large, and provides for the destruction of all roaming cats not so belled.[42] Cat license laws have been proposed in some states. (See Chapter XXVII, concerning Legislation.)

The food habits of domestic cats are too well known to leave any need for discussion of their food in detail. It is not so well known that in addition to their ordinary food they also eat fish, "the food which few cats can resist the temptation of stealing,"[43] moths, beetles,

[40] Forbush, The domestic cat: Bird killer, mouser and destroyer of wild life—means of utilizing and controlling it, *Massachusetts Board of Agriculture, Economic Biol., Bull.* No. 2, 1916; Facts about cats, *Bird-Lore,* XVII, 165-167, 1915. Henderson, *The practical value of birds,* pp, 77-78, 100-103, 1927.

[41] *Bird-Lore,* XIX, 178, 1917; XXI, 330, 1919. *Wilson Bulletin,* No. 105, p. 118, 1918. *California Fish and Game,* I, 42, 1914.

[42] Bell the cat, *American game (Bull. Amer. Game Protec. Assn.),* XVIII, 87, 1929.

[43] LaValette, *Rept. U. S. Fish Comm. for 1878,* pp. 509-516.

catnip, valerian, raisins, nuts, and some are fond of cooked green corn and clams.[44] Not only the domestic cat but various wild species of the family, such as jaguars, lynxes, etc., catch and eat fish, and the menu of *Felis viverrima,* of India, "is made up to so large an extent of fish that he is called the 'fishing cat.' "[45]

The skins of all the Felidae are valuable, especially the larger species, and even the house cat skins find a ready market. According to Osborn and Anthony, 191,799 wildcat skins were marketed in 1919-1921.[46] Innis published the following estimates of the number of various kinds of feline furs produced in 1923-1924:[47]

| | Africa | Asia | Australia | Europe | North America | South America |
|---|---|---|---|---|---|---|
| Wildcats and tigers | 100 | 30,000 | | 2,000 | | 100,000 |
| Lions | 20,000 | | | | | |
| Leopards | 20,000 | 10,000 | | | | |
| Tiger-cats | 2,000 | | | | | |
| Mountain lions | | | | | 1,000 | |
| Jaguars | | | | | | 1,000 |
| Ocelots | | | | | | 5,000 |
| Lynx | | | | 1,000 | 30,000 | |
| Domestic cats | 100,000 | 20,000 | 20,000 | 400,000 | 150,000 | 50,000 |

The beautiful snow leopards live in the high Himalayas above 9000 feet. In one year 2000 of their skins were brought to Shanghai.[48]

### Family PROTELIDAE—Aardwolf or Earth Wolf

Aardwolf (*Proteles cristatus*)—"ants, termites and other insects and possibly birds' eggs form their chief food";[1] mostly termites, not true ants;[2] includes young birds and mammals.[3]

### Family HYAENIDAE—Hyaenas

The hyaenas are scavengers, feeding largely upon carrion, thus doing some good, but often kill their own game, and are destructive to sheep and goats, killing more than they can eat. They sometimes attack horses and bite them, and enter native huts to attack women and chil-

[44] Dimmock, Abnormal food of cats, *Amer. Nat.,* XVIII, 941-943, 1884. Bailey, Food of cats, *Amer. Nat.,* XVIII, 1055, 1884.
[45] Gudger, Cats as fishermen, *Natural History,* XXV, 143-155, 1925, with an extensive bibliography.
[46] Osborn and Anthony, *Natural History,* XXII, 393, 1922.
[47] Innis, *The fur trade of Canada,* table opp. p. 76, 1927.
[48] Blair, *In the zoo,* p. 18, 1929.
[1] Drake-Brockman, *The mammals of Somaliland,* p. 38, 1910.
[2] Bequaert, *Bull. Amer. Museum Nat. Hist.,* XLV, 317, 324-328, 1922.
[3] Jennison, *Natural history: animals,* p. 85, 1927.

dren and even sleeping men.[4] Hyaenas killed two persons in India in 1895.[5] They often desecrate graveyards in the East,[6] a ghoulish habit for which they are held in horror by many people. We are told of their killing sheep for their brains alone, leaving the flesh untouched.[7]

## Order PINNIPEDIA—Seals, Sea-lions, Walruses, Sea-elephants

The pursuit of seals and other pinnipeds, in connection with the whaling industry, constituted a prominent item of "big business" in America many years ago, the influence of which upon history and exploration is discussed in Chapter XVII. The efforts of the United States to prevent the extermination of the great Alaskan fur-seal herds once threatened to disrupt the friendly relations of Great Britain and the United States, also involving Japan. The controversy was finally settled by international arbitration and treaties. The publication of the arbitration proceedings and evidence required many volumes.

It is impracticable, if not impossible, to wholly separate the discussion of the fur seal from that of the hair seal, many of the publications not clearly designating which kind is meant. The fur-seal herd of Pribilof Islands (*Callorhinus alascanus*) has long been a source of wealth. From 1786 to 1834, under the Russian régime, 1,800,000 were killed. Restrictions thereafter caused an increase in numbers from 1835 to 1867, when it was estimated that the herd numbered between 2,000,000 and 5,000,000. In 1870, under the American régime, the sealing privilege was leased for twenty years, during which time 1,977,377 were taken on the islands, but promiscuous killing at sea, thus destroying the unborn pups and young seals, caused great loss. Under more rigid restrictions the herd steadily increased from 1912 to 1921.[1] Contract sealing from 1890 to 1909 yielded a government revenue of $3,752,415 on 339,180 skins, while pelagic sealers from 1870 to 1890 got 1,840,364 skins, which would have produced a revenue of $6,010,565. From 1910 to 1921 the government revenue from

[4] Drake-Brockman, *The mammals of Somaliland,* p. 41, 1910. Roosevelt, *African game trails,* p. 59, 1910.
[5] F. C. K., *Amer. Nat.,* XXXI, 77-78, 1897.
[6] Jennison, *Natural history: animals,* p. 86, 1927.
[7] Buxton, The gadett or brain-eater, *Journ. East Africa and Uganda Nat. Hist. Soc.,* No. 15, p. 498, 1919; *Journ. Mammalogy,* I, 151, 1919.
[1] Preble, Mammals of the Pribilof Islands, *N. Amer. Fauna,* No. 46, p. 110, 1923. Osgood, Preble and Parker, The fur seals and other life of Pribilof Islands, Alaska, *Bull. U. S. Bureau of Fisheries,* XXXIV, 1-172, 1914 (1916); *Scientific Monthly,* IV, 386-409, 1917. Stejneger, The Russian fur seal islands, *Bull. U. S. Fish Comm.,* XVI, 3-149, 1896.

101,594 skins was $4,321,141.03, of which $1,010,869.24 went to Great Britain and Japan under the treaties. When first leased the Pribilof herd numbered about 2,000,000 seals, but it was depleted to 132,279 in four years, increasing, however, to 581,453 from 1910 to 1920.[2] The world's reported sales of seal skins in 1919-1921 totalled 85,164.[3]

The habit of seals, walruses and their allies, of congregating in large numbers at rookeries, together with their awkwardness on land, make them easy prey of hunters. The killing of females before or just after birth of the young would not permit the herds to maintain their numbers, much less to increase. About 30,000 young seals are reported to have starved in 1895 because their mothers were killed.[4] At Stikine River, Alaska, the natives have been in the habit of killing the females just before the pups are born, as the skins and flesh of the unborn pups are especially prized.[5] Many fur seals are destroyed by killer whales, 18 young seals having been taken from one killer stomach and 24 from another.[6]

The Guadalupe fur seal (*Arctocephalus townsendi*), now practically extinct, was once abundant on the islands off the coasts of California and Lower California. Between 1806 and 1913, 200,000 seals, probably of this species, were killed on the Farallon Islands, according to Evermann, 150,000 between 1806 and 1813, according to O'Melveny.[7]

The seals of Newfoundland also have been relentlessly pursued by shamefully wasteful methods. Formerly the "baby harp seals" were killed by hundreds of thousands annually for their blubber, and the females were killed in the spring, before the birth of the young, but now these seals are killed for their fur, yielding Newfoundland an annual revenue, which in 1921 was about $250,000.[8] It is reported that 300,000 seals whelp each year at two points in the Gulf of St. Lawrence, and 500,000 off the Straits of Belle Isle.[9] Five Newfoundland steamers in 1900 took 100,000 seals, worth $250,000, mostly harps

[2] Nelson, *Scientific Monthly*, XVI, 372-373, 1923, citing *Rept. U. S. Bureau Fisheries for 1909*, Bower and Aller, *Rept. U. S. Bur. Fish. for 1914*, pp. 67-74. Stevenson, *Rept. U. S. Fish Comm. for 1902*, pp. 283-352.

[3] Osborn and Anthony, *Journ. Mammalogy*, III, 226, 1922; *Natural History*, XXII, 393, 1922.

[4] Laut, *The fur trade of America*, pp. 125-133, 1921.

[5] Walker, *Rept. U. S. Bureau Fisheries for 1915*, pp. 47-51.

[6] Hanna, What becomes of the fur seals, *Science*, LV, 505-507, 1922.

[7] Evermann, The conservation of the marine life of the Pacific, *Scientific Monthly*, XVI, 521-538, 1923. O'Melveny, What the sea otter did for California, *The Masterkey* (California), III, No. 2, pp. 14-18, 1929.

[8] Laut, *The fur trade of America*, p. 132, 1921.

[9] Bartlett, Newfoundland seals, *Journ. Mammalogy*, VIII, 207-211, 1927.

(*Phoca groenlandica*), from Labrador and northward.[10] In 1885, 19 British vessels in the Newfoundland fishery took 211,587 seals, and in 1886, 18 vessels took 195,396, for the skins and oil.[11]

The hair seals are hunted for their oil, and the skins are made into leather. Lucas in 1889 estimated that 875,000 of them were being killed annually.[12] Half a century ago, in some seasons 40,000 seals were killed on the Island of Peshnoi, near the mouths of the Ural, 1300 having been killed in one night in 1846. It was "no infrequent occurrence to see 15,000 dead seals cover the battlefield of a single night." One factory manufactured 3,600,000 pounds of seal oil annually.[13]

There is considerable difference of opinion as to just how destructive to fish the seals are. Quite likely the different species differ somewhat in habit, and the food of a given species likely varies from time to time and from place to place. Usually animals of mixed diet take the food that is most readily obtained wherever they may be. During the salmon runs on the northwestern coast of North America the fish furnish an abundant supply of food, and may attract numbers of seals, which normally would not take many fish.

Bartlett says that the Newfoundland seals feed principally upon fishes, but eat also considerable quantities of mollusks and starfishes.[14] Walker says that at Stikine River, Alaska, 27.39 per cent of the red-meated king salmon and 8.63 per cent of the white-meated salmon in the fishermen's nets are mutilated and damaged by hair seals, and an unknown percentage removed entirely from the nets without leaving any remains, besides the damage to the nets.[15] Smith says that 13 per cent of the salmon in nets are destroyed by seals.[16] On the other hand, Merriam examined many stomachs of fur seals and found the contents to be chiefly squids, "while in only a few instances were any traces of fish discovered."[17] Of thirty-five stomachs of the harbor seal (*Phoca richardii*), only two contained remains of salmon; other food items were herring, tomcod, shiner, sculpin, shrimp, crab, squid, octo-

[10] Hornaday, *The American natural history*, I, 123-136, 1914.
[11] Southwell, *Bull. U. S. Fish Comm.*, VI, 11-16, 1887.
[12] Lucas, *Ann. Rept. U. S. Natl. Museum for 1889*, p. 611.
[13] Schultz, Fishing and sealing in the Caspian Sea, *Rept. U. S. Fish Comm. for 1874-75*, pp. 58-96.
[14] Bartlett, Newfoundland seals, *Journ. Mammalogy*, VIII, 207-212, 1927.
[15] Walker, Destructiveness of hair seals in the salmon fisheries, *Rept. U. S. Bureau Fisheries for 1915*, pp. 47-51.
[16] Smith, *Bull. U. S. Fish Comm.*, XVII, 120, 1898.
[17] Merriam, Food of sea-lions, *Science*, XIII, 777-779, 1901; *Rept. U. S. Bureau Fisheries for 1902*, pp. 113-114.

pus, skate, starfish and flounder.[18] Of 100 stomachs, 10 per cent were empty; 9 per cent contained only traces of food; fish, 93.58 per cent, largely noncommercial; 1 contained 64 singing fish (6 pounds); only 2 contained salmon.[18-a] Some following remarks on the relation of sea-lions to fish will apply with equal force to the seals. Dall has listed eight species of marine mollusks taken from stomachs of the bearded seal (*Erignathus barbatus*).[19] In addition to the value of their skins and oil, the flesh of seals is often eaten.

Sea-lions also are accused of being destructive to the fisheries. Redding said that in 1887 there were three thousand seals and sea-lions at the entrance to Golden Gate Harbor, San Francisco, each eating from twenty to forty pounds of fish daily. He seemed to consider them the cause of the decrease in the number of salmon, yet he admitted the difficulty of preventing Greek and Italian fishermen "from capturing every fish that comes into the harbor,"[20] which assuredly must have had something to do with the decrease in the salmon run up the river. The fact is that an examination of the stomachs of California sea-lions does not make a very strong case against them. An even more significant fact is that both seals and sea-lions had lived in large numbers in the vicinity for unknown ages, and yet the salmon remained very abundant until human fishermen of the Pacific Coast began to supply the world with canned salmon.[21] Hence the justice of the fishermen's demand for the extermination of seals and sea-lions is very questionable.

Eight stomachs of sea-lions killed by fishermen during the salmon season, because they were believed to be feeding on salmon, were examined by Dyche, who found no fish remains in them. Afterwards he killed twelve sea-lions and found seven of the stomachs to be filled with squid, one with octopus, four nearly empty, except a few squid beaks. Later two more were examined; he found one full of squid, the other full of octopus. He says that when sea-lions were abundant, about fifty years ago, salmon were also much more abundant, and that

[18] Scheffer, Precarious status of the seal and sea-lion on our northwest coast, *Journ. Mammalogy*, IX, 10-16, 1928.

[18-a] Scheffer and Sperry, Food habits of the Pacific harbor seal, Phoca richardii, *Journ. Mammalogy*, XII, 214-226, 1931.

[19] Dall, *Report of the Canadian Arctic expedition, 1913-1918*, VIII, Part A, Mollusks, 1919; *Journ. Mammalogy*, I, 246-247, 1920.

[20] Redding, Causes of the decrease of salmon in the Sacramento River, *Bull. U. S. Fish Comm.*, VII, 57-58, 1887.

[21] Dall, On the preservation of the marine animals of the northwest coast, *Ann. Rept. Smithsonian Inst. for 1901*, p. 687.

the best fishing was near the sea-lion rocks.[22] Both the squid and the octopus are known to feed extensively on young fishes, which may account for good fishing where seals and sea-lions are acting as a check upon the cephalopods. Thus it may be possible that the pinnipeds are actually beneficial to the fisheries, instead of harmful, but the idea that they are injurious is so deeply seated in the minds of fishermen that it is very difficult to eradicate it. It must also be remembered that thousands of cormorants, shearwaters, pelicans and other large birds are taking a constant and large toll from the fishes, probably the total amount consumed being much greater than is consumed by all the pinnipeds.[23]

Dice says that the sea-lions of the California coast eat fish, squids, octopuses, mollusks, crustaceans, etc.[24] Smith found a decided difference between the food of the northern or Steller sea-lion (*Eumetopias jubata*) and that of the California sea-lion (*Zalophus californianus*). He examined eighteen stomachs of the former and twenty-four of the latter, and only thirteen of each contained food. All of the Steller contained fish, containing also squid and octopus, the maximum number of squid in any one stomach being six, while the quantity of fish was large, thirty-five pounds in one. Of the California, five had eaten fish, seventeen small fishes being the maximum number in any one stomach; eleven had eaten squid, the five which contained fish containing squid also, from 100 to 300 each.[25] Several sea-lions were killed "in the Klamath River estuary during the height of the salmon run. . . . The stomachs were found to be filled with lampreys. It is a proven fact that lampreys are detrimental to other fish, killing great quanties of them in some places."[26]

Rowley says that the diet of sea-lions is largely fish at most times, squid when obtainable; that *Zalophus* in captivity, weighing from 100 to 150 pounds, when fed on fish, eats from 12 to 15 pounds daily; while *Eumetopias,* weighing ten times as much, perhaps will eat 150 pounds. Of course, eating what is given them in captivity does not indicate what proportions of the different kinds of food they take,

[22] Dyche, Notes on the habits of California sea-lions, *Trans. Kansas Acad. Sci.,* XVIII, 179-182, 1902. Merriam, Food of sea-lions, *Science,* XIII, 777-779, 1901. *California Fish and Game,* VIII, 135, 1922.

[23] Starks, Notes on the sea-lions, *California Fish and Game,* VII, 251-253, 1921.

[24] Dice, The sea-lions of California, *California Fish and Game,* XIV, 1-16, 1928.

[25] Smith, Destructiveness of sea-lions, *Rept. U. S. Fish Comm. for 1902,* pp. 111-119.

[26] Bonnot, Sea-lions and fisherman, *California Fish and Game,* XV, 282, 1929.

when available, under natural conditions. Rowley adds that when white men appeared on the scene there were probably 1000 times as many sea-lions and 10,000 times as many fishes as there are now. Therefore the reduction seems to be due to man, not to sea-lions and seals, and killing all the sea-lions and seals would make no appreciable difference in the number of fishes in the sea.[27] The few fishes taken by the comparatively small number of pinnipeds, from the vast swarms of fishes swimming from place to place in the ocean, are a very small percentage, while the commercial salmon fishermen, with nets and traps, take fish by the hundreds of tons each season, as they enter the rivers to spawn, thus preventing reproduction. A questionnaire sent to the seal and sea-lion hunters of Oregon by the Port Orford Chamber of Commerce is said to have brought replies unanimously favoring the removal of the bounty, as "the seals and sea-lions are not destructive to commercial fish and fishing," their food, as listed by the hunters, consisting of species of little or no commercial value, including skates, ling cod, snappers, octopuses, squawfish, redfish and crabs.[28]

The sea-lions had been greatly reduced by the attacks of the oil and hide industries before oil derived from mammals was so largely displaced in commerce by petroleum products. Besides the oil and hides, the "trimmings" (genitalia, lips with "whiskers" attached, and gall bladder) have been in great demand. The genitalia have been extensively used in China in the manufacture of a "rejuvenating decoction" for aged mandarins, the whiskers for ornaments and cleaning the stems of opium pipes, the gall sacs for medicinal purposes. Many have been killed illegally just for the trimmings, which can be easily hidden from the officers, the carcasses and hides being left in the water.[29] The Steller sea-lion was formerly of great importance to the natives of Alaska. In 1872 it was estimated that there were from 20,000 to 25,000 of them on St. Paul Island and from 7000 to 8000 on St. George, but in 1923 there were only a few hundred left.[30]

The northern sea-elephants or elephant-seals (*Mirounga angustirostris*) were once abundant on the Pacific Coast, but were so assiduously hunted for their oil that they have become too scarce for profitable hunting.[31] The production of sea-elephant oil from 1803 to 1889

[27] Rowley, Life history of the sea-lions on the California coast, *Journ. Mammalogy*, x, 1-36, 1929.
[28] *California Fish and Game*, xvi, 185-186, 191, 1930.
[29] Rowley, *Journ. Mammalogy*, x, 1-36, 1929.
[30] Preble, Mammals of Pribilof Islands, *N. Amer. Fauna*, No. 46, 1923.
[31] Lucas, *Ann. Rept. Smithsonian Inst. for 1889*, pp. 616-618.

aggregated over 242,000 barrels, valued at $540,000.[32] In 1906 it was reported that the California species had been practically exterminated for its oil, 200 gallons of which were sometimes obtained from a single individual.

Only the isolation of their present habitat and some official efforts to protect the small remnant of the herds have prevented the extinction of the species. In 1892, nine were found on Guadalupe Island. In 1911, 125 were reported. This report caused an attack upon them for their skins, which are not of much value. The United States government issued an order forbidding the importation of the hides into this country unless accompanied by a written permit from the Mexican government. In 1922 there were 264 adult males and a few young. The Mexican government posted notices forbidding any killing of the animals, under heavy penalty. In 1924 soldiers were placed on guard, because of plans of whaling and fertilizer companies to "clean up" the herd. The island has now been made a government reserve for the protection of the fauna, and landing is permitted only upon government permit. In 1923 Anthony enumerated 266 males, and estimated that the missing females and those doubtless absent on feeding expeditions would make a total of 1250.[33] Ten stomachs examined by Anthony contained only sand, gravel and "large quantities of parasitic worms," except a bass and fragments of kelp in one. One stomach examined by Huey contained a double handful of rock, numerous large stomach worms and a pile of kelp; another contained a pint of rocks, sand and stomach parasites and part of the beak of a squid; a captive one ate fish greedily.[34] In 1925 he examined three more stomachs, which contained squid beaks, and one which contained only sand, pebbles and a small piece of kelp.[35]

The walrus, which was one of the principal sources of food for the Eskimo, furnishing also skins for his clothing, etc., has been hunted so relentlessly by the oil, ivory and hide industries that the natives were in danger of starvation when the government introduced reindeer for

[32] Stevenson, Aquatic products in arts and industries, *Rept. U. S. Fish Comm. for 1902*, pp. 211-214.

[33] Anthony, Notes on the present status of the northern elephant-seal, Mirounga angustirostris, *Journ. Mammalogy*, v, 145-153, 1924. Huey, Past and present status of the northern elephant-seal, with a note on the Guadalupe fur seal, *Journ. Mammalogy*, xi, 188-194, 1930, with bibliography.

[34] Huey, Recent observations on the northern elephant-seal, *Journ. Mammalogy*, v, 237-243, 1924.

[35] Huey, Late information on the Guadalupe Island elephant-seal herd, *Journ. Mammalogy*, vi, 126, 1925.

their benefit. From 1870 to 1880, 100,000 walruses were killed on the northwest American coast, yielding 1,996,000 gallons of oil, worth $1,000,000, and 398, 868 pounds of ivory, reducing their numbers 50 per cent in that brief period.[36] A quarter-century ago about 30,000 pounds of tanned walrus hides, valued at $25,000, were imported to the United States annually.[37] In Europe the slaughter has been as great. At one rookery in Norway 600 were killed in six hours.[38] At Ingshong, Siberia, the natives, after the walrus had become too scarce to supply their needs, established a close season, opening the season for one day only after the freeze came and permitting each man to kill only enough for his winter's use. Since then "the inhabitants of this village always have plenty of walrus meat to eat, walrus hides for their dwellings and boats, and oil for fuel and lighting."[39] Bernard says that walruses now seldom land on the Alaska coast, since they have been so persistently hunted. Consequently the natives kill them at sea. Being unable to bring the meat and hides ashore, they are wasted, only the ivory being brought in.[40] Perhaps its ivory, even more than its oil and hide, has caused the undoing of the walrus. In twelve years, 1874-1885, the Arctic whaling fleet reporting at San Francisco alone brought in 260,485 pounds of walrus ivory, the ivory adding much to the profits of walrus hunting.[41] Dall says that the food of walruses consists of clams, marine snails and other mollusks which frequent shallow water and sand bars.[42]

## Order RODENTIA—Gnawing Mammals Including Lagomorpha

Of the more than 12,000 species of mammals, much the largest order is Rodentia, including squirrels, mice, rats, prairie-dogs, gophers and many other groups. It seems best, in order to present the economic data concerning these and somewhat related groups without too much repetition, to include Lagomorpha, the hares, rabbits and pikas, in accord-

[36] Stevenson, Aquatic products in arts and industries, *Rept. U. S. Fish Comm. for 1902,* p. 214. Clark, The Pacific walrus fishery, *The Fisheries and Fishery Industries of the United States,* 1887, Sec. v, Vol. 2, Part xvii, 311-318. Lucas, *Ann. Rept. U. S. Natl. Museum for 1901,* p. 618.

[37] Stevenson, Utilization of the skins of aquatic animals, *Rept. U. S. Fish Comm. for 1902,* p. 337.

[38] Lucas, *Ann. Rept. U. S. Natl. Museum for 1901,* p. 618.

[39] Bernard, Local walrus protection in northeast Siberia, *Journ. Mammalogy,* iv, 224-227, 1923.

[40] Bernard, Walrus protection in Alaska, *Journ. Mammalogy,* vi, 100-102, 1926.

[41] *Bull. U. S. Fish Comm.,* vi, 89-90, 1886.

[42] Dall, *Ann. Rept. Smithsonian Inst. for 1901,* pp. 687-688.

ance with the general former practice, though there is a strong recent tendency toward placing them by themselves in a distinct order. In North America alone 77 genera were recognized in 1910, 44 of which, with 750 species and varieties, occur north of Mexico.[1] Many have since been described or recorded.

Not only are there more genera and species than in any other order, but probably there are more individuals of rodents than there are of all other orders combined. Many of the rodent groups are very prolific breeders. For example, field mice have from 6 to 8 young to the litter, with a gestation period of 21 days; one female in captivity had 17 litters in 1 year; another had 13 litters before she was a year old; if all the young had lived and bred at the same rate the progeny would have numbered 1,000,000 in a year.[2] In these extreme cases fecundity was probably overstimulated by shelter, plenty of food and other favorable conditions provided in captivity, but the normal fertility in a state of nature is enormous. Were the death rate not also very high they would soon overrun the earth and destroy all vegetation. Fortunately after they increase in numbers to a certain point, owing to temporary favorable conditions of weather, food, cover and so on, the mortality usually greatly increases, owing to lessening of food, crowded conditions, epidemic diseases, etc., so that their numbers are again reduced to or below the normal abundance.[3]

For the house rat, assuming from 3 to 6 litters per annum, with an average of 10 young to each litter, various estimates of possible results, if all lived and bred, have been made. Lantz made the number 20,155,392 in 3 years, on a 3-litter per annum basis, or, by a later computation, on a 6-litter basis, 359,709,482. Rucker says 940,369,969,152 in 5 years, while Fischer says 48,319,698,843,030,344,720 in 10 years. True, these figures are obviously impossible, based as they are upon the assumption that all lived and bred.[4] However, such computations are valuable for the purpose

[1] Lantz, Rodent pests of the farm, *Farmers' Bull.*, No. 36, 1910.

[2] Bailey, Breeding, feeding and other life habits of meadow mice (Microtus), *Journ. Agric. Research*, XXVII, 523-535, 1924.

[3] Howell, Periodic fluctuations in the numbers of small mammals, *Journ. Mammalogy*, IV, 149-155, 1923.

[4] Silver, The reproduction potential of rats, *Journ. Mammalogy*, V, 66-67, 1924; citing various publications. See also Eaton and Stirrett, Reproduction rate in wild rats, *Science*, LXVII, 555-556, 1928. Donaldson, Control of rat population, *Science*, March 20, 1925. Forbush, Rats and rat riddance, *Mass. Board Agric., Econ. Biol., Bull.* No. 1, pp. 11-12, 1915. Rodwell, *The rat*, pp. 167-168, 1858. Lantz, The brown rat in the United States, *U. S. Biol. Surv. Bull.* No. 33, p. 16, 1909. The rat and its relation to public health, *U. S. Public Health and Marine Hospital Service*, p. 153, 1910.

of showing that rodents are a constant menace, a single year of very favorable conditions of weather, shelter and food being sufficient to start a disastrous plague. If fully aware of this danger, constant watchfulness and prompt measures for their suppression as soon as an increase in numbers begins, might often prevent such plagues. Prairie-dogs, ground squirrels and various other rodents are also very prolific. From 86 female ground squirrels (*Otospermophilus grammurus beecheyi*) were obtained 846 embryos, an average of nearly ten each.[5] Another (*Citellus mollis*) contained 13 embryos.[6]

Because of their fecundity and their ready response to varying local conditions, various species of rodents, particularly mice and rats, are subject to very great fluctuations in numbers. Serious mouse plagues have occurred at intervals in various parts of the world, especially in Europe and Asia.[7] "Lemmings have an average periodic fluctuation of three and one-half years, the maxima occurring synchronously in North America and Europe, and probably around the Arctic region."[8] In Scandinavia they indulge in somewhat periodic wholesale migrations. On high plateaus they multiply until they exhaust their food supply, then swarm out over the valleys in vast hordes, swimming streams, turning aside for nothing, devouring the crops and other vegetation in their paths, remnants of the army finally reaching the sea, plunging in and perishing. In 1868 a steamer is said to have steamed for a quarter hour through a swarm of lemmings extending as far as the eye could see. The voles of Siberia perform similar migrations.[9] Hawks, owls and other enemies, follow the migrating hordes and prey upon them. Often disease breaks out and assists in reducing their numbers. Perhaps the steady annual drain upon crops through the depredations of the small rodents is greater in the long run, but certainly much less spectacular than the devastation wrought by these great local outbreaks.

In 1822, in 14 days, 1,500,000 field mice were caught in the district of Zabern, Germany, 590,427 in the district of Nidda and 271,941 in the district of Putzbach. In 1856, 12,000 acres of land had to be replowed and replanted because of the destruction of the first crop

[5] Jacobson, Rate of reproduction in Citellus beecheyi, *Journ. Mammalogy,* IV, 58, 1923.

[6] Jewett, A breeding record of Citellus mollis, *Journ. Mammalogy,* IV, 191, 1923.

[7] Lantz, Meadow mice in relation to agriculture and horticulture, *Yearbook U. S. Dept. Agric. for 1905,* pp. 363-373; An economic study of field mice (genus Microtus), *U. S. Biol. Surv. Bull.* No. 31, 1907. Bailey, *Journ. Agric. Research,* XXVII, 523-524, 1924.

[8] Innis, *The fur trade of Canada,* p. 90, 1927.

[9] Lantz, *U. S. Biol. Surv. Bull.* No. 31, pp. 6-7, 1907.

by mice. On one estate near Breslau 200,000 were caught in 7 weeks and sold to a fertilizer factory. In 1861 the authorities paid $1,000 for the capture of 409,524 field mice near Alsheim, in Rhenish Hesse. In 1816 and 1817 "whole districts were reduced to destitution" by these mice, the department of Vendée suffering a loss of $600,000. In a meadow 1000 field mice require 12 tons of grass or other vegetation each year. In France it was estimated that there were from 1500 to 4000 to the acre.[10] In special invasions the number runs much higher.

The first serious plague of field mice on record in the United States was in 1907-1908, when *Microtus montanus* was estimated to have reached an abundance of from 8000 to 12,000 an acre in Humboldt Valley, Nevada, where the destruction of alfalfa resulted in a loss of $300,000.[11] A more serious outbreak occurred in Kern County, California, in 1926-1927. About 15 per cent of the infestation consisted of field mice (*Microtus californicus*), the balance mostly the imported house mouse (*Mus musculus*). White-footed or deer mice (*Peromyscus*), kangaroo rats (*Dipodomys*) and pocket mice (*Perognathus*) were present in only about their usual numbers. It was estimated that there were 82,280 mice to the acre, and it was computed that there were in one grain bin 20 feet square 3520 mice in sight at one time, besides those hidden among the grain bags. Two tons of them were killed in one day about one granary. Poison was placed in miles of trenches, and it was estimated that there were 85,000 dead mice to the mile in trenches.[12] Mice killed a sheep. "Penned in a small enclosure it was unable to escape, and the mice swarmed over it, pulled it down and stripped the bones of flesh."[13]

This outbreak followed a very effective wholesale poisoning campaign against coyotes, in which many skunks, foxes and probably other enemies of the mice were destroyed. Had these predacious mammals been allowed to live, they would undoubtedly have killed thousands of mice during the weeks and months immediately preceding the

[10] Lantz, *U. S. Biol. Surv. Bull.* No. 31, p. 12, 1907.

[11] Piper, The Nevada mouse plague of 1907-08, *Farmers' Bull.*, No. 352, 1907; Mouse plagues: Their control and prevention, *Yearbook U. S. Dept. of Agric. for 1908,* pp. 301-310. Bailey, Harmful and beneficial mammals of the Interior Basin, with special reference to the Carson and Humboldt Valleys, Nevada, *Farmers' Bull.*, No. 335, 1908. Taylor, Methods of determining rodent pressure on the range, *Ecology*, XI, 523-542, 1930.

[12] Hall, An outbreak of house mice in Kern County, California, *Univ. California Pub. Zool.*, XXX, 189-203, 1927. Piper, The mouse infestation of Buena Vista Lake Basin, Kern County, California, September, 1926, to February, 1927, *Monthly Bull. California Dept. Agric.*, XVII, 538-560, 1929.

[13] Humphrey, A serious plague of mice in California, *Scientific American*, May, 1927, pp. 330-331.

outbreak. The numerous descendants of the thousands of mice thus saved by the destruction of their enemies, running through the succeeding generations and multiplying rapidly, must have contributed largely to the plague, if they were not the chief element in it, though there are other probable factors, such as weather, food and shelter, to be considered.

The question as to whether the natural enemies of rodents can prevent such plagues has been much discussed.[14] Among the more active enemies may be mentioned hawks, owls, gulls, ravens, crows, shrikes, herons, coyotes, wolves, foxes, skunks, weasels, badgers and wildcats.[15] The number of rodents taken by all these and other birds, mammals and snakes each year is simply enormous. In Ohio 20,000 hawks were killed under a bounty act in 1916, and in a year or so it was said that "already the unfavorable effects of this law are shown in the large number of complaints of damage done by rats and mice in Ohio and adjoining states."[16] If natural enemies cannot entirely prevent the occasional more serious outbreaks, they certainly do so much toward keeping the pests in check during ordinary times as to perhaps justify the assertion that were it not for the predatory birds and mammals there would be an almost continuous plague of rodents. When the rodents become abundant in a given locality, they at once enter more largely into the diet of the various predators, both birds and mammals, which tend to congregate in areas of mouse abundance, as attested by many observers. Thus a direct relation between mouse abundance and the value of the fur catch has been asserted.[17] Also, it has been noted that when mice are abundant in Labrador they furnish abundant food for wolves and other beasts of prey, which then leave ptarmigan, caribou and other game alone.[18]

Most writers upon the subject of the injurious rodents of the western plains in the United States have agreed that since the settlement of the region began the rodents have increased in numbers, largely on account of the wholesale destruction of predatory mammals and birds. Couch, in view of the fact that while coyotes were being protected as enemies of jack rabbits, and were rapidly increasing in Grant County,

[14] See, for example: Brooks, Can hawks prevent mouse plagues?, *The Condor,* XXIX, 249-250, 1927. Tyler, Can hawks prevent mouse plagues? A reply, *The Condor,* XXX, 124-125, 1928. Henderson, *The practical value of birds,* 1927, many references cited in the footnotes.

[15] Piper, *Farmers' Bull.,* No. 352, p. 21, 1907.

[16] Lantz, The house rat: The most destructive animal in the world, *Yearbook U. S. Dept. Agric. for 1917,* pp. 235-251.

[17] Innis, *The fur trade of Canada,* pp. 88-91, 1927.

[18] Cabot, *Labrador,* 1921. *Journ. Mammalogy,* III, 58-59, 1922.

Washington, jack rabbits were also increasing rapidly, questions the efficacy of mammals in the control of rodents. He says: "While there is no doubt that predatory mammals are a factor in controlling rodents, yet they play but a small part in maintaining the natural balance. Larger factors are involved, and these include seasonal conditions, fecundity of species, the acts of man in providing abundant food, and the presence of natural and other shelter. On the other hand, rodents the size of ground squirrels, or smaller, are more effectively decreased in numbers by raptorial birds than by predatory mammals. The quantity of rodent remains found in the stomachs and disgorges of individual owls is almost unbelievable."[19] It is probable that during ordinary times the combined efforts of predatory mammals and birds are very important in keeping the rodents within reasonable bounds, but when abundant food and shelter, favorable weather and other conditions greatly increase the fecundity and average span of life of such prolific breeders as mice, rabbits and prairie-dogs, they are likely to get beyond control. In such cases birds, moving about very freely, can more easily concentrate on infested areas where they may find abundant food. Meantime, as has been said before, man, having by cultivation of crops provided more abundant food and better shelter for the rodents, must assume complete control and resort to poisoning and other methods.

That badgers, because of their ability as diggers, may be at times a very important factor in the control of burrowing rodents, is generally recognized. In Colorado they cleared the prairie-dogs from an area a mile and a half long in a gulch, a large percentage of the prairie-dog burrows having been excavated by the badgers.[20] It has been said to be the habit of badgers to clear up one locality and then when the rodents become too scarce to furnish them with food they move on to another locality, whereupon the locality they have abandoned becomes again infested, unless precautions are taken to prevent it.

A faint notion of the damage done to crops by rodents may be obtained from the following account of the meadow mouse, extracted from *Science News Letter* of July 20, 1929.

The meadow mouse looks soft and pretty and harmless, but he is a most expensive guest just the same. Vernon Bailey, of the U. S. Biological Survey, has been figuring his board bill, with rather startling results. A meadow mouse

[19] Couch, Relationship of predatory mammals and birds of prey to rodent life, *Journ. Mammalogy,* IX, 73-74, 1928.

[20] Silver, Badger activities in prairie-dog control, *Journ. Mammalogy,* IX, 63, 1928.

eats about 30 grams, or a little over an ounce, of green food every day. That runs up to 23 pounds in a year. A hundred mice will stow away over a ton of green grass or clover in a twelvemonth. A hundred mice to an acre is not an unusual number in meadows favorable to their habits, while in "mouse years" the number has been estimated at thousands to the acre.

Mouse plagues, disastrous as they are locally, are of minor importance in comparison with the steady yearly drain on crops by the mice over the country at large in normal years. Even as few as 10 meadow mice to the acre on 100 acres of meadow would take about 11 tons of grass or 5½ tons of hay a year. This number, on the 65,000,000 acres of hay raised in the 38 mouse states of the country, would cause a loss of over 3,000,000 tons of hay a year, or a money loss of some $30,000,000 annually in hay alone. The number of young in a litter ranges from two to nine, and one pair averages five to the litter. At this rate of increase, allowing equal numbers of males and females, and the young beginning to breed at 46 days old, the total increase from one pair, if all lived and bred, would be over 1,000,000 individuals at the end of a year. If all were confined to one acre of ground, this would mean over 20 mice to every square foot.

The annual damage by the introduced European rats and mice in warehouses in the United States has been estimated at $200,000,000, and the annual damage by native rodents to crops in the western United States has been placed at $300,000,000.[21] In 1908 it was estimated that the annual loss to agriculture and horticulture in the United States, from the depredations of ground squirrels alone, was $10,000,000.[22] The damage done to crops and range by native rodents, chiefly prairie-dogs, ground squirrels, pocket gophers and jack rabbits, in 8 states in 1917 was estimated as follows: Montana, $15,000,000 to $20,000,000; North Dakota, $6,000,000 to $9,000,000; Kansas, $12,000,000; Colorado, $2,000,000; California, $20,000,000; Wyoming, 15 per cent of all crops; Nevada, $1,000,000; New Mexico, $3,600,000; Virginia, in 1915, in a single county, $200,000 damage to orchard trees by pine mice alone.[23] In Colorado in 1918, 14,000,000 acres of land were said to have been infested with prairie-dogs and 1,000,000 acres with Wyoming ground squirrels, the annual damage therefrom, at only 10 cents an acre, amounting to $1,500,000, which, added to $500,000 damage from other rodents, would make $2,000,000 per anum, a conservative estimate.[24] To all estimates of damage must

[21] Vorhies and Taylor, Life history of the kangaroo rat, *U. S. Dept. Agric. Bull.* No. 1091, p. 2, 1922. Taylor and Loftfield, Damage to range grasses by the Zuni prairie-dog, *U. S. Dept. Agric. Bull.* No. 1227, 1924. Henshaw, Policemen of the air, *Nat. Geog. Mag.*, XIX, 79, 1908. Bell, Coöperative campaigns for the control of ground squirrels, prairie-dogs and jack rabbits, *Yearbook U. S. Dept. Agric. for 1917*, pp. 225-233.

[22] Bailey, *Farmers' Bull.*, No. 335, p. 6, 1908.

[23] Bell, Death to rodents, *Yearbook U. S. Dept. Agric. for 1920*, pp. 422-423.

[24] Burnett, Rodents of Colorado in their economic relations, *Office Colorado State Entomologist Circular* No. 25, p. 6, 1918.

be added an unknown amount of expense in fighting the rodents by various methods, and of preventing damage by them.

Silver listed seventeen kinds of rodents as potential enemies of fruit and shade trees, especially young trees, of which five may be considered serious; an experimental plot was damaged to the extent of 70 per cent in 3 days by chipmunks and deer mice; wood rats on a 1/5-acre tract killed 23 per cent of the pines and did more or less damage to 34 per cent more; rabbits killed 12,000 catalpa trees on a 25-acre tract; pocket gophers destroyed 25 per cent of the young silver maples and nearly all the honey locusts on one tract; total rodent damage to fruit and shade trees equals several million dollars annually.[25] Five of the eight rodent families inhabiting Kansas are distinctly injurious; mice girdled 5000 trees in one locality.[26] Rabbits girdled 3000 fruit trees in one small Iowa nursery in one winter and 2000 out of 4000 apple trees in Maryland in two months.[27] Other data concerning rodent damage may be found in subsequent pages, especially under rats, mice, squirrels and rabbits.

Because of the enormous amount of damage done by rodents, the United States Department of Agriculture and other organizations have devoted a great deal of attention to methods of combating and suppressing them and of preventing damage by them. Directions for the use of poisons, trapping and "building them out" by means of rodent-proof construction of buildings are included in many publications.[28] Aside from poisoning and trapping, under some circumstances, where no foodstuff is exposed to the fumes, fumigants may be used for destroying rodents and deterrent odors for driving them out of their hiding places. A great deal may be accomplished by keeping premises clean and free from weed patches, rubbish heaps, brush piles and other hiding and breeding places, and by preventing rodents from getting

[25] Silver, Rodent enemies of fruit and shade trees, *Journ. Mammalogy,* v, 165-173, 1924.

[26] Sullivan, *Economic value of bird life,* p. 25, 1912.

[27] Beal, How birds affect the orchard, *Yearbook U. S. Dept. Agric. for 1900,* p. 299.

[28] For example: Lantz, Use of poisons for destroying noxious mammals, *Yearbook U. S. Dept. Agric. for 1908,* pp. 421-422; An economic study of field mice, *U. S. Biol. Surv. Bull.* No. 31, 1907. Piper, *Farmers' Bull.,* No. 352, 1909. Birdseye, *Farmers' Bull.,* No. 484, 1912. Merriam, The California ground squirrels, *U. S. Biol. Surv. Circular* No. 76, 1910. Dearborn, Trapping on the farm, *Yearbook U. S. Dept. Agric. for 1919,* pp. 451-484. Forbush, Rats and rat riddance, *Massachusetts State Board Agric., Economic Biol., Bull.* No. 1, pp. 38-73, 1915. Oman, Fighting the pocket gopher, the prairie-dog and other rodent pests, *24th Biennial Rept. Kansas Board Agric.* (for 1923-24), pp. 46-60. Bruner, Pocket gophers, *Univ. Nebraska Agric. Exper. Sta. Press Bull.,* No. 29, pp. 6-7, 1908. Burnett, Report on rodent investigations for 1912, *Office Colorado State Entomologist Circular* No. 6, 1912. Hinton, Rats and mice as enemies of mankind, *Brit. Museum Nat. Hist., Econ. Series,* No. 8, 1920.

beneath and into buildings by the free use of cement in foundations and basement floors, tin and sheetiron about the edges of doors to prevent gnawing, plugging all holes and openings except such necessary ones as drain pipes, which may be protected by wire screens.

Coöperative campaigns over large areas are often necessary, so that, after reducing the rodents locally, others may not flow in from surrounding breeding grounds. In such campaigns the United States, with its trained workers, often coöperates with local authorities or organizations.[29] In one year the Biological Survey directed the use of 1610 tons of poisoned grain in the destruction of prairie-dogs and ground squirrels on over 18,000,000 acres of farm and range lands, with the coöperation of 132,000 farmers and stockmen. The saving of crops and range grass thereby, based upon estimates by the farmers and stockmen themselves, amounted to more than $11,000,000 for the season.[30] Considerable of the expense of such campaigns is sometimes covered by the sale of pelts of the animals killed, 25,000 pelts from the Imperial Valley campaign of 1919-1920 having brought $31,000.[31] Organized rabbit drives, found effective in the West, are discussed on a subsequent page.

Much of the damage by rodents may be prevented by constant watchfulness and the free and intelligent use of traps and poisons whenever necessary, and especially by prompt measures for the suppression of the rodents when they begin to inordinately increase, before the threatened uprising assumes plague proportions. The destruction of 1000 rodents in the incipient stages of an outbreak means the prevention of the breeding of many thousands of others.

Bounties have not proved very effective in the suppression of rodents. At least as far back as 1749 bounties were paid on squirrels in Pennsylvania.[32] Bounties are discussed at some length in Chapter XXVII, on Legislation Concerning Mammals.

Though rodents sometimes destroy all the seeds of forest trees in small isolated areas during seasons when seeds are scarce, and otherwise damage forests to some extent, the seeds they bury or otherwise store during seasons of plenty aid in natural reforestation after

[29] Bell, Coöperative campaigns for the control of ground squirrels, prairie-dogs and jack rabbits, *Yearbook U. S. Dept. Agric. for 1917,* pp. 225-233. See also Kellogg, The ground squirrel control program, *California Dept. Agric. Special Pub.* No. 109, 1931. Alexander, "Control, not extermination," of Cynomys ludovicianus arizonensis, *Journ. Mammalgy,* XIII, 302, 1932.

[30] Bell, Death to rodents, *Yearbook U. S. Dept. Agric. for 1920,* p. 431.

[31] Dixon, Rodents in Imperial Valley, *Journ. Mammalogy,* III, 136-146, 1922.

[32] Rhoads, *Mammals of Pennsylvania,* p. 55, 1903.

forest fires, and thus they compensate for any damage they do.[33] Some species, by destroying hordes of insects, to some extent offset the damage done to crops, orchards and forests by rodents in general. "Arboreal squirrels sometimes feed freely on scale insects and other tree pests; the western ground squirrels eat quantities of injurious insects, such as cutworms, wireworms and grasshoppers; and the so-called grasshopper mice perhaps deserve their name and are undoubtedly more highly insectivorous than the majority of their tribe."[34] The insect-eating habits of rodents have been discussed in Chapter XXIII, on the Economic Relations of Mammals to Insects, and many additional items of interest along this line may be found under the various species in subsequent pages.

Some species of rodents are very useful because of their pelts, a subject discussed in Chapter IX, on the Fur, Skin and Hide Trades, with additional items under various species on subsequent pages. The reported sales of rodent skins during 1919-1921, were as follows:[35] squirrel, 14,859,316; white hare, 3,713,036; muskrat, 14,109,288; nutria, 1,941,784; chinchilla, 36,448; beaver, 420,490; marmot, 3,107,759. In addition, it was estimated in 1921 that from 70,000,000 to 80,000,000 rabbit skins per annum are used.[36] The flesh of many species of rodents is used as food and that of some species is sold in the markets.

## Family SCIURIDAE—Squirrels, Chipmunks, Woodchucks, Prairie-dogs

As we have seen, some species of squirrels are quite destructive to crops. Though not carnivorous, some species are somewhat omnivorous, and it is well known that certain of them are more or less destructive to the eggs and young of wild birds (see Chapter XX). Squirrels and chipmunks eat many snails,[1] but in most regions this does no harm, and in some localities it may do some good. Conchol-

[33] Hofmann, Furred forest planters, *Scientific Monthly,* XVI, 280-283, 1923. Mice and chipmunks help restock forests, *Journ. Mammalogy,* II, 113, 1921, citing *U. S. Dept. Agric. Press Service.* Shufeldt, Four-footed foresters, *Amer. Forestry,* XXVI, 37-44, 1920. Hatt, The relation of mammals to the Harvard Forest, *Roosevelt Wild Life Bull.,* V, 645-664, 1930.

[34] McAtee, The rôle of vertebrates in the control of insect pests, *Ann. Rept. Smithsonian Inst. for 1925,* p. 416.

[35] Osborn and Anthony, *Journ. Mammalogy,* III, 216, 1922; *Natural History,* XXII, 393, 1922.

[36] Laut, *The fur trade of America,* p. 84, 1921.

[1] Elrod, *Univ. Montana Bull.,* No. 10, p. 114, 1902; *The Nautilus,* XVII, 4, 1903. Van Hyning, *The Nautilus,* XVIII, 23, 1904. Howell, *N. Amer. Fauna,* No. 52, pp. 9-11, 1929.

ogists often find snail shells which have been broken by squirrels. Squirrels are known often to eat fungi, even some species which are injurious to human beings.[2]

Many species of squirrels are more or less insectivorous, some highly so. Of the contents of 22 stomachs of striped ground squirrels (*Citellus tridecemlineatus*) from the Mississippi Valley, 46 per cent consisted of insects, "almost exclusively injurious species," averaging 13 cutworms and webworms each; and in 80 stomachs 52.9 per cent of the contents was animal matter, chiefly insects, and 44.4 per cent vegetable matter. Franklin ground squirrel (*C. franklini*): 29 stomachs, animal matter 30.3 per cent, mostly insects; vegetable matter 68.5 per cent, mostly seeds and grain. Richardson ground squirrel (*C. richardsoni*): 18 stomachs, animal matter 9.5 per cent; vegetable matter 90.3 per cent.[3] Along the foothills of Colorado the striped ground squirrels "feed on grasshoppers and other injurious insects, almost to the exclusion of all other foods," hence should be protected.[4] Red squirrels eat many insects, according to Hatt. Their ecological relations have been discussed by Klugh.[5] Gray squirrels have been found destroying oak apple galls.[6] A flying squirrel in captivity killed a sapsucker. Four others in captivity "ate prodigious quantities of pinch bugs and other beetles, as much as a pint at a meal."[7]

[2] Odell, Squirrels eating Amanita muscaria, *Canadian Naturalist*, XXXIX, 180-181, 1925; Further observations on squirrels eating Amanita muscaria, *ibid.*, XL, 184, 1926. Hastings and Mottram, Observations upon the edibility of fungi for rodents, *Trans. Brit. Mycolog. Soc.*, V, 364-378, 1929. Murrill, Animal mycophagists, *Torreya*, II, 25-26, 1902. Langham, Squirrel eating Melanogaster ambiguus, *Irish Naturalist*, XXV, 136, 1916. Ballou, Squirrels as mushroom eaters, *Journ. Mammalogy*, VIII, 57-58, 1927. Dice, *ibid.*, II, 25, 1921. Murie, *ibid.*, VIII, 39-40, 1927, citing Merriam, *Mammals of the Adirondacks*, 1884, and Seton, *Life histories of northern animals*, Vol. I, 1909. Goldman, *Journ. Mammalogy*, IX, 127-129, 1928.

[3] Bailey, The prairie ground squirrels or spermophiles of the Mississippi Valley, *U. S. Div. Orn. and Mamm. Bull.* No. 4, pp. 39-46, 55, 67, 1893. Gillette, Food habits of the striped prairie squirrel, *Bull. Iowa Agric. Exper. Sta.*, No. 6, pp. 240-244, 1889. Aldrich, Food habits of the striped gopher, *Bull. South Dakota Agric. Exper. Sta.*, No. 30, pp. 8-11, 1892. Burnett, *Office Colorado State Entom. Circular* No. 14, 1914. For additional data on the economic status of squirrels and chipmunks see Seton, *Lives of game animals*, IV, Part 2, 1929. Bailey, Notes on some of the spermophiles and pocket gophers of the Mississippi Valley, *Ann. Rept. U. S. Dept. Agric. for 1892*, pp. 185-192. *Canadian Entomologist*, XXXIX, No. 1, p. 16, 1907.

[4] Burnett, *Office Colorado State Entom. Circular* No. 18, p. 6, 1916.

[5] Hatt, The red squirrel: Its life history and habits, with special reference to the Adirondacks of New York and Harvard Forest, *Roosevelt Wild Life Annals*, II, No. 1, pp. 1-146, 1929. Klugh, Ecology of the red squirrel, *Journ. Mammalogy*, VIII, 1-32, 1927; reprinted in *Ann. Rept. Smithsonian Inst. for 1928*, pp. 495-524, "with slight changes in the illustrations."

[6] Oak apple galls destroyed by gray squirrels, *Bull. Brooklyn Entom. Soc.*, XIX, 91-93, 1929.

[7] Stoddard, The flying squirrel as a bird killer, *Journ. Mammalogy*, I, 95-96, 1919.

Bailey has published notes on the squirrels of Texas, from which we have briefed the following items:[8] Where they occur, acorns seem to be their favorite food, but they must be content with the food that is available where they happen to be living. The food habits of closely related species and subspecies elsewhere would probably be very similar if the same foods were available. Large-spotted ground squirrel (*Citellus spilosoma major*): "I have found their stomachs full of grasshoppers and beetles and their pouches full of seeds of sand bur (*Cenchrus tribuloides*), and have seen little heaps of the empty bur shells scattered about their burrows. Usually they are not sufficiently numerous in agricultural regions to do serious damage in grain fields." Black-backed rock squirrel (*Otospermophilus grammurus buckleyi*): when available, acorns are its chief diet, but in summer mainly flowers, fruit and green vegetables. One stomach contained green cactus fruit (*Opuntia*). Another was filled with yucca pulp. One had stonecrop in its cheeks and another had its cheeks stuffed with green corn. Couch rock squirrel (*O. g. couchii*): food largely juniper berries and acorns; some found feeding on clover and other plants and fruits of cactus. Rock squirrel (*O. g. grammurus*): feeds upon juniper berries and acorns, but also takes cactus fruit, *Cereus stramineus* and walnuts. One had 13 walnuts the size of cherries in its cheeks and cactus fruits in its stomach. Rio Grande ground squirrels (*Citellus mexicanus parvidens*): "feed on seeds, grain, fruit, green foliage, lizards and numerous insects . . . do considerable damage in spring, by digging up corn, melons, beans and various sprouting seeds, and, in summer and fall, by feeding on the ripening grain. Specimens examined at Roswell, New Mexico, in June, were feeding on about equal proportions of seeds and insects." Pale striped ground squirrel (*C. tridecemlineatus pallidus*): August specimens examined contained mainly grasshoppers, with a few other insects, and one contained prickly pear seeds (*Opuntia*). Texas striped ground squirrels (*C. t. texensis*): "feed largely on grasshoppers and other insects, together with seeds, grain, fruit, green herbage and flowers." Texas antelope squirrel (*Ammospermophilus leucurus interpres*): feeds on various seeds and fruits, especially acacia and mesquite. One stomach was full of cactus fruits, which had tinted its flesh purple throughout, indicating a steady diet for some time. Gray-footed chipmunk (*Eutamias cinereicollis canipes*): food chiefly scrub oak acorns. Western fox squirrel (*Sciurus niger rufi-*

[8] Bailey, Biological survey of Texas, *N. Amer. Fauna*, No. 25, 1905.

*venter*): "food consists mainly of nuts and acorns, but fruits, berries and lichens also are eaten. When feeding on nuts their flesh has a delicious nutty flavor." Texas fox squirrels (*S. n. limitis*): "pecan, hickory, oak and walnut trees furnish their food," but they take also cypress cones and other food.

The same author has discussed also the squirrels of North Dakota,[9] his report furnishing the following items: Pale flying squirrel (*Glaucomys sabrinus canescens*): rarely abundant enough to be of economic importance, but, so far as known, harmless. Seldom disturbs cultivated crops. Eats tree seeds, but pays for them by scattering those not eaten and thus seeding the forest floor. Minnesota gray squirrel (*Sciurus carolinensis hypophaeus*): in native habitat its food is largely acorns, but includes many other nuts and seeds and grain. Northern red squirrel (*S. hudsonicus*): "food consists of acorns, nuts, seeds, mushrooms and occasionally birds' eggs"; injurious when it gets into corn cribs and grain bins. Northern chipmunk (*Eutamias minimus borealis*): "found feeding extensively on chokecherries"; also takes acorns and seeds and berries of various plants. Does some damage to gardens and edges of grain fields, but not a serious pest. Pale chipmunk (*E. m. pallidus*): eats a great variety of nuts, seeds, berries and some vegetation, does some damage to crops, but is easily controlled by traps and poisons. Gray eastern chipmunk (*Tamias striatus griseus*): eats a great variety of nuts, seeds, grains, berries and some green vegetation, occasionally insects, frogs and lizards. Does some damage, but easily trapped and poisoned. Thirteen-striped ground squirrel (*Citellus tridecemlineatus*): food largely seeds, grains and nuts, but takes also berries, green vegetation, "numerous insects," mice, birds, etc. Stomachs examined contained a "considerable portion of grasshoppers, crickets, caterpillars, beetles, ants, cocoons, insect eggs, and even traces of flesh, hair of small mammals, and feathers of birds." Does some damage, but easily controlled. "But for their natural enemies, which are legion, it would be impossible to raise crops within their territory. They are constantly preyed upon by many species of hawks and some owls, and by foxes, weasels, skunks and badgers, so that in spite of their rapid increase their numbers are usually kept somewhat within bounds. However it is necessary over much of their range to supplement the work of their natural enemies by the systematic use of poison." Its pale relative (*C. t. pallidus*) has about the

[9] Bailey, A biological survey of North Dakota, *N. Amer. Fauna,* No. 49, 1926.

same habits. Franklin ground squirrel (*C. franklini*): lives largely on nuts, seeds and grain, but takes berries, vegetables, grasshoppers, crickets, ants, young birds and their eggs and is said to kill young chickens. Richardson ground squirrel (*C. richardsoni*): feeds to some extent on insects, especially grasshoppers. In its original unbroken prairie habitat it did little damage, but with the encroachment of agriculture, giving it cultivated crops as a new and abundant supply of food, damage began in earnest. The annual loss caused by these squirrels in North Dakota has been estimated at from $6,000,000 to $9,000,000 per annum, in addition to $100,000 per annum expended in fighting them and preventing depredations.

Mearns furnishes the following items concerning the squirrels near the Mexican boundary:[10] Arizona gray squirrel (*Sciurus arizonensis*): food "comprises seeds of pine cones, acorns, walnuts, berries and green vegetation." Huachuca gray squirrel (*S. a. huachuca*): "loves to feed upon the walnut (*Juglans rupestris*) and often eats the immature nuts." Texas fox squirrel (*S. niger texianus*): principal food is pecan nuts and acorns. Arizona gray-necked chipmunk (*Eutamias cinercicollis*): in summer feeds "extensively upon green herbage and the seeds of small plants, chiefly legumes, but, like most squirrels, it is fond of an occasional change from vegetable to meat diet." Eats bacon and fat salt pork about camp. Gila cliff chipmunk (*E. dorsalis*): "food consists largely of the evergreen oak (*Quercus emoryi*)." Merriam chipmunk (*E. merriami*): feeds upon "various seeds, fruits and berries, but especially on acorns and pine seeds." Antelope squirrel (*Ammospermophilus leucurus*): eats yucca fruits, pine seeds and various vegetation. Harris ground squirrel (*A. harrisii*): eats mesquite beans (cheek pouches of one contained 44 beans), yucca fruits and seeds. Eats also flesh; poisoned by eating poisoned cougar carcass. Southwestern rock squirrel (*A. h. saxicola*): "cheek pouches usually distended with mesquite beans." Say ground squirrel (*Callospermophilus lateralis*): food largely green vegetation; eats scraps about camp, nibbles bacon and meat of all sorts and steals grain. Rock squirrel (*Otospermophilus grammurus* subsp.?): destructive to crops. "Omnivorous as the bear, feasting alike upon flesh, carrion, grain or almost any sort of fruit or green vegetation that chances to be in season." Eats mesquite beans, berries of cedar and hackberry, grapes, walnuts, acorns, grass seeds, corn, barley, green herbs, browse.

[10] Mearns, Mammals of the Mexican boundary of the United States, *U. S. Natl. Museum, Bull.* No. 56, 1907.

The following items concerning New Mexico squirrels are derived from Ligon's report:[11] Arizona gray squirrel (*Sciurus arizonensis*): diet varied, but "feeds almost exclusively on walnuts after these nuts become matured;" also eats roots. New Mexican red squirrel (*S. fremonti neomexicanus*): feeds upon spruce and fir seeds. Abert tufted-ear squirrel (*S. aberti*): feeds extensively on pine twigs and inner bark, even sometimes when acorns and pine nuts, both favorite foods, become available. Rock squirrels (*Otospermophilus grammurus*): "frequently become serious pests about farms, where, unless trapped or poisoned, they carry off the greater part of the farmer's ripening corn. . . . Also a robber of the nests of ground-nesting birds and domestic fowl."

Cary furnishes the following items concerning Colorado squirrels:[12] Rock squirrel (*O. grammurus*): food chiefly pinyon nuts, acorns and juniper berries [no pinyons or acorns in a considerable part of its range]; said to be fond of young chickens; destroys apricots on the trees to get the seeds; burrows into melons and cantaloupes for seeds; digs up newly planted corn. Pine squirrel (*S. fremonti*): "feeds chiefly upon pine and spruce cones." Cary San Luis chipmunk (*Eutamias minimus caryi*): seen storing seeds of chico bush. Utah chipmunk (*E. dorsalis utahensis*): chief food is juniper berries. Least chipmunk (*E. minimus*): seen in tops of sagebrush and greasewood and gathering a winter supply of buffalo berries. Hopi chipmunk (*E. quadrivittatus hopiensis*): feeds extensively on juniper berries.

Howell's Alabama report furnishes the following items:[13] Bangs chipmunk (*Tamias striatus venustus*): feeds on nuts, seeds, grains and insect larvae. Southern gray squirrel (*Sciurus carolinensis*), lives mostly where nuts abound and they form its chief food. Flesh excellent. Southern fox squirrel (*S. niger*): food—acorns, pine nuts, etc., and green corn. Southeastern flying squirrel (*Glaucomys volans saturatus*), feeds chiefly on nuts, berries and seeds, fond of meat, occasionally destroys insects, does a little damage to pecan groves and stored nuts, but not serious.

The Wyoming ground squirrel (*Citellus elegans*) is "the most destructive rodent found in the state" of Colorado, or at least the most difficult to contend with, though the prairie-dog causes greater financial loss. Damages grain and hay. A meadow producing 12 tons of hay per

[11] Ligon, Wild life of New Mexico, *New Mexico Game Comm. Bull.*, 1927.
[12] Cary, A biological survey of Colorado, *N. Amer. Fauna*, No. 33, 1911.
[13] Howell, A biological survey of Alabama, *N. Amer. Fauna*, No. 45, 1921.

annum, after a clean-up of these squirrels produced 20 tons.[14] A desert ground squirrel (*C. cryptospilotus*) contained only poisoned alfalfa leaves.[14-a] Rock squirrel (*O. grammurus*): food in Colorado—seeds of various kinds, apples, cherries, apricots, chokecherries, blackberries, squashes, melons, peas, grain of all kinds, yucca seed pods and Indian breadroot.[15] The cheek pouches of one contained fifteen apricot pits and of another contained fifty.[16] Say ground squirrel (*Callospermophilus lateralis*) and Wortman ground squirrel (*C. l. wortmani*), both popularly known as "big chipmunk," in Colorado feed upon "seeds of various kinds and garden truck. In some localities they are a great pest to mountain gardeners." In Arizona the Say ground squirrel is fond of the seeds of *Frazera speciosa* and *Pentstemon*.[17] It is one of the hosts of the immature stages of the "spotted fever tick," and should be destroyed about ranches in infected districts.[18] The southern gray squirrel (*Sciurus carolinensis*) has been frequently detected in gnawing the bark of trees, but probably does little or no damage in this way.[19] The park ground squirrel (*Citellus spilosoma pratensis*) feeds on green herbage, seeds and grasshoppers.[20]

The California ground squirrel (*Otospermophilus grammurus beecheyi*) is very abundant and destructive in portions of California, where it feeds upon "walnuts, almonds, apricots, peaches, prunes, apples, olives, figs, oranges, certain vegetables and forage crops, and all of the grains, and also damages vineyards and young orange groves, the magnitude of its depredations amounting to hundreds of thousands of dollars annually." In a twenty-acre vineyard they "completely destroyed five acres." The principal damage done by them is to grain. "They devour barley, wheat and oats when the seed is first sown; they dig up and carry away the sprouting kernels; they invade the fields of ripening grain and feast upon it until harvest time; and when it is cut and stacked they concentrate about the stacks and attack it vigorously, eating all they can and laboring tirelessly to carry

[14] Burnett, The Wyoming spermophile or ground squirrel (Citellus elegans), *Office Colorado State Entomologist Circular* No. 9, 1913; The Wyoming ground squirrel in Colorado, with suggestions for control, *Circular* No. 20, 1916; *Circular* No. 25, 1918; Life history studies of the Wyoming ground squirrel (Citellus elegans elegans) in Colorado, *Colorado Exper. Sta. Bull.* No. 393, 1931.

[14-a] Moore, *Journ. Mammalogy*, XI, 87, 1930.

[15] Burnett, *Office Colorado State Entom. Circular* No. 25, p. 27, 1918.

[16] Warren, *Mammals of Colorado*, p. 106, 1910.

[17] Merriam, *N. Amer. Fauna*, No. 3, pp. 53, 55, 1890.

[18] Birdseye, *Farmers' Bull.*, No. 484, 1912.

[19] Brooks, Note on a feeding habit of the gray squirrel, *Journ. Mammalogy*, IV, 257-258, 1923.

[20] Merriam, *N. Amer. Fauna*, No. 3, pp. 53, 55, 1890.

the remainder to their underground storehouses." At a single stack three hundred were trapped and many more poisoned; two hundred were seen about one barley stack and later at the same place one hundred and fifty-eight were "in sight at one time." A few hours after poison was set out one hundred and fifteen dead squirrels were picked up on a six-acre field. The flesh of the young squirrels is good and they were sold in the San Francisco markets until it was discovered that they were one of the disseminators of bubonic plague during the epidemic there.[21]

The Columbian ground squirrel (*Citellus columbianus*) is said to be the most important host of the spotted fever tick. It prefers green vegetation to ripe seeds and grains more than most ground squirrels do, including alfalfa, clover, timothy, garden vegetables, etc. One farmer for six years could not get a crop because of these squirrels, but after he cleaned them out he got 35 bushels of wheat per acre. One company lost 45,000 young trees in one year through their depredations. Their burrows injure irrigation systems.[22] Two tracts of land were fenced to retain these squirrels and two check tracts fenced to exclude them. The check tracts yielded 41 pounds of wheat to each 500 square feet, the infested tracts only 4 pounds. The destruction of wheat was 50 1/3 pounds for each squirrel, worth then $1.76, and there were 25 squirrels to the acre.[23]

Each Oregon ground squirrel (*C. oregonus*) is said to consume 30 grams of forage daily, and in some localities there are 70,000 of them to the square mile, consuming 2 tons of green forage a square mile daily, which would support 90 head of cattle.[24] A Franklin ground squirrel (*Citellus franklini*) killed and ate a portion of a young rabbit and another was seen chasing a striped ground squirrel.[25] Of 35 stomachs of the chestnut-tailed ground squirrel (*Callospermophilus lateralis castanurus*), "all but ten contained remains of insects (grasshoppers, beetles, flies and larvae). Most of them contained also seeds

[21] Merriam, The California ground squirrel, *U. S. Biol. Surv. Circular* No. 76, 1910. Rucker, Plague among ground squirrels in Contra Costa County, California, Reprint No. 38 from *U. S. Public Health Reports,* XXIV, No. 35, 1909. Dixon, Control of the California ground squirrel, *Univ. California Agric. Exper. Sta. Circular* No. 181, 1917.

[22] Birdseye, Some common mammals of western Montana in relation to agriculture and spotted fever, *Farmers' Bull.,* No. 484, p. 10, 1912.

[23] Shaw, The cost of a squirrel and squirrel control, *Washington Agric. Exper. Sta. Bull.* No. 118, pp. 1-19, 1920; *Journ. Mammalogy,* I, 192, 1920.

[24] Grinnell and others, California ground squirrels, *California Comm. Horticulture Bull.,* VII, 595-807 1919; *Journ. Mammalogy,* I, 97-99, 1919.

[25] Johnson, An observation on the carnivorous propensities of the gray gopher, *Journ. Mammalogy,* III, 187, 1922.

of plants, flowers and foliage, and some were nearly full of roses. Many contained corn, beans, oats, bread, cake, potatoes and fat pork picked up about camp."[26]

Captivity experiments on striped squirrels (*Citellus tridecemlineatus*) show a preference for insects, especially grasshoppers, over cereals.[27] The cheek pouches of one striped ground squirrel were filled with seeds of Canada thistle.[28] They sometimes destroy ground-nesting birds and one killed a chicken.[29] Of 46 stomachs of *C. t. pallidus* from Colorado, 1 contained a deer mouse, 13 were nearly or quite full of insects, chiefly grasshoppers, 17 contained some insects, 15 contained no insects. "In certain localities and at certain times, the squirrels are highly injurious, and in some localities and certain seasons are beneficial, by the destruction of injurious insects and weed seeds."[30]

"Pine squirrels" (*Sciurus*) in western Montana do not ordinarily cause any serious loss of crops, but after the extensive forest fires of 1910, which destroyed their natural food, they attacked many apple orchards, doing considerable damage. They may sometimes do some damage to solitary trees by cutting off the ends of twigs, but in thick stands of timber they probably do no harm. As they are hosts of the spotted fever tick, it may be advisable to destroy them about ranches where the fever infestation is bad.[31] The Richardson red squirrel (*S. hudsonicus richardsoni*) in Idaho coniferous forests feeds chiefly on white pine bark, alpine fir and *Picea alba*.[32] The staple diet of the red squirrel or chickaree (*S. hudsonicus* and subspecies), "taking its whole range into consideration," is seeds of coniferous trees and nuts, but cedar berries are favorite food in some localities. In spring it eats buds, bark, leaves and fruit; very fond of mushrooms; eats insects and their larvae; also birds and their eggs, but not so extensively as is generally supposed; ordinarily does no damage to trees by eating seeds or buds, as usually there is a superabundance, but aids natural reforestation by burying seeds.[33] However, it is said that where the old

[26] Merriam, *N. Amer. Fauna*, No. 4, p. 19, 1890.
[27] Hisaw and Emery, Food selection of ground squirrels (Citellus tridecemlineatus), *Journ. Mammalogy*, VIII, 41-44, 1927.
[28] Hahn, *Ann. Rept. Indiana Dept. Geol. and Nat. Res.*, 1908, pp. 478-479.
[29] Seton, *Lives of game animals*, IV, Part 1, pp. 228-248, 1929. Bailey, *Journ. Mammalogy*, IV, 129, 1923.
[30] Burnett, The striped spermophiles or ground squirrels of Colorado, *Office Colorado State Entom. Circular* No. 14, 1914.
[31] Birdseye, *Farmers' Bull.*, No. 484, p. 26, 1912.
[32] Merriam, *N. Amer. Fauna*, No. 5, p. 48, 1891.
[33] Klugh, Ecology of the red squirrel, *Journ. Mammalogy*, VIII, 1-32, 1927; *Ann. Rept. Smithsonian Inst. for 1928*, pp. 495-524. Cram, The red squirrel, *Journ. Mam-*

cone-and-nut-bearing trees have been logged off in some New England localities, so that these squirrels do not have enough mast for food, they sometimes damage the trees by cutting off too many bud twigs.[34] A long list has been published of trees, shrubs and fungi and a few herbs used as food by the red squirrel, besides insects, snails and an occasional bird.[35] It stores fungi in quantity for winter food.[36] In Alaska, red squirrels were found storing large quantities of high-bush cranberries, alder cones, cow-parsnip seeds, spruce cones and "a great many mushrooms."[37]

The Kaibab squirrel (*S. kaibabensis*) feeds mostly on yellow pine cambium, cones not being abundant within its range most of the time; at various times observed eating fungi.[38] The Sierra pine squirrel or California chickeree (*S. douglasii albolimbatus*) feeds upon the seeds of the sugar pine and Shasta fir.[39] Gray squirrels on Long Island, New York, were found eating maple buds and seeds, dogwood fruit, elm buds, oak catkins, acorns and various nuts.[40] The food of the flying squirrels (*Glaucomys*) consists mostly of acorns and nuts, with some fruit, a few insects and a little carrion, and one has been known to rob a martin's nest.[41]

The antelope ground squirrels (*Ammospermophilus*) and chipmunks (*Tamias* and *Eutamias*) are usually economically neutral, but when abundant about the margins of fields and gardens they may inflict some damage to crops, and they sometimes get into stored grain and provisions.[42] The food of the chipmunks consists chiefly of "a variety of nuts, fruits, grains, and other vegetable matter, with a small percentage of animal matter," including land snails and insects, with "solitary instances reported of a chipmunk eating a salamander, a frog and a

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*malogy,* v, 37-41, 1924. Hofmann, Furred forest planters, *Scientific Monthly,* XVI, 280-283, 1929.

[34] Hosley, Red squirrel damage to coniferous plantations and its relation to changing food habits, *Ecology,* IX, 43-48, 1928. Hatt, The red squirrel: Its life history and habits, *Roosevelt Wild Life Annals,* II, 132-135 1929.

[35] Hatt, *Roosevelt Wild Life Annals,* II, 85-110, 1929.

[36] Butler, The red squirrel of North America as a mycophagist, *Trans. Brit. Mycological Soc.,* VI, 355, 1920. *Journ. Mammalogy,* II, 119, 1921.

[37] Dice, Notes on the mammals of interior Alaska, *Journ. Mammalogy,* II, 25, 1921. Murie, The Alaska red squirrel providing for winter, *ibid.,* VIII, 37-40, 1927.

[38] Goldman, The Kaibab or white-tailed squirrel, *Journ. Mammalogy,* IX, 127-129, 1928.

[39] Merriam, *N. Amer. Fauna,* No. 16, p. 91, 1899.

[40] Nichols, Notes on the food habits of gray squirrels, *Journ. Mammalogy,* VIII, 55-57, 1927.

[41] Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Nat. Res.,* 1908, pp. 485-487. Bailey, *Journ. Mammalogy,* IV, 129, 1923.

[42] Bailey, *Farmers' Bull.,* No. 335, pp. 8, 10, 1908.

snake," and an occasional attack upon birds and their eggs.[43] They have been known to kill mice, as well as birds.[44] The eastern chipmunk (*Tamias striatus*) does some damage to sprouting grain, but its food is mostly wild seeds and fruits, and it is especially fond of ragweed and horseweed seeds, and eats some insects.[45] The Great Basin painted chipmunk (*Eutamias minimus pictus*) was observed in Idaho feeding on sagebrush and greasewood.[46] Cheek pouches of a Klamath chipmunk (*E. amoenus*) from Idaho contained 332 seeds of *Pinus murrayana,* and one at Mount Shasta was observed eating service berries.[47]

In many localities tree squirrels have furnished game for sportsmen, and the flesh of some species is highly esteemed. It does not appear to be so well known that some other species of squirrels are excellent for food, including ground squirrels. The delicacy of flavor depends somewhat upon the age of the individuals and the food they obtain locally, and the tenderness of the flesh depends upon age. The squirrel-shooting championship of two Indiana townships in 1834 was won by a hunter who killed 900 in three days, while his nearest rival killed 783, mostly gray squirrels, which gives some idea of their former abundance.[48]

The woodchucks, marmots or groundhogs (*Marmota*), where plentiful, sometimes do considerable damage to field and garden crops. They feed chiefly on green vegetation, such as alfalfa, clover, native leguminous plants, growing grains, grass and vegetables.[49] They sometimes do harm by burrowing into reservoir dams and canal banks, and damage camp buildings in the Rocky Mountains by gnawing the boards and timbers. They are sometimes kept in control in the western United States by dropping poison into their dens, but in the eastern states fumigation with carbon disulphide is considered the best method, though calcium cyanide is good, and the exhaust from gasoline engines has been effectually used. Bounties have not been successful.[50] Such bounties were paid on an average of 1400 woodchucks per an-

[43] Howell, Revision of the American chipmunks, *N. Amer. Fauna,* No. 52, pp. 9-11, 1929.
[44] Warren, *Mammals of Colorado,* p. 168, 1910.
[45] Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Nat. Res.,* 1908, pp. 474-475.
[46] Merriam, *N. Amer. Fauna,* No. 5, p. 46, 1891.
[47] Merriam, *N. Amer. Fauna,* No. 5, p. 44, 1891; No. 16, p. 90, 1899.
[48] Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Nat. Res.,* 1908, p. 462.
[49] Birdseye, *Farmers' Bull.,* No. 484, 1912.
[50] Silver, Woodchuck control in the eastern United States, *U. S. Dept. Agric. Leaflet* No. 21, 1928.

num for five years in Porter County, Indiana.[51] Burnett says they are very fond of rhubarb leaves and dandelions, and the only rodent known to him that will eat onions.[52] During a large visitation of June beetles at Poland, New York, many of them were eaten by woodchucks.[53] The flesh of the woodchuck "is considered a great delicacy among the mountain people of Kentucky."[54]

"Grasses, composite flowers (*Arnica* and *Agaseris*), green leaves and blue lupines have been found in stomachs examined. . . . The flesh of the marmot, when taken young and properly prepared, is very edible; but old individuals are tough, and the meat possesses a gamy taste which some dislike."[55] Marmot skins are used in the fur trade and are sometimes dyed and sold as mink or sable. The reported sales for 1919-1921 totalled 3,107,759 skins.[56]

Because of their great numbers, prairie-dogs (*Cynomys ludovicianus*) were, before extensive poisoning and fumigating campaigns had reduced them somewhat, one of the most serious pests of the western plains and still are a menace wherever they occur. Their colonies vary from a few acres to many square miles in extent. According to Merriam, one Texas colony of 25,000 square miles contained 400,000,000 prairie-dogs, and the food consumed by them would be sufficient to support 1,562,500 head of cattle, the depredations of these rodents reducing by from 50 per cent to 75 per cent the producing capacity of the land occupied.[57] Commenting upon this estimate, Bailey says that "if the remaining 65,000 square miles of their scattered range in the state contains, as seems probable, an equal number, the state of Texas supports 800,000,000 prairie-dogs," which "would require as much grass as 3,125,000 cattle," and "as a Texas cattle ranch usually covers from 10,000 to 100,000 acres, the expense of destroying the prairie-dogs in the most economical manner often means an outlay of several thousand dollars to begin with and a considerable

[51] Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Nat. Res.*, 1908, pp. 483-484, 1909.

[52] Burnett, *Office Colorado State Entom. Circular* No. 25, p. 21, 1918.

[53] Gianini, Tree-climbing and insect-eating woodchucks, *Journ. Mammalogy*, VI, 281-282, 1925.

[54] Hamilton, *Journ. Mammalogy*, XI, 310, 1930.

[55] Taylor and Shaw, *Mammals and birds of Mount Ranier National Park*, pp. 89-91, 1927. But see Hahn, *33rd Ann. Rept. Indiana Dept. Geol. and Nat. Res.*, 1908, pp. 483-484, who says it is tender and well-flavored.

[56] Osborn and Anthony, *Natural History*, XXII, 393, 1922. See Innis, *The fur trade of Canada*, table opp. p. 76, 1927.

[57] Merriam, The prairie-dog of the Great Plains, *Yearbook U. S. Dept. Agric. for 1901*, pp. 257-270.

sum each year to keep them down."[58] Both authors agree that the great increase in the number of prairie-dogs was due to the destruction of their natural enemies, such as coyotes, foxes, wolves, badgers, ferrets, hawks, eagles, owls, snakes, and others, many of which were destroyed wantonly. The chief food of the prairie-dog being grass, with various weeds, it comes into direct competition with cattle, horses and sheep. When "great swarms of grasshoppers were observed" in Texas in 1925, they "provided a great feast" for prairie-dogs, which were "out in full force chasing after, catching and eating the grasshoppers."[59]

Experiments at two localities in Arizona show that the Zuni prairie-dogs (*Cynomys gunnisoni zuniensis*) destroy 80 per cent of the annual crops of grass and forage.[60] It has been said that prairie-dogs occupy 2 per cent of the land in eastern Colorado.[61] It was estimated in that state that 32 prairie-dogs (*C. ludovicianus, leucurus* and *gunnisoni*) eat as much grass as would one sheep, 256 eat as much as one cow, and the prairie-dogs on one well populated 160-acre tract eat as much as eight cows; and in addition they injure field and garden crops.[62]

Prairie-dogs are as cleanly in habit as are squirrels and rabbits, and more so than chickens and hogs. The flesh of young individuals, properly prepared and cooked, is excellent. If people could get rid of the prejudice aroused by the popular name of these animals, and remember always that they are not dogs, but are closely related to the squirrels, prairie-dogs would add variety to the menu and in some localities would be a valuable source of meat.

## Family GEOMYIDAE—Pocket Gophers

The pocket gophers (*Thomomys, Geomys* and *Cratogeomys*) rank with the most injurious rodents in agricultural districts where they are abundant. Though the soil turnover resulting from their burrowing operations, as we have already noted, may be an advantage under some circumstances, their mounds amid growing crops of grains and

[58] Bailey, Biological survey of Texas, *N. Amer. Fauna,* No. 25, p. 90, 1905; No. 49, pp. 62-67, 1926.

[59] Whitehead, Notes on prairie-dogs, *Journ. Mammalogy,* VIII, 58, 1927.

[60] Taylor and Loftfield, Damage to range grasses by the Zuni prairie-dog, *U. S. Dept. Agric. Bull.* No. 1227, 1924.

[61] Payne, The prairie-dog as a range pest, *Colorado Agric. Exper. Sta., Press Bull.,* No. 16, 1903.

[62] Burnett, Report on prairie-dog investigations in Colorado, *Office Colorado State Entomologist Circular* No. 8, 1913; The prairie-dog situation in Colorado, *Circular* No. 17, 1915.

vegetables often cover many of the plants and do much harm. They also sometimes cause horses to stumble, injuring and perhaps killing both horses and riders.[1] Their mounds also cause losses by preventing close cutting of hay crops. Their burrows cause erosion on steep slopes and costly breaks in reservoir dams and canal banks. They attack the roots of trees, the injuries causing crown gall, the damage being underground and usually not detected until too late, 40 trees having been ruined in one orchard in a single week.[2] Dalles pocket gophers (*T. quadratus*), in a badly infested Oregon cherry orchard, killed 71 per cent of the trees and injured another 21 per cent beyond recovery, leaving only 8 per cent uninjured.[3] Three gophers in twelve days threw up 103 mounds.[4]

Pocket gophers are occasional hosts of the spotted fever ticks.[5] Their habits are clean and their flesh is used as food in some localities.[6] They subsist chiefly on roots and green plants and sometimes girdle trees, the annual loss to farmers and fruit growers because of their operations having been estimated at more than $12,000,000.[7] The annual loss in Nebraska alone was estimated at $1,000,000.[8] Though it has often been said that pocket gophers are strictly vegetarian, like most rodents they occasionally indulge in the flesh of other animals. One in captivity greedily ate meat at every opportunity.[9] Some gophers, placed in a box with deer mice, "ate them all up, beginning with the tails."[10]

The following items concerning the pocket gophers of Texas are briefed from Bailey's report:[11] Louisiana pocket gopher (*Geomys breviceps*), sometimes seriously damages lawns, parks, pastures, fields, gardens and orchards, but is easily controlled by trapping. "Their flesh is sweeter, better flavored and more delicate than any squirrel or rabbit, and their small size is the only objection to their use as

[1] Coues, The prairie gopher, *Amer. Naturalist,* IX, 147-156, 1875. See Scheffer, Habits and economic status of the pocket gophers, *U. S. Dept. Agric. Technical Bull.* No. 224, 1931.

[2] Lantz, Pocket gophers as enemies of trees, *Yearbook U. S. Dept. Agric. for 1909*, pp. 209-218. Bailey, *Animal Life of Carlsbad Cavern,* p. 91, 1928. Burnett, *Office Colorado State Entom. Circular* No. 25, p. 15, 1918.

[3] Wight, Breeding habits and economic relations of the Dalles pocket gopher, *Journ. Mammalogy,* XI, 40-48, 1930.

[4] Bailey, The pocket gophers of the United States, *U. S. Div. Orn. and Mamm. Bull.* No. 5, 1895.

[5] Birdseye, *Farmers' Bull.,* No. 36, 1912.

[6] Bailey, *U. S. Div. Orn. and Mamm. Bull.* No. 5, 1895.

[7] Bailey, *Farmers' Bull.,* No. 335, p. 18, 1908; *N. Amer. Fauna,* No. 49, p. 125, 1926.

[8] Bruner, Pocket gophers, *Univ. Nebraska Agric. Exper. Sta., Press Bull.,* No. 29, 1908.

[9] Wade, Food habits of a pocket gopher, *Journ. Mammalogy,* VIII, 310-311, 1927.

[10] Mearns, *U. S. National Museum Bull.* No. 56, p. 411, 1907.

[11] Bailey, Biological survey of Texas, *N. Amer. Fauna,* No. 25, pp. 127-134, 1905.

a table delicacy." White-throated pocket gopher (*G. b. sagittalis*): about a dozen "destroyed an orchard of 200 six-year-old fig trees in bearing," by cutting the roots, doing damage to the extent of over $500, which could have been prevented by trapping, instead of attempting to shoot them. Attwater pocket gopher (*G. b. attwateri*): in Aransas County "there is hardly a foot of land that has not been 'plowed' several times over by gophers," 250 of which were killed in a pear orchard in six weeks. Chestnut-faced pocket gophers (*Cratogeomys castanops*): "their concentration on the best soil, together with the large size of their burrows and mounds, makes them one of the most injurious of the gopher family," but they are easily trapped. Under a cliff "where a pair of horned owls had raised their young . . . I counted 20 skulls of *Cratogeomys* among bones of other rodents, but for fear these owls would catch the chickens one had been killed by the ranchman and the other driven away." Little gray pocket gopher (*Thomomys perditus*): chief food is yucca, sotal and cactus. Lachuguilla pocket gopher (*T. lachuguilla*): principal food is the agave.

Criddle gives lists of plants stored in the dens of the prairie pocket gopher (*Thomomys talpoides rufescens*) and says they eat flesh, but few insects, and damage garden and farm crops; and that the long-tailed weasel is their most important mammalian enemy, the badger next, hawks and owls important, coyotes, foxes and skunks not negligible.[12]

Various publications mentioned in the footnotes discuss methods of trapping and other means of controlling the pocket gophers, and include as an important method the encouragement of natural enemies, especially hawks and owls, and sometimes certain predacious mammals. There are also some other publications devoted mostly to the subject of suppressing these rodents and otherwise preventing damage by them.[13]

## Family HETEROMYIDAE—Pocket Rats and Pocket Mice

Pocket mice are usually not very numerous and of little economic importance, though occasionally they take some grain, and, if they

[12] Criddle, The prairie pocket gopher (Thomomys talpoides rufescens), *Journ. Mammalogy*, XI, 265-280, 1930.

[13] See Lantz, Methods for destroying pocket gophers, *U. S. Biol. Surv. Circular* No. 52, 1908. Dixon and De Ong, Control of the pocket gopher in California, *California Agric. Exper. Sta. Bull.* No. 281, 1917. Dixon, *Journ. Mammalogy*, III, 136-146, 1922. For the amount of poison required, which depends upon the season, see Wight, Breeding habits and economic relations of the Dalles pocket gopher, *Journ. Mammalogy*, XI, 40-48, 1930.

become abundant, might be destructive.[1] In North Dakota the Maximillian pocket mouse (*Perognathus fasciatus*) was found feeding mainly on seeds of knotgrass, pigweed and Russian thistle, but it takes many other seeds of weeds and grasses and destroys grasshoppers; not very harmful, if at all, and in many ways beneficial. In the same state the food of the dusky pocket mouse (*P. flavescens perniger*) consists largely of weed seeds, though it nibbles garden vegetables. Its destruction of weed seeds counterbalances the small amount of damage done to crops, but it is not abundant enough to do much either way.[2]

From Bailey's Texas report we obtain the following items:[3] Hispid pocket mouse (*P. hispidus*): a market gardener complained of their "digging up the seeds as fast as he could plant them . . . but a few night's trapping would have cleared them all out." Kansas pocket mouse (*P. h. paradoxus*): one in Texas had corn in its pocket, one in January "had its pockets full of *Convolvulus* seeds," one in South Dakota in June "had its pockets full of *Cymopterus* seeds"; two rattlesnakes each contained one of these mice. Black-eared pocket mouse (*P. h. spilotus* Merriam, 1889, equals *P. h. hispidus* Baird, 1857, according to Miller): one had *Mimosa* seeds in its pockets and one "had its pockets full of *Petalostemon* seeds." Baird pocket mouse (*P. flavus*): favorite food is wild sunflower and pigweed seeds. Merriam pocket mouse (*P. merriami*): juniper seeds and corn found in the burrows. Dutcher pocket mouse (*P. m. gilvus*): in September found feeding on the seeds of shrubby *Baccharis*. Cope pocket mouse (*P. flavescens copei*): the type specimen was taken from a rattlesnake stomach. Three topotypes had millet seeds in their cheek pouches.

Kangaroo rats in some agricultural districts are abundant and destructive. "No rodent that occurs in the San Luis Valley, except the prairie-dog, is so abundant and destructive . . . very destructive to grain of all kinds and in some sections is a serious pest." Half a bushel of peas and other seeds have been found in a single burrow. Their burrows honeycomb irrigation ditch banks, and their mounds are as large as a medium-sized washtub,[4] sometimes from 2 to 4 feet high and 6 to 8 feet wide.[5] Horses often break through into their burrows. They sometimes store as much as 12½ pounds of forage in one den,

[1] Bailey, *Farmers' Bull.*, No. 335, p. 21, 1908. Burnett, *Office Colorado State Entom. Circular* No. 25, pp. 17-18, 1918.
[2] Bailey, A biological survey of North Dakota, *N. Amer. Fauna*, No. 49, pp. 119, 121, 1926.
[3] Bailey, Biological survey of Texas, *N. Amer. Fauna*, No. 25, pp. 135-143, 1905.
[4] Burnett, *Office Colorado State Entom. Circular* No. 25, p. 18, 1918.
[5] Bailey, *Animal life of Carlsbad Cavern*, p. 82, 1928.

largely useful grasses, one den having contained 680,000 separate pieces. The ground within a radius of from 15 to 25 feet about the den may be denuded of vegetation.[6]

On a range of 50 square miles in Arizona it was estimated that, allowing 50 pounds of forage daily as the need of each steer, the forage consumed by the large kangaroo rats (*Dipodomys spectabilis*) would be enough to feed 14 steers.[7] In another paper the same authors say 25 pounds of forage per steer would be enough, which would double the number of steers the forage consumed by the kangaroo rats would support. They also report that 592 barn owl pellets contained remains of 230 kangaroo rats.[8]

Bailey's Texas report furnishes the following items:[9] Richardson kangaroo rat (*Dipodomys ordii richardsoni*): "the food of this, as of other species of this genus, is almost entirely seeds, including those of many grasses, various native plants, and any of the small grains"; and, though usually harmless, when abundant they sometimes become destructive. Ord kangaroo rat (*D. ordii*) was found to be feeding "on seeds of wild sunflower, *Parosela* and other wild beans." Padre Island kangaroo rat (*D. compactus*) feeds on seeds of a small plant like purselane and takes oatmeal readily as bait in traps. Loring kangaroo rat (*D. elator*): one caught in a Kafir corn field contained 100 seeds of Kafir corn and 65 seeds of *Solanum rostratum*. One carried off and stored two bushels of wheat. One was taken from a large rattlesnake. Texas spiny pocket mouse (*Liomys irroratus texensis*) feeds "on the seeds of hackberry, mesquite and various other shrubs."

Dwarf pocket rat or kangaroo mouse (*Microdipodops megacephalus*): food "consists mostly of seeds," the cheek pouches containing seeds of *Gilia* and *Oryzopsis*, and one containing an insect larva.[10]

### Family CASTORIDAE—Beavers

It has been said that "the beaver is the most important fact in American history,"[1] because it was long the backbone of the fur trade, the chief industrial and commercial enterprise in the vast interior of the continent for three centuries. The quest for beaver and

[6] Taylor, *Scientific Monthly*, xxi, 2, 1925.
[7] Vorhies and Taylor, Life history of the kangaroo rat, *U. S. Dept. Agric. Bull.* No. 1091, p. 37, 1922.
[8] Vorhies and Taylor, Damage by kangaroo rats, *Journ. Mammalogy*, v, 144, 1924.
[9] Bailey, Biological survey of Texas, *N. Amer. Fauna*, No. 25, pp. 127, 144-149, 1905; see also No. 49, p. 124, 1926; *Farmers' Bull.*, No. 335, p. 22, 1908.
[10] Hall and Linsdale, Notes on the life history of the kangaroo mouse (Microdipodops), *Journ. Mammalogy*, x, 295-305, 1929.
[1] *Science*, xli, 276, 1915, quoting Merriam.

other furs led trappers and traders to explore almost every part of North America north of latitude 30° 30′, long before permanent settlers began to arrive and engage in agriculture.[2] The influence of the trade upon exploration and history is discussed in Chapter. XVII.

Beaver skins were currency in Canada in the seventeenth century.[3] "In the old days" beaver skins sold for 32 shillings each, with from 100,000 to 500,000 annually coming out by way of the St. Lawrence and Hudson Bay; but in 1910 only about 80,000 and in 1912 about 17,000 were offered in the markets.[4] The world's reported sales for 1919-1921 totalled 420,490 skins.[5] In 1900, 8000 beaver skins were produced in the United States and 66,000 in the world, worth $341,000.[6] It was estimated that in 1923-1924 the production in America was 200,000.[7] In 1913, it was estimated that the production of beaver skins in North America was 80,000 per annum, in Asia 1000, with a few in Europe, skins then bringing from $12 to $20 each, castorum from $12 to $15 a pound, and breeding stock $50 a pair.[8]

There were 14,341 beaver skins, worth $258,138, shipped from Alaska in 1923.[9] In 1624 only 400 beaver skins were shipped from New York, in 1635 the number had increased to 14,891, according to a letter from the Dutch West India Company.[10] In 1671, New Netherlands produced 80,000, in 1800 New York State produced 5000; in 1905 very few of the original stock were left there, but new stock has been introduced from elsewhere.[11] As remote from civilization as was the Snake River country a century ago, 80,000 beaver pelts were taken out in four years in about 1824, by 60 British trappers.[12] Damaged and inferior beaver pelts have been extensively used in the manufacture of felt for hats, the tail is "a delicacy on the banquet board"

[2] Morgan, *The American beaver and his works,* Philadelphia, Pa., 1868. Martin, *Castorologia, or the history and traditions of the Canadian beaver,* London, 1892. Dugmore, *The romance of the beaver,* Philadelphia, 1914. Warren, *The beaver,* Baltimore, 1927; with bibliography.

[3] Arthur, *Louisiana Department of Conservation Bull.,* No. 18, p. 16, 1928.

[4] Laut, *The fur trade of America,* p. 119, 1921; see also Concerning beaver and nutria, *Forest and Stream,* LXIX, 57, 88, 89, 1921.

[5] Osborn and Anthony, *Journ. Mammalogy,* III, 226, 1922; *Natural History,* XXII, 393, 1922.

[6] Stevenson, Utilization of the skins of aquatic animals, *Rept. U. S. Fish Comm. for 1902,* pp. 283, 352.

[7] Innis, *The fur trade of Canada,* table opp. p. 76, 1927.

[8] Jones, *Fur farming in Canada,* p. 90, 1913.

[9] *California Fish and Game,* X, 82, 1924.

[10] DeKay, *Zoology of New York,* p. 73, 1842. *47th Ann. Rept. N. Y. State Museum,* p. 47, 1894.

[11] Johnson, *Roosevelt Wild Life Bull.,* IV, 589, 1927.

[12] Dale, *Ashley-Smith exploration,* p. 98, 1918.

and its "general flesh preferred to game birds," and the castorum has been used in the manufacture of perfumery.[13] For the Eastern trade in 1918, 600 beaver carcasses were dressed and shipped to Toronto.[14]

The following items have been selected from Warren's summary of beaver statistics: From 1853 to 1877, inclusive, the Hudson Bay Company sold in London 2,965,389 beaver skins, an average of 18,615 per annum; about 50,000 in 1897, 43,000 in 1900, 49,000 in 1903. In 1859, 509,000 were sold in London and Edinburgh. In 1906, at the London sales, prices ranged from $3.60 for the poorest skins to $8.40 for high-grade pelts, but 41 first-class black skins brought $14.88 each. Since then prices have advanced. In the January, 1921, sales in New York, the average price was $12.03. In February, 1920, it was $40.70, but 40 of the best skins sold for $64 each during the month, and the lowest grade brought $8.50 each, dropping to $2.50 in April. Since that year prices have been uniformly lower, the average ranging from $14 to $21, with a maximum of $35.50 for the best. In the seventeenth century, castorum was used as medicine for many diseases, and beaver teeth were attached to the necks of children to facilitate the cutting of teeth. From 1858 to 1884, 25,000 pounds of castorum were marketed by the Hudson Bay Company. Twelve years ago the price was from $10 to $20, but the demand has practically ceased.[15] The castorum is said to have been used for medicinal purposes for many centuries, as it is mentioned in this connection by Pliny and Hippocrates, and seems to have been considered a marvelous "cure-all."[16]

In 1917 there was no legal protection for the beaver in 20 states, perhaps in some cases because there were no beaver to protect. In 1927 there was a close season in 26 states and partial protection in 8 more.[17] The beaver had been exterminated over a great part of its former range, but in recent years has been introduced to many localities. "The effect of regulations in conserving the supply of beaver is shown in the taking of from 165,000 to 230,000 beaver pelts in Canada in the years 1920-1924."[18]

The food of the beaver in summer consists mostly of grass and

[13] Laut, *The fur trade of America*, p. 119, 1921. Bailey, *N. Amer. Fauna*, No. 49, p. 108, 1926.

[14] *Field and Stream*, Aug., 1918, p. 330, as cited by Seton, *Lives of game animals*.

[15] Warren, *The beaver*, pp. 158-165, 1927.

[16] Dugmore, *The romance of the beaver*, p. 215, 1914.

[17] Bailey, Beaver habits and experiments in beaver culture, *U. S. Dept. Agric. Technical Bull.*, No. 21, 1927, replacing *Dept. Bull.*, No. 1078, 1922.

[18] Innis, *The fur trade of Canada*, p. 76, 1927.

other vegetation found near the water, and in winter chiefly the bark and twigs of shrubs and trees. In most localities small, softwood trees of little value, such as aspens, cottonwoods and willows, are preferred. Orchard and other valuable trees may be protected from them by woven-wire fences and cylinders.[19] Where other trees are scarce they sometimes cut oaks,[20] conifers and other trees not usually used by them, but damage done by cutting valuable timber is seldom serious. In Norway, beavers live largely on aspen, birch, oak and alder.[21]

Sometimes damage results from the construction of beaver dams, which cause the overflow of fields, pastures, forests and roads. It is said that this may be prevented and the water in their ponds kept at a nearly uniform level by the skillful insertion of iron pipe in the dams.[22] Where this is impracticable or ineffective, the beaver may easily be controlled by trapping under permits from the proper authorities. Beavers also sometimes cause breaks in irrigation canals.[23]

Though the flooding of lands because of beaver dams is sometimes detrimental to human interests, it is also sometimes beneficial. Beaver ponds help equalize the flow of storm waters and water from melting snow, and thus minimize the damage from floods in small streams, storing the water and thus keeping up the flow of trout streams and streams upon which the ranchers are dependent for water for their stock, during dry seasons.[24] Occasionally the ponds make it possible to obtain irrigation water needed to save crops from ruin. "Colorado ranchers recently opened beaver dams in the mountains, pouring millions of gallons of water down stream beds and out through irrigation ditches. On one stream alone crops valued at $15,000 were thus saved."[25]

There has been considerable controversy over the possible effects of beaver ponds on fishes.[26] Such ponds afford quiet water favorable to

[19] Bailey, *N. Amer. Fauna,* No. 4, p. 108, 1926; *U. S. Dept. Agric., Technical Bull.,* No. 21, 1927.

[20] Warren, Cutting of oaks by beavers, *Journ. Mammalogy,* IX, 253, 1928.

[21] Salvesen, The beaver in Norway, *Journ. Mammalogy,* IX, 99-104, 1928.

[22] Bailey, Beaver habits, beaver control and possibilities of beaver farming, *U. S. Dept. Agric., Bull.* No. 1078, pp. 11-12, 1922; *Tech. Bull.,* No. 21, pp. 13-14, 1927.

[23] Dixon, Rodents and reclamation in the Imperial Valley, *Journ. Mammalogy,* III, 136-146, 1922.

[24] Dearborn, The maintenance of the fur supply, *U. S. Biol. Surv. Circular* No. 135, p. 10, 1920.

[25] *American forests and forest life,* XXXIV, 370, 1928. Honks, When beavers aid irrigation; emergency use of the water impounded by the industrious animal, *Scientific American,* March, 1924, p. 161.

[26] For example: Bean, Fish planting in public water, *New York State Conserv. Comm.,* pp. 1-24, 1916. Embody, A study of fish-producing waters of Tompkins

the growth of young trout until they are large enough to do well in the swift water of mountain streams. However, it is asserted that harmful gases or poisons develop from the decomposition of organic matter in the stagnant ponds, not only affecting the fish in the ponds, but also getting into streams and affecting them. This probably depends somewhat upon the temperature of the water and the amount of organic matter in the water, and both of these would in turn be governed to some extent by altitude and latitude. Therefore, beaver ponds are probably often quite beneficial along cool, high mountain streams, but may be quite detrimental under some circumstances in warmer localities. Furthermore, a newly-made pond may be much less favorable to fish than an old, stabilized pond. It is a well-known fact that many beaver streams are excellent trout streams, and often good fishing is found at the beaver dams. This subject is exceedingly complex, and information now at hand is not sufficient to warrant very positive statements concerning the problem.[27]

Beavers are accused of destroying browse which would be useful to deer, but as beavers are rather localized, while deer move about freely, this accusation does not seem to be very serious. Furthermore, in some localities beaver meadows are favorite feeding grounds for deer when not too much snow covers the vegetation.[28]

### Family CRICETIDAE—Native American Rats, Mice, etc.

Though some of the wild mice are very destructive, many of them are more or less useful. Some of them are much more highly insectivorous than is generally supposed. In Michigan, of 2611 cocoons of the destructive larch sawfly on one tract, 62.5 per cent had been opened by mice in order to eat the larvae, 4.6 per cent had been parasitized by insect enemies, and 0.51 per cent had been fungicized; of 1908 cocoons on another tract, 66.3 per cent had been opened by mice, 3.5 per cent parasitized, 0.2 per cent fungicized; of 408 cocoons, 80 per cent had

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County, New York, *ibid.*, pp. 1-41, 1922. Kendall, The status of fish culture in our inland public waters, and the rôle of investigation in the maintenance of fish resources, *Roosevelt Wild Life Bull.*, II, 205-351, 1924; A trout survey of Alleghany State Park in 1922, *ibid.*, IV, 286-491, 1927. Knight, Losses in trout fry after distribution, *Science,* LXII, 590-591, 1925; LXIII, 209-210, 1926; Losses in speckled trout after distribution, *Science,* LXV, 525-526, 1927. Lawrie, Beaver vs. trout, *Fins, Feathers and Fur* (Bull. Minnesota Game and Fish Dept.), No. 27, p. 5, 1910. Beakbane, The case against the beaver, *Forest and Stream,* LXIX, 203, 236, 239-240, 1922.

[27] See Johnson, The beaver in the Adirondacks: Its economics and natural history, *Roosevelt Wild Life Bull.*, IV, 501-541, 1927. Bailey, Beaver habits and experiments in beaver culture, *U. S. Dept. Agric., Tech. Bull.*, No. 21, 1927.

[28] Johnson, *Roosevelt Wild Life Bull.*, IV, 569-572, 587, 1927.

been opened by mice, 3 per cent parasitized, 2 per cent destroyed by fungi.[1]

Grasshopper mice[2] (*Onychomys*) during the summer live almost entirely upon insects and other animal matter, but during the winter, when their summer food is scarce, they will eat vegetables, seeds and grain. They do but little harm and a great deal of good, killing and eating pocket mice, field mice, deer mice and other destructive mice, as well as large quantities of insects, mostly of harmful species. They occasionally take lizards and amphibians. The contents of 96 stomachs examined by Bailey and Sperry consisted of the following: Orthoptera, 38.76 per cent; Coleoptera, 20.73 per cent; Lepidoptera, 17.04 per cent; Hymenoptera, 2 per cent; Diptera, 0.7 per cent; Hemiptera, 0.05 per cent; miscellaneous insects, arachnids and worms, 3.25 per cent; mice, 3.09 per cent; grass seeds, 6 per cent; grain, 5 per cent; unidentified, 6 per cent; total vegetable matter, 11.13 per cent; total animal matter, 88.87 per cent (total insects, 78.28 per cent).

Their food is chiefly "grasshoppers, crickets, beetles, moths, scorpions, spiders and any other mice or other animals that they can catch, kill and eat. . . . In the arid regions they take to some extent the place of the moles and shrews of the humid regions in the destruction of ground-dwelling insects and small animal life. In this respect they may well be as useful as birds in helping to maintain a wholesome balance of nature and in controlling the abundance of injurious forms of life. The owl perhaps deserves no credit for swallowing these useful little animals, and yet we cannot be sure that in unchecked abundance even they might develop habits injurious rather than beneficial to our interests."[3]

They also take some seeds, grain and vegetables.[4] "It would doubtless be possible to keep and breed them in confinement and make them of use in ridding gardens and greenhouses of insect pests."[5] In the Southwest, where scorpions are common, these mice are frequently called scorpion mice, because of their fondness for the arachnids.[6] In the case of the desert scorpion mouse (*O. leucogaster fuliginosa*), it

[1] Graham, The larch sawfly as an indicator of mouse abundance, *Journ. Mammalogy,* x, 189-196, 1929.

[2] Bailey and Sperry, Life history and habits of grasshopper mice (genus Onychomys), *U. S. Dept. Agric., Technical Bull.,* No. 145, 1929.

[3] Bailey, *Animal life of Carlsbad Cavern,* pp. 74-75, 1928; *N. Amer. Fauna,* No. 25, pp. 93-94, 1905.

[4] Bailey, *N. Amer. Fauna,* No. 49, pp. 81, 83, 1926. Burnett, *Office Colorado State Entom. Circular* No. 25, p. 7, 1918. Cary, *N. Amer. Fauna,* No. 33, p. 100, 1911.

[5] Bailey, *Farmers' Bull.,* No. 335, p. 13, 1908.

[6] Cary, *N. Amer. Fauna,* No. 33, p. 100, 1911.

was found that in addition to taking insects, the "stomachs of all specimens procured contained scorpions, and many were distended with them to the exclusion of other food. One contained the hair and flesh of a mouse."[7] The stomach of one eastern desert grasshopper mouse (*O. l. melanophrys*) was found "packed full of scorpions."[8]

The food of harvest mice (*Reithrodontomys*) consists chiefly of seeds (mostly of grasses), with some grain and a little green vegetation. They are usually not abundant enough to do much damage, but when numerous they may be quite injurious.[9]

The white-footed mice, or deer mice, genus *Peromyscus,* with many species and subspecies, are the most generally distributed and abundant North American mammals, rivalled in this respect only by the meadow or field mice, of the genus *Microtus.* They are very prolific breeders, having a number of litters per annum, of five or six young each,[10] hence are a potential menace to crops. Plagues of white-footed mice have occurred, similar to those of lemmings and voles, such as the one of 1872-1873 in South America.[11] The food habits of the various species are very similar, though not exactly the same, and of course depend to some extent upon the food available. They are rather omnivorous. "Very few feed extensively upon green and succulent food such as is taken by the meadow mice, but nearly all prefer dry-land food, especially seeds and small nuts"; mostly seeds of native shrubs, weeds and grasses, but they take grain when they live about the edges of fields, taking also meat, and sometimes gnawing the bark of young fruit trees and nursery stock.[12] "So small, so numerous, and so widely distributed are they that they are not easily controlled, except by their natural enemies, which are numerous. They are favorite prey of all small owls and even of many of the larger owls, and form an important article of diet for weasels, skunks, badgers, foxes and such of the other small predatory species as occur within their range. Reasonable protection of the species that prey upon them, especially the owls,

[7] Merriam, *N. Amer. Fauna,* No. 3, pp. 59, 61, 1890.
[8] Mearns, *U. S. Natl. Museum Bull.* No. 56, p. 371, 1907.
[9] Bailey, *Farmers' Bull.,* No. 335, 1908; *N. Amer. Fauna,* No. 49, p. 80, 1926. Burnett, *Office Colorado State Entom. Circular* No. 25, p. 8, 1918; says food like that of grasshopper mice, but perhaps destroys more grain.
[10] Burnett, *Office Colorado State Entom. Circular* No. 25, 1918. Bailey, *N. Amer. Fauna,* No. 49, p. 78, 1926.
[11] Hudson, *Naturalist in La Plata,* pp. 64-65, 1892. Lantz, *U. S. Biol. Surv., Bull.* No. 31, pp. 52-53, 1907.
[12] Osgood, Revision of the mice of the American genus Peromyscus, *N. Amer. Fauna,* No. 28, pp. 27-28, 1909.

forms the simplest and most effective means of keeping down their abundance."[13]

Four subspecies in captivity (*P. leucopus noveboracensis, P. maniculatus bairdi, P. m. gracilis* and *P. m. sonoriensis*) all accepted the same sorts of foods, including 52 kinds of native seeds, fruits and nuts, besides seeds of some cultivated plants, green vegetation, bark of 15 species of trees and shrubs, and 15 species of insects.[14] "Salt pork and oatmeal were attractive bait" for the desert white-footed mouse (*P. eremicus*).[15] The Osgood white-footed mice (*P. maniculatus osgoodi*) "were feeding largely on bullberries," but took also "seeds of chokecherry, woodbine, wild grape, smilax, buffalo berry, hosackia, dogwood, bindweed, knotweed, pigweed, ragweed, Russian thistle, black henbane, sedge, barnyard grass and dropseed grass. The mice seem fond of any kind of camp food, as flour, meal, oatmeal, grain, meat, butter, bread or crackers."[16] Sixteen Baird white-footed mice (*P. m. bairdi*) were caught in traps in one night while feeding on cockleburs; many others were caught while eating seeds of tumbleweeds and Russian thistles, and at one place they were found to be "feeding largely on little caterpillars."[17] The food of Northern white-footed mice (*P. l. noveboracensis*) is mostly "seeds, grain and nutlets . . . fond of berries and fruit . . . get into fields, gardens, granaries, and even cellars and pantries, and help themselves."[18] They are "especially fond of basswood seeds, pits of wild cherries, beechnuts and acorns."[19] There were found "within a stump in a clover field, several quarts of clean seed of red clover collected by a family of these mice."[20] One in captivity killed an adult gartersnake.[21]

Tawny white-footed mouse (*P. maniculatus rufinus*): most of the stomachs examined contained seeds of small plants and remains of grasshoppers.[22] Chihuahua white-footed mouse (*P. m. blandus*): seeds of *Gutierrezia* and *Crassina* furnish a large share of its winter food.[23] "Largely carnivorous, devouring insects or any animal food," and

[13] Bailey, *N. Amer. Fauna,* No. 49, pp. 76, 78, 1926. Osgood, *N. Amer. Fauna,* No. 28, p. 28, 1909.

[14] Cogshall, Food habits of deer mice of the genus Peromyscus in captivity, *Journ. Mammalogy,* IX, 217-221, 1928.

[15] Mearns, *U. S. Natl. Museum, Bull.* No. 56, p. 441, 1907.

[16] Bailey, *N. Amer. Fauna,* No. 49, p. 75, 1926.

[17] Bailey, *N. Amer. Fauna,* No. 49, pp. 76-77, 1926.

[18] Bailey, *N. Amer. Fauna,* No. 49, p. 78, 1926.

[19] Osgood, *N. Amer. Fauna,* No. 28, p. 27, 1909.

[20] Kennicott, *Agric. Rept. for 1856,* U. S. Patent Office, p. 91, 1857.

[21] Hatt, Notes on some captive deer mice, *Journ. Mammalogy,* IV, 186-187, 1923.

[22] Merriam, *N. Amer. Fauna,* No. 3, p. 64, 1890.

[23] Bailey, *N. Amer. Fauna,* No. 25, p. 97, 1905.

eating small animals caught in traps.[24] Western desert mouse (*P. m. sonoriensis*): "besides insects, quantities of *Xanthium* seeds are eaten by this mouse," and it ate many cotton rats which were caught in traps.[25] San Clemente mouse (*P. m. clementis*), "feeds on the ripe fruits of the prickly pear (*Opuntia*)."[26] LeConte white-footed mouse (*P. m. gracilis*): 2 stomachs contained green vegetation and insects.[27] Rowley white-footed mouse (*P. boylii rowleyi*), food "consists largely of juniper berries . . . but acorns and pine nuts are eaten while they last."[28]

The white-footed mice are hosts of the spotted fever ticks, and, as they enter occupied dwellings, they are a special source of danger in fever-infested districts.[29] They are not usually found in buildings which harbor the European mouse (*Mus musculus*). The mound made by the old-field mouse (*P. polionotus*) is very large for so small an animal. "At times it doubtless contains several large cupfuls of soil," while some of the burrows are nearly or quite a foot deep.[30] "Little is known of the food habits of this species, but it is believed to feed largely on the seeds of grasses, weeds and grain; several stomachs from Abbeville contained remains of blackberries, with other finely chewed food."[31]

"Cotton rats (*Sigmodon*), when numerous in cultivated ground, often prove very destructive to crops, not only cotton, but all grains, alfalfa, hay and many other farm products. But for owls and such enemies they would be a serious menace to agriculture."[32] The natural food of the northern cotton rat (*S. hispidus hispidus*) consists of "stems and seeds of wild grasses and other plants," but it takes also grain, where available.[33] The Texas cotton rats (*S. h. texianus*) "become so numerous as to suggest the plagues of voles that from time to time have overrun parts of Europe," and they then do much damage to the cotton crops. During the cycle of abundance in Bexar County, Texas, from 1889 to 1891, hawks, owls, weasels and skunks became more abundant and preyed upon the rats; rattlesnakes and other snakes

[24] Mearns, *U. S. Natl. Museum Bull.* No. 56, p. 389, 1907.
[25] Mearns, *U. S. Natl. Museum, Bull.* No. 56, p. 394, 1907.
[26] Mearns, *U. S. Natl. Museum, Bull.* No. 56, p. 400, 1907.
[27] Johnson, *Journ. Mammalogy,* III, 37, 1922.
[28] Bailey, *N. Amer. Fauna,* No. 25, p. 98, 1905.
[29] Birdseye, *Farmers' Bull.,* No. 484, p. 29, 1912.
[30] Sumner and Karol, Notes on the burrowing habits of Peromyscus polionotus, *Journ. Mammalogy,* x, 214, 1929, citing Howell.
[31] Howell, *N. Amer. Fauna,* No. 45, pp. 44-46, 1921.
[32] Bailey, *Animal life of Carlsbad Cavern,* p. 81, 1928.
[33] Howell, *N. Amer. Fauna,* No. 45, p. 52, 1921.

were found gorged with them; and coyotes killed many.[34] These rats are "very destructive to ripening tomatoes," and destroyed a third of the crop in one truck garden.[35] The Chisos cotton rat (*S. ochrognathus*) lives in the Chisos Mountains and feeds "on the stems of grass and various small plants."[36]

Dusky-footed wood rats (*Neotoma fuscipes*) "subsist on a great variety of green vegetation, including grasses, leaves, fresh fruits, small bulbs, bark and flowers. . . . We found maple leaves stored to the surprising amount of a full bushel in a single nest. In one instance a nest twenty feet from the ground contained no less than six quarts of maple seeds. Acorns and hazelnuts, along with fruit-pits of prune, plum and cherry also occurred." The food fragments found in 63 nests included 37 kinds of trees, shrubs and herbs, 16 varieties having been found in one nest.[37] Western bushy-tailed wood rat (*N. cinerea occidentalis*), injured apple and cherry trees in an Oregon orchard by gnawing the bark and girdling branches.[38] Mountain or pack rat (*N. c. orolestes*), does but little damage to crops, but is a great nuisance about dwellings because of its thieving propensities. It carries away "almost anything portable," and destroys stored food, clothing, bedding and rugs.[39] This species is one of the hosts of the spotted fever tick, which, together with the fact that they enter dwellings, makes them a source of special danger in fever-infested districts.[40] Pale bushy-tailed wood rat (*N. c. rupicola*): the contents of stomachs examined consisted mostly of green vegetation, but these rats are eager also for grain, fruit, bacon, and various other food.[41]

Allegheny wood or cliff rat (*N. pennsylvanica*): food "mainly of vegetable origin and consists in part of hickory nuts, acorns, chestnuts and the tender leaves of herbaceous plants."[42] Its "middens," or rubbish heaps included fern fronds, coral fungi, mushrooms, puffballs, red oak acorns and leaves, Juneberry (*Amelanchier*) twigs and leaves, wild cherry, elder, etc., and storing fungi is "a well-developed in-

[34] Bailey, *N. Amer. Fauna,* No. 25, pp. 115-117, 1905.
[35] Strecker, Notes on the Texas cotton and Attwater wood rats, *Journ. Mammalogy,* x, 216-220, 1929.
[36] Bailey, *N. Amer. Fauna,* No. 25, p. 118, 1905.
[37] English, The dusky-footed wood rat (Neotoma fuscipes), *Journ. Mammalogy,* iv, 1-9, 1923.
[38] Dice, Wood rat damage to fruit trees in eastern Oregon, *Journ. Mammalogy,* vi, 282, 1925.
[39] Burnett, *Office Colorado State Entom. Circular* No. 25, p. 9, 1918.
[40] Birdseye, *Farmers' Bull.* No. 484, p. 31, 1912.
[41] Bailey, *N. Amer. Fauna,* No. 49, p. 86, 1926.
[42] Howell, *N. Amer. Fauna,* No. 45, p. 53, 1921.

stinct."[43] Nests of brush rats or large-eared wood rats (*N. fuscipes macrotis*) contained leaves of 15 species of native trees, shrubs and herbs.[44] Portala wood rat (*N. f. annectens*), is "a nuisance and a serious pest . . . destructive to a high degree," carrying off or destroying papers, books, clothing and all sorts of other things; fond of wild fruits and fungi.[45] White-throated wood rats (*N. albigula*) carried off boxes of pills, powder boxes, candles, soap and other useful articles.[46] Colorado Valley wood rat (*N. albigula venusta=cumulator*), eats gourd seeds and gnaws the bark of mesquite trees.[47] Florida wood rats (*N. floridana*), in summer "doubtless feed largely on succulent herbs and berries," and in winter nuts form an important item in their diet; they also eat pawpaw seeds.[48] Attwater wood rat (*N. f. attwateri*) is very destructive to pecans, one nest having contained nearly a bushel of them.[49] Desert wood rat (*N. desertorum*) sometimes becomes abundant and does much damage along the edges of grain fields and gardens. "Their flesh is as white and delicate as that of quail and finer in flavor than that of squirrel or rabbit."[50] It is reported that a "brush rat," evidently some species of wood rat, successfully attacked a rattlesnake.[51]

Bailey's Texas report furnishes the following wood rat items:[52] Attwater wood rat (*N. f. attwateri*) eats acorns, walnuts, juniper berries, cactus capsules, Mexican buckeye nuts, grapes, mushrooms, etc. Its flesh "is delicious, of good flavor, white, tender and more delicate than that of the squirrel." Bailey wood rat (*N. f. baileyi*): flesh is "very tender and of good flavor, with no trace of the external odor peculiar to wood rats." Mexican wood rat (*N. mexicana*): "food seems to be largely acorns and the sweet berries of *Juniperus pachyphloae*." White-throated wood rat (*N. albigula*) includes in its diet "cactus stems and fruit, mesquite, acacia and other leguminous pods, juniper berries, acorns, and various seeds, green foliage and flowers.

[43] Newcombe, An ecological study of the Allegheny cliff rat (Neotoma pennsylvanica Stone), *Journ. Mammalogy*, XI, 204-211, 1930.

[44] Gander, Experiences with wood rats, Neotoma fuscipes macrotis, *Journ. Mammalogy*, X, 52-58, 1929.

[45] Parks, The genus Neotoma in the Santa Cruz Mountains, *Journ. Mammalogy*, III, 241-253, 1922.

[46] Mearns, *U. S. Natl. Museum, Bull.* No. 56, p. 476, 1907.

[47] Mearns, *U. S. Natl. Museum, Bull.* No. 56, p. 474, 1907.

[48] Howell, *N. Amer. Fauna*, No. 45, p. 52, 1921.

[49] Strecker, Notes on the Texas cotton and Attwater wood rats, *Journ. Mammalogy*, X, 216-220, 1929.

[50] Bailey, *Farmers' Bull.*, No. 335, p. 17, 1908.

[51] Hartman, *Journ. Mammalogy*, III, 117, 1922.

[52] Bailey, Biological survey of Texas, *N. Amer. Fauna*, No. 25, 1905.

. . . It is the especial prey of *Lynx, Urocyon* and *Bassariscus,* which, with the owls, keep its ranks thinned until in many places few are left." Baird wood rat (*N. micropus*): "food consists of a great variety of green vegetation, especially the juicy flesh of cactus, but mainly of seeds, nuts and fruit. Cactus fruit and the sweet pods of the mesquite bean are extensively eaten." It sometimes becomes exceedingly numerous and does some damage. Their abundance then "attracts great numbers of hawks, owls and other enemies," which soon bring the rats to or below their normal numbers. Among the "more deadly enemies" are rattlesnakes, bull snakes, black snakes and whip snakes.

Not only do the "pack rats" or "trade rats" carry off all sorts of articles to their nests, but other wood rats have the same habit, at least to some extent. A nest of the western bushy-tailed wood rat (*N. cinerea occidentalis*) contained 35 different kinds of articles, many of which were not used and could not be used by the rats as food.[53] Wood rats also store very large quantities of food when it is plentiful, whether they need it or not. In the vicinity of Magdalena, New Mexico, wood rats store pinyon nuts, and the Mexicans residing in the region take the stored nuts, thus saving themselves the labor of gathering them. Anthony says: "I was told that eight carloads had been sent to the eastern dealers, at that date, and as many more were expected before the end of the season," and that the store taken from the rats "would be renewed within a week and the same rat pay rent, perhaps as many as five or six times during the fall and winter."[54] Guano from the nests of wood rats has been used extensively by florists in the southwestern United States as a fertilizer for ferns and other plants.[55]

*Subfamily Microtinae*

But little seems to be known of the habits of the American lemming mice, genus *Synaptomys,* which are confined mostly to bogs and swamps and are not of much economic importance. The contents of 11 stomachs from Kansas and one from Minnesota consisted of "finely-ground grass and sedge leaves and a few insignificant traces of other green vegetation," but "judging from the habits of related rodents, these animals may occasionally feed upon a variety of bulbs and even insects."[1]

[53] Taylor, The wood rat as a collector, *Journ. Mammalogy,* I, 91-92, 1920.
[54] Anthony, The wood rat as a harvester, *Journ. Mammalogy,* I, 140-141, 1920.
[55] Streator, Commercial fertilizer from wood rat nests, *Journ. Mammalogy,* XI, 318, 1930.
[1] Howell, Revision of the American lemming mice (genus Synaptomys), *N. Amer. Fauna,* No. 50, p. 2, 1927.

The Cooper lemming mice (*Synaptomys cooperi cooperi*) are "chiefly herbivorous, feeding on grass stems and seeds." In captivity they ate grass, clover, dandelions, plantain, narrowleaf dock and rolled oats, while one ate apple, but refused carrots, radishes and celery. Of 8 stomachs taken in the field, 6 contained only finely ground, green plant material, apparently grass, and 2 contained dark, unidentified material, with a coleopterous wing covert.[2] Goss lemming mouse (*S. cooperi gossii*): 9 stomachs, full of vegetation, probably grass; 5 per cent of the contents of one was fungus spores and mycelial threads; another contained a beetle, with grass; in captivity they showed a preference for grass and apples, but ate also lettuce, cabbage, peanut butter, raisins, alfalfa, oats, clover seed and a little potato.[3]

It has been said that nothing is known of the food habits of the Idaho mountain vole (*Phenacomys orophilus*) and Preble mountain vole (*P. preblei*).[4] Both names are said to be synonyms of *P. intermedius*, the Rocky Mountain vole.[5] Coast or short-tailed phenacomys (*P. albipes*), usually lives in dry situations and probably feeds "on a variety of seeds, tender growth, and other relatively soft or brittle foods for which their teeth are best suited. The long-tailed or red tree mouse (*P. longicaudus*) and forest tree mouse (*P. silvicola*) are arboreal, and "their food, so far as known, consists chiefly of the fleshy parts of the needles of the conifers. . . . Some tender bark also is consumed."[6] Olympic mouse (*P. intermedius olympicus*) feeds upon twigs of heather, beargrass, lousewort and huckleberry leaves.[7]

The familiar generic name, *Evotomys* Coues, 1874, applied to the red-backed mice, appears to be preoccupied by *Clethrionomys* Tilesius, 1850.[8] Gale red-backed mouse (*C. gapperi galei*) eats grass and seeds, is confined to the mountains and is of no economic importance.[9] Loring red-backed mouse (*C. g. loringi*) eats seeds, green vegetation and

[2] Stegeman, Notes on Synaptomys cooperi cooperi in Washtenaw County, Michigan, *Journ. Mammalogy,* XI, 460-466, 1930.

[3] Burt, Additional notes on the life history of the Goss lemming mouse, *Journ. Mammalogy,* IX, 212-216, 1928.

[4] Burnett, *Office Colorado State Entom. Circular* No. 25, p. 10, 1918.

[5] Anthony, *Field book of North American mammals,* p. 406, 1928. Howell, Voles of the genus Phenacomys, *N. Amer. Fauna,* No. 48, p. 15, 1926.

[6] Howell, Voles of the genus Phenacomys, *N. Amer. Fauna,* No. 48, p. 2, 1926. Jewett, Notes on two species of Phenacomys in Oregon, *Journ. Mammalogy,* I, 165-168, 1920.

[7] Shaw, Alpine life of the heather vole (Phenacomys olympicus), *Journ. Mammalogy,* V, 12-15, 1924.

[8] Palmer, An earlier name for the genus Evotomys, *Proc. Biol. Soc. Washington,* XLI, 87-88, 1928.

[9] Burnett, *Office Colorado State Entom. Circular* No. 25, p. 10, 1918.

grain. When abundant about orchards or ornamental shrubbery it sometimes does damage by girdling.[10]

The field or meadow mice, genus *Microtus,* are the most abundant mammals of North America, except the white-footed mice (genus *Peromyscus*). They are very prolific, having from 2 to 6 litters of from 6 to 13 young, per annum.[11] Consequently they are a constant menace to agriculture as they may increase very rapidly when conditions are favorable, and overrun large areas, destroying all crops and forage. During an outbreak of field mice in Nevada in 1907 it was estimated that there were 12,000 mice to the acre, and in some fields they completely destroyed the alfalfa, roots and all.[12] In a meadow, 1000 mice require 12 tons of grass or other vegetation in a year.[13]

Mouse outbreaks may to some extent be avoided by constant watchfulness and prompt measures for suppression as soon as an increase in their numbers is noticed, and damage from the girdling of trees may be minimized by keeping orchards and land adjacent thereto clean and free from weeds, grass and other shelter, especially in winter, when they are more likely to attack trees.[14] As these mice feed mostly above ground, mechanical and chemical protection, such as wire screens and repellent washes, aid in preventing damage to trees.[15] Among the natural enemies that habitually destroy mice are wolves, lynxes, coyotes, foxes, badgers, raccoons, opossums, skunks, weasels, shrews, cats, dogs, hogs, hawks, owls, shrikes, cuckoos, crows, herons, bitterns, storks, ibises, gulls and snakes,[16] yet many farmers and hunters kill those bird and mammal enemies of mice at every opportunity. Snakes are cold-blooded, their digestion is slow and they require but little food, hence are not of great value as mousers.[17]

The fluctuations in the field mouse population affects other human interests besides agriculture and horticulture. When they are abundant

[10] Bailey, *N. Amer. Fauna,* No. 49, p. 88, 1926.

[11] Piper, The Nevada mouse plague of 1907-08, *Farmers' Bull.,* No. 352, 1909; Mouse plagues: Their control and prevention, *Yearbook U. S. Dept. Agric. for 1908,* p. 303. Hatt, The biology of the voles of New York, *Roosevelt Wild Life Bull.,* v, 513-623, 1930; discusses food stored, enemies, damage to crops, trees, destruction of insects by, mouse plagues, protection of trees from.

[12] Bailey, *Farmers' Bull.* No. 335, p. 11, 1909. Piper, *Farmers' Bull.,* No. 352, 1909; *Yearbook for 1908,* pp. 301-310.

[13] Lantz, An economic study of field mice, *U. S. Biol. Surv. Bull.* 31, 1907.

[14] Birdseye, *Farmers' Bull.* No. 484, 1912.

[15] Silver, Mouse control in field and orchard, *Farmers' Bull.,* No. 1397, 1924.

[16] Lantz, An economic study of field mice, *U. S. Biol. Surv. Bull.* No. 31, pp. 38-53, 1909.

[17] Burnett, *Office Colorado State Entom., Circular* No. 25, p. 31, 1918; No. 18, p. 7, 1916.

in Labrador they furnish plenty of food for wolves and thus tend to lessen the destruction of stock and game.[18] It is also well known that the world's fur markets are affected by the relative abundance of mice, which furnish food for the furbearers.[19]

"Meadow mice choose a somewhat varied diet, but their food consists mainly of green vegetation, roots and bark. Grass, especially the tender base of grass stems, forms the bulk of their food, but almost every plant with which they come in contact is eaten to some extent. Bark, both from roots and trunks of trees and shrubs, is a favorite winter food. Seeds and grain are eaten when found, but are not especially sought; flesh in any form is never refused."[20]

Although usually classed "among the most destructive rodents that the farmer has to contend with . . . under ordinary conditions these mice are useful as destroyers of noxious weeds and grasses of no agricultural value."[21] However, the constant levy upon crops, especially hay and forage crops, day by day throughout the year, must aggregate a very large loss, in addition to damage to orchards. Ten field mice in captivity for thirty days ate an average of 55 per cent of their own weight in food daily, which feat they could equal under natural conditions where food is abundant and they are leading a more active existence, to the aid of their digestion. Hence only 10 mice to the acre on a 100-acre meadow would take 11 tons of grass or 5½ tons of hay per annum; or, on the 65,000,000 acres of hay raised in the United States, may cause a loss of 3,000,000 tons of hay, or a monetary loss of $30,000,000, per annum.[22]

In a seed-beet silo, field mice destroyed the crowns of 90 per cent of the beets.[23] They are known to destroy many snails,[24] but probably do no harm and no good in that way. In 1903-1904 they did great damage to orchards and nurseries in Kansas and Missouri, and in 1901-1902 did damage to the estimated extent of $100,000 to nurs-

[18] Allen, *Journ. Mammalogy,* III, 56-57, 1922, citing Cabot's *Labrador.*

[19] Hewitt, *Conservation of the wild life of Canada,* pp. 214-215, 1921. Innis, *The fur trade of Canada,* pp. 90-91, 1927.

[20] Bailey, Revision of the American voles of the genus Microtus, *N. Amer. Fauna,* No. 17, p. 6, 1900; *N. Amer. Fauna,* No. 49, p. 91, 1926.

[21] Burnett, Meadow mice, *Office Colorado State Entom., Circular* No. 18, p. 5, 1916.

[22] Bailey, Breeding, feeding and other life habits of meadow mice (Microtus), *Journ. Agric. Research,* XXVII, 532, 1924.

[23] Burnett, Rodents of Colorado in their economic relations, *Office Colorado State Entom., Circular* No. 25, p. 11, 1928.

[24] Pilsbry and Bequaert, *Bull. Amer. Mus. Nat. Hist.,* LIII, 497, 1927.

eries at Rochester, New York, girdling the trunks of the trees above ground and the roots below ground.[25] In 1920, field mice ruined 1500 trees in one orchard, did damage to the extent of $10,000 in another, and $200,000 in one county, and girdled 1000 six-year-old pines on a 5-acre tract.[26]

The bean mouse (*M. pennsylvanicus wahema*) gathers and stores large quantities of beans of *Falcata comosa,* wild artichoke tubers (*Helianthus tuberosa*), etc. These stores sometimes furnished the Indians and early explorers with food, but agriculture now has provided these mice with a better food supply and they have become a pest in some localities.[27] The Cascade large-footed mouse (*M. richardsoni arviculoides*) eats many kinds of native plants, a list of which has been published.[28]Texas stomachs of Louisiana field mice (*M. ludovicianus*) contained only green vegetation.[29] Numerous caches of mint bulbs were found in the runways of the Townsend field mice (*M. townsendii*).[30] Least field mouse (*M. minor*): "summer food apparently consists entirely of green vegetable matter, of which *Artemisia dracunculoides* seems to be particularly favored. The contents of a storehouse of this species in autumn weighed 19¾ pounds, consisting of wheat heads, 29 per cent; *Liotris punctata* bulbs, 39 per cent; juniper berries and galls, 7 per cent; *Allium stellatum* bulbs, 6 per cent; *Psoralia, Helianthus* and *Artemisia,* 7 per cent. Another store, weighing 24½ pounds, contained *Taraxacum erythrospermum* roots, 85 per cent; *Convolvulus sepium* roots, 13 per cent; *Sisyrhinchium,* 2 per cent. Others included *Solidago, Geum, Aster* and *Calamovilfa.* One of 2½ gallons in a rye field contained rye heads, 94 per cent. One in an oat field contained oat spikelets, 93 per cent. One beneath oaks contained acorns, 83 per cent; roots, 17 per cent.[31]

The natural food of the pallid field mouse (*Lagurus pallidus*) is largely silver sage and blazing star, but it takes also grass and other

[25] Lantz, An economic study of field mice, *U. S. Biol. Surv., Bull.* No. 31, pp. 24-37, 1909.

[26] Silver, Mouse control in field and orchard, *Farmers' Bull.,* No. 1397, 1924.

[27] Bailey, Biological survey of North Dakota, *N. Amer. Fauna,* No. 49, p. 94, 1926; Identity of the bean mouse of Lewis and Clark, *Journ. Mammalogy,* I, 70-72, 1909. Gilmore, Food stored by the bean mouse, *Journ. Mammalogy,* I, 157, 1920.

[28] Taylor and Shaw, *Mammals and Birds of Mount Rainier National Park,* p. 76, 1927.

[29] Bailey, *N. Amer. Fauna,* No. 25, pp. 119-120, 1905.

[30] Couch, Storing habits of Microtus townsendii, *Journ. Mammalogy,* VI, 200, 1925.

[31] Criddle, The habits of Microtus minor in Manitoba, *Journ. Mammalogy,* VII, 193-200, 1927.

native plants and grains.[32] Sagebrush field mouse (*L. artemisiae*): "a large proportion of the food is composed of *Artemisia*."[33]

The pine mice (*Pitymys,* closely related to *Microtus,* especially *P. pinetorum* and its subspecies) "are probably the most destructive of any of the native field rodents of the eastern states." They attack white and sweet potatoes, bulbs, strawberry, blackberry and other plants, nursery stock and stored vegetables, eat freshly planted seeds, and damage orchard trees by gnawing off the bark near the surface of the ground and girdling the roots.[34] As they feed largely underground, attacking trees at the base unseen, it is difficult to detect their work until too late to prevent damage.[35] It is estimated that in 1915-1917 these mice damaged fruit trees in Virginia to the extent of $200,000.[36]

*Prometheomys,* of the Caucasus, assigned to this subfamily (Microtinae), "feeds on the grass of the alpine meadows, digging up the earth, and so destroys the roots of the grass and spoils the meadows." Mr. Kasnakov writes: "A person who lived in the Gudaur village for thirty years told me that formerly the peasants gathered from 400 to 500 ricks, whereas now they collect only from 150 to 200 ricks, although the recent ricks are far smaller than before!"[37]

The round-tailed muskrats or Florida water rats (*Neofiber alleni* and *nigrescens*) live in bogs and feed upon "vegetation, such as grass, bark and roots."[38] They are of very limited distribution and of no economic importance.

The muskrat (*Ondatra*=*Fiber* of many authors), native in America, introduced into some European countries, is now the "most important fur animal in North America," the annual catch in the United States alone averaging 13,000,000 or 14,000,000 pelts.[39] The actual reported sales in leading markets for 1919-1920-1921 reached 14,109,288 skins.[40] The large increase in the use of muskrat fur is shown by the fact that in 1900 only 4,035,000 from the United States and 5,285,000 from the whole world were reported to have reached the markets, and they

[32] Bailey, *N. Amer. Fauna,* No. 49, p. 101, 1926.

[33] Hall, Notes on the life history of the sagebrush meadow mouse (Lagurus), *Journ. Mammalogy,* IX, 201-204, 1928.

[34] Howell, *N. Amer. Fauna,* No. 45, p. 54, 1921.

[35] Silver, Mouse control in field and orchard, *Farmers' Bull.,* No. 1397, 1924.

[36] Bell, Death to rodents, *Yearbook U. S. Dept. Agric. for 1920,* p. 423.

[37] Ognev, Prometheomys, a remarkable rodent from the Caucasus, *Journ. Mammalogy,* VII, 215-220, 1926.

[38] Anthony, *Field book of North American mammals,* pp. 439-442, 1928.

[39] Ashbrook, *Fur farming for profit,* pp. 198-202, 1928.

[40] Osborn and Anthony, *Journ. Mammalogy,* III, 226, 1922; *Natural History,* XXII, 393, 1922.

were worth only $703,000 at prices then prevailing.[41] In the London market the reported average annual sales of muskrat skins from 1763 to 1915 were as follows, the big slump in 1915 being the result of the World War:[42]

| *Dates* | *Average Annual sales of skins* | *Dates* | *Skins* | *Totals* | |
|---|---|---|---|---|---|
| 1763-1800 | 75,000 | 1912 | 5,014,921 | 1763-1900 | 165,000,000 |
| 1801-1850 | 411,000 | 1913 | 6,876,417 | 1901-1913 | 240,000,000 |
| 1851-1900 | 2,534,000 | 1914 | 10,488,647 | | |
| 1901-1910 | 4,223,000 | 1915 | 3,500,000 | | |
| 1911 | 5,197,530 | | | | |

Muskrat pelts brought from 10 to 12 cents each in 1875, 10 to 50 cents in 1907, 80 to 85 cents in 1911, $1.25 in 1912, 12 cents to $5.10 in 1919, $5 to $7 in 1920, according to Laut, 13 cents to $4.55, according to Lantz; 8 cents to $2.58 in 1921, 12 cents to $2.46 in 1922.[43]

In 1918, 399,938 muskrat skins, worth $599,907, were obtained in the State of New York.[44] In 1924, 319,611 skins, worth $367,552, were shipped from Alaska.[45] In the season 1926-1927 Texas produced 30,000 muskrat skins and Louisiana 3,000,000,[46] 163,000 acres of waste marsh land producing 350,000 in one season.[47] Kansas produced 238,174 muskrat skins, for which the dealers paid over $240,000, during the three-month season of 1927-1928.[48] The muskrat industry in one Maryland county brings in $100,000 annually.[49] The Canadian muskrat catch for 1923-1924 was valued at $2,985,395, and the beaver catch at $2,542,992.[50]

The drain upon the supply of muskrats has been seriously felt in many localities. Notwithstanding the lure of increased prices, one Boston dealer reported a falling off of 50 per cent in the offerings for the three seasons of 1918, 1919 and 1920, and in Wisconsin, with a 10

[41] Stevenson, Utilization of the skins of aquatic animals, *Rept. U. S. Fish Comm. for 1902,* pp. 283-352.

[42] Lantz, The muskrat, *Farmers' Bull.* No. 396, pp. 24-26, 1910; The muskrat as a fur bearer; with notes on its use as food, *Farmers' Bull.,* No. 869, p. 12, 1917; revised, 1923. *Rept. Indiana Dept. Fish and Game for 1913-14,* pp. 241-249.

[43] Laut, *The fur trade of America,* pp. 90-96, 1921. Lantz, *Farmers' Bull.,* No. 869, 1923. Jones, *Fur farming in Canada,* pp. 89-90, 1913.

[44] Johnson, The muskrat: Its natural history and economics, *Roosevelt Wild Life Bull.,* III, 205-320, 1925.

[45] *California Fish and Game,* X, 82, 1924.

[46] Arthur, The fur animals of Louisiana, *Louisiana Dept. Conserv. Bull.* No. 18, p. 220, 1927. *Conservation News,* March, 1924. *California Fish and Game,* XI, 141, 1925.

[47] Ashbrook, *Fur farming for profit,* p. 198, 1928.

[48] Dose, Kansas' enormous fur trade, *Kansas Fish and Game Bull.,* p. 67, 1928.

[49] Lantz, *Farmers' Bull.,* No. 869, p. 17, 1923.

[50] Seton, *Lives of game animals,* IV, Pt. 2, pp. 569-601, 1929.

per cent increase in the number of licensed trappers each year, 800,000 skins were obtained in 1917, only 300,000 in 1918 and only 150,000 in 1919.[51] It long ago became evident that the muskrat fur industry was doomed unless some steps were taken for its preservation. Especially important was it to curtail the taking of skins during breeding seasons and at seasons when they are of little value, which practices were responsible for the fact that so many skins, even during the period of inflated prices, sold for only a few cents each, thus greatly reducing the average prices. Consequently, close seasons have been established by law in most states. In 1925 muskrats were unprotected in only ten states, protected throughout the year in two, with open seasons of over 5 months in eight, over 3 months in fifteen, 3 months or less in eleven.[52]

The value of muskrats is not confined to their furs. Their flesh is used largely as food, and is sold in the markets of Baltimore, Washington, Wilmington, Philadelphia and perhaps other cities, under the name "marsh rabbit," for which purpose they were selling in 1927 at $2.50 a dozen and the skins at $1.50 each.[53] As far back as 1907 one Philadelphia dealer sold 3000 carcasses a week during February. Several publications give directions for preparing and cooking muskrat meat.[54] Inasmuch as the trappers must skin the animals anyhow in order to sell the pelt, the sale of the meat adds considerable to their income without much effort.

Muskrats reproduce rapidly, having, according to various writers, from 2 to 5 litters per annum, of from 5 to possibly 20 young to the litter, 13 embryos having actually been taken from one female.[55] Their fecundity and the facts that they thrive on waste swamp land and do little or no damage, make muskrat farming profitable in suitable localities.

Muskrats are largely herbivorous, eating stems and roots of water plants, grasses, tules, cat-tails, garden vegetables, etc., but also eat

[51] Dearborn, The Maintenance of the fur supply, *U. S. Biol. Surv. Circular* No. 135, pp. 6-7, 1920.

[52] Ashbrook, Trapping laws and the fur supply, *Journ. Mammalogy*, VI, 168-173, 1925.

[53] Ashbrook, *Fur farming for profit*, pp. 200, 218, 1928.

[54] Johnson, *Roosevelt Wild Life Bull.*, III, 303-304, 1925. Lantz, The muskrat, *Farmers' Bull.*, No. 396, pp. 22-24, 1910; No. 898, pp. 10-11, 1923. Arthur, *The fur animals of Louisiana*, pp. 275-277, 1927.

[55] Lantz, *Farmers' Bull.* No. 396, 1910, citing *Proc. U. S. Natl. Museum*, XXVIII, 738, 1905; No. 869, 1923. Johnson, *Roosevelt Wild Life Bull.*, III, 227, 1925. Dixon, Rodents and reclamation in the Imperial Valley, *Journ. Mammalogy*, III, 136-146, 1922 Arthur, *The fur animals of Louisiana*, pp. 290-352, 1927.

snails, mussels, crustaceans, insects, fishes and occasionally small birds.[56] The muskrats at one Minnesota locality "had been cutting down some young shoots of poplar, about the size of a lead pencil in thickness, from which the leaves had been stripped and eaten, as shown by the stomach contents."[57] Their mussel-eating habit is well known and has been mentioned by many writers. The fishes caught by muskrats are mostly sluggish species of little value, such as carp. On the other hand, it is asserted that in the north they are helpful to fish by keeping airholes open, thus aërating the water.[58] A muskrat was seen catching a salamander, and they are known to eat crippled ducks during the hunting season.[59]

Muskrats sometimes damage river levees, reservoir dams and canal banks by their burrows, thus flooding fields, or injuring rice fields by draining them at the wrong season. Such damage may often be prevented by 3-foot woven wire fences, the lower edge set 6 inches beneath the surface of the soil.[60] In Europe the introduced muskrats are said to have endangered whole systems of waterways by burrowing into the embankments and strict regulations have been issued to curtail their spread.[61] Although muskrats are said to sometimes injure rice fields, it has been said that they are necessary to the existence of wild rice fields.[62]

Since its introduction into Europe the muskrat has spread very rapidly and become locally abundant. Because of its damage to crops of corn, potatoes, kohlrabi, turnips, carrots, frogs, mussels and fish, and the damage done to roads and embankments by its burrows, it is proposed to prohibit its introduction into other localities. In 1921 from 60,000, to 80,000 European muskrat skins were sold at prices comparing favorably with those paid for American skins.[63]

The nutria of South America is "a little rat known as coypu, some-

[56] Bailey, *N. Amer. Fauna,* No. 49, p. 102, 1926. Lantz, *Farmers' Bull.,* No. 396, pp. 15-21, 1910; No. 869, pp. 8, 10, 1923. Arthur, *The fur animals of Louisiana,* pp. 232-243, 1927. Johnson, *Roosevelt Wild Life Bull.,* III, 247, 1925. The muskrat in Czechoslovakia, *The Nautilus,* XXXVIII, 103, 1925.

[57] Johnson, Notes on the mammals of northern Lake County, Minnesota, *Journ. Mammalogy,* III, 37, 1922.

[58] *American Forests and Forest Life,* XXXIV, 120, 1928.

[59] Warren, *Mammals of Colorado,* p. 106, 1910.

[60] Bailey, *N. Amer. Fauna,* No. 49, p. 102, 1926. Burnett, *Office Colorado State Entom. Circular* No. 25, p. 13, 1918. Lantz, *Farmers' Bull.,* No. 396, 1910; No. 869, 1923.

[61] Ahrens, Muskrats in central Europe, *Journ. Mammalogy,* II, 236-237, 1921.

[62] Lucas, A viewpoint on the disappearance of rice beds, *Fins, Feathers and Fur,* No. 36, pp. 123-124, 1923; *Journ. Mammalogy,* V, 140, 1924.

[63] The muskrat in Europe, *Nature,* CXXIII, 775, 1929. The muskrat in Czechoslovakia, *The Nautilus,* XXXVIII, 103, 1925.

what resembling our own northern muskrat." At the spring auction sales in 1920, 150,000 were sold in St. Louis, 58,000 in New York and 20,500 in London, at from 50 cents to $6.10 each.[64] Formerly about 6,000,000 pelts were received annually, and were used mostly in the manufacture of felt hats, but in 1900 the catch had dropped to 1,500,000, worth $444,000 at prices then prevailing.[65] In the 3-year period, 1919-1921, the reported sales totalled only 1,941,784,[66] or an average of 647,261 per annum.

One group of South American rats has received the generic name *Ichthyomys,* because of their pronounced fish-eating habit.[67]

### Family MURIDAE—Old World Mice and Rats

The European house mice (*Mus musculus*), introduced into the United States and other American countries, seldom do much damage to field crops, as they are found chiefly about buildings; but they destroy large quantities of stored grain and provisions, damaging as much as they destroy, because they run about in all sorts of places and track filth over exposed food supplies.[1] However, there has been one serious outdoor plague of these little pests, when they became very destructive to crops and forage in a California valley. This outbreak is discussed on a preceding page, in the introductory remarks on rodents. The total amount of damage done by them annually in the United States doubtless runs up into millions of dollars, but is difficult to estimate with accuracy. There is an account of one house mouse in captivity killing and eating lizards placed in the cage.[2]

The European brown rats, or house rats (*Rattus norvegicus,* better known as *Mus norvegicus*), also transported into nearly all parts of the civilized world, are a scourge to the human race. As with the house mouse, they congregate about buildings and grain stacks and do an immense amount of damage, estimated at $200,000,000 per annum.[3]

With the lapse of ages the rat has become a parasite on man. It has developed into the greatest rodent pest ever known. It is far more destructive, directly

[64] Laut, *The fur trade of America,* pp. 120, 123, 1921; Concerning beaver and nutria, *Forest and Stream,* LXIX, 57, 88, 89, 1921.

[65] Stevenson, Utilization of the skins of aquatic animals, *Rept. U. S. Fish Comm. for 1902,* pp. 283, 317.

[66] Osborn and Anthony, *Journ. Mammalogy,* III, 226, 1922; *Natural History,* XXII, 393, 1922.

[67] Thomas, On a new fish-eating rat from Bogata, *Ann. and Mag. Nat. Hist.,* Ser. 9, VIII, 164-165, 1924; A new fish-eating rat from Equador, *ibid.,* 541-542.

[1] Howell, *N. Amer. Fauna,* No. 45, p. 59, 1921.

[2] Burt, A note on the mouse as an enemy to lizards, *Copeia,* No. 162, pp. 15-16, 1927.

[3] *Science,* LXIX, 378, 1929.

or indirectly, to human life and property than any wild beast or venomous serpent. It appropriates nearly everything that man eats, and drinks many of his beverages. It follows him with its baleful influence from the cradle to the grave. It destroys his poultry and molests his domesticated animals. It has been known to attack and mutilate infants, sleepers, the sick, aged and infirm. It is the forerunner of famine, pestilence and death. It carries the germs of disease. It infects man's ships and habitations with the dreaded plague; sets fire to his dwellings and ships, and ceases its ravages only when the house burns or the ship sinks. As if not satisfied with pursuing him through life, it follows him in death, desecrating and mutilating his mortal remains.[4]

The brown or Norway rat (*Mus norvegicus*) is the worst mammal pest in the United States, the losses from its depredations amounting to many millions of dollars yearly—to more, indeed, than the losses from all other injurious mammals combined. In addition to its destructive habits, this rat is now known to be an active agent in disseminating infectious diseases. . . . It destroys grains when newly planted, while growing, and in the shock, stack, mow, crib, granary, mill, elevator or ship's hold, and also in the bin and feed trough. It invades store and warehouse, and destroys fur, laces, silks, carpets, leather goods and groceries. It attacks fruits, vegetables and meats in the markets, and destroys by pollution ten times as much as it eats. It carries disease germs from house to house and bubonic plague from city to city. It causes disastrous conflagrations; floods houses by gnawing lead water pipes; ruins artificial ponds and embankments by burrowing; destroys the farmers' pigs, eggs and young poultry; eats the eggs and young of song and game birds; and damages foundations, floors, doors and furnishings of dwellings.[5]

The brown house rats affect a "larger percentage of the population than any other pest in existence."[6] Where sheltered and well fed, about dwellings, stores, warehouses and farmyards, they multiply very rapidly. Their fecundity is discussed on a preceding page. The following items are selected from Forbush's and Lantz' accounts of these rats: There were 31,981 of them killed on a 2000-acre farm in 5 years; 38,000 killed on one Jamaican plantation in 1 year; 16,050 killed in a French slaughterhouse in 1 month; 47,000 killed on 2 Georgian plantations in the winter and spring of one year; 1700 killed in fumigating 1 ship in London; 103,000 killed in Copenhagen in 18 weeks, and 711,797 in Stockholm in 7 years; during an outbreak of bubonic plague in San Francisco 278,000 were captured in 4 months and it was estimated that 500,000 more were poisoned; during a plague in India 12,000,000 were killed under a bounty or reward system; 28 were shot in one cherry tree in a single afternoon; in one crib they ruined enough corn to have paid the taxes on a 400-acre farm; on a 29-day voyage

[4] Forbush, Rats and rat riddance, *Massachusetts Board of Agric., Economic Biology, Bull.* No. 1, p. 7, 1915.

[5] Lantz, Methods of destroying rats, *Farmers' Bull.,* No. 297, pp. 3-4, 1907; The house rat: The most destructive animal in the world, *Yearbook U. S. Dept. Agric. for 1917,* pp. 235-251. Hogarth, The rat, a world menace, 1929.

[6] Silver, How to get rid of rats, *Farmers' Bull.,* No. 1303, p. 13, 1923.

44,000 bags of grain out of 46,000 were cut by rats, the damage amounting to $2,200. The damage caused by these rats is estimated at $3,000,000 in Denmark, $40,000,000 in France, $50,000,000 in Germany, $73,000,000 in Great Britain and Ireland; $193,615 damage to business men in Washington, D.C., and $700,000 to business men of Baltimore, in 1 year; probably $20,000,000 damage annually in cities of more than 100,000 inhabitants in the United States. They "kill more chickens than any other animal."[7]

Many publications contain directions for the destruction of rats, and suggestions for the prevention of damage by them.[8] Among the methods for destroying them are trapping, poisoning, fumigating and the use of ferrets, cats and dogs, though very few cats will attack rats and many dogs will not. Deterrents, such as odors (naphthaline in large quantities, creosote, carbolic acid, lysol, paracide, etc.), may be successfully used in some cases to drive them from their hiding places, where no foodstuffs are exposed to the fumes. All weed patches, rubbish piles and other hiding and breeding places should be eliminated. All buildings should be rat-proofed by the free use of cement in foundations and for basement floors, and sometimes metal to prevent gnawing about doors. All unnecessary holes or openings in foundations should be plugged and necessary openings such as drain pipes should be screened. All food and garbage receptacles should be made rat-proof and kept closed. Corn cribs may be protected by setting them three feet above the ground, on posts topped by inverted tin pans. Depriving the rats of food makes them hungry and more easily trapped or poisoned. Depriving them of breeding places and hiding places and driving them out into the open is one of the most effective methods of preventing their increase. Community action is often necessary in campaigns against rats, as against other pests, in order to get rid of sources of infestation and to prevent continual inflow of new stock from extraneous breeding grounds. In cities, professional rat hunters are often employed very advantageously, as trapping and poisoning rats is not an easy matter. They have acquired considerable resistance to strychnine and perhaps to other poisons. City building regulations should re-

[7] Fisher, *Yearbook U. S. Dept. Agric. for 1908*, p. 193.

[8] In addition to publications cited in preceding footnotes, see Claremont, *A practical handbook on rat destruction*, London, 1926. Silver, Rat control, *Farmers' Bull.*, No. 1533, 1927. Lantz, The brown rat in the United States, *U. S. Biol. Surv. Bull.* No. 33, 1909; House rats and mice, *Farmers' Bull.*, No. 896, 1917. Dice, Lethal dose of strychnine for the Norway rat, *Journ. Mammalogy*, IV, 188-189, 1923. Hovell, *Rats and how to destroy them*, London, 1924. Reese, *Outlines of economic zoology*, pp. 234-244, 1919. Munch, Silver and Horn, Red squill powders, *U. S. Dept. Agric. Technical Bull.*, No. 134, 1929.

quire the rat-proofing of all buildings, not only as a sanitary measure, but also to prevent them from becoming breeding places for rats. Silver, in the preface to a recent bulletin, says: "When rat-proofing becomes the regular practice the rat problem will have been largely solved."[9]

The house rat as a disseminator of bubonic plague has been discussed in Chapter XIII. Introduced into Japan, these rats at ebb tide "enter into sea water and capture shells, as well as small fishes, etc."[10]

In view of all that has been said against the brown rat, it is refreshing to record an item in its favor. One is reported to have killed a rattlesnake.[11]

### Family APLODONTIDAE—Mountain Beavers

The genus *Aplodontia* ranges from northern California to British Columbia. Their summer food is mostly green vegetation, "practically everything the season affords," and they do some damage to vegetable gardens. Their winter food is mostly bark, and in girdling trees they cause more or less injury. In their storehouses in the Puget Sound Basin 32 different kinds of plants have been found. In some places their burrows damage roads.[1] Their habit of "hay-making," or gathering, piling up apparently to dry, and storing vegetation, a habit shared with the pikas, has led to a difference of opinion. One author says that the material is used only for nest building, perhaps overlooking the fact that their summer food, green vegetation, is not available in the winter.[2]

### Family ZAPODIDAE—Jumping Mice

Prairie jumping mouse (*Zapus hudsoni campestris*): many stomachs examined, contained only seeds, usually of grasses, but some seeds of other plants and grain.[3] Usually not abundant enough to do harm.

### Family ERETHIZONTIDAE—American Porcupines

The summer food of the North American porcupines (*Erethizon*) consists of almost any green vegetation available, including alfalfa and

[9] Silver, Rat-proofing buildings and premises, *Farmers' Bull.* No. 1638, 1930.
[10] Kuroda, *Journ. Mammalogy*, III, 44, 1922.
[11] Hartman, A brown rat kills a rattler, *Journ. Mammalogy*, III, 116-117, 1922.
[1] Scheffer, Mountain beaver in the Pacific Northwest: Their habits, economic status and control, *U. S. Dept. Agric. Technical Bull.*, No. 1598, 1929. Taylor and Shaw, *Mammals and birds of Mount Rainier National Park*, pp. 86-87, 1927.
[2] Seton, *Lives of game animals*, IV, Part 2, pp. 526-555, 1929; citing Nelson, *Wild animals of North America*, pp. 532-533, 1918. Camp, Excavation of the burrows of the rodent Aplodontia, etc., *Univ. California Pub. Zool.*, XVII, No. 18, pp. 517-536, 1918.
[3] Bailey, *N. Amer. Fauna*, No. 49, p. 117, 1926.

other crops, and in the winter, the bark of trees.[4] In Alaska some birch trees have been "entirely stripped of bark" by porcupines.[5] In New York one was observed eating lily pads.[6] Locally, where abundant, they do considerable damage to forest trees, and injure buildings wherever salt has gotten on the wood. At a ranger station thirteen were killed while gnawing the front porch where sacks of salt had been stored, and one, attracted by the salty taste of the sweaty handles of a plow, gnawed them off.[7] Another gnawed the steering wheel of an automobile nearly off.[8] An orchard was unmolested for seven years, with porcupines all about it. Then in about sixteen days of late September and October they killed 140 plum and cherry trees, and damaged apple trees by climbing to the tops and nibbling the fruit spurs.[9] They sometimes damage field and garden crops, as well as trees. The contents of 20 stomachs weighed 10 per cent as much as the total weight of the bodies, including contents. Because of their fondness for salt, a salt-strychnine mixture is excellent for poisoning them.[10] In some localities they are protected by law or public sentiment, while in other localities they become abundant and are so destructive that it is deemed advisable to thin them out.

Porcupine quills often seriously injure dogs that attack them, and perhaps other mammals, as well as eagles.[11] The quills have been much used by the American Indians in the ornamentation of clothing, moccasins, tobacco pouches, war bonnets, baskets and other articles, "one of the most distinctive of native American arts."[12]

### Family HYSTRICIDAE—Old World Porcupines

The African porcupine (*Hystrix cristata*) is almost entirely vegetarian and does a great deal of damage to gardens.[13] "The flesh, baked in clay, is a popular food in Africa."[14]

[4] Bailey, *N. Amer. Fauna,* No. 49, p. 114, 1926.
[5] Murie, The porcupine in Alaska, *Journ. Mammalogy,* VII, 109-113, 1926. See also Hatt, The relation of mammals to the Harvard Forest, *Roosevelt Wild Life Bull.,* V, 652-656, 1930.
[6] Schoonmaker, *Journ. Mammalogy,* XI, 84, 1930.
[7] Gabrielson, Porky, *Forest and Stream,* Jan., 1929, p. 22.
[8] Wyman, A hungry porcupine, *Journ. Mammalogy,* IV, 190, 1923.
[9] Mosteller, Porcupines in relation to Wyoming orchards, *7th Biennial Rept. Wyoming State Board Horticulture,* pp. 25-27, 1918.
[10] Gabrielson, Notes on the habits and behavior of the porcupine in Oregon, *Journ. Mammalogy,* IX, 33-38, 1928.
[11] Lano, Golden eagle (Aquila chrysaetos) and porcupine, *The Auk,* XXXIX, 258-259, 1922.
[12] Ingersoll, *The life of animals,* p. 415, 1907.
[13] Drake-Brockman, *The mammals of Somaliland,* p. 145, 1910.
[14] Jennison, *Natural history: animals,* p. 180, 1927.

### Family CHINCHILLIDAE—Chinchillas

The Andean South American chinchilla is "a rodent with a fine fur that has long had a high value in commerce," though often popularly confused with the much less valuable "chinchilla rabbit."[1] Chinchilla skins were used by the ancient Incas as fur for clothing, and the long hairs from the fur were utilized in weaving cloth. Their flesh is good. They were abundant a century ago, but the demand for fur has nearly exterminated them except in the more inaccessible regions.[2] In 1919-1921 the reported fur sales included only 36,448 chinchilla skins.[3] The skins of the blue chinchilla bring about $110 a dozen, and those of the white chinchilla from $43 to $58 a dozen. "Bolivia has had to enforce a close time for some years to allow it to recover from the furrier's demand for one of the world's finest furs."[4]

The viscachas of eastern South America occur in colonies and do some damage to crops.[5] On the plains of Argentina they are numerous and troublesome.[6]

### Family CAVIIDAE—Cavies

The "guinea pigs" were domesticated by the natives of the Andean region in South America, lived in their houses and were used as food, before the arrival of the Spaniards. Their flesh is said to be excellent.[7] They have been introduced into many other countries as pets, and are extensively used in scientific experiments, such as testing serums, antitoxins and foods.

### Family OCHOTONIDAE—Pikas

This family, including the pikas, or little chief hares (*Ochotona*), sometimes called conies, though quite different from the Old World conies, is placed in the order Lagomorpha, with the family Leporidae—hares and rabbits. The pikas in the United States are confined to high mountains and are of little economic consequence. They feed upon many species of native plants. Indeed, they utilize for food most of the species of plants about them. From their habit of cutting small plants and piling them up "to dry" for winter food, they are often called "haymakers."[8]

[1] Green, Chinchilla rabbits for food and fur, *U. S. Biol. Surv. Leaflet* No. 22, 1928.
[2] Ashbrook, *Fur farming for profit*, pp. 231-239, 1928.
[3] Osborn and Anthony, *Natural History*, XXII, 393, 1922.
[4] Jennison, *Natural history: animals*, p. 416, 1927.
[5] Jennison, *Natural history: animals*, p. 183, 1927.
[6] Ingersoll, *The life of animals*, p. 416, 1907.
[7] Raising guinea pigs, U. S. Dept. Agric., *Farmers' Bull.*, No. 525, 1921.
[8] Osgood, *N. Amer. Fauna*, No. 30, p. 27, 1909. Merriam, *N. Amer. Fauna*, No. 5, p. 73, 1891; No. 16, p. 99, 1899. Taylor and Shaw, *Mammals and birds of Mount*

## FAMILY LEPORIDAE—HARES AND RABBITS

This is a very important family, useful because of the flesh and fur, often harmful to crops because of numbers and food habits. The destructiveness of rabbits is partly discussed in connection with that of various rodents, in the introductory remarks under Rodentia. Being much larger than most rodents, they individually require more food. Their birth rate is high, so that under favorable circumstances they multiply very rapidly. The common European rabbit is said to breed at the age of six months and to live 7 or 8 years, producing from 4 to 8 litters per annum, of from 3 to 8 young to the litter.[1]

As a general rule their natural enemies, such as eagles, hawks, owls, wolves, coyotes, foxes, wildcats and human hunters, keep the rabbits within reasonable bounds,[2] especially the cottontails. Under one great horned owl's nest 100 skulls of cottontails were found.[3] It was long ago declared that in Montana jack rabbits were common only where coyotes and wolves were scarce,[4] but it has been noted also that predacious animals sometimes congregate where rabbits are abundant for food. Rabbits are subject to somewhat periodic fluctuations, regardless of predacious animals. The periods in case of the varying hare (snowshoe rabbit) is about 10 or 12 years, according to Innis,[5] or 7 years, according to Henderson.[6] Such fluctuations, at least in case of jack rabbits, do "not affect the whole country simultaneously, for at the same season the rabbits may fairly swarm in one valley and be scarce in another."[7] This is also true of cottontails in southwestern Colorado, and probably elsewhere.

Rabbits have many diseases and parasites,[8] and it has been noticed by many observers that when rabbits become very abundant epidemic diseases finally check their further increase and eventually reduce

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*Rainier National Park,* p. 111, 1927. Seton, *Lives of game animals,* IV, Part 2, pp. 636-646, 1929.

[1] Palmer, The jack rabbits of the United States, *U. S. Div. Orn. and Mam. Bull.* No. 8, 1896; *U. S. Biol. Surv. Bull.* No. 8, 1897.

[2] Bailey, *N. Amer. Fauna,* No. 49, pp. 134-138, 1926.

[3] Bailey, *N. Amer. Fauna,* No. 25, 157-159, 1905.

[4] Grinnell (G. B.), *Rept. of Chief of Engineers, U. S. Dept. War, for 1876,* Part 3, p. 639.

[5] Innis, *The fur trade of Canada,* p. 90, 1927.

[6] A. D. Henderson, Cycles of abundance and scarcity in certain mammals and birds, *Journ. Mammalogy,* IV, 264-265, 1923.

[7] Bailey, *N. Amer. Fauna,* No. 25, pp. 152-155, 1905.

[8] Schwartz and Snook, Rabbit parasites and diseases, *Farmers' Bull.,* No. 1568, 1928. Stiles, A revision of the adult tapeworms of hares and rabbits, *Proc. U. S. Natl. Museum,* XIX, 145-235, 1897. De Ong, Parasites which affect the food value of rabbits, *California Fish and Game,* I, 142-143, 1914. Dearborn, Rabbit raising, *Farmers' Bull.,* No. 1090, pp. 32-34, 1920.

them to normal numbers.[9] The relation of rabbits to tularemia, which affects human beings, is discussed in Chapter XIII, on Mammals as Disease Carriers. They also are among the hosts of the ticks which carry the spotted fever.[10]

Rabbits are almost strictly vegetarian and feed upon all sorts of vegetation.[11] When abundant, they cause a great deal of damage to farm crops and range grass, and, by gnawing the bark, sometimes kill fruit trees. In a small area in New York State the winter food of the cottontails includes the bark, shoots, stems and small branches of at least 71 kinds of trees and shrubs.[12] The summer food of the white-tailed jack rabbits (*Lepus townsendii campanius*) in North Dakota is largely grass and other prairie plants, growing grain, when obtainable; in winter, mostly browse on tips of branches and buds of small trees and shrubs, including fruit trees and berry bushes.[13] Skinner tells of a white-tailed jack rabbit eating dandelion stems at the rate of 80 in 10 minutes, discarding the seeds.[14] The varying hare (*Lepus americanus*) has about the same food habits as the white-tailed jack rabbit.[15]

The Rocky Mountain snowshoe rabbits (*L. bairdi*) are very injurious to new growth of conifers in the Wasatch Mountains, Utah. They continually eat back the tops, one small fir having been annually eaten back for 46 years before one shoot grew beyond the reach of the rabbits. The loss, from this cause, of newly planted trees is very large. Similar damage has been noted in Australia, Austria, England, France and northern Europe. "It is reasonably certain that the rabbits will increase as the coyotes decrease and that the injury to conifers will therefore increase. With the destruction of a large number of coyotes on the national forests the rabbits have had to be controlled, especially in the vicinity of plantations."[16] Five jack rabbits eat as much grass as one sheep. At only one rabbit to the acre the rabbits on a 1000-acre

[9] Cary, *N. Amer. Fauna*, No. 33, p. 161, 1911. Lantz, Cottontail rabbits in relation to trees and farm crops, *Farmers' Bull.*, No. 702, 1916; revised, 1924. Hewitt, *The conservation of the wild life of Canada*, p. 218, 1918, citing Seton, *Life histories of northern mammals*, I, 640-641 1909. Preble, *N. Amer. Fauna*, No. 27, p. 201, 1908. Soper, Notes on the snowshoe rabbit, *Journ. Mammalogy*, II, 101-108, 1921. Seton, *Lives of game animals*, IV, Part 2, pp. 705-714, 1929.

[10] Birdseye, *Farmers' Bull.*, No. 484, 1912.

[11] Palmer, *U. S. Biol. Surv. Bull.* No. 8, 1897.

[12] Todd, Winter food of cottontail rabbits, *Journ. Mammalogy*, VIII, 222-228, 1927.

[13] Bailey, *N. Amer. Fauna*, No. 49, p. 141, 1926.

[14] Skinner, White-tailed jack rabbit eats dandelion stalks, *Journ. Mammalogy*, VIII, 249, 1927.

[15] Bailey, *N. Amer. Fauna*, No. 49, p. 139, 1926. Ligon, *Wild life of New Mexico*, N. Mex. Game Comm., p. 108, 1927.

[16] Baker, Korstian and Fetherolf, Snowshoe rabbits and conifers in the Wasatch Mountains of Utah, *Ecology*, II, 304-310, 1921.

ranch would eat as much as 100 sheep.[17] The damage done to the cotton crop by rabbits in Midland County, Texas, was estimated at $95,000.[18] In 1916 cottontails and jack rabbits destroyed the entire crop in some fields in San Diego County, California.[19] The Macfarlane snowshoe rabbits (*Lepus americanus macfarlani*) "feed mostly on the bark and small twigs of willow and paper birch, but in winter hunger sometimes drives them to eat alder and spruce."[20] Two coast swamp rabbits (*Sylvilagus aquaticus littoralis*) in captivity ate an average of grass equivalent to 42.2 per cent of their own weight daily.[21]

European hares (*Lepus europaeus*) were liberated in New York and Ontario many years ago, for sport, and have spread into Vermont, Massachusetts, Connecticut, New Jersey, Pennsylvania and probably other states. They damage orchards, small fruit bushes, shade trees and ornamental shrubbery, in winter when other food is scarce. The damage to orchards in one county alone in the winter of 1915-1916 amounted to $100,000.[22] These hares in the San Juan Islands have barked trees, destroyed other vegetation and done considerable damage by burrowing, undermining some government buildings.[23] Introduced into Australia, where they had no natural enemies, rabbits increased rapidly, and in ten years, from 1878 to 1888, did damage to the extent of $15,000,000.[24] Because of the damage by the plague of rabbits to the food for sheep, the number of sheep in New South Wales was reduced from 60,000,000 in 1893 to 32,000,000 in 1923.[25] In addition to the direct damage, millions of dollars have been spent in the destruction of rabbits and in the construction of rabbit-proof fences to prevent their ravages.

Though it is usually considered that hares and rabbits are strictly vegetarian in habit, Soper says that snowshoe rabbits often spring traps set for valuable fur-bearers, by "tampering with meat baits,"

[17] Bailey, *N. Amer. Fauna,* No. 25, pp. 152-155, 1905.

[18] *Science,* LXIX, 378, 1929.

[19] Bryant, Rabbits damage crops in San Diego County, *California Fish and Game,* II, 215-218, 1916.

[20] Dice, Notes on the mammals of interior Alaska, *Journ. Mammalogy,* II, 20-28, 1921.

[21] Svihla, Habits of Sylvilagus aquaticus littoralis, *Journ. Mammalogy,* X, 315-319, 1929.

[22] Silver, The European hare (Lepus europaeus Pallas) in North America, *Journ. Agric. Research,* XXVIII, 1135-1137, 1924.

[23] Couch, Introduced European rabbits in the San Juan Islands, Washington, *Journ. Mammalogy,* X, 334-336, 1929.

[24] Palmer, *U. S. Biol. Surv. Bull.* No. 8, p. 32, 1897.

[25] *Nature,* CXII, 553, 1923. See also Beal, *Yearbook U. S. Dept. Agric. for 1900,* p. 300.

and that they will eat the flesh of "another rabbit, muskrat, or any other small animal," if the skin has been torn or removed, but will not eat those whose skins are entire.[26] Saunders says that in Ontario the introduced European hares sometimes kill cottontail rabbits, but do not eat them.[27] Rabbits are said to devour land snails also, and cottontail rabbits were found to be eating the cocoons of the large silk moth, *Samia cecropia*.[28]

Because of the recreational value they provide for numerous hunters, and the value of their flesh for food, rabbits are partially protected by law in many states and Canadian provinces.[29] In addition, at least seven states have, within the past few years, brought in live rabbits from other states and liberated them, in order to replenish their depleted stock.[30] In contrast with this, many states at various times have paid bounties for the destruction of both cottontails and jack rabbits, but that course has not proved effective, a subject discussed in Chapter XXVII, on Legislation Concerning Mammals.

In western states, where rabbits have been particularly destructive, organized drives and poisoning campaigns are frequently conducted, often in coöperation with the United States Biological Survey. In one such campaign 40,000 jack rabbits were killed in one Idaho county, 15,000 in another, 20,000 in another, 19,000 in another and 5000 in another.[31] One day's shooting by 200 guns at Lamar, Colorado, netted 5142 rabbits, a two-day hunt at the same place netted 6000, while a one-day drive in San Joaquin Valley, California, netted 35,000 rabbits.[32] In Crook County, Oregon, 59,000 were killed in one winter.[33] In Grant County, Washington, 61,000 rabbits were killed in one campaign, and 94,000 in adjacent counties.[34] Palmer gives detailed lists of 220 rabbit

[26] Soper, Notes on the snowshoe rabbit, *Journ. Mammalogy,* II, 101-107, 1921.

[27] Saunders, Carnivorous habit of the European hare, *Journ. Mammalogy,* X, 170, 1929.

[28] Wright, *Journ. Conch.,* XII, 268, 1922. Oldham, *Journ. Conch.,* XVIII, 335, 1929. Lawson, *Journ. Conch.,* XVIII, 327-328, 1929. Pilsbry and Bequaert, *Bull. Amer. Mus. Nat. Hist.,* LIII, 479, 1927. Taylor, *Monog. land and fresh-water Mollusca of Brit. Isles,* III, 281. Bird, Cottontail rabbits are insectivorous, *Journ. Mammalogy,* XI, 240, 1930.

[29] Game laws for the season 1929-1930, *Farmers' Bull.,* No. 1616, 1929.

[30] Dice, The transfer of game and fur-bearing mammals from state to state, with special reference to the cottontail rabbit, *Journ. Mammalogy,* VIII, 90-96, 1927.

[31] Bell, Death to rodents, *Yearbook U. S. Dept. Agric. for 1920,* p. 436.

[32] Jones, *The squirrel hunters of Ohio,* p. 172, 1898. Miller, *Recreation,* Jan., 1899, p. 45. McCurdy, *Recreation,* Jan., 1899, pp. 17-18. All cited by Seton, *Lives of game animals,* IV, Pt. 2, pp. 757-761, 1929.

[33] Bell, Coöperative campaigns for the control of ground squirrels, prairie-dogs and jack rabbits, *Yearbook U. S. Dept. Agric. for 1917,* p. 232.

[34] Couch, Relationship of predatory mammals and birds of prey to rodent life, *Journ. Mammalogy,* IX, 73, 1928.

drives in California, Oregon, Idaho, Utah and Colorado, in which 470,107 rabbits were killed. In California, 20,000 were killed in Tulare County in one month, 70,000 altogether during the spring of 1888, 70,000 in Kern County and 40,000 in Fresno County. During a Grand Army of the Republic drive in Fresno County in 1892, in which 8000 people were said to have participated, it was estimated that between 20,000 and 30,000 rabbits were killed.[35] In one drive 15,000 were killed on a tract of about twenty square miles.[36]

Methods of destroying rabbits and of protecting crops, trees and shrubbery therefrom, including the encouragement of their natural enemies, the construction of rabbit-proof fences, etc., are discussed in various publications mentioned in foregoing footnotes. From 1879 to 1888 New Zealand and Australia spent $5,323,315 in the destruction of rabbits and $468,468 in the construction of rabbit-proof fences.[37] In 1887, 19,182,539 were destroyed in New Zealand alone.[38]

With higher prices and the increasing demand for furs, and the consequent decreasing supply, rabbit skins have come into extensive use, not only in the manufacture of felt hats and the like, but also for fur clothing. New methods have been developed for preparing and dyeing them, and they are sold under various trade names, not merely as rabbit fur. As long ago as 1898 it was said that 15,000,000 rabbit skins had been exported from New Zealand during the preceding five years, and 200,000,000 since 1873.[39] The following figures are given of exports of such skins from Australasia prior to 1895:[40]

| *Exported from* | *Year* | *Number* | *Value* |
|---|---|---|---|
| New Zealand | 1873-1884 | 180,037,562 | $6,854,187 |
| Tasmania | 1892-1894 | 31,912,182 | 1,083,098 |
| Victoria | 1878-1893 | 68,637,990 | 1,989,177 |
| South Australia | 1885-1894 | | 335,584 |
| | | | $10,262,046 |

In 1921, Miss Laut said: "This year England has paid as high as 50 cents a pound and imported 90,000,000 rabbits. In the New York auction sales, best Australian rabbit sold at from $1.40 to $3.15."[41]

[35] Palmer, Jack rabbits of the United States, *U. S. Biol. Surv. Bull.* No. 8, pp. 47-64, 1896.
[36] *Forest and Stream,* XXXVIII, March 3, 1892, p. 197, cited by Palmer.
[37] Palmer, *U. S. Biol. Surv. Bull.* No. 8, p. 44, 1896.
[38] Palmer, The danger of introducing noxious animals and birds, *Yearbook U. S. Dept. Agric. for 1898,* p. 93.
[39] Palmer, *Yearbook for 1898,* p. 93.
[40] Palmer, *U. S. Biol. Surv. Bull.* No. 8, p. 70, 1896.
[41] Laut, *The fur trade of America,* p. 5, 1921; see also p. 84.

There were 3,713,036 white hare skins reported as sold in the world's markets in 1919-1921.[42] In 1928, 100,000,000 rabbit skins were imported to the United States, 40 per cent for fur garments, 50 per cent used in the manufacture of felt hats.[43]

Chinchilla rabbits have often been confused with *Chinchilla lanigera,* a small very different South American rodent, which has a fine fur. This has led to a very much exaggerated idea of the value of the chinchilla rabbits as fur-bearers. Their furs are more attractive than those of most other rabbits, but prices do not justify raising them for the fur alone, though they may be profitably bred for both meat and fur, as with other rabbits.[44]

Not only do rabbit skins form an important item in the world's fur sales, but they also affect the fur trade indirectly, "as a source of sustenance for various fur-bearing animals, as when these [varying] hares are plentiful, meat-eating fur-bearers are also plentiful. In order to show just how important it is to the fur trade, the following figures may be of interest. In the winters of 1905-1906 and 1906-1907, when hares were very abundant, I bought at Pembina River 860 and 980 lynx skins. In the spring of 1907 the hares died off and in the season of 1907-1908 I received only 40 lynx skins from the same territory."[45] Canadian trappers recognize the dependence of the fur catch upon the relative abundance of rabbits and mice.

The meat of rabbits is also valuable. In 1918, 465,000 cottontail rabbits were killed in the State of New York; 2,700,000 killed in Pennsylvania in 1919 and 5,000,000 in 1921, furnishing 14,250,000 pounds of meat; 293,625 in Virginia in 1920, 332,000 in 1922; probably 25,000,000 killed annually in the United States, which, at 20 cents each, are worth $5,000,000 for their meat alone.[46] Over $1,000,000 worth of rabbit meat was sold in Los Angeles in 1928.[47] Missouri shipped to the nation's markets, for the Christmas trade of 1928, over 3,500,000 rabbits, worth $450,000.[48] Seton intimates that the meat of cottontail rabbits in the United States reaches a value of $25,000,000

[42] Osborn and Anthony, *Journ. Mammalogy,* III, 226, 1922; *Natural History,* XXII, 393, 1922.
[43] Ashbrook, *Fur farming for profit,* p. 4, 1928.
[44] Green, Chinchilla rabbits for food and fur, *U. S. Biol. Surv. Leaflet* No. 22, 1928. *Science,* LIII, 387, 1921.
[45] A. D. Henderson, *Journ. Mammalogy,* IV, 264-265, 1923.
[46] Palmer, Game as a national resource, *U. S. Dept. Agric. Bull.* No. 1049, 1922. Adams, *Roosevelt Wild Life Bull.,* III, 551, 1926.
[47] Ashbrook, *Fur farming for profit,* p. 219, 1928.
[48] *Missouri Fish and Game News,* V, No. 1, 1929. *California Fish and Game,* XV, 181, 1929.

per annum, and that they furnish sport to 10,000,000 hunters, which may be somewhat overestimated.[49]

Before the outbreak of the World War, 100,000,000 rabbits were marketed each year in France, $1,000,000 worth annually imported from Belgium to England, England herself produced from 30,000,000 to 40,000,000, London consumed 500,000 pounds of rabbit meat daily in 1911 and Paris 200,000, and $4,500,000 worth was imported from Australia and New Zealand to London in 1911.[50] About 35 years ago the canning of rabbit meat for exportation to Europe was begun and developed rapidly.[51] The United States Bureau of Home Economics has recently issued a leaflet containing recipes for the cooking of rabbit meat.[52]

There are reasons for suspecting that the flesh of varying hare in the Mackenzie River region may not be very nourishing in the winter, especially when used as an almost exclusive diet. "In summer, when the animals live mainly on herbaceous plants, their flesh is very palatable, though woefully lacking in nourishing qualities, but in winter, when they feed largely on the foliage and bark of resinous trees, the meat acquires a somewhat bitter taste. When Indians are living mainly on rabbits, they call it 'starving,' though they may be eating bounteously of the meat every two or three hours, and it is said that if nothing else is obtainable, they gradually grow weaker on this diet."[53] Under the ancient Hebrew law hares were considered "unclean" and forbidden as food for the people.[54]

## Order HYRACES—Conies

The conies of Asia Minor and eastern and southern Africa (*Hyrax capensis*) are very different from the so-called conies of western North American mountains. They are probably the conies of the Bible: "The conies are but feeble folk,"[1] "the prey of every predatory beast and bird and reptile."[2] They were pronounced "unclean," in the Law of Moses, therefore not to be eaten by the chosen people.[3] They live on

[49] Seton, *Lives of game animals*, IV, Pt. 2, p. 791, 1929.

[50] Dearborn, Rabbit growing to supplement the meat supply, *Yearbook U. S. Dept. Agric. for 1918*, pp. 145-152; Rabbit raising, *Farmers' Bull.*, No. 1090, 1920.

[51] Palmer, *Yearbook U. S. Dept. Agric. for 1898*, p. 93.

[52] Yeatman and Stienberger, Rabbit recipies, *Bur. Home Econ. Leaflet* No. 66-L, 1930.

[53] Preble, A biological investigation of the Athabaska-Mackenzie region, *N. Amer. Fauna*, No. 27, p. 201, 1908.

[54] *Leviticus*, XI, 6; *Deuteronomy*, XIV, 7.

[1] *Proverbs*, XXX, 26.

[2] Jennison, *Natural history: animals*, p. 197, 1927.

[3] *Lev.* XI, 5; *Deut.*, XIV, 7.

rocky ground and feed on leaves, roots, bulbs and shoots. The Somali dassie (*Procavia brucei somalica*) also lives among rocks and is entirely herbivorous.[4] No species of this order is of economic importance.

## Order PROBOSCIDEA—Elephants

Asiatic elephants have long been trained to work, and are employed advantageously in various industries, such as handling heavy timbers. Their great strength makes them very valuable for certain kinds of work. A large elephant will carry from 1800 to 2500 pounds on its back according to Austin, 1200 according to Jennison, and can push or pull heavy loads, exerting a force equal to that of 50 men.[1] Trained elephants are successfully used in hunting tigers in India.[2]

It is generally believed that the African elephants cannot be domesticated, but they are said to have been trained for service in war by the ancient Romans and Carthagians.[3] Oswell, according to Selous, thinks the Carthagians may have used Asiatic elephants obtained in India.[4] Recent attempts to train the African species to work in harness have met with success, and it is declared that in the Belgian Congo they are more economical in plowing than tractors, while, unlike horses, they are immune from the tsetse fly.[5] White elephants in India are not used as work animals, but are reserved for religious ceremonies.

Trained elephants perform many rather astonishing feats, considering their size and awkward appearance, in circuses, to the delight of thousands of people annually, and they find a place in every menagerie, as also in many zoological parks. Elephants occur in a wild state in portions of Asia, Africa and some tropical islands. The wild animals, of such great bulk and travelling in herds, are capable of doing much damage when they visit plantations or native villages, and are very dangerous to human beings. Hence they must give way as the regions inhabited by them are settled by large populations of permanent human inhabitants. However, that does not justify the ruthless slaughter that

[4] Drake-Brockman, *The mammals of Somaliland*, p. 109, 1910.

[1] Austin, Queer methods of travel in curious corners of the world, *Natl. Geog. Mag.*, p. 688, 1907. Jennison, *Natural history: animals*, p. 204, 1927.

[2] Morden, Tiger hunting in Nepal, *Nat. Hist. Mag.*, XXIX, 339-352, 1929, with many photos.

[3] Jennison, *Natural history: animals*, p. 203, 1927.

[4] Selous, *Nature Lovers Library*, V, 156-157, 1917, citing Oswell; *Standard Library of Nat. Hist.*, I, 178-179, 1908.

[5] Phillips, Trained African elephants, *Journ. Mammalogy*, VI, 130-131, 1925. Lyell, Domestication of the African elephant, *The Field*, London, CXL, 153, 1927; *Journ. Mammalogy*, VIII, 171, 1927. Science News Supplement, *Science*, April 6, 1928, p. x.

has for years been in progress and still continues. Unfortunately for the elephants, they possess large ivory tusks, which find a ready market and appeal to the avarice of tusk hunters. In 1889 it was estimated that 100,000 elephants, "a procession 180 miles long," were killed each year in order to supply the world with ivory.[6] In 1926 it was said that, notwithstanding efforts to protect them by law, $250,000 worth of tusks are still annually smuggled across the boundary from British Africa to Italian Somaliland.[7] Occasionally even circus elephants "run amuck" and kill people, as happened in one of the southern states in 1929, and of course wild elephants are always dangerous. Many people are killed by them in both Africa and Asia. Elephants killed four people in India in 1895.[8] Such tragedies are not uncommon where these huge animals run wild.

A great deal of ivory has been obtained from the tusks of fossil mammoths—extinct species of elephant. Such tusks are often found in the United States, but are usually considerably weathered. In Alaska they are frequently found in frozen soil and ice, which has preserved them from weathering and kept them in good condition. They are much more abundant in the frozen portions of Siberia. Digby says he saw 1,000 pairs of mammoth tusks in a single year, and that ancient Chinese writings show that mammoth ivory was brought into China from Siberia centuries ago.[9] Very ancient carved ivory is found in European caves, and the search for fossil ivory extends far back in the past. Mammoths were obtained by the prehistoric peoples of Europe by means of pitfalls and the ivory tusks were used by them. The northern ivory trade of China has been traced back as far as 50 B.C. The estimates of the number of fossil mammoths discovered in Siberia during the last 250 years vary from 20,000 to 62,000.[10]

### Order ARTIODACTYLA—Even-toed, Hoofed Mammals

This order includes, among others, several of the most important families of domesticated mammals.

[6] Lucas, *Ann. Rept. U. S. Natl. Museum for 1889*, p. 611.

[7] Carey, *Journ. Mammalogy*, VII, 83, 1926. Lang, *Journ. Mammalogy*, IV, 163, 1923. Phillips, *Journ. Mammalogy*, VI, 130-131, 1925.

[8] F. C. K., Deaths from wild mammals and snakes in India, *Amer. Naturalist*, XXXI, 77-78, 1897.

[9] Digby, *The mammoth and mammoth hunting in northeast Siberia*, pp. 21, 53, 1926.

[10] Osborn, The romance of the woolly mammoth, *Natural History*, XXX, 227-239, 1930.

### Family SUIDAE—The Swine (Hogs, Peccaries, etc.)

The domesticated swine are very important animals. The domestication was accomplished so long ago that there is no record of it in written history—at least 4900 years ago in China.[1] They are quite omnivorous. Their flesh, familiarly known as pork, constitutes about one-half of all the meat used in the United States, 68.5 pounds per capita in 1927, together with 13.8 pounds of lard per capita, the total amount of pork consumed being 8,122,000,000 pounds, and of lard 1,634,000,000.[2] Pork is particularly valuable, because, unlike most other meats, it may readily be cured by salting and smoking, without losing flavor or becoming dry and hard, and may thus be kept in good condition for a long period and transported long distances, without refrigeration, the smoked bacon and ham being eaten with relish by many people who do not care for fresh pork.

In 1927 there were in the United States 52,536,000 head of swine, valued at $838,420,000, and in other countries, 103,278,000 head.[3] In 1925 the United States produced under federal inspection 8,255,000,000 pounds of pork and 2,223,000,000 pounds of lard.[4] In addition to the meat and lard, the skins and bristles are articles of commerce.

Formerly there were very heavy losses to hog-raisers, chiefly due to epidemics of cholera, but methods of controlling the disease have been developed, resulting in the stimulation of that industry.[5]

Hunting wild boars has for centuries furnished exciting sport in various parts of Europe and Asia. They are formidable antagonists. Though hunting them with modern repeating rifles in expert hands may not be especially dangerous, hunting them in the old-fashioned way with spear and bow and arrow was very dangerous sport. In India wild boars are said sometimes to kill tigers,[6] and they often kill human beings, at least 51 people having been killed by them in one year.[7]

[1] Heller, The derivation of the European domestic animals, *Ann. Rept. Smithsonian Inst. for 1912,* pp. 483-491. Hewitt, *The conservation of the wild life of Canada,* p. 310, 1921.

[2] Statistics of farm animals and animal products, Separate No. 976 from *Yearbook U. S. Dept. Agric for 1927. Statistical Bull., U. S. Dept Agric.,* No. 20, 1927.

[3] *New York World Almanac for 1928,* pp. 371, 376.

[4] *U. S. Dept. Agric. Statistical Bull.,* No. 20, 1927.

[5] Hess, Less cholera—more hogs, *Yearbook U. S. Dept. Agric. for 1918,* pp. 191-194.

[6] Bryden, in *Nature Lovers Library,* v, 276, 1917.

[7] *Science,* XXXVII, 938, 1913.

## Family PHACOCHOERIDAE—Wart and Forest Hogs

The wart hogs (*Phacochoerus*), of Africa, are vegetarians, and feed largely on grass, but take also leaves, bulbs, roots and fruit.[8] They "often root up the ground, but the stomachs of those we shot were commonly filled with nothing but grass."[9] Their flesh is pronounced good. The forest hogs (*Hylochoerus*), also of Africa, are said to live on leaves and fruit.[10]

## Family TAYASSUIDAE—Peccaries

The Texas collared peccaries (*Pecari angulatus*) feed largely on acorns, but take also pecans, walnuts and other mast, roots, herbs, fruits and berries. When other food is scarce, they "utilize the hardy cacti and other desert plants to meet their needs." "The flesh, though strong, is sometimes eaten, but its value to the sportsman lies in the sport of hunting, as well as in the trophies gained." They are vicious fighters, with powerful tusks that can "quickly cut a dog to pieces."[1] Mearns tells of the "treeing of a negro servant by a band of infuriated peccaries," but adds that "although stories of similar occurrences are commonly repeated by the white settlers of the Southwest, this is the only instance of an attack made on man by peccaries that has come to me on unimpeachable authority."[2]

## Family HIPPOPOTAMIDAE—Hippopotamuses

"Hippos are sometimes dangerous at night," and have been known to wantonly attack and kill a boy, and to attack canoes and boats and damage crops. They feed on water plants in the late afternoon, but at night "come ashore to feed on the grass and land plants. In consequence, those killed during the day, until the late afternoon, had their stomachs filled, not with water plants, but with grasses which they must have obtained in their night journeys."[3]

"The Kafue and Zambesi River hippos eat only grass." The dried

[8] Jennison, *Natural history: animals,* p. 310, 1927. Drake-Brockman, *The mammals of Somaliland,* p. 100, 1910.

[9] Roosevelt, *African game trails,* p. 87, 1910.

[10] Jennison, *Natural history: animals,* p. 311, 1927.

[1] Ligon, *Wild life of New Mexico,* New Mexico Game Comm., p. 97, 1927. Cary, in Bailey, *N. Amer. Fauna,* No. 25, p. 59, 1905. Mearns, *U. S. Natl. Museum Bull.* No. 56, p. 16, 1907. Stone and Cram, *American animals,* p. 30, 1902.

[2] Mearns, Mammals of the Mexican Boundary, *U. S. Natl. Museum Bull.* No. 56, p. 167, 1907.

[3] Roosevelt, *African game trails,* pp. 212, 243-244, 347. Jennison, *Natural history: animals,* p. 308, 1927.

hide "has a market value of roughly a shilling a pound." "The fat also makes very acceptable lard and sells for the same price as the hide."[4]

Each hippopotamus "has two sickle-shaped canine teeth and two straight incisors, probably for defense. . . . These teeth are the whitest and hardest ivory known, much in demand for piano keys and dentistry. Many hippopotami are killed for them alone, but a big specimen will yield in addition a ton of excellent fat, and of the tough hide the Kourbash whip is made."[5]

### Family CAMELIDAE—Camels, Llamas, Alpacas, etc.

Camels were domesticated in very ancient times. In certain desert regions of Africa and Asia they are indispensable animals, "ships of the desert." There are about 3,000,000 of them in tropical and oriental countries, and during the Crimean war 25,000 of them were pressed into service.[1] "Field Marshall Lord Allenby, the conqueror of Jerusalem, is said to have used as many as 60,000 camels in his campaign against the Turks during the World War. Here it was fully demonstrated that the camel in his own country and climate is vastly superior to the horse or mule as an army transport."[2] They carry persons or heavy loads of merchandise on their backs and are sometimes used to draw wheeled vehicles. A load is usually from 350 to 600 pounds, but sometimes they carry 1300 pounds or more, and travel from 25 to 30 miles a day. In Texas, 3 six-mule teams (18 mules) hauled 4400 pounds 60 miles in five days, while 6 camels carried 3648 pounds 60 miles in two and one-half days. In 1856 and 1857, the government imported 75 camels for use as beasts of burden in the arid portions of southwestern United States. The experiment, not a fair one and interrupted by the Civil War, was a failure, and was abandoned in 1867 or thereabouts.[3]

Fast saddle dromedaries (one-humped camels), formerly much used, could travel very rapidly for a day or two. "Couriers often did the 240 miles to and from Mecca in 48 hours on the same dromedary."

[4] Hubbard, *Journ. Mammalogy,* x, 296, 1929.

[5] Jennison, *Natural history: animals,* p. 308, 1927.

[1] Austin, Queer methods of travel in curious corners of the world, *Natl. Geog. Mag.,* XVIII, 688, 1907.

[2] Blair, *In the zoo,* p. 68, 1929.

[3] Carroll, The government's importation of camels, *U. S. Bureau of Animal Industry Circular* No. 53, 1904; reprinted from *20th Ann. Rept.,* pp. 391-409, 1903. Leslie, *Uncle Sam's camels,* Harvard Univ. Press.

The baggage animals, carrying 600 pounds, would travel 2½ miles an hour for a short distance, or with 300 pounds on a long journey. Dromedary "caravans three hundred strong left Pekin for Turkestan as early as 1500 B.C.," but they have now been mostly displaced by two-humped camels in central Asia.[4]

From their camels the Arab derives meat, rich milk, leather and fuel, and the hair is used in making his tents, shawls, ropes and other articles.[5] Camel's hair is also used in other countries for various purposes. An old male Bactrian camel, with long, woolly hair hanging from its neck, shoulders and rump, is an imposing animal. Camels were pronounced "unclean" and the eating of their flesh forbidden by the Law of Moses (Lev., XI:4; Deut., XIV:7). Camels and dromedaries always attract a great deal of attention in menageries and zoological parks.

Llamas were long ago domesticated and used as beasts of burden in South America. "Eight millions were said to be in use by the Incas when the Spaniards invaded Peru. At present there are about five hundred thousand."[6] They will carry from 50 to 200 pounds each and travel from 6 to 12 miles a day, living on the forage along the way.[7] They furnish both meat and milk for their owners. Their woolly hair is excellent for the manufacture of cloth, though inferior to that of the closely related alpacas.

The alpacas, also domesticated, are bred in great flocks in Peru and Chili for their long woolly hair, which for over a century has been exported to other countries, where it is used in the manufacture of blankets, shawls and other cloth articles. The vicunias, found in a wild state in the Andes, also yield fine, curly wool, and are hunted for their flesh, as well as for their wool. The guanacos, or huanacos, found wild in the Andes and "in large numbers on the plains of Patagonia," provide the principal meat supply of Patagonian nomads, as well as skins for clothing and tents. About 5000 vicunia and 20,000 guanaco skins reached the markets of the world in 1913, and 30,000 guanaco skins, perhaps including vicunia, in 1923.[8]

[4] Jennison, *Natural history: animals,* pp. 304-307, 1927.
[5] Ingersoll, The Arab's debt to the camel, in *The life of animals,* pp. 336-337, 1907.
[6] Jennison, *Natural history: animals,* p. 300, 1927.
[7] Austin, Queer methods of travel in curious corners of the world, *Nat. Geog. Mag.,* XVIII, 688, 1907. *The Riverside Natural History,* V, 284-285.
[8] Innis, *The fur trade of Canada,* table opp. p. 76, 1927.

## Family CERVIDAE—The Deer Family

In Africa the various antelopes, grouped together, are very important game animals. In North America the bison and the pronghorn antelope once swarmed over the vast western plains, but they have been reduced in numbers almost to the vanishing point. At the present time, considering the world as a whole, Cervidae is the most important family of large game animals, including deer, moose, elk, caribou and reindeer, distributed over most of North America, Europe and Asia. The deer is one of our most beautiful and graceful American mammals, rivalled only by the pronghorn antelope. The wapiti, or American elk, is a stately creature. The moose is the most majestic American animal, not excepting even the bison. The caribou, with its long, slender, branching, reindeer antlers, is a sight worth a long trip to see. Because of their esthetic value, their beauty and the interest they arouse whenever they are seen, the ruthless slaughter of deer and their relatives should have been stopped long ago.

It is scarcely conceivable that such animals were ever killed by thousands for their hides alone, the flesh being left to decompose, yet such is the case. Before game laws for Alaska were enacted, many thousands of deer were killed there for their skins, which sold for a few cents each,[1] there being no market for the meat. In Montana in 1876 they were being "most recklessly slaughtered for the hides alone."[2] In Texas 75,000 deer skins were handled at one trading post from 1844 to 1853, and 5000 sent out in one shipment in 1853,[3] most of the deer having been killed for their hides. This takes no account of the skins handled by other traders in that region. "During the hide-hunting days, deer were killed by the thousands in all parts of the state [California]. One San Francisco firm in 1880 handled 35,000 hides taken from Siskiyou, Trinity and Shasta counties. Two men are reported to have killed 3000 deer in one year in northern California and southern Oregon. Such killing would certainly have led to extermination in a comparatively short time, but fortunately the price secured for the hides was very low, about 50 cents each, and as deer became scarcer it was no longer profitable; hunters were forced into other work. Deer were

[1] Osgood, The game resources of Alaska, *Yearbook U. S. Dept. Agric. for 1907,* p. 478.

[2] Grinnell (G. B.), *Rept. Chief of Engineers, U. S. Dept. War for 1876,* Part 3, p. 640.

[3] Strecker, The trade in deer skins in early Texas, *Journ. Mammalogy,* VIII, 106-110, 1927.

so reduced in numbers that in 1888 the Fish and Game Commission recommended to the legislature that a close season be established."[4] It was estimated that in Michigan, 100,000 deer were killed in 1890, 75,000 in 1894, 25,000 in 1903, 7000 in 1904, showing a steady decline.[5] Caribou have been exterminated in Arctic coastal portions of Alaska, and greatly reduced elsewhere, largely for their skins.[6]

Deer were so ruthlessly pursued that they were nearly or entirely exterminated in many states before anything approaching adequate legal protection was provided, notwithstanding the fact that there have been local laws giving them some sort of protection in many places for a long while. Ancient laws in New England were directed toward preventing certain persons from hunting. In New Jersey in 1771 an open season of three months each year for deer was established, permitting only voters and their sons over eighteen years of age to hunt on unimproved public lands.[7] In 1920 there were open seasons in 33 states, with does fully protected in 17, but in 15 states there was no deer hunting, because they were all gone or so scarce that no hunting of them was permitted.[8] It is true that the spread of dense populations in some areas would inevitably drive out the deer,[9] but most of the destruction was inexcusable, and they could still easily be maintained in most of their former range.

In addition to their esthetic value, deer furnish sport and recreation to many hunters and constitute an economic resource which may be greatly increased by proper protection, whereas without protection they would soon cease to be an asset—esthetic, recreational or economic. In point of utility, the deer family ranks next to the Bovidae and Equidae (cattle, sheep, goats and horses).[10] The utilitarian aspect of their status must be recognized, and some hunting must be allowed, or they would soon overstock their range, to their own detriment, as well as to the detriment of human interests.

What may be done to partly restore deer to their former position as game animals has been demonstrated in some states. In Vermont deer were practically exterminated before 1870; 13 were introduced in 1875, they and their offspring were protected until 1897, then a short

[4] Hunter, Deer hunting in California, *California Fish and Game,* x, 20, 1924.
[5] *Shields' Magazine,* Sept., 1905, p. 251.
[6] Hewitt, *The conservation of the wild life of Canada,* pp. 59-66, 1921.
[7] Rhoads, *Mammals of Pennsylvania and New Jersey,* p. 26, 1903.
[8] Palmer, Game as a national resource, *U. S. Dept. Agric. Bull.* No. 1049, pp. 2-3, 1922.
[9] Stone and Cram, *American animals,* p. 35, 1902.
[10] Lantz, Deer farming in the United States, *Farmers' Bull.,* No. 330, 1908.

open season permitted. They continued to increase, and the number killed continued to increase, from 211 in 1902 until it reached 5261 in 1909, computed to have furnished 716,358 pounds of meat, worth $85,962,[11] besides the skins, horns, etc. The license fees paid for hunting and fishing, including deer hunting, add considerable to the revenues of the states, the fees in Vermont in 1925-1926 totalling $90,824.70. The value of the deer killed in Vermont in 1908-1909 was estimated at $109,790. Under rigid protection on the National Bison Range in Montana, elk have become too abundant for their own good, because of the limited forage supply, and deer became so abundant as to overstock their range in Kaibab National Forest.[12]

In New York State deer had become scarce because of the ravages of market hunters and wolves, but have become more plentiful since market hunting was prohibited and the wolves thinned out.[13] In the national forests of California 11,522 deer were killed in 1917, 2271 less than the preceding year, though there were 7160 more licensed hunters.[14] Does this indicate a decrease in the number of deer present? In 1927, 19,507 were killed in California, and 21,515 in 1928, probably indicating an increase under better protection.[15] In Michigan, Wisconsin and Minnesota 68,286 were killed in 1919, 48,072 in 1920, 37,500 in 1921,[16] worth $4,415,740.[17] There is need of a thorough nation-wide survey of the deer situation, to ascertain just what factors regulate the fluctuation in the number of deer, including legal protection, freedom from natural enemies, food supply, etc.

In 1922 it was estimated that from 60,000, to 80,000 deer were killed each year in the United States, and that, at 75,000, the meat would weigh 11,250,000 pounds, which, at 20 cents a pound, would be worth $2,250,000.[18] In 1884 it was estimated that there were in the national forests 441,000 deer (185,000 in California, 57,000 in Oregon, 41,000 in Montana, 39,000 in Idaho, 34,000 in Arizona), and 40,500 elk.[19] In 1925 the estimate was 605,964 deer, 72,165 elk, 6061

[11] Hornaday, *Wild life conservation,* p. 106. Hewitt, *The conservation of the wild life of Canada,* p. 9, 1921.
[12] *California Fish and Game,* xv, 138-139, 155-156, 1929.
[13] Burnham, *Journ. Mammalogy,* ix, 43-47, 1928.
[14] *American forestry and forest life,* p. 304, 1928.
[15] *California Fish and Game,* xv, 44, 1929.
[16] Adams, *Roosevelt Wild Life Bull.,* iii, 553-557, 1926.
[17] Nelson, The economic importance of wild life, *Scientific Monthly,* xvi, 367-373, 1923.
[18] Palmer, Game as a National Resource, *U. S. Dept. Agric. Bull.,* No. 1049, 1922.
[19] *California Fish and Game,* x, 28, 36-37, 1924.

moose and 143 caribou.[20] In 1927 it was 671,050 deer (70 per cent of the total for all of the United States) and 82,478 elk.[21]

Human hunters are not the only enemies of deer. In 1924 it was estimated that 31,000 deer are killed annually in California alone, by mountain lions,[22] though in many instances the destruction of deer is, without investigation, wrongfully attributed to these big cats. Wolves, coyotes and bears also kill deer at times. Deer and elk are also subject to many diseases and at least 15 kinds of parasites. In one county alone no less than 5000 deer died in one epidemic of bladder-worm infestation.[23] Among other diseases with which they are afflicted may be mentioned the foot-and-mouth disease, pinkeye, fatal neck tumors, liver flukes and various other diseases of stock, and nasal parasites.[24] Also heavy winter snows are harder on deer than on elk, moose and caribou.[25]

Under natural conditions an approximate balance had been struck between deer and their enemies and diseases, so that during the centuries the deer neither decreased to the point of extinction nor increased beyond the capacity of their range to support them. With the advent of modern civilization the equilibrium was sadly disturbed. Forests were cleared off, agriculture claimed large areas for grain fields, herds of cattle and flocks of sheep came in to compete with the native animals for grass, herbage and browse, bringing with them serious diseases from which deer were not immune, predatory mammalian enemies of deer were killed in large numbers, on one hand, while on the other death-dealing rifles were placed in the hands of thousands of hunters, for the destruction of deer. Hence it has become necessary for man to assume complete control of the situation to prevent the extermination of the deer or their increase beyond bounds. The whole subject is very complex and much yet remains to be learned about the best plans to accomplish these ends.

It has been found that too rigid protection may overstock the range and lead to disastrous results. Several years ago newspapers had much to say about moving a large number of deer from Kaibab National

[20] Adams, *Roosevelt Wild Life Bull.*, III, table opp. p. 558, 1926.
[21] *New York World Almanac for 1928*, p. 364.
[22] *California Fish and Game*, X, 22, 1924; XVI, 253, 1930.
[23] Hunter, Deer hunting in California, *California Fish and Game*, X, 22, 1924.
[24] *California Fish and Game*, X, 127-128, 145, 1924. Hall, The deer of California, *California Fish and Game*, XII, 248-249, 1927. See also Murie, An epizootic disease of elk, *Journ. Mammalogy*, XI, 214-222, 1930.
[25] Brandreth, Deer in winter, *Forest and Stream*, Jan., 1928, p. 26, etc.

Forest, Arizona, where their natural food had become so scarce that they were starving.[26] Serious question is raised as to the wisdom of completely protecting the does year after year, which results in unbalancing the sexes[27] and probably weakens the herd as a whole. Though the wisdom of thinning out the does after prolonged complete protection at the expense of the bucks has been disputed by some naturalists,[28] recent experiences and investigations in Pennsylvania cannot be ignored or lightly set aside. "Overcrowded conditions of the herds have resulted in the poor development of antlers among the bucks; the breeding season is so upset as a result of the unbalanced condition of the sexes that many fawns are produced too late in the season for them to compete with their elders in securing food during the winter." In one county "the old deer, by standing on their hind legs, had eaten the edible food to a height of about six feet. The young deer, being unable to reach so high, were forced to feed on woody stems, bark and other indigestible matter; consequently they died from malnutrition. Dead deer seemed to be everywhere . . . 6 within a distance of 200 yards." "Over one thousand dead fawns were found in four townships of northwestern Clearfield County." Around one refuge 46 dead deer were counted. "All of the dead deer examined were greatly emaciated, but none showed signs of injury or disease.[29] A special doe season was provided in 1928, when 25,097 does were taken and no bucks. As Pennsylvania has been very successful in maintaining and increasing its deer herds, in the face of annual open seasons on bucks and increasing number of licensed hunters, the table on page 315 is of interest.[30]

It seems manifest that if deer are to be protected for the benefit of the hunters or of the general public, and are thereby encouraged to multiply, then farmers, gardeners, and others whose crops or other property are injured by deer should receive compensation out of the hunting license fee fund or from tax funds. In Pennsylvania it was

[26] Grinnell, The starving deer of the Kaibab Forest, *Outlook,* CXXXVI, 186-187, 1924. In 1929, during a 10-weeks open season on this plateau, 2372 licensed hunters killed 3428 deer, *California Fish and Game,* XVI, 251, 1930. Griswold, The Kaibab—facts, not fancies, *Outdoor Life,* LXVI, 35-36, 1930.

[27] Kalmar, The Adirondack deer, *American Game,* XVIII, 85, 1929. Sherman and Hill, Should does be killed?, *American Game,* XVII, 92-93, 1928. Schierbeck, Is it right to protect the female of the species at the cost of the male?, *Canadian Field Naturalist,* XLIII, 6-9, 1929.

[28] See *California Fish and Game,* XV, 263, 1929, citing Hall, *Canadian Field Naturalist,* March, 1929.

[29] The Pennsylvania deer problem, *Pennsylvania Board Game Comm. Bull.* No. 12, pp. 7, 8, 1929. See also Forbes and Beckdel, *Ecology,* XII, 323-333, 1931.

[30] *Outdoor Life,* p. 37, 1929; pp. 36-37, Oct., 1930.

proposed to set aside \$100,000 from the game fund for that purpose, but the bill failed to pass the legislature.[31] In Massachusetts the amounts paid to farmers for damage to their crops through the depredations of deer have varied from \$237.30 in 1903 to \$19,977.29 in 1913, the amount for 1926 being \$15,702.77. The number of deer shot in accordance with law while damaging crops has varied from 16 in

| Year | No. of Bucks Killed | Special. No. of Does Killed | No. of Hunters Licensed | Year | Bucks Killed | Does Killed | Hunters Licensed |
|---|---|---|---|---|---|---|---|
| 1913 | 800 | — | 305,028 | 1921 | 4,840 | — | 462,371 |
| 1914 | 1,102 | — | 298,972 | 1922 | 6,115 | — | 473,735 |
| 1915 | 1,287 | — | 262,355 | 1923 | 6,452 | — | 497,216 |
| 1916 | 1,722 | — | 290,422 | 1924 | 7,778 | 126 | 501,572 |
| 1917 | 1,725 | — | 315,474 | 1925 | 7,278 | 1,029 | 521,855 |
| 1918 | 1,754 | — | 311,290 | 1926 | 11,646 | 1,295 | 520,574 |
| 1919 | 2,939 | — | 401,131 | 1927 | 14,374 | — | 437,727 |
| 1920 | 3,300 | — | 432,240 | 1928 | — | *25,097 | 437,727<br>**78,876 |
| | | | | 1929 | 22,822 | — | 504,748 |

* Antlerless deer.
** Special deer licenses only.

1907 to 327 in 1910, but was only 90 in 1926.[32] The amount paid for such damage in New Hampshire in 1918 was \$1,016, and in 1927 it was \$1,299.25.[33] In Vermont it was \$2,167.55 for the season of 1918-1919 and \$973.14 for 1919-1920.[34] In 1923-1924 it was \$2,131.96.[35] Few of the states have laws providing for the payment for such damages.

Though deer eat grass freely at times, especially in the spring, at other times it constitutes only a very small part of their food, unless other food is scarce. Bailey found no grass in stomachs of western white-tailed deer (*Odocoileus virginianus macrourus*) killed during the hunting season, but says their food is chiefly "leaves, buds and seeds of a great variety of trees." They are fond of acorns and pods of leguminous plants, and prefer weeds to grass, hence a few of them

[31] The Pennsylvania deer problem, *Pennsylvania Board of Game Comm. Bull.* No. 12, p. 5, 1929.
[32] *Ann. Rept. Massachusetts Div. Fisheries and Game for 1921*, p. 54; *for 1926*, p. 27.
[33] *Rept. New Hampshire Fish and Game Comm. for 1918*, p. 4; *for 1928*, p. 18.
[34] *25th Biennial Rept. Vermont Dept. Fish and Game*, p. 21, 1920.
[35] *27th Biennial Rept.*, as cited in *California Fish and Game*, XI, p. 91, 1925.

in cattle pastures might improve grazing by keeping weeds down.[36] However, cattle also eat many plants taken by deer besides grass, though their normal food is not the same as the favorite food of deer. Competition between sheep and deer is more serious, as their food habits more nearly coincide. McLean says that over 60 per cent of the plants eaten by deer are eaten also by sheep, and 50 per cent are grazed also by cattle. Competition is therefore certain.[37] He says that the food of deer in summer includes 50 kinds of plants; that they will browse almost any kind of plant to some extent; that the deer bush (*Ceanothus integgerimus*) is their favorite food in winter; and that they do not eat azalea, larkspur, cow parsnip and other plants which are poisonous to domestic stock. Hall lists 10 species of trees and shrubs upon which deer browse in Yosemite Park, and says that on the Kaibab Plateau a native species of clover is their favorite food, though they eat many herbaceous plants and mushrooms.[38] The Kaibab item may be abnormal, as the range there is overstocked with deer, resulting in a shortage of their usual food.

In Pennsylvania 393 deer stomachs contained laurel, teaberry and other leaves, numerous acorns, particles of pine and hemlock leaves and bark; all contained acorns and some contained corn, grass and wheat.[39] In California the Columbian black-tailed deer are said to "resort to the oak groves to glean the crop of acorns, of which they are very fond."[40] Some deer in Maine are reported to eat fish, probably a habit acquired by a few individuals from eating refuse about camps.[41] Mearns says of the Mexican mule deer (*Odocoileus hemionus canus*) that in addition to its chief food of shrubs, leaves and many small plants, it is "extraordinarily fond of acorns, especially those of the evergreen oak (*Quercus emoryi*)."[42] Fawns in captivity ate all sorts of vegetable food and fruit.

The following items are abstracted from Bailey's Texas report:[43] Texas white-tailed deer (*O. texanus*): natural food is leaves of live-oak, brush, acorns, mesquite and other bean pods. Even as late as 1902 they were being killed by "wagonloads" for the market, and many were killed "for the hides only, leaving the carcasses to rot." They

[36] Bailey, *N. Amer. Fauna,* No. 49, p. 36, 1926.
[37] McLean, What deer eat, *California Fish and Game,* XIV, 221-223, 1928.
[38] Hall, The deer of California, *California Fish and Game,* XIII, 250-259, 1927. Dixon, What deer eat, *Amer. Forests and Forest Life,* XXXIV, 143-145, 1928.
[39] Sutton, in The Pennsylvania deer problem, *Pennsylvania Board of Game Comm. Bull.* No. 12, p. 19, 1929.
[40] Henshaw, *Rept. Chief of U. S. Engineers, 1876,* Part 3, p. 529.
[41] Burgess, Fish-eating deer, *Journ. Mammalogy,* v, 64-65, 1924.
[42] Mearns, *U. S. Natl. Museum Bull.* No. 56, p. 200, 1907.
[43] Bailey, Biological survey of Texas, *N. Amer. Fauna,* No. 25, 1905.

"rarely, if ever, eat grass or any forage plant eaten by horses or cattle, but live on leaves and twigs of bushes, seeds, pods and flowers, including acorns and the pods of numerous kinds of bean bushes." Western white-tailed deer (*O. v. macrourus*) in Texas feeds largely on acorns in autumn. Sonora or Arizona white-tailed deer (*O. couesi*): in June their food "consisted mainly of leaves, flowers, green seeds, and capsules or pods of a great variety of shrubs and plants," including oaks, etc. "Acorns were the great attraction during fall and winter. No trace of grass could be found in any of the three stomachs examined." Mexican mule deer (*O. h. canus*): "they eat the green stalks of the big century plants (*Agave wislizeni* and *applanata*), and paw open the cabbage-like caudex of the sotol (*Dasylirion texanum*) for its starchy and juicy center," and in March and April "they seem to feed to a great extent on the blossoms of *Yucca macrocarpa* and *Dasylirion texanum*."

The question as to the effect of a mountain laurel and rhododendron diet upon white-tailed deer has been discussed recently at some length.[43-a]

Because of their browsing habit, deer often damage orchard trees, especially young trees.[44] It is said this may be prevented by the use of cloths soaked in sheep dip, suspended from trees by wires, so as not to come into contact with the trees, this keeping the deer away without killing them.[45] Wagner recommended 1 pound of blood-meal to 3 gallons of water as the best repellant spray and wash, repeated every two weeks, to prevent damage to trees by deer and rabbits.[46] They are also destructive to young forest and shade trees, whose tops they are able to reach and browse. "Ninety per cent of the 197,000 trees planted on the Moshannon State Forest, in Pennsylvania, during the past three years have been destroyed by deer," according to John W. Keller, chief of the State Bureau of Extension. The plantation of Scotch pine showed 40 per cent of the trees killed by deer, and 50 per cent so injured that it is doubtful if they will survive. Eleven per cent of the pitch pine plantations were killed and 65 per cent of the trees severely injured. Only trees planted in aspen and wild cherry

[43-a] Forbes and Beckdel, Mountain laurel and rhododendron as foods for the white-tailed deer, *Ecology*, XII, 323-333, 1931.

[44] Hall, The deer of California, *California Fish and Game*, XIII, 234-259, 1927. True, Damage by deer to crops in California, *California Fish and Game*, XVIII, 136-137, 1932; Repellents and deer damage control, *ibid.*, pp. 156-165.

[45] Dondero, Protecting orchards from deer, *California Fish and Game*, XIV, 221, 1928.

[46] Wagner, A spray for preventing damage by deer, *California Fish and Game*, I, 241, 1915.

thickets were undamaged."[47] Probably such serious damage was because the districts were overstocked with deer and their food consequently scarce, as is suggested by the fact that no damage was done where there were aspen and cherry thickets. Because of the damage to the young trees it was decided by the state authorities to "curtail the planting of forest tree seedlings until they are certain these will not be consumed by deer which lack sufficient natural food during the winter."[48]

There has been an interesting discussion of the "deer line," or "plimsoll" line of the white cedar forests on the shores of certain Adirondack lakes.[49] The term "plimsoll" is derived from the line on the hull of a ship which marks the water line when the vessel is loaded as heavily as is safe. In the discussion of the work of deer it refers to the uniform line, parallel with the water or ice of the lakes, to which the branches of the cedars are trimmed from below. It is claimed by some that this line is caused by the deer browsing while standing on the level platform of the ice during the winter, and rearing on their hind legs. Though this has been denied by others, it is consistent with other facts concerning the effect of browsing by deer in the winter when food is scarce. Though overbrowsing from below does not seriously injure large trees, browsing on young trees may prevent them from getting a start. Hence, as the old trees must eventually die, if overbrowsing should continue indefinitely it might destroy the forest. Thus it is said that overbrowsing by deer and cattle in Kaibab Forest keeps the young aspens from getting a start.[50]

The flesh of deer being valuable as food, the skins used in the manufacture of leather (buckskin) of special excellence for some purposes, the antlers made into handles for knives, forks, etc., and the waste therefrom made into gelatine or into size used in the manufacture of cloth, the ease with which they may be reared and kept in captivity has naturally suggested deer farming.[51] Though deer have never been

[47] Deer destroy Pennsylvania tree plantations, *Amer. Forests and Forest Life,* XXXIV, 252, 1928.

[48] The Pennsylvania deer problem, *Pennsylvania Game Comm. Bull.* No. 12, pp. 10-11, 1929.

[49] Johnson, On the supposed relation of deer to cedars bordering certain Adironlakes, *Journ. Mammalogy,* VIII, 213-221, 1927. Burnham, *Journ. Mammalogy,* IX, 43-47, 1928. Merriam, *Mammals of the Adirondack region,* pp. 110-111, 1886. Bailey, *American Game,* XVII, 56-66, 1929.

[50] Adams, Ecological conditions in national forests and national parks, *Scientific Monthly,* XX, 561-593, 1925.

[51] Lantz, Raising deer and other large game animals in the United States, *U. S. Biol. Surv. Bull.* No. 36, 1910; Deer farming in the United States, *Farmers' Bull.,* No. 330, 1908. *Natl. Geog. Mag.,* XXI, 269, 1910. Roseberry, Experience in raising Virginia deer, in Jones, *Fur farming in Canada,* pp. 118-119, 1913.

really domesticated, there seems no good reason why it could not be done if the incentive were sufficient, as it was in case of the reindeer, which meant so much to the people where it was brought under control. However, there are a great many deer held in public and private parks, and they are completely protected by law in our national parks, where no hunting is permitted. Whether deer farming will ever become a profitable business is yet to be demonstrated, but there are large areas of mountain lands unsuited to cattle and horses but well suited to deer and elk, which may some time be used for that purpose. A 6-foot fence is said to be sufficient to hold a 4-year-old elk, but a foot or so higher would be better.

The wapiti, or American elk (*Cervus canadensis*, etc.), not very closely related to the European elk (*Alces alces,* which is more nearly related to the American moose), was once abundant over large portions of North America, but has now been exterminated from much of its former range, and greatly reduced in the small areas where it still roams. Of the estimated 70,000 in the United States in 1919, or 52,000 in 1926, about half were in or near Yellowstone Park.[52] Unfortunately for the elk, it posseses two peculiar tusks, of unknown function, in the upper jaw. These were worn by Indian women in North Dakota, the men not being permitted to wear them; but the Indians did not kill the elk for the teeth alone.[53] They utilized the flesh, skins, sinews and antlers. When members of a great fraternal order began to use the teeth as an emblem of the order, the slaughter began in earnest. Thousands of elk have been killed for the tusks, their carcasses and even their skins being left untouched.[54] The practice has not yet entirely ceased.

The food of the elk is largely browse (twigs of deciduous trees and shrubs and cedar twigs), with some grass and other plants in summer. The Yellowstone Park herd is subject to scabies, introduced by sheep, and serious tick infestation, and probably to other diseases and parasites.[55]

The European elk or moose (*Alces alces*) is a browser. It and the American moose are the largest living members of the deer family.

[52] Graves and Nelson, Our national elk herd, *U. S. Dept. Agric. Circular,* No. 51, p. 4, 1919. Palmer, Game as a national resource, *U. S. Dept. Agric. Bull.* No. 1049, 1922. Adams, *Roosevelt Wild Life Bull.,* III, 557, 1926.

[53] Bailey, *N. Amer. Fauna,* No. 49, p. 33, 1926.

[54] Leek, Elk tusk hunting, *Outdoor Life,* XXXV, 149-151, 1915. Bailey, *N. Amer. Fauna,* No. 49, 1926. Graves and Nelson, *U. S. Dept. Agric. Circular* No. 51, p. 18, 1919.

[55] Stone and Cram, *American animals,* p. 33, 1902. Skinner, The elk situation, *Journ. Mammalogy,* IX, 309-317, 1928.

"The elk trots with a loping stride, beyond the pace of any horse, and keeps it up for hours. It was regularly used for traction purposes in Sweden until it was forbidden in the seventeenth century because it helped so many malefactors to escape from justice."[56] "The European moose was formerly under domestication and proved valuable for transportation in the cold northern countries. It is on record that it once hauled a sleigh 234 miles in one day. For diverse reasons—the chief one being that exiles in Siberia used it to effect their escape—it became unlawful to maintain moose in captivity in Russia."[57] Its food in Norway is browse, chiefly roan-tree, sallow, aspen, birch, alder and cherry, but it eats also fir leaves, juniper leaves and berries, and various plants.[58]

The American moose (*Alces americana,* etc.) is still found in small numbers in various widely separated localities in the United States and is common at many localities farther north. The total number in the United States national forests was estimated in 1925 at 6061, and in 1927 at 7192.[59] It is said to be increasing somewhat in numbers where it is well protected and not already exterminated.[60] During an open season in Maine, in 1927, 100 bull moose were killed, but they are not plentiful enough to "warrant another open season for some time to come."[61] "They are much more valuable to the state alive than dead. The moose is a great attraction to visitors, and a close-up photograph is prized highly by the sportsman. Many spend the entire season in the Maine woods with kodak and fly-rod."[62]

We are told of a team of moose in North Dakota and a single moose in Manitoba which were driven in harness.[63] Jones says that, with its great size and strength, perhaps it "could be developed into a domestic animal of value. Several cases are recorded of its being successfully used for draught purposes. It is but just to add, however, that the moose has not yet [1913] been bred in captivity."[64] Because of its short neck and long legs, it is difficult for the moose to feed from the

[56] Jennison, *Natural history: animals,* p. 293, 1927.
[57] Jones, *Fur farming in Canada,* p. 95, 1913.
[58] Salvesen, The moose and red deer in Norway, *Journ. Mammalogy,* x, 59-62, 1929.
[59] Adams, *Roosevelt Wild Life Bull.,* III, 558, 1926. *New York World Almanac,* for 1928, p. 364.
[60] Bailey, *N. Amer. Fauna,* No. 49, p. 31, 1926.
[61] *Amer. Forests and Forest Life,* XXXIV, 512, 1928.
[62] Fishing and hunting in the State of Maine, p. 12, from *Rept. Maine Comm. Inland Fisheries and Game for 1926.*
[63] Shields, Moose in harness, *Forest and Stream,* XLI, 316, 1893.
[64] Jones, *Fur farming in Canada,* p. 95, 1913.

ground. Its food consists chiefly of browse, such as leaves and twigs of willows, small birch trees and shrubs, but it will eat grass, hay, etc., and in summer it is very fond of water lilies and other aquatic plants, which it obtains by wading into the water.[65]

Far back in history the reindeer is mentioned as a domesticated animal in Norway, Sweden, Finland, Russia and Siberia. Its flesh has furnished food, its skin has furnished raiment and has been used for various other purposes, its milk has been long used directly and in the making of cheese by Laps and Finns, its antlers and sinews are excellent material for various purposes, and it has been extensively used in harness. All this, coupled with its ability to resist severe winter weather and to subsist on the browse, "reindeer moss" and other food obtainable when the ground is covered with snow, makes it an almost indispensable animal in some localities.[66]

The rapid destruction of the walrus having deprived the natives of northern Alaska of an important source of food and much needed skins, reindeer were introduced for their benefit in several shipments from 1892 to 1902.[67] They thrived and multiplied. Although 100,000 had been killed in the meantime, for food and clothing, in 1902 there were about 200,000 live ones in the various herds, divided as follows: Belonging to the natives 162,000; government herds, 12,000; mission herds, 24,000; others 52,000.[68] Reindeer meat is shipped to various cities of the United States, but is said not to be meeting with much favor. Recipes for preparing and cooking the meat have been published by the government.[69] It is stated that Alaska would support 3,000,000 or 4,000,000 reindeer,[70] but that would be useless unless a good market can be found for the meat. Reindeer meat is sometimes served on passenger steamers plying Alaskan waters. Reindeer have also been introduced into Labrador for the benefit of the natives.[71]

[65] Stone and Cram, *American animals,* pp. 42-45, 1902. Lockhart, Notes on the habits of the moose in the far north of British America in 1865, *Proc. U. S. Natl. Museum,* XIII, 305-308, 1890.

[66] Mason, Primitive travel and transportation, *Ann. Rept. U. S. Natl. Museum for 1894,* p. 548. Hatt, Notes on reindeer nomadism, *Memoirs Amer. Anthrop. Assn.,* VI, 75-133, 1919.

[67] Nelson, Reindeer in Alaska thrive and multiply, *Yearbook U. S. Dept. Agric. for 1926,* pp. 631-633.

[68] McAllister, California's large game animals, *California Fish and Game,* IX, 11-15, 1923.

[69] Stanley and Yeatman, Reindeer recipes, *U. S. Dept. Agric. Leaflet* No. 48, 1929.

[70] Hadwen and Palmer, Reindeer in Alaska, *U. S. Dept Agric. Bull.* No. 1089, p. 4, 1922.

[71] Jones, *Fur farming in Canada,* pp. 92-95, 1913. Hewitt, *The conservation of the wild life of Canada,* pp. 318-330, 1921.

The caribou of northern United States, British America and Alaska (*Rangifer*) is closely related to the reindeer, and has furnished food and raiment not only to the natives of the North, but to numerous white prospectors, trappers, explorers and settlers within the caribou country.[72] One herd was estimated at from 100,000 to 200,000 caribou, and during migration caribou are said to have passed Fort Rae for 14 days in an unbroken line, in such a mass that "daylight could not be seen" through the column.[73] Seton estimated one herd of barren-ground caribou at 25,000,000[74] The caribou has been practically exterminated in the Arctic coastal portion of Alaska, largely for the skins, and is now scarce on the Mackenzie delta.[75] As better transportation facilities render the movement of skins easier and less expensive, greater inroads will be made upon the herds of the interior unless ample protection is provided by the government. That is just what happened to the American bison.

The caribou eats more or less grass in the summer, but in winter its food is chiefly "reindeer moss," where it may be had, otherwise browse of willows and the like. In Labrador the abundance of caribou is somewhat regulated by the abundance of mice. When the mice are abundant they furnish plenty of easily obtained food for the wolves, which then leave the caribou alone, returning to a caribou diet when mice became too scare to satisfy them,[76] a striking example of the interactions of organisms.

### Family GIRAFFIDAE—Giraffes and Okapis

The giraffe, native of Africa, "has no economic value, nor is it very intelligent."[1] These great animals are picturesque in their native haunts, exceedingly interesting in parks and menageries, and their skins find a ready market. They have been slaughtered in large numbers, "almost solely for the hide, which is worth from £3 to £5 in the case of full-grown beasts; so perishes the giraffe from South Africa."[2] They are browsers, feeding on the buds, leaves and twigs of trees,

[72] Hadwen and Palmer, *U. S. Dept. Agric. Bull.* No. 1089, p. 3, 1922.

[73] Preble, A biological investigation of the Athabasca-Mackenzie region, *N. Amer. Fauna,* No. 27, p. 141, 1908.

[74] Seton, *The Arctic prairies,* p. 259, 1917 (cited by Adams); *Lives of game animals,* III, Part 1, pp. 97-135, 1929. Adams, The economic and social importance of animals in forestry, with special reference to wild life, *Roosevelt Wild Life Bull.,* III, 576, 1926.

[75] Hewitt, *The conservation of the wild life of Canada,* pp. 59-66, 1921.

[76] Allen, *Journ. Mammalogy,* III, 56-57, 1922, reviewing Cabot's *Labrador.*

[1] Jennison, *Natural history: animals,* p. 226, 1927.

[2] *Nature Lovers Library,* V, 239, 1917.

which they are able easily to obtain, as some of them reach a height of 18 feet. With some difficulty they eat grass and various herbs from the ground.

The okapis are forest mammals, and are much smaller and quite rare. "Okapi flesh is excellent venison."[3]

### Family ANTILOCAPRIDAE—American Pronghorn Antelope

The pronghorn of North America, commonly called antelope, is closely related to the Bovidae, but is considered a distinct family, represented by one living species and at least one subspecies. Unlike the Bovidae, the sheaths of its horns are deciduous and are shed annually, but it does not shed the whole horns, as deer do their solid antlers. Its range formerly extended from Kansas and Minnesota to the Cascade Mountains, and from British America to Mexico.[1] These very interesting and beautiful animals existed by millions, "far more abundant than buffalo" (Nelson), but have been totally destroyed over most of their former range by persistent hunting and by bringing prairie lands under cultivation. In 1925 it was estimated that there were only 30,326 of them left alive, in 286 discontinuous areas—26,604 in the United States, 1327 in Canada and 2385 in Mexico.[2] A census of the antelope now living in the United States, compiled by the National Association of Audubon Societies, from letters received from the various game commissioners, is as follows:[3]

| | | | |
|---|---|---|---|
| Arizona | 4,200 | North Dakota | 200-300 |
| California | 800 | Oklahoma | Several |
| Colorado | 2,000 | Oregon | 25,000 |
| Idaho | 3,000 | South Dakota | 1,900 |
| Kansas | None | Texas | 2,000 |
| Montana | 5,000 | Utah | 200 |
| Nebraska | 100 | Washington | None |
| Nevada | 4,500 | Wyoming | 20,000 |
| New Mexico | 4,000 | | |

They were abundant in Idaho in 1872, but an epidemic in 1873 destroyed many of them, and they have never since been abundant there.[4] It was estimated that there were 25,000 still alive in Colorado

[3] Jennison, *Natural history: animals,* p. 278, 1927.
[1] Lantz, Raising deer and other large game animals in the United States, *U. S. Biol. Surv. Bull.* No. 36, p. 11, 1910.
[2] Nelson, Status of the pronghorned antelope in 1922-24, *U. S. Dept. Agric. Bull.* No. 1346, 1925. The vanishing race of pronghorns, *Travel,* XL, 5-10, 1923. *Nature Magazine,* II, 121-123, 1923. Bailey, *N. Amer. Fauna,* No. 49, p. 27, 1926.
[3] "An antelope census," *Bird-Lore,* XXXII, 172-174, 1930.
[4] Merriam, *N. Amer. Fauna,* No. 5, p. 80, 1891.

in 1898, and only 1200 in 1909,[5] since which time they have been still further reduced. In 1906 it was stated in the report of the state game warden of Wyoming that the Green River herd had diminished from 6000 to less than 2000 in three years.[6] In a letter of September, 1928, the Wyoming State Game Commissioner estimated the number of antelope in the game preserves of that state at 17,600. About 1884 "thousands of them were killed annually around the San Francisco and Bill Williams Mountains," but by 1888 they "had become comparatively uncommon except in the restricted areas still unoccupied by the whites."[7] This is a fair statement of what was occurring about that time in many other localities in the West. In Yellowstone Park they were killed "by the thousands" each year from 1872 to 1883. Better protection was provided in 1886, but even with that they decreased from thousands in 1877 to only 253 in 1923.[8]

It was estimated in 1925 that there were 7568 pronghorns in the United States national forests, and in 1927 the estimate was 6942.[9] They were entirely or practically removed from the game lists of all the states by 1909, in the effort to save the remnants of the once great herds.[10] Special state and other refuges for pronghorns have been established in several states.[11]

The pronghorns are grazers, their chief natural food being largely sagebrush, greasewood and cactus,[12] with the hard prairie grasses of the western plains and lower mountains, which cure well on the stem. They do not thrive so well on rich, green grasses of moist regions. Away from the open ranges they are hard to keep in zoological parks. The only hope for their preservation is in the establishment of refuges where they may be protected, with access to their natural food, and in the fact that no hunting is allowed in national parks, where some still remain.

[5] Cary, *N. Amer. Fauna*, No. 33, 1911.
[6] Lantz, *U. S. Biol. Surv. Bull.* No. 36, p. 11, 1910.
[7] Mearns, Mammals of the Mexican boundary, *U. S. Natl. Museum Bull.* No. 56, p. 226, 1907.
[8] Skinner, The pronghorn, *Journ. Mammalogy*, III, 82-105, 1922; *The American antelope in Yellowstone National Park*, 1924, revised and extended from preceding paper.
[9] Adams, *Roosevelt Wild Life Bull.*, III, 558, 1926. *New York World Almanac for 1928*, p. 364.
[10] Palmer, Chronology and index of the more important events in American game protection, 1776-1911, *U. S. Biol. Surv. Bull.* No. 41, 1912.
[11] Nelson, *U. S. Dept. Agric. Bull.* No. 1346, 1925. Pearson, *Bird-Lore*, XXX, 157-158, 1928. *Bull. Amer. Game Protective Assn.*, Apr.-May, 1928, p. 44.
[12] Seton, *Lives of Game animals*, III, Part 2, p. 446, 1929.

## Family BOVIDAE—Cattle, Buffaloes, Sheep, Goats and Their Allies

This family includes more domesticated mammals than does any other and they are immensely valuable to the human race. As with other domesticated animals, the domestication of cattle and sheep antedates written history.[1] They were not introduced into America until the coming of the white race. Hump-backed cattle were domesticated in Egypt as early as 2100 B.C.[2]

The following incomplete statistics will give some sort of an idea of the importance of domesticated Bovidae. Other statistics may be found in Chapters V and VI.

Domestic stock in the United States in 1925:[3]

| | | | |
|---|---|---|---|
| Cattle | 61,572,000, | worth | $3,651,970,000 |
| Sheep | 35,251,000, | worth | 395,401,000 |
| Goats | 3,459,000, | worth | 17,565,000 |
| | 100,282,000 | | $4,064,936,000 |

Value of exports from and imports to the United States in 1925 was: exports: cattle, $2,388,000; sheep, $270,000; total $2,658,000; imports: cattle, $5,173,000; sheep, $498,000; total, $5,671,000.

In 1927 there were 57,521,000 cattle, worth $2,430,593,000, and 41,909,000 sheep and lambs, worth $406,531,000, in the United States; 402,564,000 cattle (21,824,000 dairy cows) and 240,003,000 sheep and lambs in other countries.[4]

Meat produced in the United States under federal inspection in 1925:[5]

| | | |
|---|---|---|
| Beef | 7,146,000,000 pounds, | per capita 62.1 pounds |
| Veal | 1,101,000,000 pounds, | per capita 8.7 pounds |
| Lamb and mutton | 599,000,000 pounds, | per capita 5.2 pounds |

The value of mutton and lamb exported was: $313,000; imported, $610,000; value of beef and veal exported: $2,765,000; imported $1,765,000.

In 1926 milk, butter and cheese to the value of $2,952,012,000 were produced in the United States.[6] Statistics concerning wool and other commodities derived from domesticated Bovidae may be found on sub-

[1] Keller, The derivation of the European domestic animals, *Ann. Rept. Smithsonian Inst. for 1912,* pp. 483-491. Morse, The ancestry of domesticated cattle, *27th Ann. Rept. U. S. Bureau of Animal Industry* (for 1910), pp. 187-239, with bibliography. Austin, *Natl. Geog. Mag.,* XVIII, 694, 698, 699, 1917.
[2] Hewitt, *The conservation of the wild life of Canada,* p. 310, 1921.
[3] *Statistical abstract of U. S. for 1925,* U. S. Bureau of Commerce.
[4] *New York World Almanac for 1928,* pp. 371, 376, 435.
[5] *U. S. Dept. Agric. Statistical Bull.,* No. 20, 1927.
[6] *New York World Almanac for 1928,* p. 370.

sequent pages. In 1915 the following skins were produced in the United States:

| | | | |
|---|---|---|---|
| Calf skins | 5,424,000 | Sheep skins | 15,865,000 |
| Cattle skins | 12,645,000 | Goat skins | 432,000 |

Cattle hides produced in the United States in 1918, 68,830,000; for the whole world, probably 350,000,000.[7]

Imports and exports of cattle and calf skins in 1925:[8]

| | |
|---|---|
| Imports to United States | 190,950,000 pounds |
| Imports to other countries | 1,507,592,000 pounds |
| Exports from United States | 62,857,000 pounds |
| Exports from other countries | 1,252,907,000 pounds |

Prices in Chicago from 10 cents a pound for bull hides to 22 cents for calf skins

Imports and exports of hides to and from Germany in 1909-1910:[9]

| | *Imports* | *Exports* |
|---|---|---|
| Cattle hides | $46,356,212 | $15,770,000 |
| Buffalo hides | 479,808 | |
| Calf skins | 31,533,624 | 4,497,000 |
| Lamb skins | 3,296,062 | |
| Sheep skins | 3,024,752 | 916,062 |
| Goat and kid skins | 6,902,952 | 1,355,648 |

"The world's cattle stocks are estimated in round numbers at 500,000,000 head, but this total includes Asian and African figures, upon which no great reliance can be placed."[10] In 1926 there were 61,128,000 cattle in the United States, worth over $3,000,000,000, of which 22,290,000 were milk cows, worth $1,278,877,000.[11] In addition to the meat, milk, butter, cheese and hides, other products derived from domestic cattle include tallow, horns and bones, the latter used in the manufacture of fertilizer, etc., the total value of these products being considerable.

Oxen have been used in many parts of the world for drawing loads, plowing and other heavy work. Sometimes they have been used even as driving animals harnessed to carriages. In the early settlement of our western plains ox teams transported the belongings of the settlers to and beyond the frontiers. They were often shod with iron shoes, divided into two parts to fit the divided hoofs of the oxen. Ancient Hebrew law and the writings of Hindus, Greeks, Egyptians and

[7] Holmes, Hides and skins: Production, foreign trade, supply and consumption, *Yearbook U. S. Dept. Agric. for 1917*, pp. 425-446.

[8] *U. S. Dept. Agric. Statistical Bull.* No. 20, pp. 298-312, 1927.

[9] U. S. Dept. Commerce and Labor, Bureau of Manufactures, *Special Agent Series*, No. 50, 1912.

[10] Sanders, The taurine world, etc., *Natl. Geog. Mag.*, XLVIII, 597, 1925.

[11] *Statistical Bull.*, No. 20, pp. 9, 11, 72, 1927.

Romans, insisted upon humane treatment of cattle, particularly of oxen.[12]

The former abundance and subsequent almost complete extermination of the American bison, or American buffalo, as a wild animal, has been discussed at some length in a former chapter. It has been estimated that before railroads on the western plains provided cheap and easy transportation for the heavy bison skins, 1860-1870, there were from 5,000,000 to 60,000,000 bisons on the western plains.[13] Probably the former estimate is too small and the latter too large. An estimate placing the total at from 30,000,000 to 60,000,000 was based partly upon the great quantity of bones shipped to market, but all of the bisons whose bones were shipped did not live at the same time. In Kansas, Nebraska and Missouri, according to estimates, $2,500,000 were paid for bones at $8 a ton, each ton estimated to represent 100 bison. Hewitt has published an interesting photograph of an immense pile of bones and skulls representing over 25,000 bisons, awaiting shipment from Canada to the United States, to be used in the manufacture of charcoal.[14] He quotes Catlin to the effect that in about 1832 150,000 to 200,000 bison robes were marketed annually, before the great slaughter began.

In the single year of 1848, 25,000 bison tongues and large quantities of bison fat were sent down the river to St. Louis.[15] In 1840, west of Fargo, North Dakota, 1375 bison tongues were obtained on the first day of the hunt and 2000 bisons estimated to have been killed by the 400 mounted hunters. In 1882, 600 Indian hunters killed 5000 in two days. In 1881, 75,000 skins were shipped from Bismarck, but they were mostly obtained in Montana.[16] The Atchison, Topeka and

[12] Sanders, The taurine world: Cattle and their place in the human scheme—wild types and modern breeds in many lands, *Natl. Geog. Mag.*, XLVIII, 591-710, 1925, especially pp. 610-614.

[13] *Natl. Geog. Mag.*, XXX, 389, 1916. Stone and Cram, *American animals*, p. 68, 1902. Dall's *Life of Baird*, p. 333. McAllister, California's large game animals, *California Fish and Game*, IX, 11-15, 1923; Canada leads in buffalo conservation, *California Fish and Game*, XIV, 155-156, 1928. Palmer, Chronology and index of the more important events in American game protection, 1776-1911, *U. S. Biol. Surv. Bull.* No. 41, 1912. Hornaday, The extermination of the American bison, with a sketch of its discovery and life history, *Ann. Rept. U. S. Natl. Museum for 1887*, pp. 367-548. Allen, History of the American bison, Bison americanus, *9th Ann. Rept. Hayden's U. S. Geol. and Geog. Surv. Terr.* (for 1875), pp. 443-587; reprinted with amended title from *Mem. Geol. Surv. Kentucky*, I, Part 2, 1876, and *Mem. Museum Comp. Zool.* (Harvard), IV, No. 10, 1876. Seton, *Lives of game animals*, III, Part 2, p. 656, 1929.

[14] Hewitt, *The conservation of the wild life of Canada*, pp. 113-142, 1921.

[15] Chittenden, *History of the American fur trade*, II, 817, 1902.

[16] Bailey, A biological survey of North Dakota, *N. Amer. Fauna*, No. 49, pp. 22-25, 1926.

Santa Fe Railroad in 1872-1874 shipped 1,378,359 bison hides, and it was estimated that in 1872 one hide represented 3 animals killed, or 2 in 1873, and 100 hides represented 125 killed in 1874, hence altogether 3,158,730 dead animals were represented by the three years' shipments; 2,250,400 pounds of bison meat and 10,793,350 pounds of bones were also shipped.[17] These figures represent only part of the animals destroyed in one area in three years.

When the American Bison Society was organized, December 8, 1905, it was said that there were only 1100 pure-bred bisons in America, but there were 3453 in 1913 and 10,000 in 1922.[18] In 1924 it was reported that the Canadian herd had increased from 709 to 8000, making it necessary to dispose of some each year to avoid overstocking the limited range, and that there were 4500 in the United States, shipments having been made from the Montana National Bison Range to prevent overstocking.[19] The bison is a grazer, best suited to the western plains, but occurred also in the mountains and at an early date extended into the eastern states. Efforts to domesticate it have met with marked success, considering the short time since the experiment was begun. It has also been sucessfully crossed with domestic cattle, producing a breed known as cattalo. The bisons' great strength would have made them valuable draft animals, had they been domesticated and trained to work in harness a few decades ago, when draft animals were more needed than they are in this motor-truck age.

The European bison, or wisent, once widely distributed in Europe and abundant in some localities, is now extinct except possibly for a few small herds in isolated mountain regions, and somewhat more than sixty pure-bred animals in European game parks and zoological gardens.[20]

The African buffalo was formerly abundant in many localities. About 1890 a virulent form of rinderpest exterminated them in large areas. After the epidemic they increased rapidly where breeding stock was left.[21] The buffalo is listed by Roosevelt as one of the five dangerous

[17] Nelson, The economic importance of wild life, *Scientific Monthly,* XVI, 367-373, 1923.

[18] *Science,* XXXIX, 586, 1914; LV, 639, 1922. Hewitt, The coming back of the bison, *Natural History,* XIX, 553-565, 1919.

[19] *California Fish and Game,* X, 45, 1924.

[20] Lucas, Animals recently extinct or threatened with extermination, *Ann. Rept. U. S. Natl. Museum for 1889,* p. 621. Ahrens, The present status of the European bison or wisent, *Journ. Mammalogy,* II, 58-62, 1921; Proposals for the preservation of the European bison, or wisent, *Bull. Zool. Soc.,* XXVI, 46-50, 1923; *Science,* LVIII, 107, 1923. Mohr, Misleading news regarding the wisent, *Journ. Mammalogy,* X, 356, 1929.

[21] Roosevelt, *African game trails,* pp. 58, 288, 1910.

African mammals, the others being the elephant, lion, leopard and rhinoceros; but Hubbard says the buffalo is not dangerous when not molested.[22]

The carabao, better known as the water buffalo, native in India, introduced into Egypt, Palestine, Italy, Spain, Hungary, Turkey, China, Japan, Hawaiian and Philippine Islands and the Malay Archipelago, is one of the most useful animals in some oriental regions. It gives rich milk, and is the "strongest beast of draft in the world except the elephant,"[23] especially useful in the muddy rice fields, because of its spreading feet, an adaptation to swamp life. It has been estimated that there are 20,000,000 of them in India, 1,222,000 in the Philippines and 415,000 in Bulgaria.[24] They are used not only as draft animals, but also as beasts of burden, each capable of carrying on its back a load weighing from 1800 to 2500 pounds.[25] Probably most of the 479,808 buffalo skins mentioned on a preceding page as having been imported into Germany in 1909-1910 were water buffalo. There is always a market for buffalo skins of any kind, and the flesh of the younger animals is excellent. The water buffalo is, next to the tiger, the most dangerous mammal in India, and it is able to successfully cope with the tiger. Many are still found in a wild state, and even in captivity they sometimes attack men. In 1910, sixteen human beings were killed by buffaloes in British India.[26]

The wild yak still exists on the high, bleak plateau of Tibet. "The breed provides the domesticated animals of Tibet, without which life would be impossible. Sure-footed as goats, they traverse the roughest passes, they cross snow-covered glaciers with a glissade."[27] They furnish the people of that desolate region with meat and milk, are used as both draft and saddle animals, and their tails are prized by the Chinese as tassels. They have been successfully crossed with domestic cattle.

The wildebeest, an African game animal, runs wild in herds, and is valuable for its flesh. Stomachs examined by Roosevelt contained only grass, no browse.[28] Africa possesses a considerable number of species of game animals, representing several distinct subfamilies, usually re-

[22] Hubbard, *Journ. Mammalogy,* x, 295-296, 1929.
[23] The wanderings of the water buffalo, *Ann. Rept. Smithsonian Inst. for 1901,* pp. 679-682; reprinted from *London Spectator,* Aug. 31, 1901, pp. 278-279.
[24] Holmes, Hides and skins, *Yearbook U. S. Dept. Agric. for 1917,* pp. 425-446.
[25] Austin, *Natl. Geog. Mag.,* XVIII, 688, 1907.
[26] *Science,* XXXVII, 938, 1913.
[27] Jennison, *Natural history: animals,* p. 232, 1927.
[28] Roosevelt, *African game trails,* p. 47, 1910.

ferred to in a general way as antelopes, which "is a very loose term, meaning simply any hollow-horned ruminant that is not an ox, a sheep or a goat."[29] Among them are the hartebeest, klipspringer, water buck, oryx, eland, gazelle and others. They are grazing animals, but occasionally browse, as most ruminants do. Their flesh is excellent and has been much depended upon by African explorers as a source of food. They have been so persistently hunted that the once great herds are in many places greatly depleted, some of them are becoming very scarce and the range of many has become much restricted. "White hunters and modern firearms have reduced the countless thousands to a number so small that the capture and exportation of elands [for exhibition purposes] has practically ceased. Their complete extermination is merely a matter of time because they are slaughtered for their valuable hides."[30] Various species are also found in Asia. There are at least 100 species altogether, some of which might be adapted to our arid Southwest, but their introduction, as advocated by some sportsmen, would be a risky experiment, which should not be attempted. Some of them are quite large, the eland weighing from 800 to 1100 pounds, some old males even 1400 or 1500 pounds.[31] Some of them have remarkable, very ornamental horns, and their skins are used for various purposes. About 200,000 gazelle skins were marketed from Africa in 1923-1924,[32] probably including other antelopes, as the term gazelle is used very loosely by fur dealers.

Domesticated sheep furnish not only a large amount of meat, but the almost indispensable wool. "Sheep husbandry is one of the most important, as well as one of the oldest, of the world's agricultural industries." The per capita consumption of lamb and mutton in several countries, and the ratio it bears to the total meat consumption in those countries have been stated as follows:[33]

| | | |
|---|---|---|
| United States | 6.2 pounds, | 4.35 per cent |
| Canada | 9 pounds, | 5.57 per cent |
| United Kingdom | 26.7 pounds, | 22.25 per cent |
| France | 9.25 pounds, | 11.25 per cent |
| Germany | 2.2 pounds, | 1.91 per cent |

The most valuable contribution of sheep to mankind is wool. We get from an individual sheep but one crop of meat, obtained only by de-

[29] Roosevelt, *African game trails,* pp. 47, 275, 1910.
[30] Blair, *In the zoo,* p. 69, 1929.
[31] Lantz, Raising deer and other large game animals in the United States, *U. S. Biol. Surv. Bull.* No. 36, 1910.
[32] Innis, *The fur trade of Canada,* table opp. p. 76, 1927.
[33] Spencer and others, The sheep industry, *Yearbook U. S. Dept. Agric. for 1923,* pp. 229-310.

stroying the life of the animal, while from one individual we get several crops of wool. The world's production of wool in 1925 was estimated at 2,892,416,000 pounds (United States, 301,060,000; Australia, 735,000,000; Argentina, 275,000,000).[34] The production in the United States increased from 19,000,000 pounds in 1840 to 61,000,000 in 1900. The world production decreased from 2,807,000,000 pounds in 1901 to 2,717,000,000 in 1916. In the United States the average annual production from 1905 to 1914 was 306,000,000. Some other figures for various countries follow:[35]

| | | | |
|---|---|---|---|
| Algeria, in 1912 | 8,000,000 | Argentina, 1914 | 43,000,000 |
| Australia, 1891 | 106,000,000 | Brazil, 1914 | 10,000,000 |
| Brit. So. Africa, 1913 | 36,000,000 | Mexico, 1902 | 3,000,000 |
| Canada, 1917 | 2,000,000 | New Zealand, 1917 | 25,000,000 |
| Uruguay, 1908 | 26,000,000 | Russia, 1914 | 80,000,000 |

There were 64,000,000 sheep in the United States in 1903 and only 28,000,000 in 1922, a decrease of 43 per cent in 19 years, with steadily increasing population, so that we now produce only one-half the wool necessary to supply our own demand.[36] Among the reasons given for the decrease are that the eastern farm sheep cannot compete with western open-range sheep; that values have been too low, and parasites and diseases too prevalent, for profitable sheep-raising; and that depredations of sheep-killing dogs, coyotes and other predacious animals cause too great losses. Dog-and-wolf-proof fences may be constructed of 60-inch woven wire, set 3 inches above the ground, with a barbed wire close to the ground, and another offset a few inches on the outside, above the top, to prevent the animals from climbing over; or of 32-inch wire with several barbed wires above, set 5 inches apart up to 60 inches, the uppermost offset.[37] The dog and coyote hazards in sheep-raising, methods of their control, and laws concerning sheep-killing dogs, have been discoursed upon in Chapters VII, XXVI and XXVII.

Sheep feed upon many kinds of herbaceous plants, besides grass. They also browse upon leaves and twigs of shrubs, but not to the same extent as goats do. In many places in the semi-arid portions of the western United States, overgrazing has seriously injured sheep ranges. There were in the world in 1927 about 240,003,000 sheep, and in the United States about 41,909,000,[38] an increase over the estimate for 1925.

[34] *New York World Almanac for 1925,* p. 376.
[35] Holmes, Wool: Production, foreign trade, supply and consumption, *Yearbook U. S. Dept. Agric. for 1917,* pp. 401-424.
[36] Coll, Sheep-killing dogs, *Farmers' Bull.,* No. 1268, p. 2, 1922.
[37] Lantz, Coyotes in their economic relations, *U. S. Biol. Surv. Bull.* No. 20, 1905.
[38] *New York World Almanac for 1928,* p. 371.

The karakul sheep (broad-tail or Persian lamb), the source of an important fur, were originally from Turkestan, not Persia. According to estimates made in 1921, 1,500,000 of their pelts, from Bokhara and Turkestan, worth $14,000,000, were being imported annually into the United States. The price of pelts advanced 180 per cent from 1895 to 1913, brought $12 or more during the World War, and after the war again advanced 140 per cent.[39] In 15 years 2,900,000 pelts were imported into Leipsig alone.[40] The best skins are not obtained, as is popularly believed, from unborn lambs, by killing the ewes, but from lambs from three to five days after birth, because later they lose their curl and luster.[41] Karakul sheep have been introduced into the United States and the flocks have increased rapidly.[42]

"Sheraz is half-Persian lamb. It comes from the south of Persia and resembles wool more than fur. Next, astrakhan is not dog skin. It is a lamb skin from the south of Russia. Gray Persian lamb is really krimmer, lamb from the Crimean region of Russia. The lamb that makes Persian fur, grown to a sheep makes the Bokhara rug."[43]

In many regions domesticated goats are prized for their flesh and skins, and especially for their milk. They are distinctly browsers, more so than are sheep. The number of goats in the United States in 1925 was estimated at 3,459,000.[44] Whether this includes Angora goats is not stated.

Angora goats, from which mohair is obtained, are in great favor and increasing in number. The use of mohair, according to the interpretation of *Exodus*, Chapter 35, by the Goat and Mohair Committee, dates back at least to the time of Moses. It was known in western Europe prior to 1554 A.D., and the goats were introduced into Africa in 1838. In 1927 there were 1,499,000 Angora goats in the Union of South Africa, 3,160,000 in Turkey, and in the United States there were 3,159,000 in Arizona, California, Missouri, New Mexico, Oregon and Texas. The production of mohair in the United States in 1927 was 13,470,000 pounds, in South Africa 10,681,000 and in Turkey (1926) 6,500,000.[45] Mohair is 9 inches or more in length, alpaca 12,

[39] Laut, *The fur trade of America*, pp. 59, 66-77, 1921.
[40] Jones, *Fur farming in Canada*, p. 106, 1913.
[41] Ashbrook, *Fur farming for profit*, pp. 239-262, 1928.
[42] Marshall, Heller and McWhorter, Karakul sheep, *Yearbook U. S. Dept. Agric. for 1915*, pp. 249-262.
[43] Laut, *The fur trade of America*, pp. 66-67, 1921.
[44] *Statistical abstract of the United States for 1925*, U. S. Bureau of Commerce, 1926.
[45] The Angora goat and mohair industry, *U. S. Dept. Agric. and Dept. Commerce, Interdepartmental Committee, Miscell. Circular*, No. 50, 1929. Williams, The Angora goat, *Farmers' Bull.*, No. 1203, 1921.

camel hair 5, cashmere 3. Mohair is the strongest, with best luster, but not so fine.

The Angora goats are decidedly browsers, preferring twigs and leaves of shrubs to herbaceous plants, and prefer hills and rocky cliffs to meadows and swamps, hence are suitable for waste mountain lands not available for other domestic stock. They have been utilized in keeping farm and pasture lands free from brush, and in California in keeping the "fire breaks" clear of weeds and shrubbery, thus reducing the forest-fire hazard. They may be pastured with cattle and sheep without much competition for food.[46] There are said to be 250,000,000 acres of land in the United States not suitable for tillage and not suitable for pasturage for cattle, horses or sheep, but suitable for goats.[47]

The danger of introducing goats of any kind into any region and leaving them without control is illustrated by incidents discussed in Chapter IV. They have almost denuded certain islands of vegetation, and, nothing being left to hold the soil on steep slopes, it has been eroded away, leaving only barren rocks.

Goat skins are much used for various purposes. It is estimated that in 1923-1924 3,000,000 Chinese goat skins and 2,000,000 Chinese kid skins reached the markets of the world.[48]

The wild mountain sheep, or bighorns, and the mountain goats, of the mountains of western United States, northern Mexico, British America and Alaska, are not sufficiently abundant to be of much economic importance, but they are highly interesting from esthetic, recreational, educational and scientific points of view. In 1926 there were said to be 17,837 mountain goats (mostly in Alaska), and 12,052 mountain sheep in our national forests, but the count for 1927 was 18,418 goats and 13,285 sheep.[49]

Mexican bighorn (*Ovis mexicana*): 2 stomachs, "full of freshly eaten and half-chewed vegetation, and most of the plants composing the contents were easily recognized by the stems, leaves and fruits. The leaves, twigs and carpels of *Cercocarpus parvifolius* formed a large part of the contents, while the leaves, twigs and seed pods of *Philadelphus microphyllus* were present in less abundance," with a conspicuous amount of wild onion and about 2 per cent grass. Meat tender, juicy and delicious. The meat of an old ram was "tough and

[46] Thompson, The Angora goat, *Farmers' Bull.*, No. 137, 1901. Heller, The Angora goat, *Farmers' Bull.*, No. 573, 1914.
[47] Lantz, *Farmers' Bull.*, No. 330, p. 14, 1908.
[48] Innis, *The fur trade of Canada*, table opp. p. 76, 1927.
[49] Adams, *Roosevelt Wild Life Bull.*, III, 558, 1926. *New York World Almanac for 1928*, p. 364.

dry, but without any bad flavor," and over half of the contents of the stomach was green stems of *Ephedra trifurcata,* with stems, leaves and flowers of *Tecoma stans,* stems, leaves and berries of *Garrya wrighti, Pentstemon* and *Opuntia,* but not a trace of grass.[50] Mountain goat (*Oreamnos*): found feeding on huckleberry, Oregon grape, rattlesnake plantain, evergreen violet, alder buds, willow twigs, sedge, etc.[51]

The musk ox (*Ovibos*), of Arctic America, is one of the most interesting mammals in North America. It will be a disgrace to civilization if hunters succeed in exterminating it, which they seem likely to do. It possesses a fine undercoat of wool, which might prove of commercial value if it could economically be freed of its "rain coat" of long hair, and perhaps it could be bred in large numbers in the Arctic region, as indicated by Stefansson.[52] It has been hunted for its skin more industriously than is generally supposed. The natives have at times been encouraged by the fur traders to "bring in all the musk ox robes that it was possible to obtain," which has destroyed all of them over most of the former range and much reduced their numbers elsewhere. The Hudson Bay Company handled not over 200 skins annually from 1864 to 1878, 600 in 1881, 1400 in 1890, 2000 in 1892, after which the number steadily declined as the animals became scarcer.[53] It was estimated in 1925 that not more than 250 musk oxen then survived.[54] "Those who know the Arctic best are predicting the doom of the musk ox."[55] Out of this dark picture has now come a gleam of light. It is announced that the Thelon Game Sanctuary, a 15,000-mile preserve east of Great Slave Lake, Northwest Territory, "which contains the last known herd of musk ox on the Canadian mainland," about 250 animals, has been closed to both whites and Indians.[56]

[50] Bailey, *N. Amer. Fauna,* No. 25, pp. 70-75, 1905.

[51] Taylor and Shaw, *Mammals and Birds of Mount Ranier National Park,* p. 125, 1927.

[52] *Nature,* CXII, 804, 1923.

[53] Hewitt, *The conservation of the wild life of Canada,* pp. 90-101, 310-318, 1921.

[54] Massingham, *Discovery,* London, 1928, quoted in *Literary Digest,* August 25, 1928, p. 23.

[55] Anthony, *Field book of North American mammals,* p. 542, 1928.

[56] *California Fish and Game,* XVI, 179, 1930. *Conserving Canada's musk oxen, being an account of an investigation of Thelon Game Sanctuary, 1928-1929, with a brief history of the area and an outline of known facts regarding the musk ox,* Northwest Territory and Yukon Branches, Department of the Interior, Canada.

## Order PERISSODACTYLA—Odd-toed, Hoofed Mammals

This order includes the horses, donkeys, asses, zebras, rhinoceroses and tapirs, and perhaps the Hyraces.

### Family EQUIDAE—Horses and Their Allies

This is probably the most useful family of mammals except the Bovidae. The most outstanding member of the family is, of course, the horse. Domesticated in the Old World long before the era of written history,[1] it has been introduced into all of the continents and principal islands of the world. Although large, one-toed horses developed from small, three-toed ancestors in North America during the Cenozoic Era, they disappeared at the end of Pleistocene time. The horses we have here now were brought over by Europeans after the discovery of the New World by Columbus.

In 1907 it was estimated that there were 100,000,000 horses in the world, 80 per cent of them in the temperate zone, the majority in Europe and America; 1 horse to every 3½ people in the United States and Canada, 1 to every 7 people in South America, 1 to 12 in Mexico, 1 to 33 in Japan, 1 to 40 in Turkey, 1 to 50 in the Philippines, 1 to 150 in Africa, 1 to 200 in India and southern China.[2] In 1917 it was estimated that there were 21,563,000 horses in the United States, 35,000,000 in Russia, 3,000,000 in Canada and 8,000,000 in Argentina.[3] In 1925 the combined estimate for horses, mules and burros in the United States was 22,267,000 head, valued at $2,569,570,000; exports, $4,141,000; imports, $1,640,000.[4] In 1927, horses and colts in the United States numbered 15,279,000, worth $974,886,000; 5,734,000 mules, worth $426,175,000.[5] Perhaps the marked decrease in number is due to the fact that the automobile has supplanted the horse to a great extent.

Because of their great strength and speed, horses are the most useful of all draft and saddle animals. Their flesh is used as food by various nations, and their skins make excellent leather. The imports of horse hides to Germany in 1909-1910 were valued at $2,906,498, and exports at $1,904,238.[6]

[1] Heller, The derivation of the European domestic animals, *Ann. Rept. Smithsonian Inst. for 1912*, pp. 483-491.
[2] Austin, Queer methods of travel in curious corners of the world, *Natl. Geog. Mag.*, XVIII, 687-688, 1907.
[3] Holmes, Hides and skins, *Yearbook U. S. Dept. Agric. for 1917*, pp. 425-426.
[4] *Statistical abstract of U. S. for 1925*, U. S. Bur. Commerce.
[5] *New York World Almanac for 1928*, p. 371.
[6] *U. S. Dept. Commerce and Labor, Bureau of Manufactures, Special Agent Series*, No. 50, 1912.

Though the majority of horses in civilized lands are docile, they are easily frightened, and, when they were used on the roads and in the fields of the United States more than they are now, there were numerous runaways and other accidents, which resulted in many deaths and injuries of human beings. In addition, a few horses are really vicious and freely indulge in kicking and biting. Indeed, the horse was once characterized by a magazine writer as the most dangerous animal.[7] In proportion to the total mileage covered by each, there were probably more fatal accidents and serious injuries of people by horses 25 years ago than by automobiles today.

Except along waterways, where boats may be used, and in deserts, where camels are so useful, the horse has, until recently, been much the best means of long-distance travelling. It is perhaps not too much to say that but for the horse the development and spread of civilization might have proceeded along very different lines. Had horses been available to the American Indians centuries earlier, perhaps they would have reached a higher, or at least a different, state of development before the coming of Europeans. Certainly, when they obtained horses from the Spanish invaders, their methods of hunting and warfare were soon radically affected thereby on the western plains.

In some of the western states there are many bands of escaped horses running wild and breeding on the plains, to the detriment of the stock ranges, and laws have been enacted in some jurisdictions to encourage the shooting of such wild animals.[8] They not only consume much grass that is needed for domestic stock, but also "pick up" horses belonging to ranchers, which soon become as wild as the wild herds. In Arizona, 8000 wild horses were killed in 1928.[9] Though Europeans brought modern horses and mules to America, the debt has probably been cancelled, with interest. During the world war alone the United States shipped abroad, mostly to Europe, 950,000 horses and 345,000 mules.[10]

The importance of the horse is indicated by the fact that "more than 2000 books relating to this animal have been published in England and an equal number elsewhere," and there are in the Library of Congress at Washington "nearly 1000 volumes devoted exclusively to the horse," though the library had made no special effort to accumulate such books, owing to the fact that the Department of Agri-

[7] Bache, The terrible horse, *Saturday Evening Post,* Nov. 25, 1905, p. 11.
[8] Palmer, The danger of introducing noxious animals and birds, *Yearbook U. S. Dept. Agric. for 1898,* p. 88.
[9] *Science News Letter,* Nov. 9, 1929, p. 288.
[10] Carter, *Natl. Geog. Mag.,* XLIV, 456, 1923.

culture is specializing in that subject. The number of volumes containing references to the horse "are countless." Under domestication, many breeds of horses have been developed, in addition to the varieties of wild horses from which the domesticated animals have been derived.[11] The mule is hybrid.

Donkeys, smaller than our hybrid mules, largely supplant horses in some oriental and tropical countries. In the absence of better means of transportation, they are very useful animals, carrying from 100 to 200 pounds each and travelling from 10 to 20 miles per day. It is estimated that there are 10,000,000 of them in the tropics and orient.[12]

Wild asses of several species are found in small herds in various parts of Africa and Asia. "Hunting the wild ass has been a favorite pastime of the Persians for some thousands of years. The flesh in olden days was esteemed a regal dish. . . . Like the Persians the Arabs delight in asses' flesh."[13] "Somalis will not touch their flesh."[14] They are wary, not easily approached and swift on foot.

The zebras are found in Africa. They are often kept in captivity and ridden and driven, but have not been really domesticated.[15] They are especially valuable as riding and driving animals "in parts of equatorial Africa infested by the tsetse fly, to which they are immune,"[16] as these flies make it impracticable to use horses. "The older males are generally covered with scars, showing them to be very pugnacious."[17] When 70 wild zebras were coralled, "the stallions fought to the death with teeth and hoofs during the first night, and no less than twenty were killed outright or died of their wounds," according to Roosevelt, who shot zebras as "food for the porters, who like their rather rank flesh." "Recently in British East Africa the increase of the zebras, and the harm they did to the crops of the settlers, rendered it necessary to remove a large measure of the protection formerly accorded to them, and in some cases actually to encourage their slaughter." When stampeded by their chief foes, the lions, "their mad, heed-

[11] Carter, The story of the horse: The development of man's companion in war camp, on farm, in the marts of trade, and in the field of sport, *Natl. Geog. Mag.*, XLIV, 456-566, 1923. Lydekker, *The horse and its relatives,* New York, 1912. Rommel, The preservation of our native types of horses, *U. S. Bureau Animal Industry Circular* No. 137, 1908. Bell, Breeds of draft horses, *Farmers' Bull.*, No. 619, 1914. Reese, Breeds of light horses, *Farmers' Bull.*, No. 952, 1921.

[12] Austin, *Natl. Geog. Mag.*, XVIII, 688, 694, 1907.

[13] Jennison, *Natural history: animals,* pp. 217-218, 1927.

[14] Drake-Brockman, *The mammals of Somaliland,* p. 104, 1910.

[15] *Forest and Stream,* LVII, 24, 1901.

[16] Jennison, *Natural history: animals,* p. 219, 1927.

[17] Drake-Brockman, *The mammals of Somaliland,* p. 105, 1910.

less rush takes them through a wire fence as if it were made of twine and pasteboard."[18] "They break through our best wire fences, ruin our crops, despoil us of the fruits of long and toilsome efforts, and much expenditures. We simply cannot live in a country inhabited by herds of wild zebras."[19] Since the foregoing quotations were written, persistent hunting has greatly reduced the herds of zebras in many places. The related quagga, which once roamed the plains of South Africa in great herds, also captured and used as a draft animal a century ago, was hunted to its death, having become extinct about 1875.[20]

### Family RHINOCEROTIDAE—Rhinoceroses

The rhinoceroses are rapidly dwindling away. Of the Somali rhino (*Diceros bicornis*) it was said twenty years ago: "Unfortunately this strange beast is being driven before civilization, and a few years more will see its disappearance from all save the most remote regions."[1] The range of the square-lipped rhino (*Ceratotherium simum*) is limited and its habitat localized by environmental requirements, so that it "does not seem to be able to hold its own and is in need of organized protection;"[2] which has been provided by a 90,000 acre reserve, but it does not seem certain that this will save the species.[3]

Roosevelt listed the rhinoceros as one of the five most dangerous animals of Africa.[4] The district commissioner, "while at Neri, had been obliged to undertake a crusade against the rhinos, because, quite unprovoked, they had killed several natives." The rhinoceroses are not of much economic importance. "The Somalis value the hide for their shields, and whip handles are made of it."[5] "The rhino's horn is one of the insignia of royalty among the Kaffirs, and many wars have been waged for the possession of big specimens. The value of the horn is still the principal reason for the great destruction of the rhinoceros. They are sold chiefly to China to be used for some medicinal purpose. In other days, a cup of rhinoceros horn was highly valued, as it was supposed to turn poisoned liquids a milky color and so detect them."[6]

[18] Roosevelt, *African game trails,* pp. 13, 48, 50, 130, 227-228, 1910.
[19] Hornaday, *Our vanishing wild life,* p. 183, 1913, quoting the settlers' grievances.
[20] Jennison, *Natural history: animals,* p. 214, 1927; Hornaday, *Our vanishing wild life,* p. 35, 1910.
[1] Drake-Brockman, *The mammals of Somaliland,* p. 106, 1910.
[2] Lang, Recent and historical notes on the square-lipped rhinoceros (Ceratotherium simum), *Journ. Mammalogy,* IV, 155-163, 1923.
[3] Hornaday, Threatened quick extinction of the white rhinoceroses, *Bull. New York Zool. Soc.,* XXVII, 13, 1924. Lang, Threatened extinction of the white rhinoceros (Ceratotherium simum), *Journ. Mammalogy,* V, 173-179, 1924.
[4] Roosevelt, *African game trails,* pp. 243, 289, 1910.
[5] Drake-Brockman, *The mammals of Somaliland,* p. 106, 1910.
[6] Jennison, *Natural history: animals,* p. 207, 1927.

### Family TAPIRIDAE—Tapirs

Fossil tapirs of extinct species are found widely distributed over the earth, but living species are confined to Central and South America and the Malay Archipelago. They are "browsers, feeding on twigs, water plants, bulbs and a little grass."[7] *Tapirus terrestris* was found in Brazil feeding on the fruit of a tree.[8] The principal foes of the American species are jaguars, and of the Malayan species, tigers. "Tapirs are hunted by the natives for the sake of their thick hides, which are cut into thongs for reins and bridles. The flesh is also esteemed by some."[9] The hides are also made into leather.

### Group EDENTATA—Sloths, Armadillos, Anteaters, etc.

It has long been recognized by systematists that the old heterogeneous "order" Edentata includes animals which seem too distinct to be retained in one order. The present tendency is to divide the group into several orders. Sloths have several teeth and armadillos have numerous teeth. For them the name Edentata is misleading. The armadillos are placed by some recent authors in an order Xenarthra, and the African aard vark in an order Tubulidentata. The practice does not yet seem to be entirely uniform. The marsupalian anteaters of Australasia always have been considered distinct. There is much confusion concerning the habits of armadillos and anteaters, because of the loose use of the term "ants" in referring to termites, or white ants.

### Family BRADYPODIDAE—Sloths

The living sloths are confined to Central and South America. Unlike the fossil ground sloths, the living species hang from the branches of trees. They feed on leaves, shoots and fruits. They are of no economic importance. It is believed that the great extinct ground sloths, belonging to a different family, browsed from the ground.

### Family DASYPODIDAE—Armadillos

The armadillo, found from Texas southward, "is a voracious consumer of insects, especially white grubs and their adults, caterpillars and ants," and it deserves "thorough protection as a most useful aid to the farmer."[1] It has been accused of destroying the eggs of wild

[7] Jennison, *Natural history: animals,* p. 210, 1927.
[8] Miller, *Journ. Mammalogy,* XI, 21, 1930.
[9] *Nature Lovers' Library,* V, 158, 1917. Miller, *Journ. Mammalogy,* XI, 21, 1930.
[1] McAtee, The rôle of vertebrates in the control of insect pests, *Ann. Rept. Smithsonian Inst. for 1925,* p. 416. Seton, *Lives of game animals,* IV, Part 2, pp. 848-863, 1929; citing Nelson, *Wild animals of North America,* p. 585, 1918.

turkeys and other wild birds, but Graham says he never either saw one do so or found anyone who had.[2] Texas nine-banded armadillo (*Dasypus novemcinctus texanus*): "The excrement of the armadillos found scattered along the trails in the form of clay marbles and with the texture of baked mud gives some clue to the food habits of the animals. Careful examination shows only the remains of insects, mainly ants and a few small beetles, embedded in a heavy matrix of earthy matter." These animals are "much sought after for eating purposes . . . very tender, without any gamy taste."[3] This useful and interesting species is being rapidly exterminated for its skin, which is used in the manufacture of ornamental baskets.[4]

The food of the South American armadillo (*D. villosus*) is flesh, fruit, and vegetables, according to Jennison.[5] Ingersoll says the armadillos of the Amazon Valley live chiefly on ants and termites, while the smaller pampas species is fond of carrion and eats much plant food, but its chief diet is insects and worms.[6]

### Family MYRMECOPHAGIDAE—South American Anteaters

The great South American anteater (*Myrmecophaga jubata*) is four feet long, its head over a foot long, its mouth "a mere tube through which is projected the long and sticky tongue," which is especially adapted for catching ants. "The anteater, finding its whole nourishment in these little insects, is wonderfully adapted for the purpose. The head is thrust into the aperture and the viscid tongue, shot in and out with great rapidity, carries thousands of the creatures to the stomach. The anteaters are exceedingly valuable in a country where the ant in its billions is an absolute peril." Stomachs examined by Roosevelt "contained adult and larval ants, chiefly termites, with earth and leaves."[7] So large an animal must devour a great number of termites to satisfy its appetite. In Ecuador the giant anteater is used as food by the natives.[7-a]

The tamandua (*Tamandua tetradactyla*), of South America, is similar to the anteater in its habits. "Its food consists mainly of termites,

[2] Graham, The armadillo and the wild turkey, *The Oologist,* XLI, 90, 1924.
[3] Bailey, *North American Fauna,* No. 25, pp. 53, 56, 1905. Anthony, *Field book of North American mammals,* p. 552, 1928.
[4] McDaniels, Beautiful baskets from ugly hides, *Amer. Forests and Forest Life,* XXXV, 44-45, 1929. Criticized in *Journ. Mammalogy,* X, 89, 1929, as "nothing more than an advertisement for the destruction of an interesting and harmless animal."
[5] Jennison, *Natural history: animals,* p. 316, 1927.
[6] Ingersoll, *The life of animals,* pp. 476-477, 1907.
[7] Jennison, *Natural history: animals,* pp. 317-318, 1927.
[7-a] Tate, *Journ. Mammalogy,* XII, 249, 1931.

to obtain which it opens their nests with its powerful anterior claws, and as the insects swarm to the damaged part of their dwelling, it draws them into its mouth by means of its long, flexible, rapidly-moving tongue covered with glutinous saliva."[8] Hansel is quoted as saying that it does not feed on termites, but that in all specimens examined the stomachs were filled with true ants, even where termite mounds were common, while, on the other hand, Zeitz is said to have fed this species in captivity with termites, and "ants were obstinately refused."[9]

### Family MANIDAE—Pangolins or Scaly Anteaters

The scaly anteaters are found in India and Malayasia. Bequaert, in discussing the suoject in detail and at length, says it appears "that the pandolins, or scaly anteaters (*Manidae*) of the Old World tropics are the only edentates whose myrmecophagous propensities are beyond doubt." Stomachs examined contained several species of ants.[10]

### Family ORYCTEROPIDAE—Aard Vark, etc.

The antbear (*Orycteropus aethiopicus*), of Somaliland, "lives entirely on termites," according to Drake-Brockman.[11] The aard vark, or earth pig (*O. afer*) "is inoffensive and of inestimable value in keeping down the plague of ants and locusts. Like the anteater, it breaks the ant heaps and takes the insects on its long, conical, viscid tongue." Its burrow is "an ever-present danger to horsemen."[12] Bequaert says it appears from an examination of the contents of stomachs of *Orycteropus*, "that the regular food consists of termites, while true ants are only taken when they happen to occur in the termite mounds."[13]

## Order SIRENIA—Manatees, Sea-cows and Dugongs

These animals are of little or no economic importance. The Florida Manatee (*Trichecus latirostris*) lives on manatee grass and other aquatic vegetation found in shallow lagoons and estuaries.[1] It has be-

[8] Flower and Lydekker, *An introduction to the study of mammals, living and extinct,* p. 191, 1891; quoted by Bequaert. Bates, *The naturalist on the River Amazon,* II, 178-179, 1863.

[9] Bequaert, "The predacious enemies of ants," in Wheeler, Ants of the Belgian Congo, *Bull. Amer. Museum Nat. Hist.,* XLV, 317, 1922, citing Hansel, Zeitz, and Flower and Lydekker.

[10] Bequaert, *Bull. Amer. Mus. Nat. Hist.,* XLV, 318-328, 1922.

[11] Drake-Brockman, *The mammals of Somaliland,* pp. 175-176, 1910.

[12] Jennison, *Natural history: animals,* p. 321, 1927.

[13] Bequaert, *Bull. Amer. Museum Nat. Hist.,* XLV, 317, 1922.

[1] Hornaday, *American natural history,* II, 160, 1914. Anthony, *Field book of North American mammals,* p. 555, 1928. Stone and Cram, *American animals,* p. 27, 1902.

come scarce and much restricted in range. Sirenia skins have been used to some extent for leather, but the quantity marketed has never been large.[2]

The great northern or Steller's sea-cow (*Rytina gigas*), of the northwestern North American coast, is said to have subsisted on "sea-weeds." The history of its extermination by the greed of civilized man is scandalous. It was discovered in 1742, and the last one was killed in 1767 or 1768, the date given by Nordenskjold, 1854, being erroneous.[3]

## Order CETACEA—Whales, Porpoises and Dolphins

The interesting and romantic history of the whaling industry, its former importance, its influence upon political history, exploration and geographic science, its rise and fall, with statistics concerning the production of oil, whalebone, ambergris, and other whale products, the amount of capital invested and number of men employed in the business, and the decrease in the number of whales, because of persistent and uncontrolled hunting, are discussed at some length in Chapter VI, with numerous references to the literature of the subject.

Before petroleum and its products became available, followed by gas and electric lights, whale and sperm oil were almost indispensable, and sperm candles were a great improvement over tallow "dips" and the torches of savages. The business of procuring and marketing these commodities was considered "big business" before the vast expansion of various enterprises growing out of modern inventions and modern business methods. Whaling vessels pushed out into uncharted seas, discovered many theretofore unknown bays, inlets and islands, and carried our national flag for the first time to various foreign ports.

Ambergris, a pathologic product from whale's stomachs, is much more valuable in proportion to its weight than any other whale product. Indeed, it is said to be the most valuable product of marine life except pearls. However, in the aggregate, because of its quantity, baleen, or whalebone, is, next to oil, the most valuable product of the whaling industry. It consists of the elastic plates, 260 to 360 on each side of the upper jaw in certain species of whales, forming strainers by means of

[2] Stevenson, Utilization of the skins of aquatic animals, *Rept. U. S. Fish Comm. for 1902*, p. 338.

[3] Lucas, Animals recently extinct or threatened with extermination as represented in the collections of the U. S. National Museum, *Ann. Rept. U. S. Natl. Mus. for 1889*, p. 623. Stejneger, Investigations relating to the extermination of Steller's sea-cow, *Proc. U. S. Natl. Mus.*, VII, 181-189, 1884; How the great northern sea-cow (*Rytina*) became exterminated, *Amer. Naturalist*, XXI, 1047-1055, 1887.

which mollusks, crustaceans and other food are strained from the water. It was formerly used extensively in the manufacture of whips, corset stays, umbrella ribs, hoops, coverings for telescopes and other tubes, imitation hair cloth and various other articles,[1] for which cheaper and better substitutes are now known, though there is still a demand for the lessened supply.

The flesh of both whales and porpoises is used as food for human beings.[2] Porpoise meat was a favorite Lenten food during the Middle Ages.[3] The skins of both whales and porpoises are made into leather, even the intestines of the whales being used for that purpose.[4] After all these products have been saved, the remainder of the whales' carcasses is made into fertilizer, bone-meal and food for cattle.[5]

"The cetaceans are entirely carnivorous, and their food generally consists of small mollusks, shrimps and fishes."[6] The food of the sperm whale consists largely of squids and cuttlefishes.[7] Bristles identified as facial vibrissae of a seal were found in ambergris supposed to have been taken from a sperm whale.[8] One hump-backed whale contained from 1500 to 3000 pounds of sardines and a miscellaneous lot of smelt, anchovies, shrimps and squids; a sperm whale's stomach contained a 10-foot shark, a piece of fur seal skin and a bunch of fish-hooks, and one killer whale at Pribilof Islands contained 18 and another contained 24 young fur seals.[9] One gray whale's mouth contained shrimps; 10 humpbacks contained shrimps and 6 contained "sardines," probably including various small fishes; 16 finbacks contained shrimps and 5 contained "sardines," some containing about three barrels of small, mackerel-like fishes.[10]

Modern science has affected the whaling industry, as it has almost everything else, by providing more effective apparatus. Steamships

[1] Stevenson, Whalebone: Its production and utilization, *U. S. Bureau of Fisheries Document* No. 626, 1907.

[2] Radcliffe, Whales and porpoises as food, *U. S. Bureau of Fisheries, Economic Circular,* No. 38, 1918.

[3] Jennison, *Natural history: animals,* p. 151, 1927.

[4] Prince, *The whaling industry and the Cetacea of Canada,* Gov. Ptg. Office, Ottawa, Special Repts., 1926.

[5] Bower and Aller, *Rept. U. S. Fish Comm. for 1914,* Appendix x, pp. 58-64.

[6] Stone and Cram, *American animals,* pp. 11, 18, 1902.

[7] Stevenson, Aquatic products in arts and industries, *Rept. U. S. Fish Comm. for 1902,* p. 248.

[8] Murphy, Seals as sperm whale food, *Journ. Mammalogy,* v, 132, 1924.

[9] Evermann, The conservation and proper utilization of our natural resources, *Scientific Monthly,* xv, 309-310, 1922.

[10] Howell and Huey, Food of the gray and other whales, *Journ. Mammalogy,* xi, 321-322, 1930.

have replaced the slow sailing vessels. Airplanes, equipped with wireless apparatus, are used in hunting the whales and in reporting them to the ships. Electrical harpoons are used to make the killing of the whales more certain. A United Press dispatch of May 17, 1930, reported that the fleet of whaling vessels and floating refineries then returning from the South Seas were bringing "the largest cargoes of sperm oil and by-products ever loaded, one vessel containing 62,000 barrels and another 37,000 barrels. The necessity of conservation of whales is so keenly felt by students of the situation that, under the auspices of the American Society of Mammalogists, a Council for the Conservation of Whales has been organized. Never having been as abundant as most other mammals, and not breeding prolifically, having only one young at a time, whales are "in peculiar danger of extermination under modern destructive and systematic methods, if unrestricted."[11] A movement is now on foot to obtain through the League of Nations, international regulation of whaling in order to prevent the extinction of whales,[12] and Norway has taken an enlightened and advanced stand on the subject by the adoption of legislation for the regulation of whaling and the preservation of whales from extinction.[13]

Normally other whales constituted the chief food of the killer whales or orcas (*Orcinus orca*), but since the supply of the other whales has been so depleted, the killers have become the chief non-human enemies of seals.[14] "Each spring and fall these 'wolves of the sea' come about the Pribilof Islands in schools, and have been seen to devour seals in large numbers. I once saw a school capture three seal pups in less than five minutes. In their eagerness to capture their prey they sometimes 'run aground' and of course they then die. The stomachs of two which thus came ashore were once examined by Captain Bryant and in them he found 18 and 24 seals respectively—$2000 meals in each of them."[15]

The orca is also "a great enemy of the salmon, and it may be seen in numbers at the mouths of salmon rivers during the salmon season destroying what doubtless amounts to tons of this most valuable food fish. . . . Roy C. Andrews, in his first monograph of the Pacific Cetacea (*Memoirs of American Museum,* New series, Vol. I Part v) has

[11] Prince, *The whaling industry and the Cetacea of Canada,* 1906.
[12] *Natural History,* XXIX, 445, 1929.
[13] Norway to save whales, *Science News Letter,* Nov. 9, 1929, p. 288. *Natural History,* XXX, 667, 1930, quoting letter from A. Brazier Howell to the Council for the Conservation of Whales.
[14] Hanna, Rare mammals of the Pribilof Islands, Alaska, *Journ. Mammalogy,* IV, 209-220, 1923.
[15] Hanna, What becomes of the fur seals, *Science,* LV, 506, 1922.

shown that next to man the greatest enemy of the gray whale is the orca."[16] "They are the only whales which eat Mammalia, not only devouring the largest fish, but seals and all other dolphins, porpoises and large whales are the main objects of their gluttonous rapine. Though the old walrus is safe from them, the young are greedily eaten. . . . From the maw of one of these killers Eschricht states that 13 porpoises and 14 seals were extracted,"[17] (young seals, doubtless, as the orca itself was only 16 feet long). The statement that the killers are the only whales that eat mammals is subject to doubt, as there is evidence, noted in a preceding paragraph, indicating that seals are eaten by the sperm whale, whose "throat is capacious enough to swallow a man."[18]

Porpoises and dolphins are hunted chiefly for the skins and oil.[19] In 1887, 20,000 porpoise skins were obtained along the Atlantic Coast of the United States, which was the largest catch on that coast at least up to 1902, the green hides bringing $2 a side. However, the commercial "porpoise leather" then being sold in the English markets was the beluga,[20] or white whale. Porpoises and dolphins are said to feed chiefly on fishes, though Aflalo says that the Risso dolphin probably feeds on squids and cuttlefishes.[21]

## Order PRIMATES—Apes, Baboons, Monkeys, etc.

Considering the world as a whole, the mammals of this order, except mankind, are not generally distributed or of much importance. Nevertheless, locally some of the species are abundant and become a serious problem because of their destructiveness, while in other regions the flesh of some species is eaten and their skins are marketed, thus being a source of some commercial profit. They are also much used in zoological and amusement parks and circus menageries.

Gorillas are very powerful animals and are known to sometimes attack natives, both men and women. However, they are by no means as

[16] Starks, A history of California shore whaling, *California Fish and Game Comm., Fish Bull.*, No. 6, pp. 37-38, 1922.
[17] Rhoads, *Mammals of Pennsylvania and New Jersey*, p. 23, 1903.
[18] Jennison, *Natural history: animals*, p. 148.
[19] Cook, The manufacture of porpoise oil, *Proc. U. S. Natl. Museum*, I, 16-18, 1878. Clark, The blackfish and porpoise fisheries, *The Fisheries and Fishing Industries of the U. S.*, Sec. V, Vol. II, 295-310, 1887.
[20] Stevenson, Utilization of the skins of aquatic animals, *Rept. U. S. Fish Comm. for 1902*, pp. 339-340.
[21] Hornaday, *American natural history*, II, 154, 1914. Aflalo, *Standard Natural History*, II, 335, 1908; *Nature Lovers' Library*, V, 299, 1927.

ferocious as they are reputed to be, and the stories of their carrying off women and holding them captive are mythical.[1]

The grivet (*Ceropithecus aethiops*), of Africa, "does great damage to the small plantations of the Wagosha, Gurre and other tribes who inhabit the banks of the Somali rivers."[2] Baboons "ravage the crops and tear open new-born lambs to get at the milk inside them; and where the natives are timid and unable to harm them, they become wantonly savage and aggressive and attack and even kill women and children. In Uganda, Cunningham had once been asked by a native chief to come to his village and shoot the baboons, as they had just killed two women, badly bitten several children, and caused such a reign of terror that the village would be abandoned if they were not killed or intimidated. He himself saw the torn and mutilated bodies of the dead women."[3]

It is said that the dog-faced baboon (*Cyanocephalus hamadryas*) in Somaliland lives "entirely on wild fruits and roots."[4] Chimpanzees are said to be fond of ants and ant cocoons.[5] Lemurs usually feed chiefly on vegetation of various kinds and fruits, with some insects and other food. Many species of monkeys subsist largely on insects, but take also small reptiles, birds, eggs, fruits and other food, and are sometimes destructive to crops.[6] "The big black and white monkeys (*Colubus*) ate nothing but leaves."[7] The Somali lemur (*Galago gallarum*) feeds chiefly on seeds, fruit and insects.[8]

The flesh of monkeys is eaten in many regions, and in Brazil it is said to be more delicious than that of any other Brazilian native mammal and is much sought after by the natives.[9]

Some monkey skins make very fine robes and coats. At a single sale in London 30,000 monkey skins were sold.[10] In 1892, 180,000 skins of the Colobus monkeys were exported from the Gold Coast of Africa, and the slaughter was so great that five years later only 1067 were

[1] Aschemeier, On the gorilla and the chimpanzee, *Journ. Mammalogy*, II, 90-92, 1921. Akeley, Gorillas, real and mythical, *Natural History*, XXIII, 429-447, 1923.

[2] Drake-Brockman, *The mammals of Somaliland*, p. 3, 1910.

[3] Roosevelt, *African game trails*, pp. 218-219, 1910. Percival, Concerning baboons, *Journ. East Africa and Uganda Nat. Hist. Soc.*, No. 14, p. 415, 1919. Northcote, Baboons attacking children, *ibid.*, No. 16, pp. 60-61, 1921.

[4] Drake-Brockman, *The mammals of Somaliland*, p. 4, 1910.

[5] Bequaert, *Bull. Amer. Mus. Nat. Hist.*, XLV, 328-329, 1922.

[6] Jennison, *Natural history: animals*, pp. 1-49, 1927. Ingersoll, *The life of animals*, pp. 24-37, 1907.

[7] Roosevelt, *African game trails*, p. 363, 1910.

[8] Drake-Brockman, *The mammals of Somaliland*, p. 7, 1910.

[9] Holt, Monkeys as human food, *Journ. Mammalogy*, IV, 193-194, 1923.

[10] Lucas, *Ann. Rept. U. S. Natl. Museum for 1889*, p. 611.

obtained.[11] In 1923-1924 Asia produced 50,000 monkey skins and Africa produced 30,000.[12] Though the accounts of monkeys having been trained and utilized in picking coconuts, fruit and other products and in performing various other services for mankind, have been ridiculed, they seem to be founded on fact.[13]

[11] Lang, *Natural History,* XXIV, 316-317, 1924. Buxton, *Journ. Soc. Arts* (London), LI, 576.

[12] Innis, *The fur trade of Canada,* table opp. p. 76, 1927.

[13] LaRue, Monkeys as coconut pickers, *Science,* L, 187, 1919. Gudger, On monkeys trained to pick coconuts, *Science,* XLIX, 146-147, 1919; Monkeys trained as harvesters: Instances of a practice extending from remote times to the present, *Natural History,* XXIII, 273-279, 1923, citing various books by Shelford, Weber-Van Boss, Beccari, Bird, Fortune, Osbeck, Tyson, Dapper, Gassendi, Acosta and others.

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