

FOOD OF THE MUSKRAT IN SUMMER.

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Few attempts have been made to study the food supply of the muskrat under natural conditions in the northern states. Almost every paper on the animal lists some foods, but most dismiss this subject with the statement that they eat cat-tails and other marsh vegetation. By far the best list of foods published (Johnson, 1925) names several foods of animal origin and some twenty-six plants. In addition to this descriptions of what portion of the plants is consumed and, in some cases, how it is eaten, are given. Arthur, (1928, p. 338), lists the foods usually eaten in Louisiana, as does Svihla (1931).

The work upon which the following report is based was carried on from June 8 to September 14, 1930, while the writer was employed as temporary Mammalogist, Division of Conservation of Ohio. The work was part of a survey of the muskrat in the state, and was carried on under the direction of E. L. Wickliff, Chief, Bureau of Scientific Research. The indebtedness to Mr. Wickliff for the opportunity to do the work, and for his suggestions and co-operation is gratefully acknowledged by the writer. Professor L. H. Tiffany is responsible for many of the identifications. Without his help the list of food plants would be shorter and would lose much of its value. Any mistakes are the writer's, who willingly admits that his knowledge of botany leaves much to be desired.

The habitats of the muskrat in Ohio may be divided roughly into two types: marsh or swamp habitats and stream habitats. There is no accurate method available which would permit an estimate of the relative number of animals in each habitat, but it is the opinion of the writer that the numbers in Ohio are approximately equal. The concentration in marshes is more noticeable, but the larger area of stream banks, as compared with marshes equalizes the numbers.

In the marshes, which are located chiefly along the western shore of Lake Erie, but occur locally over much of the northern half of the state, the study of food plants is complicated by the

house building activities of the muskrat. It is often a problem to determine just what has been cut for food, and after eating, how much was used in the construction of houses, and what was gathered for such building. As the activity of house building is seasonal, the problem is somewhat simplified. Plants are listed as food only where the animals were observed feeding upon them, or where the plant has been cut and portions eaten before being utilized for raft or house building.

Where dikes, ditch sides, or roadways pass through a marsh the muskrats feed on some of the plants found in such places, in addition to the marsh plants which furnish the bulk of the food. The plants eaten here offer a transition from the marsh plants to those eaten by the stream or "bank rats."

As would be expected, the largest variety of foods is eaten by these "bank rats," for they range well back from their burrows in search of desirable foods. When food plants are found they may be cut and dragged entire to the water, they may be cut up into convenient size for transportation, or they may be consumed on the spot. Sometimes one finds all three conditions on the same plot. Since these animals live in burrows and do not usually use plants except for food and bedding material, the problem is simpler than in the marsh; but care must be exercised in determining just which plants were used for food. In most burrows the usual bedding was grass or sedge. In the houses cat-tail appeared to be used to the exclusion of other materials.

During the course of the survey attempts were made to visit certain places at frequent intervals to study the seasonal variation in foods. The habit of the muskrat is to take most of its food to some protected place for consumption. These feeding stations are usually located in a burrow mouth, under projecting roots, or under a snag or tree at the edge of the water. In seasons of low water these piles accumulate until they may amount to two or three bushels, for only a small portion of each plant may be eaten. High waters remove these piles, so it is relatively easy to determine the length of time that has elapsed since the pile was started. Thus a good idea of the seasonal variation may be formed from a study of these accumulations.

With the "marsh rats" the formation of rafts by the accumulation of debris from feeding offers some information as to seasonal habits; but since the raft is usually in still water, the accumulation is not so easily dated. The writer proposes to

destroy some rafts in an attempt to study seasonal feeding habits in such areas.

Little or no work on the winter foods has been done. It is to be hoped that this work will be carried on, for the critical period, so far as food supply is concerned, is in winter and early spring.

One interesting sidelight brought out is the fondness of the muskrat for certain plants not native to America, but invaders from Europe and Asia. The muskrat, except for a few that have been introduced into Europe, is confined to North America. A recent study in Saxony (Ulbrich, 1927) lists *Acorus*, *Elodea*, *Potamogeton*, *Alisma*, and species of *Gramineae*, *Cyperaceae*, *Juncaceae*, *Nymphaeaceae*. Representatives of these groups of plants are eaten in Ohio. At least one, *Elodea*, may have been an American species introduced into Europe. This brings to mind the fondness of a native American cat, the mountain lion, for catnip (*Nepeta Cataria*) which was introduced from Europe where the mountain lion does not occur. How long were the plant and mammal lines separated before they were reunited? The same question might be asked in connection with the muskrat.

The foods listed here are by no means exhaustive, and are offered only as a beginning.

ANNOTATED LIST OF FOOD PLANTS.

Common cat-tail (*Typha latifolia*).

Narrow-leaf cat-tail (*Typha angustifolia*).

The common cat-tail is the outstanding food of the marshes. It is not, however, the sole food anywhere, as the writer will show. Because of its conspicuousness in growing, the amount cut, and its use both as bedding and building material in houses, the common impression has grown up that it furnishes everything that the muskrat needs. It forms the back bone of the diet, but may be neglected for many other plants, such as the cow lily, Jerusalem artichoke, duckweed, and others.

In eating the cat-tail the rats reach up as far as possible, standing on the hind legs, cut the leaf, and then cut or tear it into pieces several inches in length. After a few nibbles the piece is discarded and another taken up. The food is not washed; the sound of the tearing is audible at a distance of twenty feet. In addition to the leaf the base is eaten as well as the tender shoots from the roots. The roots themselves are not often attacked during this season.

The narrow-leaf cat-tail is not nearly so abundant as the common cat-tail, but is treated in the same way. When drought comes the common cat-tail is better able to resist wilting.

Bur-reed (*Sparganium eurycarpum*).

The base of the stems of this plant are eaten extensively. The cutting is done at the base, after which a small portion is consumed. On several occasions the prickly seed heads had been gnawed, but had not been eaten.

Pondweed (*Potamogeton foliosus*).

A few stems of this plant showed signs of gnawing. While it is used as house building material, it is of great importance neither in this connection nor as food.

Broad-leaved Arrow-head (*Sagittaria latifolia*).

During the early summer the base of the stalk is eaten. Unlike the condition found in New York (Johnson, 1925, p. 249) this plant furnishes considerable food to the muskrats along Lake Erie and in the "bottoms" along Killbuck Creek, to mention but two outstanding habitats. Later on the fruiting heads also were eaten.

Grasses: (*Panicum species*), (*Calamagrostis canadensis*), (*Poa compressa*), (*Poa pratensis*), (*Hordeum jubatum*).

The grasses are treated together as it was impossible for the writer to distinguish between them in the field. The fragmentary condition of many specimens increased the difficulty, so only those species are listed that have been identified by Doctor Tiffany from specimens submitted to him. Undoubtedly many more species are eaten when other food is too tough or too difficult to secure.

Generally only the tender basal stem is eaten as in the sedges and many other plants, but occasional patches of grass are found which show the effects of cropping. Here the grass is kept short by the animals' eating off the top growth without, apparently, any of the material being carried away. Woodchucks, too, attack grass after this fashion. The only other plant so eaten is white clover (*Trifolium repens*) and sweet clover.

On the banks of one pond grass stems had been piled over the entrance to a burrow which had been uncovered by the lowering of the water. These stems formed a half-house, as it were, the bank forming the back half as though a muskrat house had been cut in two and one half placed against the bank. The pond was enclosed in a rat-proof fence and only grass and *Lemna* were available, which probably explains the use of grass stems in construction. The pile contained two bushels or more, all well packed. The restricted diet did not effect the animals adversely, for many were seen, all of which were in good condition.

Under certain conditions grasses may form an important item in the diet of muskrats, and they appear to thrive on it. Of the grasses cut *C. canadensis* is most frequently encountered.

Sedge (*Cyperus strigosus*), (*Scirpus fluviatilis*), (*Scirpus validus*), (*Scirpus species*), (*Carex lupulina*), (*Carex vulpinoidea*).

These families are grouped together, as they were not identified in the field and because they furnished the same type of food. Many

species not listed are consumed, too. As a rule only the tender basal portion of the stem is eaten, although a few fruiting heads were found which showed that the muskrats had sampled them.

Duckweed (*Lemna*).

Muskrats were observed feeding on what appeared to be duckweed. In each case the animal swam about slowly, eating the floating plants with evident relish. The sound was audible at a distance of fifty feet and was very noticeable when the animals were closer. *Lemna* was found also on the tops of houses and at feeding stations. It may have been carried there as building material rather than as food, as it showed the characteristic balled condition of material used in house construction. The abundance of duckweed in certain habitats, notably about the shores of still lakes and ponds, makes it an item of considerable importance, for in most cases where animals were observed eating it, it was chosen in preference to *Typha*.

(*Wolffia*).

What has been said of *Lemna* applies possibly to *Wolffia*. (Johnson, 1925, pp. 248.)

Willow (*Salix spp.*).

Both leaves and bark of the willow are eaten, young shoots, recently cut, being found from time to time. One captive muskrat always ate willow in preference to *Typha*. The abundance of young willows along streams running through pastures does much to encourage the establishment of burrows in this type of habitat.

Elm (*Ulmus sp.*).

The leaves and bark of young shoots of the elm are a favorite food of the muskrat whenever they are available. Sprouts are cut about twelve to sixteen inches above the ground and transported to the water where the leaves and some of the bark are eaten. Cutting apparently takes place as soon as the sprouts leaf out. Elm was eaten in one habitat which was unusually rich in the variety of foods available and where there was no need for eating anything unpalatable. Such efforts were made to secure the elm that the writer is convinced of its desirability as a food for muskrats.

Curly Dock (*Rumex crispus*).

The internodes of curly dock forms an important item of food. In addition to the internodes the leaf base is also eaten at times. Along the Mohican River and most similar streams examined this dock was extensively eaten. Cutting begins early, as the plants are eaten usually before they flower. Later, when the seed has set, the plant appears again at the feeding stations and on the feeding platforms. While no animals were seen eating the matured seed, the frequency of occurrence of empty fruiting calyces indicated that it is the seed for which the plant is cut. That this is an important plant in the diet of "bank rats" is shown by the numbers of plants cut, the distance the animals will travel to secure it, and the large number of localities in which dock

grows. Where both curly dock and cat-tails are available the dock appears to be the favorite. Only the artichoke (*H. tuberosus*) was eaten in preference to dock along many streams.

Bitter dock (*Rumex obtusifolius*).

Where this rather tough plant is available the base of the stems is eaten. As the plant grows on the dikes in the marshes it is fed upon by "marsh rats" as well as "bank rats." It is not an important food plant, as only a few of the more tender leaf stems are cut from each plant. As with *R. crispus*, it is possible that the mature seeds are eaten also.

Smart weed (*Polygonum acre*).

Muskrats cut large amounts of this weed in certain habitats. Very little of each plant is eaten, only a few of the internodes being consumed before the plant is discarded. However, where a small stream passed through an old pasture, large quantities were cut and transported to the feeding places. Such activities indicated that smart weed was forming an appreciable portion of the diet here.

Yellow pond lily, cow lily (*Nymphaea advena*).

In the bottoms, along ditches, and in certain marshy localities the yellow pond lily furnished considerable food. The base of the stems, the basal portions of the leaves and the fruiting body are eaten. Even the root is attacked where the food variety is not great. Possibly the root is of great importance in winter, but it is not much used in summer, except where pressure of numbers has reduced the available food supply. Wherever other plants such as *Typha*, *Nelumbo*, and certain of the sedges are to be had, the cow lily is not eaten to any extent. From these facts one is led to the belief that while it may form the staple diet where other plants are not available, the muskrat is not partial to it.

White lily (*Castalia sp.*).

The basal portion of the flower is eaten to some extent, though not many flowers are attacked. Hence, the muskrats do not destroy many blossoms, nor is the plant of any importance in their economy during the summer.

Water chinquapin, "lotus" (*Nelumbo lutea*).

At Buckeye Lake this plant proved to be the finest type of food plant for muskrats. In the early summer the stem furnishes food, while the leaves are used as a building material. The leaf stem is cut from one to two feet under water, and again an inch from the leaf. Only the central portion of the stem is eaten, the tough outer layer being removed and discarded. In removing this unedible material the stem is not stripped, but is uncovered by biting and pulling off small pieces an inch or an inch and a half long. These pieces were found frequently on the leaves of the *Nelumbo* where the rat had rested while making a meal. Later in the summer the "nuts" or seeds in the fruiting head are eaten. Oddly enough, few, if any, of the fruiting

stems had been cut before the seed ripened. As the root is farinaceous, it, too, may serve as food when green stuffs are not available.

Such an admirable food plant deserves attention from the ranchers of muskrats and state game commissions, for it will grow in water too deep for *Typha*, and is well liked. It should be planted extensively in waters where an additional source of food is wanted.

Water Cress (*Radicula nasturtium-aquaticum*).

A few stems of this spicy plant are eaten. There is very little wasted.

Sycamore (*Platanus occidentalis*).

In August some twigs and leaves of sycamore were found at feeding places, indicating that this tree furnishes food from time to time, but is not a constant source of supply like the willow or elm. This might have been due to the difficulty of securing the twigs rather than to any preference on the part of the animals.

Red clover (*Trifolium pratense*).

There is little waste when red clover is eaten, for a large portion of each plant is consumed. The flowering head is discarded, and it is from this that an idea of the amount utilized is formed. The extensiveness of the cuttings checked well with the number of heads, indicating that only the head was not consumed.

White clover (*Trifolium repens*).

This appears to be one of the favorites, if not the favorite plant, whenever it is available. In one old unused pasture well defined trails led from the stream to patches of clover. These trails ran back to the patches, spread out, and disappeared. These patches had been grazed down well below the level of the surrounding vegetation, and were kept down all through the summer. That this was not the work of woodchucks was evident from the small size of the paths, as well as their direction. Moreover, the woodchucks had been shot and trapped constantly over this area, so were rare or absent. Most of the clover was eaten on the spot, although some was carried to the stream.

This is an important food and one of the best of muskrat foods, as it is a favorite; and, since stems and leaves are eaten, there is little waste.

Sweet clover (*Melilotus alba*).

On the other hand, there is much waste where sweet clover is eaten, for the animals eat a small portion of the stem only. As the clover grows tough with the advance of the season, less and less is cut or eaten. Although abundant in some habitats, sweet clover is not a very important food plant; but when other food plants are scarce, as in an inclosure, muskrats have been known to eat the mature plant, roots and all.

Maple (*Acer sp.*).

Leaves and twigs of maple were found in feeding places along the Mohican during June, but no cuttings were seen. The leaves and some of the bark of the twigs are eaten.

Jewelweed (*Impatiens biflora*).

This is not an important source of food, although it appears from time to time on the piles of discarded foodstuffs. It is abundant along many streams and is easily available. Thus, much would be found at feeding places were it a favorite food.

Water hemlock (*Cicuta maculata*).

This plant may be poisonous to stock, but it is eaten by the muskrat. The stems are eaten, but the leaves discarded, so it is just possible that the stems lack some substance found in the leaves. The name, Musquash root, may indicate the recognition of the plant as a food supply of the muskrat. Not much is found on the feeding places, but neither is the plant itself abundant in any of the localities studied.

Spearmint (*Mentha spicata*).

Peppermint (*Mentha piperita*).

A few stems of each of these plants were found on several rafts. Only a few stems had been cut and only a small portion of each stem eaten.

Common plantain (*Plantago major*)

In early summer the base of the leaf stem and the tips of the leaves are eaten in considerable quantities. Later in the season the same parts of tender plants are consumed, as well as the fruiting heads of more mature ones.

Ironweed (*Vernonia sp.*).

The stems of ironweed are eaten. On July 22 the largest cuttings were found, which marked the period when most was consumed. Although some had been eaten before this date and some was eaten after it, this marked the period when ironweed was most abundant on the feeding rafts and in the accumulations in the water.

Boneset (*Eupatorium perfoliatum*).

Immature plants are eaten during July and August. Only the internodes are eaten, the leaves being discarded. While not a food of importance, considerable quantities are cut and taken to the water.

Golden-rod (*Solidago spp.*).

A small portion of stem about four inches above the ground is eaten. Very few plants are cut at any time, and none after blooming.

Aster (*Aster multiflorus*), (*Aster, spp.*).

Musk rats will travel as much as two hundred and fifty feet from the water to secure aster. Usually only the tops are cut off, which induces branching. In one plot this cutting of the tops had been done several times until the plants had taken on a bushy appearance; for not only had the tops been eaten, but the ends of the lateral branches had been eaten also. Even where abundant food is available, aster is eaten extensively.

Giant ragweed (*Ambrosia trifida*).

In June the base of the stem is eaten. Judging from the amount consumed ragweed is relished at this time of the year.

Roman wormwood (*Ambrosia artemisiifolia*)

A few plants of this species were utilized, the tender unfolding leaves at the top having been eaten.

Jerusalem artichoke (*Helianthus tuberosus*).

This very common plant was extensively eaten by the muskrats living along certain streams. On the Walhonding during the middle of June the stems of the artichoke were furnishing more food than all the other sources combined, sedges were second, and *R. crispus* was third. Great quantities of the artichoke had been cut, the leaves and nodes discarded, and the internodes of the plant eaten. Not only was more of this plant cut than all others, but more of each stem was utilized. The preference for this food was such that the animals passed other food plants close to the water to go over the bank to reach it. Many cuttings were found fifty feet from the water. This was not an unusual distance. After cutting off the stem about nine inches above the ground the plant was dragged to the feeding places. As this plant was growing luxuriantly on the tops of unshaded banks and along the edges of cultivated fields, its importance was evident. From the first of June until September the stems of this plant formed a very important item in the diet of muskrats wherever it was available. It is possible that the roots are eaten later in the season.

Yarrow (*Achillea millefolium*).

Although this plant was found at several feeding stations, only a little of the stem was eaten. It was cut before flowering.

White Lettuce (*Prenanthes alba*).

The internodes of a few plants had been eaten to judge from the remains at the feeding places. This plant, too, was cut before mature.

Corn.

Corn planted near marshes or stream banks is attacked. Before the stalk grows tough the basal portion is eaten. After the grain develops the stock is cut and the grain eaten off the ear where it lies. The cob may be carried to the water or den for consumption.

Wheat.

The amount of damage done by muskrats to ripening wheat is not nearly so great as that done by the woodchuck. The muskrat cuts the stalks and removes the unripe grains. Usually the cut stalks are carried to the water before being eaten.

Oats.

Some oat stalks were found along a stream which ran between a field of oats and a field of wheat. Wheat was preferred, evidently, since very little oats had been cut.

Mussels.

While many mussel shells were seen bearing marks and heaps of shells were seen near feeding places, the species of mussels are not listed, since the evidence was purely circumstantial.

Muskrats.

Muskrats killed on unfrequented roadways by passing cars were found to have been eaten by their fellows. This statement is based upon the collection of feces about such carcasses. Just why the animals should pass over an exposed roadway instead of going under a bridge is difficult to understand. Nevertheless, many banks showed well defined trails leading over the bank to cross the road. On one occasion three animals were seen to use such a trail within the hour, while not one animal was detected passing under the bridge during that period.

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