# STUDIES ON TRAPPED MINK (*MUSTELA VISON MINK*) IN SOUTHERN MICHIGAN.

by

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A THESIS

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# INTRODUCTION

Perusal of the literature on mustelids reveals that to date published information concerning the status of the mink in the wild is relatively incomplete. The accounts of Coues (1877), Seton (1926), and Bailey (1926) are of a general nature while the many articles published in veterinary and fur-trade journals stress, chiefly, the practical aspects of mink ranching. A considerable body of literature is contained in fur-breeding sections of sporting magazines and in periodicals catering to the fur industry but much of this material is difficult of access and, in many cases, of rather dubious authenticity. Other published information existent does not, by any means, satisfactorily answer the many questions which arise concerning the relationships of this animal in the wild.

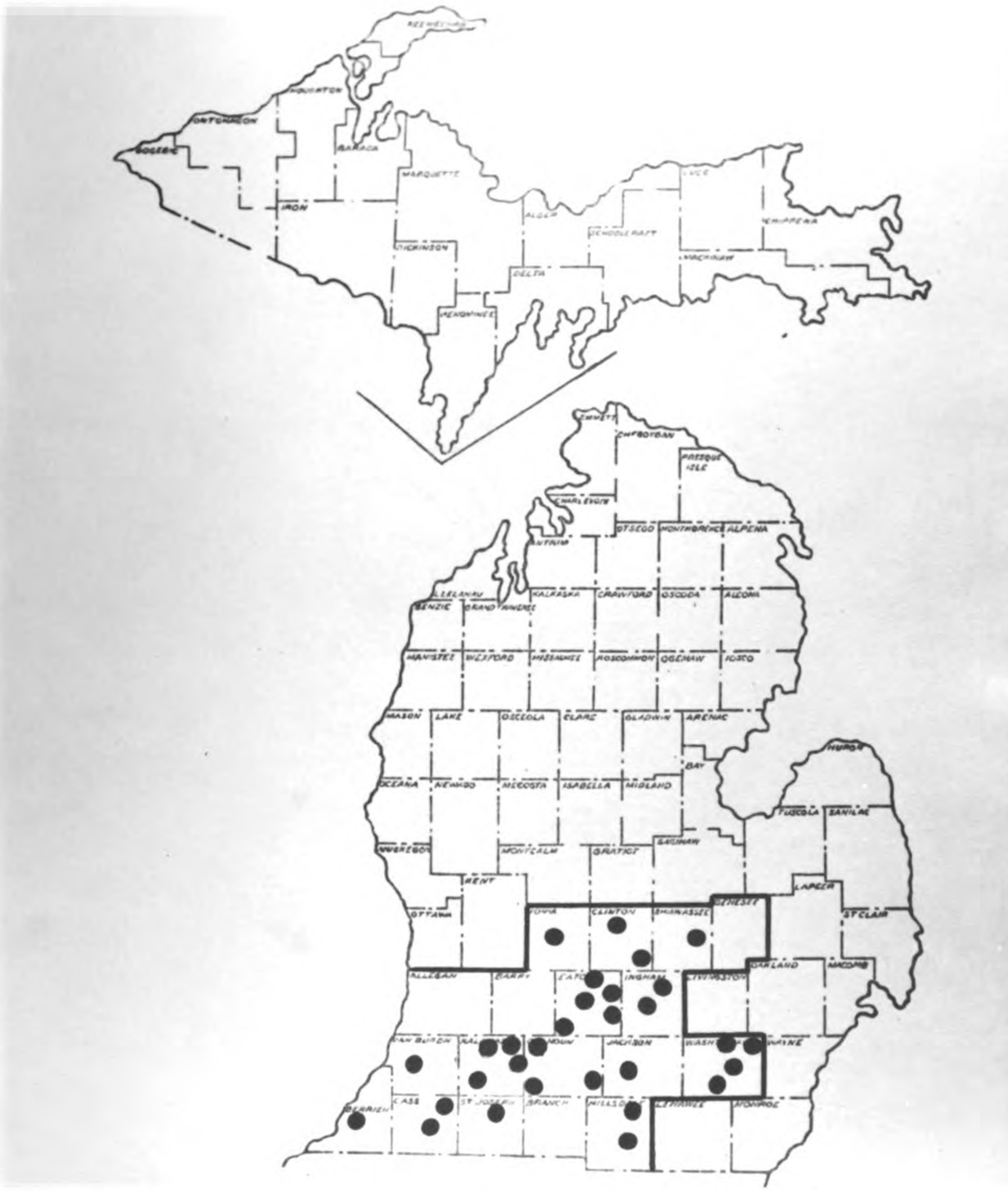
The mink is one of Michigan's most important fur-bearers, generally ranking about second in annual fur value. Approximately fifty percent of the mink trapped in Michigan are taken from the southern half of the Lower Peninsula. This region, which includes most of the good agricultural land of the state, annually produces the majority of the crop of furs harvested by Michigan trappers (Hayne, 1941). Thus, along with other fur-bearers, the mink augments the incomes of people in rural sections to no small degree during the trapping season.

In view of its importance as a fur-bearer, the mink has received surprisingly little attention. This may be due in part to the fact that, unlike some other fur-bearers, it has been able to survive and even increase despite intensive trapping, hunting, and reduction of suitable habitats in agricultural areas. According to trappers and fur-buyers the mink has been increasing rapidly in numbers during the last few years and all are vociferous in their complaints about the inroads being made upon the muskrat population. There is a tendency on the part of the trappers and fur-buyers to attribute this increase to the law which prohibits the disturbance or molestation of any beaver, muskrat, racoon, or rabbit house, hole, burrow or den. Because the mink frequents and uses the same situations as do the aforementioned mammals the trapper is virtually prevented from hunting them with dogs. The trends in computed kills, as indicated by compilation of data from trappers' report cards, tend to substantiate their conclusions in respect to a population increase. However, a coincident upward trend in the computed kill of most other fur-bearers, including muskrat, is also indicated and hence caution is necessary in searching for the cause of such trends.

The only available studies of the species in Michigan are those by Dearborn (1932) relating to food habits, and by Marshall (1936) describing winter activities. Other published information concerning the mink in Michigan is only fragmentary.

The object of this research was to accumulate as much information concerning the species, from the available material, as was practicable and to interpret the data as correctly as possible in the light of known facts since the proper evaluation of data concerning food habits, parasites, and the like is of fundamental importance in determining sound management practices for a species.

In conducting the laboratory examinations, standard procedures were followed as a rule. However, whenever it seemed feasible special techniques were adopted in order to secure additional information.




MAP OF THE STUDY AREA.—Large dots indicate the localities from which specimens were secured.

**Figure 1. Map of the study area.**

## MATERIALS AND METHODS

Since this investigation was largely confined to the laboratory, the writer deemed it expedient, from the start, to glean as much information as possible, relating in any manner to the animal in the wild, from the material available which consisted of entire carcasses of mink besides a number of individual stomachs. To this end a specimen record (see Appendix) was prepared upon which all observations concerning each individual specimen were entered. As the individual records were completed they were catalogued in chronological order. Thus all observations pertaining to a single specimen were conveniently placed together while the records would also be easily sorted to assemble particular groups of data for inspection.

The principle techniques employed in gathering the data pertinent to the problem will be described here. Minor procedures and special techniques which were adapted to the securing of more specific information will be discussed in the text wherever it seems feasible to do so.

<u>Source of material and general procedure</u>

A large portion of the material used in this study was obtained during the months of December 1940 and December 1941 from southern Michigan fur-buyers (see Fig. 1). Previous to the trapping season the fur-buyers were visited and containers left with them. A five percent formalin solution was placed in each of the containers and the carcasses of mink bought from trappers were placed in this solution by the fur-buyers. The buyers were requested to place a tag, bearing locality and approximate date of capture, upon each specimen before immersing it in the formalin solution. They were also instructed to slit the wall of the abdomen to allow quick and thorough penetration of the preservative to all parts of the body.

The carcasses were collected at intervals during the trapping season from the fur-buyers in order to secure as reliable data as possible and to decrease the loss of specimens through improper handling. In a few cases, it was found necessary to discard specimens which were extremely dessicated and undergoing decomposition because of incomplete immersién in the preservative. However, when the carcasses were properly handled the formalin solution proved sufficiently strong to insure good preservation and there was no appreciable loss of specimens.

In most instances when the dealer operated on a small scale the carcasses secured represented catches of local trappers. However, some of the larger dealers who were contacted secured animals from trappers located within a 25-50 mile radius. This fact was kept in mind when blocking out the limits of the study area. County boundaries have been followed in delimiting the area in order that available population data upon fur-bearers, for the various counties, might be better utilized.

In addition to 158 carcasses collected from fur-buyers, a total of 43 stomachs were kindly turned over to the writer by Professor A. E. Woodhead, of the University of Michigan, who has been engaged for some time in the study of the life cycle of the giant kidney worm, Dioctophyme renale, in the mink. These stomachs were taken from mink collected in southern Michigan during the winters of 1938 and 1939 and have been incorporated into the study. Stomachs and intestinal tracts from several mink taken in the winter of 1940 were also received from Mr. Don W. Hayne of the Michigan State College Department of Zoology.

After collection from the fur-buyers the carcasses were brought back to the laboratory and transferred to a ten percent formalin solution. Each specimen was assigned a collector's number and this together with locality and date of capture was recorded in india ink upon a parchment tag. The data pertaining to each specimen was then recorded under a corresponding series of numbers in a catalogue at the time of examination.

Measurements

After removal from the preservative, each specimen was weighed to the nearest gram on a trip balance. Care was taken to drain the body cavity thoroughly and to remove all excess fluid with absorbent towelling before doing any actual weighing.

Standard body measurements were taken on all specimens before autopsying them. These measurements are as follows: total length, on body stretched out to its full length, from tip of nose to tip of last tail vertebrae; length of tail, from a central point in sharp curve on upper side at base where tail can be bent at right angles to back, to tip of last tail vertebrae; length of hind foot, with sole flat, at right angles to leg, from hindermost surface of heel to tip of longest claw; length of ear from notch to tip (taken on unskinned specimens). Since the nasal cartilages and nose pads were lacking in the skinned specimens the measurements of total length are from five to ten millimeters less than those taken on unskinned specimens.

After the body measurements were taken the head was severed from the body at the juncture between the occipital condyles and the atlas vertebra. All excess flesh was then removed from the skull before taking cranial measurements. The cranial measurements taken were as follows: condylobasal length, from posterior edge of occipital condyles to the anterior border of the upper incisors; mastoidal breadth, greatest transverse dimension of skull across the mastoidal processes; least interorbital width, breadth of cranium across the frontals at narrowest place above the orbits; length of upper molar-premolar row, from posterior margin of alveolus of last molar to anterior margin of alveolus of premolar.

After removing all of the flesh from the bacula, a number of measurements were taken. These are as follows: greatest length measured in a straight line from the proximal end of the base to the tip of the shaft; greatest dorso-ventral diameter of the base; greatest lateral diameter of the base; greatest dorso-ventral diameter of the median portion of the shaft; greatest lateral diameter of the median portion of the shaft. The bacula were also weighed to the nearest milligram on an analytical balance. Before weighing, the bacula were degreased in xylol, dehydrated in 95 percent alcohol, and then left in a dessicator for 24 hours in order that all excess moisture would be eliminated.

Volumes of testes (including epididymis) and ovaries were determined by water displacement. Length and breadth of these organs were also measured in millimeters. The measurement of volume was found to be unsatisfactory for the ovaries since the volume was so small that it could not be accurately measured.

All of the linear measurements, with the exception of total length and tail length, were taken with a Vernier caliper to the nearest 0.1 of a millimeter. The total length and tail length were measured to the nearest millimeter with a meter stick.

Autopsies

Autopsies were performed upon 158 animals during the course of the investigation. The specimens were first inspected for any outward signs of disease or parasitism. Next, the body cavity was laid open with a pair of heavy shears and the general condition of the viscera noted.

Stomach and intestines were removed and tied in cheesecloth together with the specimen tag. They were then placed in ten percent formalin to be examined at a later date. The other organs were examined very carefully for evidences of parasitism or for anything of a gross pathological nature. When parasites were found, a number were usually saved for identification and a count or estimate of the number present in each organ was made. In addition to the organs in the body cavity, the nasal passages and frontal sinuses were opened to permit inspection for parasites.

Visceral analysis

Stomachs--Of a total of 216 stomachs examined, 93 were empty and 21 contained unrecognizable amorphous material, vegetation, and trap debris. Included in the trap debris were such items as dirt, sticks, trap pads, and toes chewed off by the animal while in the trap. This left a total of 102 stomachs upon which to base an appraisal of the winter diet of the mink.

In examining the stomachs it was usually noted that a single item of food was represented. Several exceptions to this were recorded, however, some of the stomachs containing from three to four different items. The material in the stomachs was usually chewed into pieces which were one-half inch or smaller in size. Usually the fleshy material was at least partially digested. Small mammals, fish, and crayfish always appeared to be thoroughly chewed while larger prey was apparently swallowed in larger chunks.

The volume of the contents of the stomach was determined to the nearest 0.1 ml. by water displacement. Volumes under 0.1 ml. were recorded as traces. The contents of the stomach were washed into a white enamel pan to render the food items more visible. If more than one item was represented the volume of each was determined after the contents had been carefully separated. When a large amount of fat or grease was present which tended to obscure the identity of diagnostic items, hot water was used to remove the excess. A series of sieves of varying mesh proved useful in separating food particles of various sizes making it possible to separate diagnostic items rather easily. Light colored or white objects often were readily picked out by washing the contents of the stomach into a large culture dish and placing this over a black background. The minimum numbers of individuals (as indicated by counts of appendages, bones, etc.) of each item represented in a stomach were always recorded.

In all cases identifications were as specific as possible. When items could not be immediately identified, diagnostic parts such as hairs, scales, claws, etc., were placed in an envelope together with the catalogue number of the specimen and identified later. Diagnostic items which proved most useful in making determinations were the hairs, teeth, and claws of mammals; feathers of birds; scales of reptiles and fish; skin and feet of amphibians; and the hard chitinous parts of crayfish and insects. Cross sections, medullary patterns, and cuticular scale patterns of guard hairs were utilized in identifying mammals. In most instances determination to genera was possible by comparison with known samples and through the use of keys. The publications of Mathiak (1938), Williams (1938), Dearborn (1939), and Hardy and Plitt (1940) were especially valuable in this respect and were constantly used. Sturgis' breast feather key to the orders of birds north of Mexico (Wight, 1939) proved useful in some cases for confirming the identification of feathers. The action of digestive juices upon the feathers often mitigated the value of this key, however, and direct comparison of feather color and pattern with known specimens proved more trustworthy. Action of digestive juices upon fish scales, resulting in their partial dissolution, made it practicable to determine them to family only, even though a number of the better preserved scales could be identified to species. Other items were determined as accurately as possible depending upon their condition.

Intestines--A total of 166 intestines were examined. 30 of these were empty and 35 contained unrecognizable material, vegetation, and trap debris, leaving 101 intestines from which the frequency and bulk percentages were computed. Frequency percentages are based on 101 intestines while bulk percentages have been computed from 69 intestines.

The intestines were slit lengthwise and the contents washed out into a pan. The contents of the pan were then poured into a number 80 mesh screen. The material was concentrated by the removal of all excess water by thorough draining and by absorption through the screen with towelling. Due to the fineness of the screen, a negligible loss of food particles occurred. Volume of the contents was then determined to the nearest 0.1 ml. by water displacement. When more than one item was represented a bulk estimation of the relative proportions of each item to the total bulk was made by inspection since the material in the intestines would not be easily separated. Hence there is a wider margin of error in the volumetric measurement of food items in the intestines than in the stomachs.

Identification of food items was essentially the same for the intestines as for the stomachs. Because of a greater amount of amorphous material and debris in the intestines, a more thorough straining through sieves of various meshes was necessary to uncover diagnostic items.

## FOOD HABITS

The economic status of an animal is determined to a considerable extent by its food habits. Is it destructive or beneficial? To what extent is its choice of food determined by availability? How do its food preferences affect other game or fur animals? The final decision as to the animal's economic position is dependent upon the answers to these as well as to other related questions.

The present study, based on winter mink only, is admittedly lacking in the completeness which a year-round study would provide. However, the studies of Dearborn (1932) and Hamilton (1936, 1940) should serve to bridge this hiatus satisfactorily. Since the study covers the critical period during the winter when animal populations are on the wane, it is felt that some light might be shed upon the problem of predation by the mink, particularly upon the muskrat. Also a food habits study over a period of years allows for a better interpretation of results by making it possible to compare abundance and availability of food items as well as to appraise the effects of certain external factors affecting the animal's activities.

To facilitate comparison with other studies, both volumetric and frequency percentages of prey items are given. The number of individuals of each prey item represented in the diet is also included to make a comparison of stomachs and intestines possible and to allow a proper evaluation to be placed on the smaller items in the diet. The percentage occurrence index tends to place more emphasis upon items which appear in many stomachs even though lacking in bulk but does not take into account the fact that two or more small items of the same kind may occur in one stomach. Hence the relative numbers of small items taken by an animal are often not properly emphasized either by volume or by frequency. From an economic standpoint the numbers of the various items consumed are often more important than either volume or frequency since they allow comparison with figures on abundance of prey, economic status, etc., all of which are measured by individuals. The volumetric method on the other hand gives the best indication of which foods furnished the bulk of the animal's sustenance.

Intestinal analysis has been used to supplement stomach analysis in so far as possible. The combined data for the four year period are not strictly comparable, however, since intestinal analysis was made only on the specimens taken during 1940 and 1941.

The results of the stomach and intestinal analyses are presented in Tables 1 and 2.

Discussion of results

As Nelson (1918, p. 472) has aptly stated, "Few species are more perfectly adapted to a double mode of life than the mink. It is equally at home slyly searching thickets and bottomland forests for prey or seeking it with otter-like prowess beneath the water." This double mode of existence is amply borne out by the results of both stomach and intestinal analyses since aquatic and non-aquatic prey items are about equally represented in the diet. All of the mink examined appeared to be exclusively carnivorous. Grass and other debris when found in stomachs and intestines was present only in very small quantities and was usually associated with the smaller prey items suggesting that it was bolted along with the food. Therefore such material was assumed to have been incidentally ingested and is not considered as a regular part of the diet.

Table 2.

Percentages by frequency and by volume of the food items found in the intestines of 101 winter mink. 1940-1941.

| Item | Number of individual items | Percentage by volume | Percentage occurrence |
|---|---|---|---|
| Mammals: volume--53.90 % frequency--65.34 % | | | |
| Muskrat, Ondatra | 24 | 17.61 | 23.76 |
| Cottontail, Sylvilagus | 16 | 11.38 | 15.84 |
| Meadow Mouse, Microtus | 8 | 10.08 | 7.92 |
| Deer Mouse, Peromyscus | 4 | 6.18 | 3.96 |
| Pine Mouse, Pitymys | 2 | 3.04 | 1.98 |
| Short-tailed Shrew, Blarina | 4 | 2.71 | 3.96 |
| Star-nosed Mole, Condylura | 2 | 1.30 | 1.98 |
| Long-tailed Shrew, Sorex | 1 | .54 | .99 |
| Snowshoe Hare, Lepus | 1 | .08 | .99 |
| House Mouse, Mus | 1 | .00 | .99 |
| Brown Rat, Rattus | 1 | .00 | .99 |
| Unidentified | 2 | .98 | 1.98 |
| Birds: volume--5.20 % frequency--7.92 % | | | |
| Domestic Chicken, Gallus | 2 | 1.30 | 1.98 |
| Pheasant, Phasianus | 2 | .33 | 1.98 |
| Ruffed Grouse, Bonasa | 1 | .00 | .99 |
| Egg (Domestic Chicken) | 1 | .54 | .99 |
| Unidentified | 2 | 3.04 | 1.98 |
| Reptiles: volume--.22 % frequency--.99 % | | | |
| Snakes (unidentified) | 1 | .21 | .99 |

Table 1. (cont.)

| Item | Number of individual items | Percentage by volume | Percentage occurrence |
|---|---|---|---|
| Bull Frog, Rana | 3 | 2.54 | 2.98 |
| Spring Peeper, Hyla | 1 | .05 | .98 |
| Unidentified (frogs) | 8 | 2.02 | 7.84 |
| Fish: volume--5.89 % frequency--10.78 % | | | |
| Centrarchids | 6 | 3.22 | 5.88 |
| Catastomids | 2 | 1.18 | 1.96 |
| Cyprinids | 1 | 1.15 | .98 |
| Unidentified | 2 | .35 | 1.96 |
| Arthropods: volume--1.84 % frequency--5.88 % | | | |
| Crayfish, Cambarus | 6 | 1.84 | 5.88 |
| Totals | 131 | 100.00 | 123.53 |

Representation by classes shows that in both stomachs and intestines mammals constitute well over half of all the food eaten. Graphic presentation of these data are given in Figures 2 and 3. The number and relative proportions of the different genera of mammals occurring in both stomachs and intestines did not differ greatly (see Figs. 4 and 5). It is noticeable, however, that the volumetric percentages for small mammals tend to be larger in the intestines than in the stomachs, whereas for the cottontail and the muskrat the opposite seems to hold true. This seems to be the case for fish, frogs, and crayfish as well. Since chiefly the fleshy parts of larger mammals appear to be eaten while smaller mammals are apparently eaten entire, it seems reasonable to assume that the changes in relative proportions by volume are the result of digestive action. The fleshy parts of muskrats and cottontails eaten by mink may be expected to decrease in bulk as they traverse the digestive tract. Small mammals which are eaten whole, however, have a relatively larger proportion of indigestible parts such as hair, skin, and bones, and hence would be expected to increase proportionately in volume as they pass from the stomach into the intestine where digestion is completed. The hard, chitinous exoskeletons of crayfish and insects, and the scales and bones of fish, being relatively indigestible, likewise tend to form a larger percentage by bulk in the intestine than in the stomach while frogs which consist largely of soft parts show a decrease. In comparing scat, intestinal, and stomach analyses, then, this sort of evidence must be kept in mind.

The volumetric percentages, on the whole, appear to be far more reliable for stomach analyses than for intestinal analyses and in general it may be said that percentages of occurrence are more consistent, as a

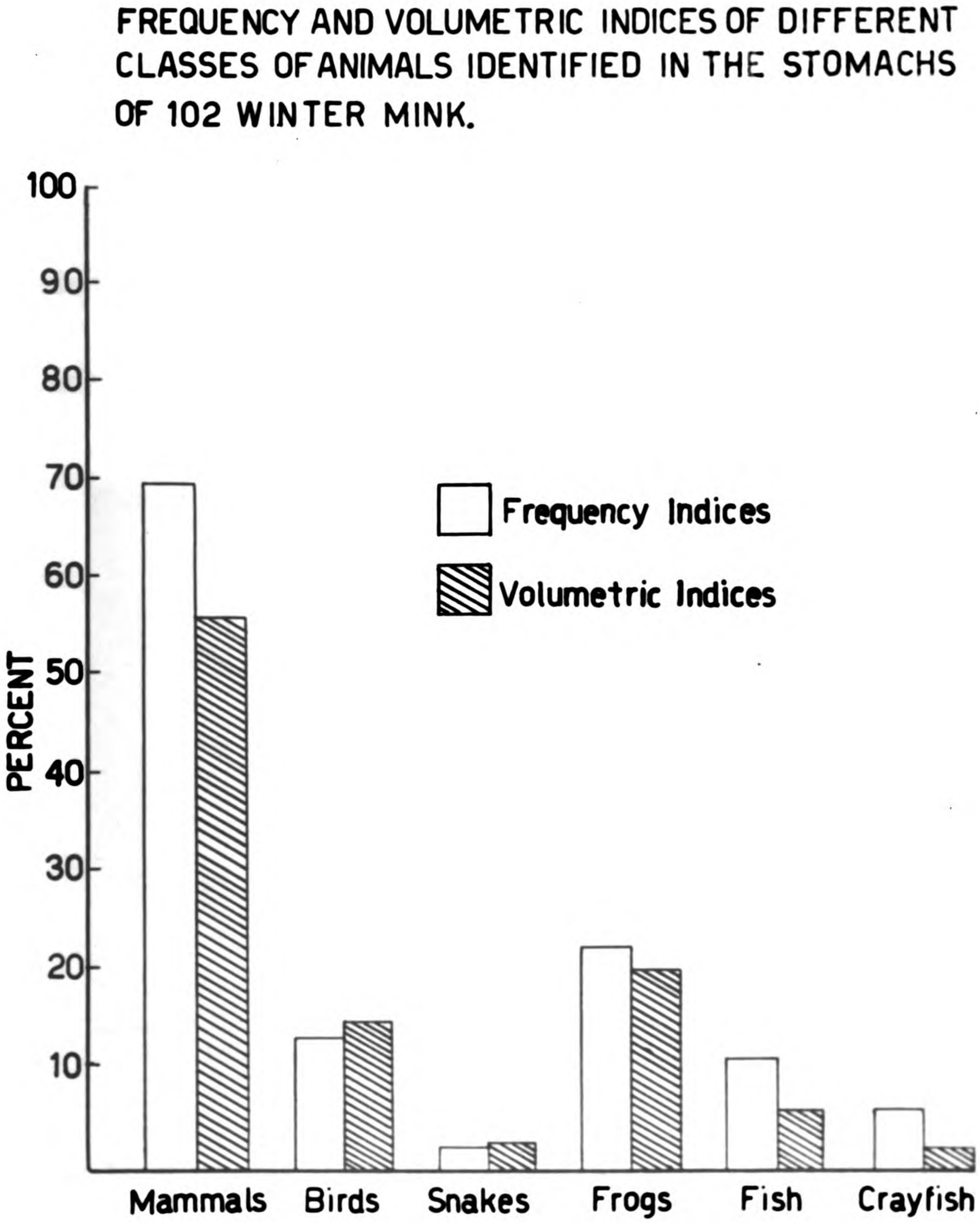



Figure 2. Graph showing the relative proportions of different classes of animals found in the stomachs of winter mink.

FREQUENCY AND VOLUMETRIC INDICES OF DIFFERENT CLASSES OF ANIMALS IDENTIFIED IN THE INTESTINES OF 101 WINTER MINK.

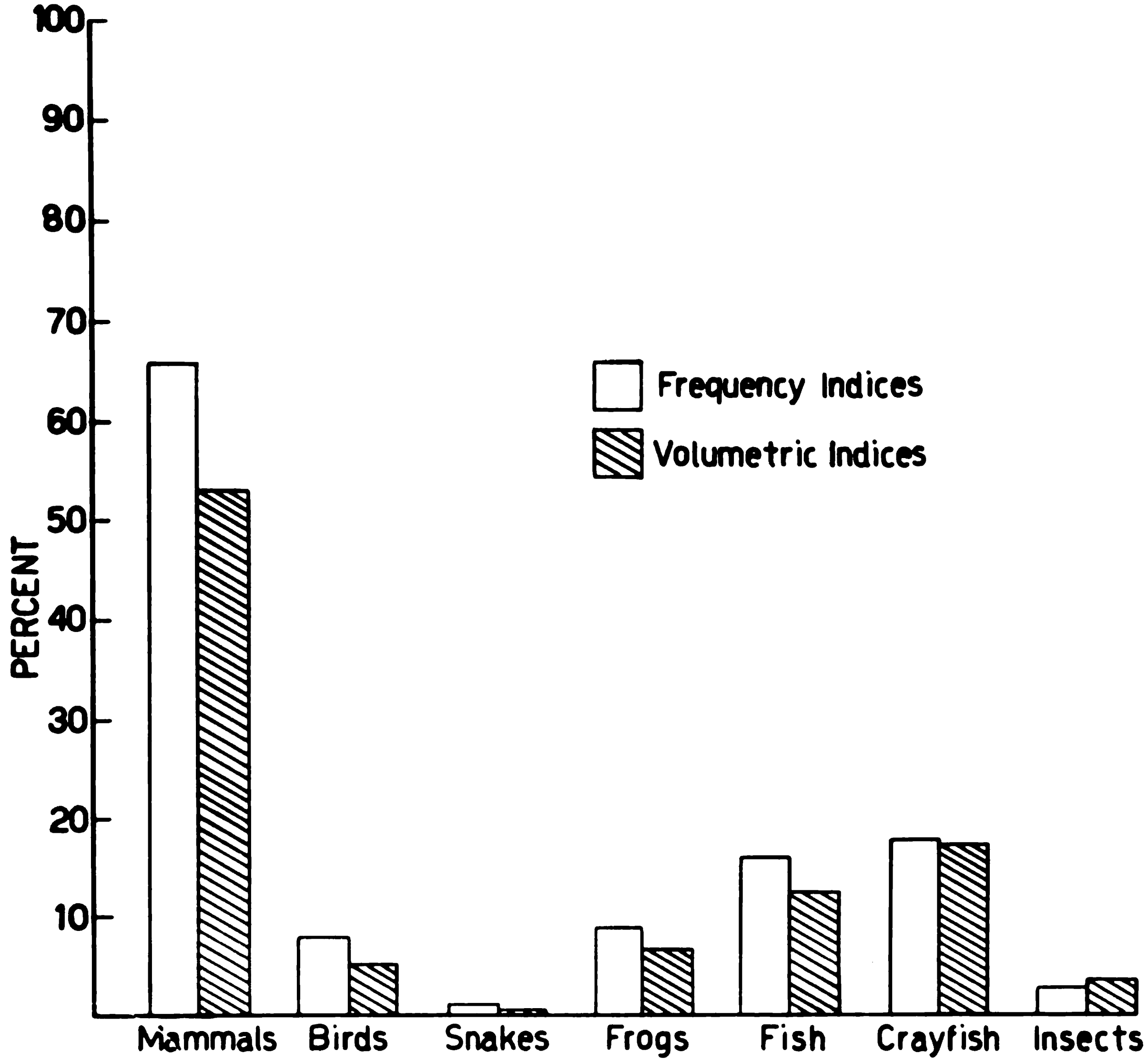



Figure 3. Graph showing the relative proportions of different classes of animals found in the intestines of winter mink.

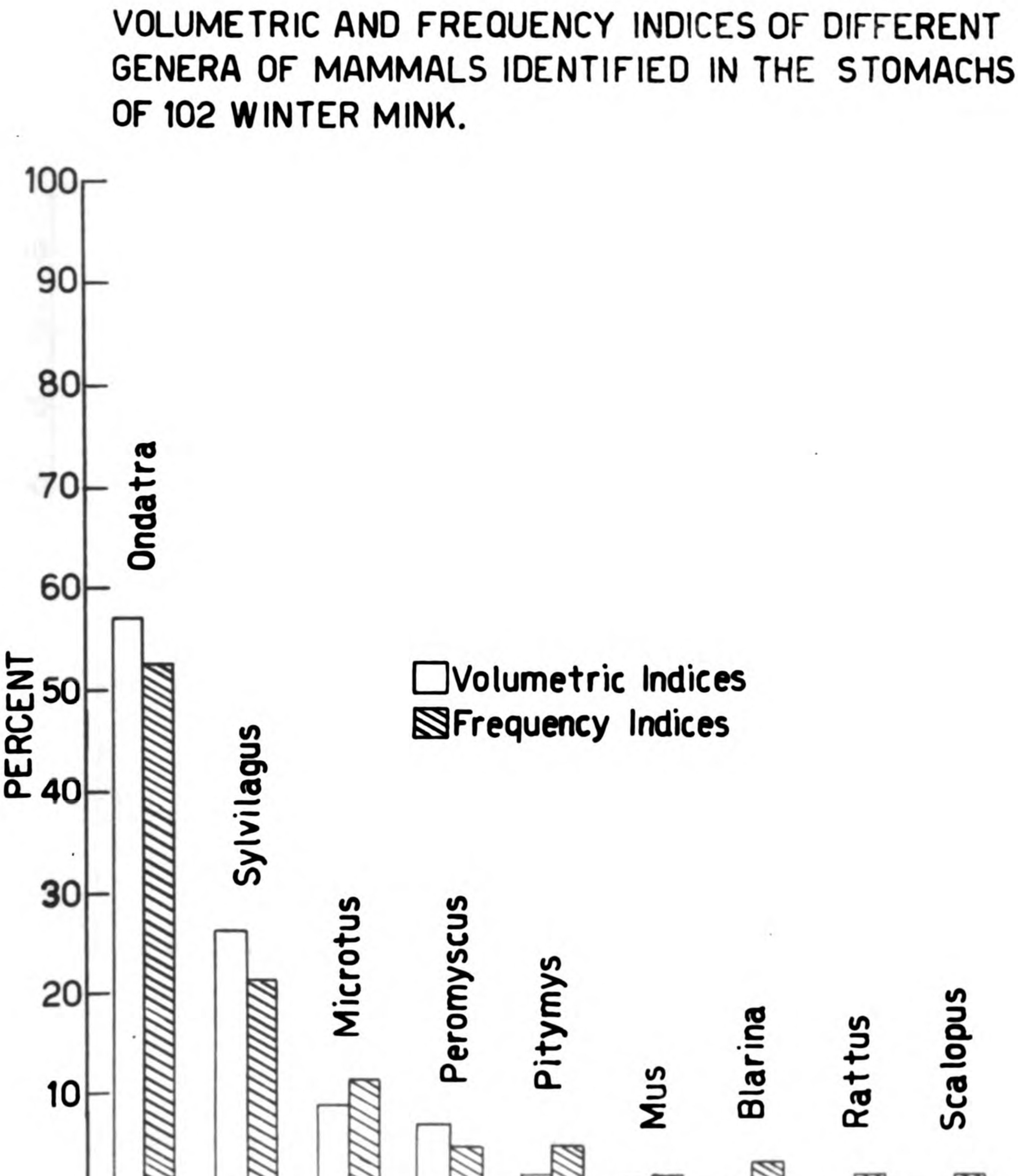



Figure 4. Graph showing the relative proportions of different genera of mammals identified in the stomachs of winter mink.

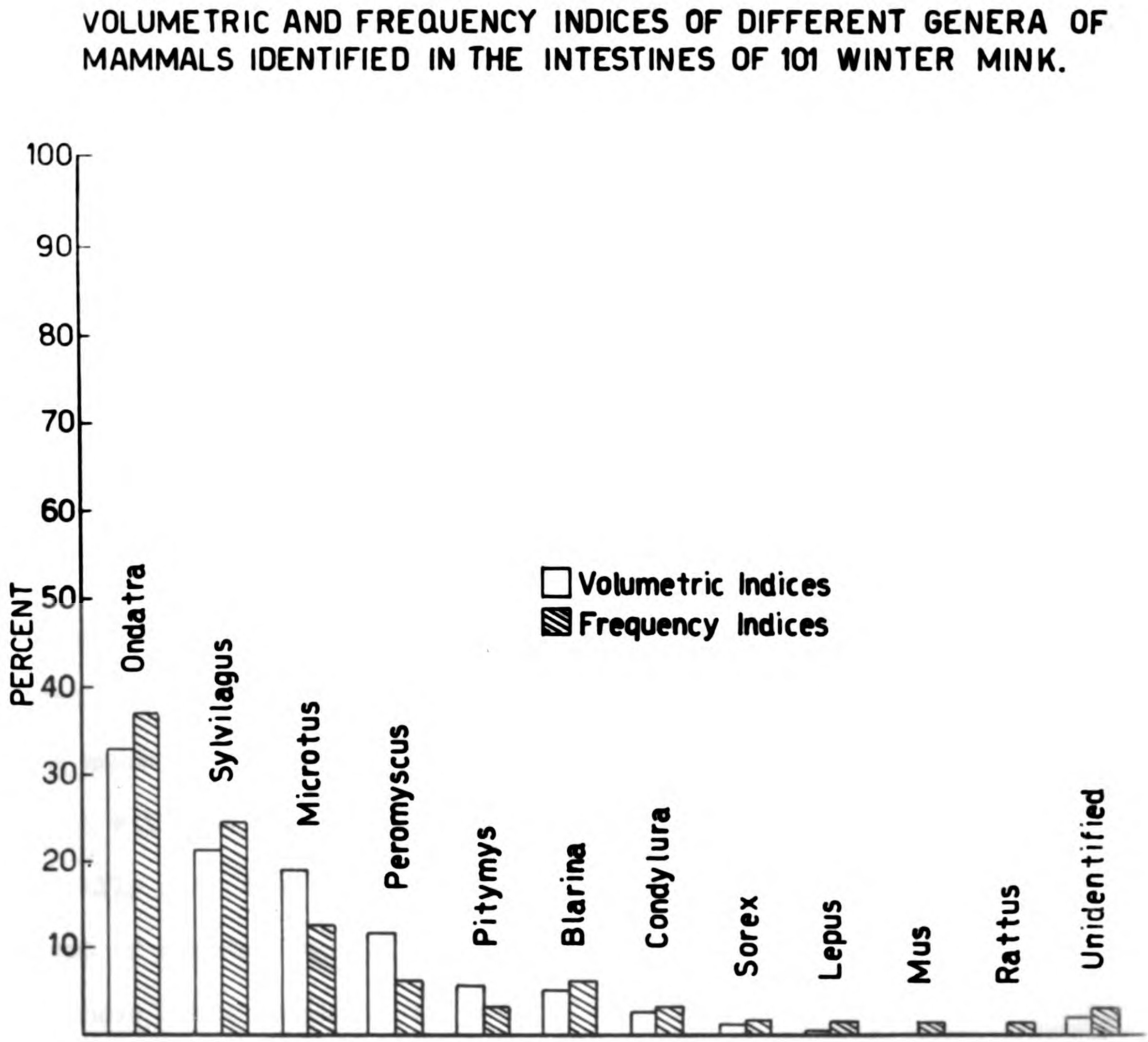



**Figure 5.** Graph showing the relative proportions of different genera of mammals identified in the intestines of winter mink.

rule. Single occurrences of large, bulky items, such as the coot found in one of the stomachs, often tend to place a disproportionate amount of emphasis upon the volumetric percentage when only a few items are represented. Scott (1941) has concluded that the frequency of occurrence method in fecal analysis provided for the most reliable interpretation of the relative quantities of food consumed. The findings reported here tend to support those of Scott although no really marked degree of disparity could be discerned between the two methods of representation.

A further source of error is involved in the determination of volumetric percentages in the intestines, aside from that introduced when making bulk estimation of the relative proportions when more than one item was present. When removing the contents of the intestine, a certain amount of the mucous lining of the intestine was unavoidably included with the intestinal contents. In an intestine which is only partially full this material would thus tend to put a disproportionate amount of emphasis upon the bulk determination. Even though the amount of mucous lining remains as a more or less constant factor there is the possibility that those items occurring less frequently receive an undue amount of emphasis.

A significantly greater number of crayfish were found in the intestines as compared to the stomachs. Also a significantly greater number of frogs were found in the stomachs as compared to the intestines. It appears probable from these results that a differential rate of passage of different food items exists. Apparently the hard, indigestible pieces of food are passed rather quickly from stomach to intestine while fleshier material is retained in the stomach for a longer period of time. Crayfish consisting largely of hard parts, and frogs consisting largely of soft parts might then be expected to show the greatest difference in rate of passage. Items such as mammals, birds, and fish in which the relative proportion of soft to hard parts approaches neither extreme might well be expected to be passed along the digestive tract at a rate somewhere between that for frogs and crayfish. Dearborn (1932, pp. 14-15) has shown that evidence of a meal eaten by a mink continued to appear in its feces for three days after the meal was eaten. Errington (1935, p. 197) has noted residuums of indigestible material, such as worn feather butts, teeth and claws, coarse hair, etc., in stomachs and throughout the length of the intestine of foxes which he assumes are passed in from the stomach, bit by bit, over variable periods of time. It would seem, however, that this residual material would not be retained in the stomach for a very long period of time even though such resistent particles from prey individuals might be retained for several days in the intestine.

The findings reported here tend to corroborate those of Dearborn and Hamilton in most respects. Birds and frogs were taken more frequently than shown by either Dearborn or Hamilton, while fish were taken less frequently. The greatest discrepancy is found between these findings and those of Hamilton. Undoubtedly abundance and availability have affected the relative proportions in which prey items appear in the diet. This serves to emphasize the point that to gain a reasonably clear picture of the general food habits of an animal it is necessary to collect food habits material over its entire range and over a period of years.

Nonfood items

Included among the material falling into this category were unrecognizeable amorphous mixtures of dirt and black protein waste, vegetation consisting of grasses and aquatic plants, and trap debris made up of such items as dirt, sticks, trap pads, and toes chewed off by the animal while in the trap. Most of the vegetable material showed relatively few effects of digestive action. The amorphous material, as is to be expected, was largely found in the intestine.

Much of the above material is no doubt taken indidentally and is to be expected in the stomachs of predators which capture and bolt small animals or feed off carcasses on the ground. A certain amount of vegetable material might conceivably be secondarily acquired from herbivoreus animals which are captured as prey. It is problematical whether or not the animal would deliberately eat dirt or vegetation in an effort to relieve vitamin or mineral deficiencies although ingestion of such material probably does have a definite nutritional importance.

The occurrence of hair, toe nails, and toe pads of mink in the stomachs and intestines of a number of the animals came as no surprise since it is well known that many species of mammals when trapped become infuriated and chew off the imprisoned foot below the trap jaws in an effort to escape. It is possible that some of the mink fed upon other members of their kind caught in traps and subsequently were caught themselves. The presence of a considerable quantity of mink in the stomach and intestines of one animal would suggest that perhaps a dead mink was found and eaten. The mink may also not be averse to preying upon others of its own kind when they are in a helpless condition if the evidence can be construed as such.

Out of 123 stomachs amorphous material and vegetation occurred in 13.01 percent and comprised 1.26 percent of the total volume. In the same stomachs mink totalled .73 percent by volume and 8.13 percent by frequency. Out of 136 intestines amorphous material and vegetable debris occurred in 13.22 percent and made up 14.73 percent of the total volume. Mink were represented in 12.5 percent of the intestines and made up 7.53 percent of the total volume.

Lead pellets were found in the stomachs of three mink which had apparently been shot because the stomachs were perforated and evidences of gunshot wounds were visible on the carcasses thus ruling out the possibility that carrion had been eaten.

Sex differences in food habits

It was thought worthwhile to consider the possibility of sex differences in the diet of the mink, not only out of idle curiosity but also with the thought that such differences, if they existed, would contribute indirectly to the knowledge concerning the behavior of the two sexes, particularly during the trapping season. Discrimination by either sex as to kind or size of food items taken was looked for when examining the assembled data. Numerical representation of items and tabulation of percentages by volume and occurrence are given for the two sexes in Tables 3, 4, 5, and 6. The numerical representations were compared statistically for significance (see Tables 7 and 8). However, the percentages by volume and occurrence are comparable by inspection only.

The number of muskrats taken by males, as shown by both stomach and intestinal analysis, was greater than the number taken by females and when compared statistically was shown to be highly significant. The number of small mammals found in the stomachs of females was significantly larger than the number occurring in the intestines of males. No significant difference was found between the number of other items taken by

Table 6.

Percentage by frequency and by volume of the food items found in the intestines of 37 female mink. 1940-1941.

| Item | Number of individual items | Percentage by volume | Percentage occurrence |
|---|---|---|---|
| Muskrat | 3 | 6.06 | 8.10 |
| Cottontail | 5 | 5.62 | 13.51 |
| Small Mammals | 13 | 33.30 | 35.13 |
| Large Birds | 2 | 2.16 | 5.40 |
| Small Birds | 1 | 0.00 | 2.70 |
| Snakes | 0 | 0.00 | 0.00 |
| Frogs | 5 | 17.30 | 13.51 |
| Fish | 10 | 23.79 | 27.02 |
| Crayfish | 8 | 11.77 | 21.62 |
| Insects | 0 | 0.00 | 0.00 |
| Totals.................... | 47 | 100.00 | 126.99 |

Table 8.

Tests of significance of the difference in rate of occurrence of prey items found in the intestines of 57 male as compared to 37 female mink.(1

| Item(2 | Number found in male stomachs | Number found in female stomachs | $X^2$ Value |
|---|---|---|---|
| Muskrat | 20 | 3 | 10.20** |
| Cottontail | 8 | 5 | .09 |
| Small Mammals | 9 | 13 | .76 |
| Large Birds | 5 | 2 | .58 |
| Small Birds | 0 | 1 | ...... |
| Snakes | 1 | 0 | ...... |
| Frogs | 4 | 5 | .70 |
| Fish | 6 | 10 | 3.11* |
| Crayfish | 8 | 8 | .45 |
| Insects | 3 | 0 | ...... |
| Totals.................... | 64 | 47 | |

(1. Seven intestines used in determining volumetric and frequency percentages have been omitted because of lack of data as to sex.

(2. Each item in the table has been compared with the number of all other items.

* Five percent significance.

** One percent significance.

the two sexes. No widely disproportionate number of either one sex or the other occurred during any one year so that significant differences in numbers of muskrats, small mammals, and fish taken by males and females do not appear to be attributable to any particular year.

Inspection of the percentage tabulation further reveals that the percentage by volume and by occurrence of frogs found in the stomachs of females seems to be considerably larger than for the males. Likewise the percentage occurrence and the percentage by volume of small mammals found in the intestines of females is noticeably greater than for the males. The percentage of frogs in the intestines of females likewise seems to be larger than those in the males.

A definite selection as to size of prey items taken by males and females seems to be indicated from the data. Females apparently take the smaller prey items more often than do the males. The reason for this is not readily perceptible. However, several factors may contribute. A marked disparity in the size of the sexes is true of the mink as well as a number of other mustelids. Some males may easily weigh twice as much as the average female. It seems probable that the smaller females might hesitate before attacking a large muskrat and might even come off second best in the ensueing struggle (Cram, 1923). On the other hand the larger and more powerful males might prefer to hunt for larger prey to satisfy their appetites most quickly since the mink hunts largely for food and seldom indulges in such wanton destruction as is characteristic of the weasel (Seton, 1926, p. 553). Another factor to be considered is the cruising radius of the two sexes. Marshall (1936) has observed that the females tend to remain in a restricted area not exceeding twenty acres while the males cover too large an area to be estimated accurately. It is logical then to assume that the males which range over a more extensive territory will encounter more muskrats than the females. Hence, in areas where large concentrations of muskrats do not exist the proportion of muskrats taken by the males should tend to be larger. The females which do not travel so extensively must then make up the bulk of their sustenance from the smaller items of prey. The fact that no significant difference existed in the numbers or amount of cottontails taken by either sex might be attributed to the fact that the cottontail is not as formidable an opponent to the female mink as is the muskrat. An unbalanced sex ratio occurring during the trapping season could also be a contributing factor in determining sex food habits (see p. 65). During the period prior to the breeding season when an unbalanced sex ratio occurs the females appear to be more retiring or wary and are not caught in exposed situations as readily as are males. The frequenting of less exposed situations by females at this time might lead to more frequent encounters with cottontails and fewer with muskrats which would inevitably be reflected in the diet.

It might be said in passing that the above hypotheses concerning the reasons for sex differences in food habits are conjectural and are not to be accepted as fact. The suggestions are tentative and are offered in lieu of more definite information.

Predation

In recent years there has been a great deal of controversy regarding the relationship of the mink to the muskrat. On one side is ranged a sizeable group of trappers and fur-buyers who would prefer to have the mink classed as a predator to be hunted the year around. This group feels that the number of mink they take during the trapping season does not nearly compensate them for the destruction wrought upon the muskrat population by the mink. On the other side there is a more thoughtful group of trained and untrained individuals who would prefer to have the animal investigated thoroughly before deciding prematurely upon policies which might not produce the desired results.

It is a known fact that the heaviest predation and greatest losses occur in areas where there are animal concentrations. Likewise complaints of mink predation on muskrats appear to be more numerous coming from those areas which normally produce the most muskrats. In areas where muskrat concentrations occur, then, the surplus must be trimmed down either by trappers and predators or in other ways. The proportion of the surplus harvested by trappers and that captured by mink is not known. How efficiently the trappers would be able to remove the surplus in the absence of the mink is problematical. Certainly a considerable number of muskrats would undoubtedly succumb to disease, exposure, intraspecific strife, and other factors before the trapper could harvest them. The net effect of predation upon populations may thus be minor in comparison to the effect of the controls which are inherent in the population itself. As Errington (1936, p. 252) has said, "The accumulating evidence seems to suggest that many prey populations are constituted to withstand far more pressure from enemies than they ordinarily get; and within the restrictions imposed by their habitats, seem to be mainly self-limiting and self-adjusting in numbers." In order then to be able to place a proper interpretation upon food habits data, with respect to predation, it is necessary to know the abundance of the prey item concerned and some of the factors which operate to affect its availability by making it more or less vulnerable to the predator. Many of the factors which affect the availability of prey items are hard to evaluate because they act indirectly and hence are difficult to compare with direct observations.

Data which may be used in interpreting food habits data are often incomplete and in some cases inaccurate. Hence, in lieu of actual field observations to supplement the data, only a very meagre amount of available information applicable to the present study was found to be useable. Computed kills of fur-bearers which are based upon trappers' and hunters' reports returned to the Michigan Department of Conservation (see Table 9) may serve as indices of population trends. The computed kills indicated are not to be considered exact, however, because of several sources of error. The actual annual take of furs exceeds the catch reported by trappers. Trappers' compulsory reports are not indicative of the total catch since they do not include fur-bearers taken by unlicensed trappers. Hayne (1941) found that unlicensed trappers took about twenty-five percent of the furs in Williamston township, Ingham county. Because of a rather prevalent notion among many trappers that reports of too great a catch will cause the Department of Conservation to shorten or close the season untruthful reports are sometimes submitted. These are difficult to appraise. The number of licensed trappers operating during each year sometimes varies, depending upon economic conditions and fur prices. Reported kills might reasonably be expected to be affected by these variations.

The computed kills of muskrats, mink, and cottontails in the study area as indicated from trappers' and hunters' reports, are depicted graphically in Figure 6. From the graph it would appear that the trends of both muskrat and cottontail populations during the winter

Table 9.

Computed kills of muskrats, cottontails, and mink for 18 southern Michigan counties* compiled from hunters' and trappers' reports for the period from 1938 to 1941.

| Computed kill | 1938 | 1939 | 1940 | 1941 |
|---|---|---|---|---|
| Computed muskrat kill** | 385,735 | 235,241 | 163,099 | 194,244 |
| Computed cottontail kill*** | 1,154,400 | 699,787 | 1,114,688 | 1,163,485 |
| Computed mink kill** | 6,169 | 3,520 | 5,591 | 7,976 |

* Counties--Allegan, Barry, Berrien, Branch, Calhoun, Cass, Clinton, Eaton, Genesee, Hillsdale, Ingham, Ionia, Jackson, Kalamazoo, Shiawassee, St. Joseph, Van Buren, Washtenaw.

** Compiled from trappers' reports.

*** Compiled from hunters' reports.

Table 10.

Average precipitation in inches for the months of July, August, and September in Zone III from 1938 to 1941.

| Month | 1938 | 1939 | 1940 | 1941 |
|---|---|---|---|---|
| July | 2.8 | 1.5 | 1.3 | 2.5 |
| August | 3.5 | 3.2 | 8.0 | 3.3 |
| September | 1.8 | 2.0 | 1.3 | 3.1 |

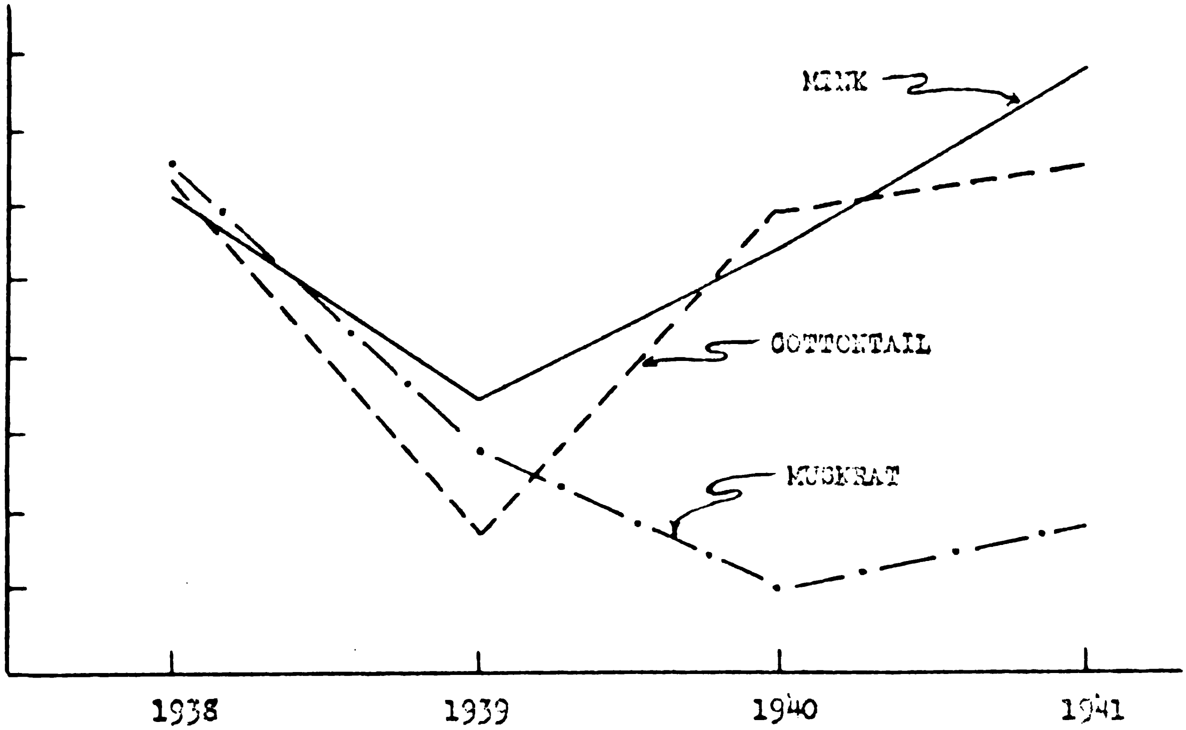



Figure 6. Graph showing computed kills of muskrat, mink, and cottontails in the study area as indicated by trappers' and hunters' reports.

months are relatively independent of the mink population. It is true that the muskrat population appears to be lowest when the mink population seems to be high. However, the decline in numbers of muskrats began at the same time as did that of the mink and the increase in their numbers began when the mink appeared to be most abundant which would seem to support the viewpoint that muskrat populations are mainly self-limited and that predation by the mink plays a minor role in controlling them.

Perhaps late summer droughts are indirectly more responsible in determining the population of muskrats going into the winter than any other factor since the drying up of habitats and the limiting of food supplies renders the population more vulnerable to predation by a number of predators including the mink. Intraspecific strife might also increase due to competition for food and the concentration of the population in the vicinity of the remaining water. Some data have been acquired concerning the average precipitation for the months of July, August, and September in Zone III (see Table 10). The month of July was arbitrarily chosen and the average precipitation during this month was graphed along with the computed kill of muskrats in the study area (see Fig. 7). Some degree of correspondence is evident from the graph which might indicate that the drought factor is important in regulating muskrat populations.

Svihla (1931) has estimated that an adult mink requires about 100 grams of rat per day while Stevens (1931) states that he has mink which will eat as much as a pound of food during the day. Smith and Loosli (1940) have shown that food may traverse the alimentary tract of a mink in 15 hours or less. With these facts at ones disposal it becomes poss-

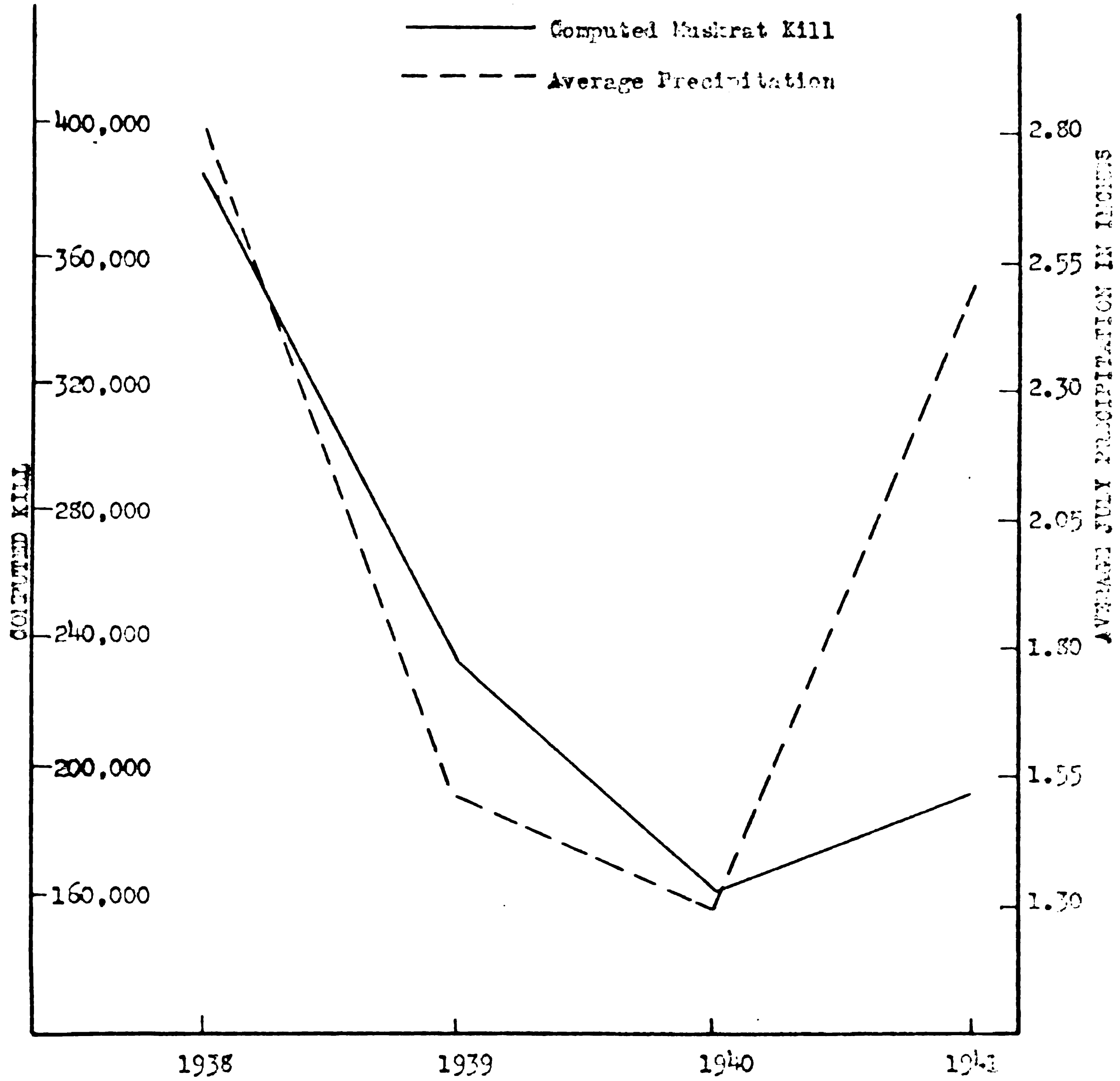



Figure 7. Graph showing computed muskrat kill as compared to average July precipitation.

ible to make some use of food habits data in evaluating the muskrat item in the diet of the mink. A mink would normally require from one to two average-sized muskrats per day to satisfy its appetite providing that it does not kill beyond its immediate needs. Available food habits studies show that during the winter months muskrat comprises not more than fifty percent of the mink's diet. A very liberal estimate would then allow about thirty rats per month to an adult mink during the winter months. Since Dearborn and Hamilton have shown that the muskrat is not as important a constituent of the summer diet of the mink as the winter, the average number taken per month throughout the year would probably be considerably smaller. During the trapping seasons from 1938 to 1941 the ratio of mink to muskrat in the study area varied from 1:66 in 1939 to 1:24 in 1941. This ratio is based on computed kills. It appears then that, during the winter months at least, the mink is an important natural predator of the muskrat.

The relative percentages in which four major prey items appear in the stomachs of mink by volume (see Table 11) are indicated graphically in Figure 8. The possibility that frogs and small mammals may serve in a buffering capacity against predation upon the muskrat is not to be overlooked and some indication of this is shown in the graph. Errington (1941, p. 79) has observed masses of mink-piled frogs and fish in snow-drift tunnels along the Big Sioux river of South Dakota indicating that at times such items may constitute a large part of the mink's diet.

Annotated list of food items

The following list of items found in the winter diet of the mink is included in order that material not indicated in tabular form might be presented and for the value which it might have in life history stud-

Table 11.

Numbers and percentages of four major food items found in the stomachs of 102 winter mink from 1938 to 1941.

| Item | | 1938 | 1939 | 1940 | 1941 |
|---|---|---|---|---|---|
| Muskrat | Percentage by volume | 50.81 | 26.48 | 30.30 | 15.70 |
| | Percentage occurrence | 55.00 | 75.00 | 30.30 | 24.39 |
| | Number | 11 | 6 | 10 | 10 |
| Cotton-tail | Percentage by volume | 13.42 | 0.00 | 23.11 | 13.28 |
| | Percentage occurrence | 20.00 | 0.00 | 21.21 | 9.75 |
| | Number | 4 | 0 | 7 | 4 |
| Meadow Mouse | Percentage by volume | 0.00 | 0.00 | 2.50 | 15.22 |
| | Percentage occurrence | 0.00 | 0.00 | 6.06 | 14.63 |
| | Number | 0 | 0 | 2 | 6 |
| Frogs | Percentage by volume | 12.65 | 52.99 | 20.46 | 11.40 |
| | Percentage occurrence | 25.00 | 57.14 | 18.18 | 14.63 |
| | Number | 7 | 7 | 7 | 6 |

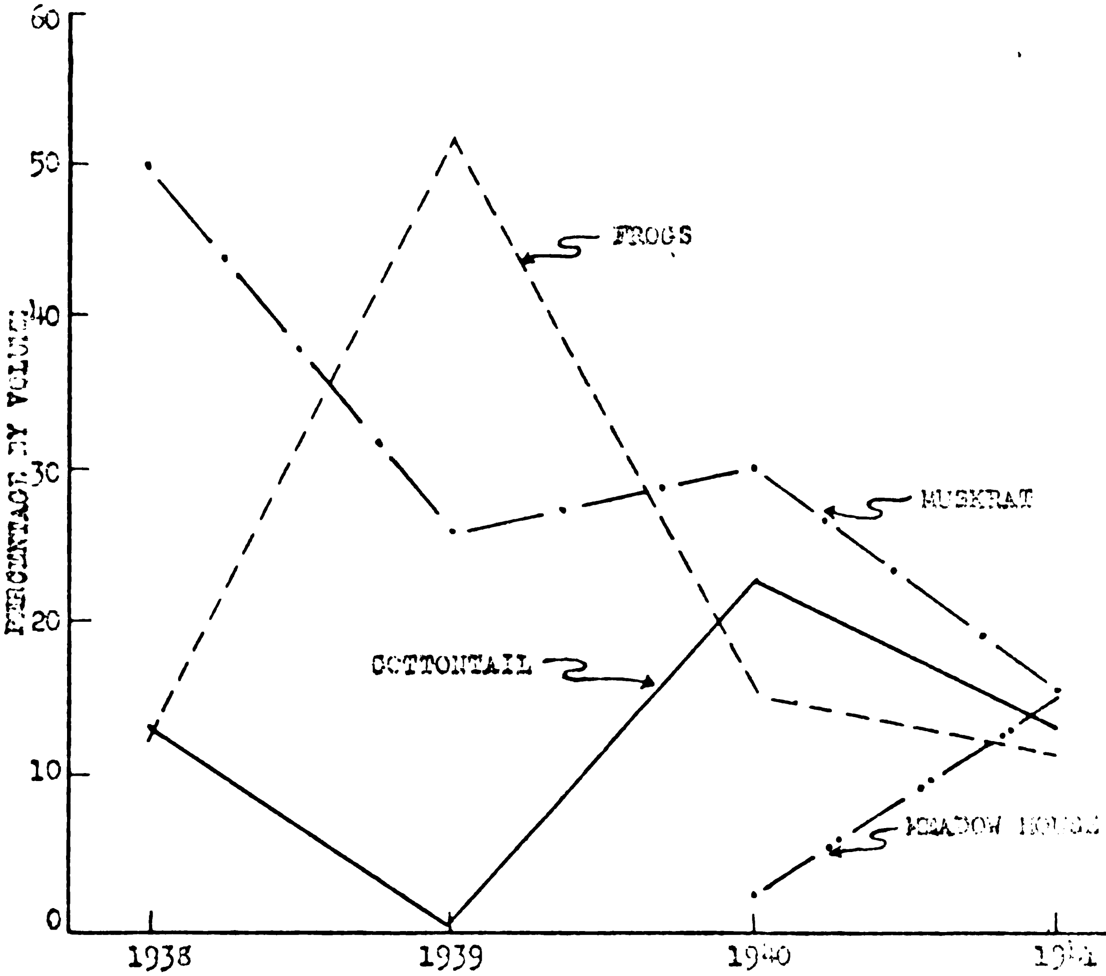



**Figure 8.** Graph showing the percentage by volume of four major food items in the winter diet of the mink over a four year period.

ies of parasites or in the study of food-chains of the various animals entering into the diet of the mink which is of basic ecological importance. The text also contains references to diagnostic items which were used to identify the various food items found in the stomachs and intestines.

Mammals--Mammals made up over fifty percent of the mink's diet whether rated by volume or by frequency of occurrence (see Figs. 2 and 3). Muskrats, cottontails, and meadow mice comprised most of the mammals taken both by volume and by frequency (see Figs. 4 and 5). Muskrats easily took first place in the diet (see Tables 1 and 2) while cottontails and meadow mice were of lesser importance. It is interesting to note that meadow mice were not represented in the 1938 and 1939 stomachs (see Table 11) possibly indicating low populations in those years. The data for 1939 were limited since only 9 stomachs taken in that year were analysed. However, Blair (1940, p. 161) states that meadow voles were very scarce in southern Michigan in the summer of 1939 in contrast with their abundance in 1938 and it seems reasonable to assume that the decimation of the 1938 population may have occurred during the winter of 1938. The remainder of the mammalian food in the stomachs and intestines consisted of mice, shrews, moles, and one snowshoe hare. At present the snowshoe hare is known to occur only in the "thumb" region of lower Michigan. Since the specimen in which the snowshoe hare was found came from the northeastern part of the study area which lies close to the "thumb" it is presumed that the distribution of the snowshoe extends south from the "thumb" at least as far as Genesee county.

Items which were most useful in identifying the mammal remains to genera were such things as hair, teeth, and claws. Very few specimens contained bones or teeth which could be used for identification so that most of the identifications were based on cross sections, cuticular scale patterns, and medullary patterns of guard hairs. The characteristic shape and color of the claws were most useful for identifying mink in the stomachs and intestines.

Birds--Birds were not found as often in the intestines as in the stomachs (see Figs. 1 and 2). Remains of pheasants were found in five stomachs and two intestines and domestic chickens were identified in two stomachs and two intestines. Whether rated by volume or by frequency pheasants and chickens formed the largest percentage of the birds eaten. Pheasants are evidently an important food of the mink (see Tables 1 and 2) although stomach and intestinal analyses are at variance in this respect. Domestic chicken does not rank as a very important food item as compared with other items in the diet. A coot made up the entire contents of one stomach. Since the migration of the coot occurs in the fall it is very likely that the bird was a cripple. Ruffed grouse feathers were found in one intestine. Most of the unidentified birds were small passerines. One of them appeared to represent the remains of a cardinal but could not be identified with certainty.

Size, shape, and color pattern of feathers proved to be most useful for identification purposes when compared with known specimens. Sturgis' breast feather key to the orders of birds north of Mexico (Wight, 1939) was used to verify some of the identifications but could not always be used because of the action of digestive juices on the feathers and because of accumulations of grease and gummy protein wastes which could not be satisfactorily removed from the feathers.

Reptiles--Snakes occurred rather infrequently in both stomachs and intestines. Genera or families could not be determined due to digestive action upon the scales and because of the small size of the pieces which were found in the digestive tract.

Amphibians--The only amphibians which were found in the stomachs and intestines were frogs. Most of those which could be identified were either leopard frogs or green frogs. Other species which were identified were bullfrogs and a spring peeper.

The characteristic color pattern of the integument was the most useful criterion for determining species, while bones, feet, and skin were used to identify those items which were listed merely as "frogs".

Fish--It was found practical to identify fish only as far as the family because of the state of dissolution presented by most of the scales. Remains of smallmouth black bass and bluegills were recognizeable in a few cases and a miller's thumb was recognized by its characteristic otoliths but otherwise no specific identifications were made. The family Centrarchidae ranked first in both stomachs and intestines with Cyprinidae and Catastomidae next in order.

Crayfish--Crayfish appeared more frequently in the intestines than in the stomachs. Specific identification was impossible because of the thoroughness with which most of them had been chewed. The characteristic orange color of the hard chitinous pieces of exoskeleton and the fragments of the appendages made recognition easy.

Insects--Remains of insects were found in three intestines but none were identified in the stomach material. Elytra and appendages were most diagnostic. Under the binocular microscope the tarsal claws on the appendages were easily recognized. However, the items were too fragmentary to allow a specific identification to be made.

Other items--The remainder of the material recognized in stomachs and intestines was composed of nonfood items. It is possible that clams and other soft-bodied prey might be included in this category through failure to recognize them as such among the stomach and intestinal contents. However, until they can be identified in some way they must be omitted from the list of food items.

Check list of food items found in stomachs and intestines

Mammals

| | |
|---|---|
| Muskrat | *Ondatra zibethica zibethica* |
| Cottontail | *Sylvilagus floridanus mearnsii* |
| Meadow Mouse | *Microtus sp.* (probably *pennsylvanicus*) |
| Deer Mouse | *Peromyscus sp.* |
| Pine Mouse | *Pitymys pinetorum scalopsoides* |
| House Mouse | *Mus musculus musculus* |
| Brown Rat | *Rattus norvegicus* |
| Short-tailed Shrew | *Blarina brevicauda brevicauda* |
| Long-tailed Shrew | *Sorex sp.* |
| Prairie Mole | *Scalopus aquaticus machrinus* |
| Star-nosed Mole | *Condylura cristata cristata* |
| Snowshoe Hare | *Lepus americanus americanus* |

Birds

| | |
|---|---|
| Domestic Chicken | *Gallus domesticus* |
| Pheasant | *Phasianus colchicus torquatus* |
| Ruffed Grouse | *Bonasa umbellus umbellus* |
| Coot | *Fulica americana* |

Amphibians

| | |
|---|---|
| Green Frog | *Rana clamitans* |
| Leopard Frog | *Rana pipiens* |

| | |
|---|---|
| Bull Frog | *Rana catesbeiana* |
| Spring Peeper | *Hyla crucifer* |

Arthropoda

| | |
|---|---|
| Crayfish | *Cambarus sp.* |

## PARASITES AND DISEASES

From a wildlife management standpoint it is important to determine the role which various destructive factors play in regulating populations. There is still relatively little known concerning some of the parasites and diseases affecting some of our wild animals. Until quite recently the approach to the problem has been largely taxonomic. However, if population trends and cyclic phenomena in populations are to be correctly interpreted, the proportion of the population infected and the severity of the infections from year to year should be known. Food habits data will also shed valuable light upon the modes of infection and transmission of parasites in the population. It is not to be expected that parasites infecting animals in the wild state can be brought under control to any great extent but a knowledge of their distribution, incidence, life cycles, and modes of transmission may serve to prevent them from becoming a menace to ranch-bred animals.

An effort has been made in this study to determine the incidence of some of the more important parasites of the mink and to uncover evidence of a gross pathological nature which might indicate diseases occurring in wild mink. No doubt some parasites have been overlooked because of the techniques employed and preservation of the animals in formalin may have destroyed some of the pathological evidence. The incidence of microscopic parasites has not been determined because insufficient time did not allow for such close scrutiny of each specimen. A fecal sample was taken from about every tenth specimen and examined for ova and for small helminth parasites. A saturated sugar solution was mixed with the centrifuged fecal material in order to float the ova to the top of the solution whence they were removed to a slide by means of a small glass spatula. A gross inspection was made of all organs of the body for evidence of parasitism or disease.

The mink spends a good deal of its time in or near water and hence constitutes the normal host for a number of parasites which pass their intermediate stages in aquatic animals eaten by the mink. Different species of crustaceans, frogs, and fish no doubt act as intermediate hosts for the large assortment of flukes and roundworms which habitually infect the mink. In common with the muskrat, the mink has often been referred to as a virtual "museum of parasites". A fruitful field for parasitological research is open here, much of it being relatively untouched.

The incidence of some of the more important parasites of the mink is presented in Table 12. No significant difference in the incidence from one year to the next was found for any of these parasites (see Table 13). Apparently then, the mink may have been at the peak of its cycle, if it has a cycle, during these years since it is known that the incidence of parasitism shows an increase for some species when the population is declining.

The sinus worm, Skrabingylus nasicola, appeared to be the most common parasite of the mink. This worm occurs in the frontal sinuses of the animal and is frequently overlooked. In heavy infestations the frontal sinuses were noted to be inflated and discolored by the mass of worms within. In one mink 45 of these worms were recovered from the two sinuses although the usual number found more closely approximated a dozen. In one or two instances the worms had apparently bored through the wall of the sinus into the overlying muscle. Perhaps the high incidence of this parasite may account for the difference in temperament

Table 12.

Incidence of some helminth parasites found in trapped mink taken during the trapping seasons of 1940 and 1941. (1

| Species | Year | Number infected | Incidence | Average incidence for the two year period |
|---|---|---|---|---|
| Skrabingylus nasicola | 1940 | 32 | 100.00% | 93.67% |
| | 1941 | 116 | 92.06% | |
| Filaroides bronchialis | 1940 | 3 | 9.37% | 18.98% |
| | 1941 | 27 | 21.42% | |
| Paragonimus kellicotti | 1940 | 2 | 6.25% | 9.49% |
| | 1941 | 13 | 10.31% | |
| Physaloptera sp. | 1940 | 0 | 0.00% | 3.79% |
| | 1941 | 6 | 4.76% | |
| Dioctophyme renale | 1940 | 1 | 3.12% | 2.53% |
| | 1941 | 3 | 2.38% | |

(1. 32 mink were autopsied in 1940 and 126 were autopsied in 1941.

Table 13.

Tests of significance of the difference in percentage of infestation with some helminth parasites of mink taken during the trapping season of 1940 and 1941. (1

| Species | No. of mink parasitized in 1940. (2 | No. of mink parasitized in 1941. (3 | $X^2$ Value |
|---|---|---|---|
| Skrabingylus nasicola | 32 | 116 | 1.10 |
| Filaroides bronchialis | 3 | 27 | 2.41 |
| Paragonimus kellicotti | 2 | 13 | .49 |
| Physaloptera sp. | 1 | 3 | .06 |
| Dioctophyme renale | 0 | 6 | .... |

(1. The number of parasitized individuals for each year has been compared with the number of unparasitized individuals.

(2. 32 mink were autopsied in 1940.

(3. 126 mink were autopsied in 1941.

shown by wild and domesticated mink. The ferocity which is generally ascribed to the mink in the wild, as contrasted to the friendliness shown by domesticated mink, might well be attributed to the presence of these worms. It is unlikely that these worms would harm the mink as long as they were confined to the sinuses but their movements and borings might cause the mink excruciating pain and account in part for its supposedly diabolical nature. The sinus worm of the mink was originally described as Filaroides mustelarum but has recently been assigned a new species name and transferred to the genus Skrabingylus. No life history study has been made of this parasite as yet to the best of my knowledge. In view of its importance it would seem to offer a worthwhile problem for parasitological research.

Lungworms, Filaroides bronchialis, are perhaps the next most common nematode parasites of the mink (see Fig. 9). They occur as small, compact knots of closely intertwined worms lying below the mucosa of the trachea and bronchi and also occur on the surface of the pulmonary vein. Because of the difficulty encountered in the removal and clearing of these worms a study of their morphology has not been attempted by anyone to date. As many as six cysts were found in the lungs of one mink. The incidence of this parasite may perhaps be somewhat higher than indicated since some very light infections may possibly have been overlooked.

The lungfluke, Paragonimus kellicotti, which is an occasional parasite in the lungs of cats, dogs, and pigs finds its natural definative host in the mink. Various species of crayfish belonging to the genus Cambarus constitute the second intermediate host while the snail, Pomatiapsis lapidaria, is the first (Ameel, 1934). Wallace (1931)


Figure 9. Lungworms, <u>Filaroides bronchialis</u>, in the lungs of a mink (courtesy of the Michigan Department of Conservation).

reports snails of the genus Melania as constituting the first intermediate host. An incidence of 8.09 percent is reported by Wallace (1931) from 84 carcasses received from fur farms in Minnesota. This compares closely with the incidence of infection found in wild mink but the mode of infection of the ranch-bred mink is obscure. Perhaps crayfish in the stomachs of raw fish fed to the ranch mink may have been the source of infection. Ova of this species were detected in a number of the fecal samples. All of the specimens in which ova were detected also contained the adult flukes. The large cysts in which the flukes were located were easily recognized. As many as four cysts were found in the lungs of one mink with as many as six flukes to a cyst. However, the usual number of cysts found in the lungs was one.

Larval and adult Physaloptera sp. were found in the stomachs of six mink, the identification being furnished by Mr. J. T. Lucker of the Bureau of Animal Industry. As many as ten of these roundworms were found in one stomach. In one of the animals which was heavily infected with this parasite the wall of the stomach had evidently undergone hypertrophy and was very much thickened.

The giant kidney worm, Dioctophyme renale, (see Fig. 10) was found in only four of the 158 mink which were autopsied. In one instance an atrophied and totally degenerated kidney suggested a possible former infection. Though not occurring as frequently as other parasites this worm is probably more destructive in the wild because of the total damage which it inflicts upon the infected organ. A compensatory hypertrophy of the uninfected kidney was noticed in some of the parasitized animals. One of the kidney worms was found free in the abdominal cavity. A large urinary calculus was found in one kidney associ-

Figure 10. A mink infected with the giant kidney worm, <u>Dioctophyme renale</u>. The infected kidney is opened to show the worm in place (courtesy of the Michigan Department of Conservation).

ated with one of the kidney worms. Another urinary calculus was found in an unparasitized kidney. Recent investigations have shown that vitamin A deficiencies, by creating improper elimination of various inorganic elements such as lime, may be responsible for the formation of urinary calculi in ranch mink (Shillinger, 1937). Holmes, Tripp, and Satterfield (1938) have shown, however, that the vitamin A reserve in wild mink is far above that of ranch-bred animals. It would seem then that mechanical obstructions by parasites are chiefly responsible for the occurrence of urinary calculi in wild mink.

Knowledge of the giant kidney worm in the mink dates back for some time. Seton (1926, p. 549) recounts the story of a Maine trapper who found two or three of these worms in the kidney of a small female mink. Little is yet known of the life cycle of this important parasite. Dr. Woodhead, of the University of Michigan, who has been working on its life history for some time, has traced one of its intermediate stages into a small annelid worm which is parasitic on crayfish but has not yet succeeded in tracing the entire life cycle.

Several other parasites have been recorded for the mink in this study. Some of these were of infrequent occurrence, and hence are probably of little importance while others which were detected through analysis of fecal samples may have been important although their numbers and incidence were not ascertained.

A tapeworm taken from the intestine of one of the mink was identified by Mr. Allen McIntosh of the Bureau of Animal Industry as *Mesocestoides sp.*

Eggs of *Capillaria sp.* were frequently noted in the fecal samples along with larvae and adults. An adult female roundworm of this genus was recovered from one of the stomachs. Coccidia, Isospora bigemina, were also encountered quite frequently in the fecal samples. Coccidia are probably to be considered as important parasites of wild mink. Heavy infestations have often been noted to end in the death of ranch-bred animals and the same would probably hold true for wild mink. The greenish colored mucous which was noted in the intestines of several of the mink was probably an indication of coccidiosis.

A possible symptom of infection with the gall bladder fluke, Parametorchis canadensis, was indicated by the jaundiced appearance of several of the mink examined. Heavy infestations of this parasite are often indicated by a jaundiced appearance due to obstruction of the bile duct by the parasite (Hanson, 1933).

Some secondarily acquired parasites were also noted in stomachs and intestines. Immature Pomphorhynchus bulbocolli, which is a frequent acanthocephalan parasite of suckers, were identified in the intestines of one mink associated with sucker remains. About a dozen of the parasites were recovered. Agamascaris odontocephala, which is a fairly common nematode parasite of frogs was found in the stomach of one animal along with some partially digested frog remains. Two specimens were recovered.

A number of other parasites occurring in the mink have been reported by various workers. Benbrook (1940) reports the occurrence of the guinea worm, Dracunculus medinensis, in a mink. Hanson (1933) states that trichinae are occasionally found in the mink and also reports spinyheaded worms, Gnathostoma spinigerum, as occurring in wild mink. Skinker (1932) reported Molineus patens from a mink in Mississippi. The morphology and life cycle of Euryhelmis monorchis has been worked out by Ameel (1938), while Wallace (1932) has worked out the life cycle of Troglotrema mustelae. Price (1929) has determined a new species of trematode Parametorchis canadensis in the mink. Law and Kennedy (1932) report on a number of parasites which have been identified in the mink. Among these are Strongyloides sp., Ascaris sp., Filaria sp., Plagiorchis proximus, Euparyphium melis, Euparyphium inerme, Alaria mustelae, and Taenia sp. Shillinger (1940) has reported heavy losses in ranch mink from grubs, Wohlfartia vigil. Hanson (1933) mentions fleas, Ceratophyllus vison, and lice, Trichodectes retusus, as being found on wild as well as domesticated mink.

Very little evidence of a pathological nature was found in the mink examined. It seems very likely that mink suffering from diseases in the wild would seldom be caught unless the disease was in its incipient stages. The only evidence of a pathological sort was the jaundiced appearance of several of the mink. As previously mentioned this jaundice might be associated with the presence of the gall bladder fluke, Parametorchis canadensis. There is a possibility that the jaundice could have been caused by a paratyphoid infection which is often found in domestic mink. Failure to eliminate bile is often associated with this disease.

A number of diseases affect ranch mink which may find their counterpart in wild mink. However, many of these diseases are the result of crowded conditions and improper sanitation so that the incidence in the wild would probably be much lower. Distemper and anthrax are common diseases among domesticated mink with which the rancher has to contend. Other diseases of rarer occurrence are also found in domesticated stocks. Lewis (1929) reports a case of hemmorrhagic septicemia while Hall and

Stiles (1938) have reported the death of 146 out of 148 mink on a fur farm near Denver, Colorado from botulism. Law and Kennedy (1934) have reported cases of nutritional anaemia in the mink which they attribute to lack of liver in the diet.

## BREEDING

Most authors are agreed that mating takes place during the latter part of February and in March with the young being born from April to May. There are usually five to six young in the average litter although this number varies from three to ten. There is but one litter a year. The length of the oestrum which occurs but once a year is not definitely known although some information concerning this should be forthcoming from Enders' work. The gestation period generally extends for 45-60 days. Lohr (1937) has recorded a gestation period of 69 days.

No evidence was uncovered in this study which might possibly refute any of the above statements. The reproductive tracts of all of the females examined appeared to be normal in every respect. That is there appeared to be no evident signs of breeding. Histological sections of the testes of twelve mink taken in 1940 showed the presence of no mature spermatozoa although the testes ranged greatly in size. It must be concluded from the above evidence that no breeding takes place during December although the approach or onset of the oestrum may possibly take place during this month. A difference in behavior of the males and females at this time was reflected both in food habits and in sex ratio.

A marked disparity in the sex ratio occurred during December 1940 and 1941 as indicated from trapped mink collected during that month. This ratio is not necessarily an indication of an unbalanced ratio in the population itself but more likely it indicates a differential activity of the two sexes during the trapping season. Of the total of 158 mink examined 62 were females and 96 were males or a ratio of 1:1.54. The disproportionate ration might be accounted for in several ways.

The most plausible theory would seem to be that the males having a greater cruising radius (Marshall, 1936) would encounter and enter more traps than would the females. The psychology of the two sexes might also enter in. Males might conceivably be bolder and less wary than the females and hence would be caught oftener. The unbalanced ratio might also indicate the onset of the oestrous cycle in the female. It is known that the females tend to be more retiring and wary and go into hiding at this time. Therefore one would expect fewer females than males to be trapped. Likewise male animals are known to range more widely previous to and during the breeding season, possibly in search of mates. Such a tendency would serve to upset the ratio further. Apparently then, for lack of information of a more definite sort, the unbalanced sex ratio must be attributed to a differential activity of the two sexes and a difference in behavior of the two sexes at this particular time of the year.

The ovaries of 32 female mink were measured. The average width of these was 5.5 mm. and the average length was 8.9 mm. Volumetric measurements were inexact because the ovaries were two small to allow for an accurate measurement of the amount of water they displaced. Those measurements of volume which were taken ranged from one to two milliliters. The testes of 68 males were measured and the volume determined. The average volume was .88 ml., the average width was 10.3 mm., and the average length was 17.8 mm. A frequency distribution of the testes volume is shown in Figure 11. The marked skewness to the left would seem to indicate either that relatively few of the males were approaching breeding condition at this time or that a large number of young males which were not fully mature comprised a large proportion of

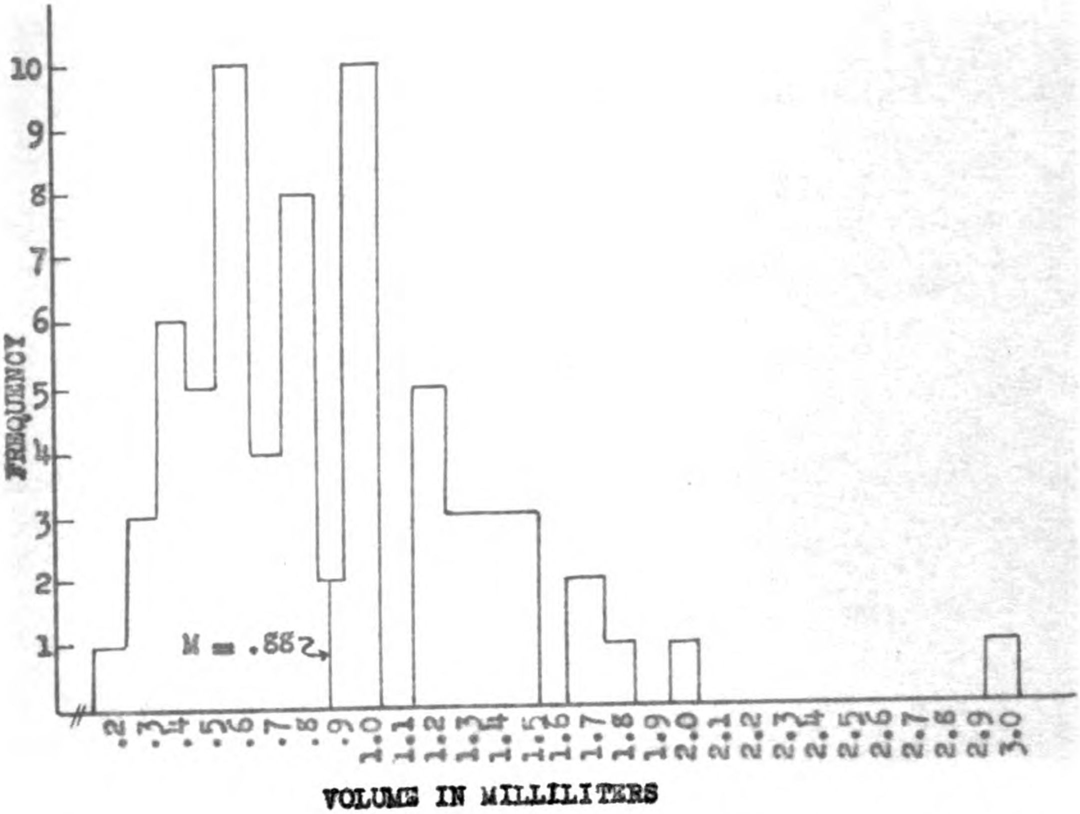



Figure 11. Frequency distribution of testes volume of 68 mink.

the population. Since known ages are lacking for all of the specimens, any suggestion relative to age ratios in the population must be regarded as purely speculative.

# WEIGHTS AND MEASUREMENTS

There is very little published information on weights and measurements of the mink (*Mustela vison mink*). Average measurements as given by Dice (1927), Lyons (1936), and others are subject to inaccuracies because of the small number of animals involved. In order to furnish more information along this line measurements were taken on 157 mink of both sexes. The summarized results of these measurements are given in Tables 14 and 15.

The possibility that a significant difference might occur in the body measurements of mink collected in 1940 as compared to those collected in 1941 was investigated. A calculation based on the standard error of the difference between the means was used. A significant difference on a five percent level (a difference which would be due to chance in only about one out of twenty times) was found between the tail lengths of males collected in 1940 and those collected in 1941. Since none of the other body measurements of either sex were significantly different for the two years it seems probable that the difference was due to an error in sampling. The measurements for the two successive years can thus be safely averaged together since the characteristics of the population in regard to measurements appear to have remained constant over the two year period. A highly significant difference in the weights and measurements of males as compared to females is true of the mink as well as of a number of other mustelids. No significant difference was found, however, between the ear measurements of male and female mink.

All of the weights given in Table 14 are based on skinned specimens. A means of approximating the actual weight of the animals was sought in

Table 14.

Summary of the weights and measurements of 157 mink collected in southern Michigan.

| | Males | | | | Females | | | |
|---|---|---|---|---|---|---|---|---|
| Measurement | Mean | Range | $\sigma$ | Number averaged | Mean | Range | $\sigma$ | Number averaged |
| Weight in grams | 851.06 | 419.50 to 1332.0 | 175.09 | 95 | 453.82 | 234.00 to 650.00 | 66.95 | 60 |
| Total length in millimeters | 571.25 | 485.00 to 659.00 | 35.02 | 84 | 483.48 | 440.00 to 526.00 | 17.38 | 58 |
| Tail length in millimeters | 200.55 | 160.00 to 250.00 | 15.48 | 85 | 167.13 | 140.00 to 190.00 | 9.12 | 58 |
| Length of hind foot in millimeters | 59.70 | 50.00 to 70.00 | 3.87 | 91 | 50.13 | 45.00 to 55.00 | 2.16 | 61 |
| Ear length in millimeters | 25.10 | 20.00 to 28.00 | 2.07 | 10 | 22.20 | 20.00 to 24.00 | 1.83 | 5 |

Table 15.

Summary of the skull measurements of 126 mink collected in southern Michigan.*

| | Males | | | | Females | | | |
|---|---|---|---|---|---|---|---|---|
| Measurement | Mean | Range | $\sigma$ | Number averaged | Mean | Range | $\sigma$ | Number averaged |
| Condylobasal length | 64.82 | 54.70 to 73.00 | 3.52 | 77 | 58.17 | 54.00 to 61.00 | 2.18 | 50 |
| Least interorbital width | 15.24 | 12.00 to 17.70 | 1.12 | 77 | 13.44 | 12.00 to 14.80 | .57 | 50 |
| Mastoidal breadth | 31.74 | 28.00 to 36.00 | 1.82 | 75 | 27.73 | 25.00 to 29.00 | .97 | 50 |
| Length of upper molar-premolar row | 16.58 | 11.50 to 19.50 | 1.14 | 75 | 15.15 | 14.00 to 17.50 | .59 | 48 |

* All measurements are in millimeters

Table 16.

Tests of significance of the difference in body measurements of mink collected in 1940 as compared to those collected in 1941.

| Measurement | Sex | Year | Number of measurements | Mean | σ | Value |
|---|---|---|---|---|---|---|
| | Female | 1940 | 15 | 460.71 | 43.94 | .46 |
| | Male | 1941 | 45 | 451.55 | 73.55 | |
| Weight in grams | | | | | | |
| | Female | 1940 | 17 | 810.41 | 170.89 | .10 |
| | Male | 1941 | 78 | 857.35 | 169.91 | |
| | Female | 1940 | 15 | 482.80 | 16.43 | .18 |
| | Male | 1941 | 43 | 483.72 | 17.68 | |
| Total length in millimeters | | | | | | |
| | Female | 1940 | 16 | 556.75 | 12.67 | 2.15* |
| | Male | 1941 | 68 | 574.66 | 32.75 | |
| | Female | 1940 | 15 | 163.40 | 7.46 | 1.88 |
| | Male | 1941 | 43 | 168.44 | 9.40 | |
| Tail length in millimeters | | | | | | |
| | Female | 1940 | 16 | 198.13 | 19.11 | .70 |
| | Male | 1941 | 69 | 201.10 | 14.17 | |
| | Female | 1940 | 15 | 49.99 | 2.27 | .30 |
| | Male | 1941 | 46 | 50.18 | 2.12 | |
| Hind foot length in millimeters | | | | | | |
| | Female | 1940 | 15 | 58.46 | 4.42 | 1.40 |
| | Male | 1941 | 76 | 59.94 | 3.66 | |

* Five percent significance

order to make comparison with actual weights possible. An opportunity was obtained to weigh fifteen specimens before they were skinned. The loss in weight was then determined by subtracting the weight of the preserved specimen from the actual weight. A slight but not appreciable gain in weight was observed for two specimens which were weighed fresh before being put into formalin so that for all practical purposes the loss in weight as determined by subtracting the preserved weight from the actual weight represents the actual loss in weight. A predicting equation based on linear regression was used to determine the weight loss due to skinning (see Table 17). Using the regression equation, $Y = a + b(X)$, the values of (a) and (b) were determined by the normal equations:

$$(1)\ \Sigma(Y) = Na + b\Sigma(X)$$

$$(11)\ \Sigma(XY) = a\Sigma(X) + b\Sigma(X^2)$$

Solving for the equations the regression coefficient (b) was found to be .268 and the correction factor (a) was found to be -64. The theoretical loss in weight may then be determined by substituting the values of (a) and (b) into the formula, $L = a + b(X)$. The standard error of estimate which is the measure of variation about the line of regression was determined by using the formula, $Sy = \sqrt{\frac{\Sigma(d^2)}{N}}$. Solving for Sy the value of 48.7 was obtained. The corrected formula for theoretical loss in weight is then, $L = a + b(X) \pm 48.7$ gr.

Identification of sex by measurements

Marshall (1936) has proposed a census technique for determining mink populations which is based on measurements of tracks of the hind feet in fresh snow. This involves the assumption that the lengths of the hind feet of the males and females fall into two distinct groups

Table 17.

The determination of the predicting equation for weight loss due to skinning.*

| Actual loss of weight due to skinning<br>Y | Weight after skinning<br>X | Theoretical loss of weight due to skinning<br>Yc | Deviation of actual values from the theoretical (Y-Yc)<br>d | $d^2$ |
|---|---|---|---|---|
| 122.0 | 1040 | 218.6 | -96.6 | 9331.56 |
| 154.0 | 923 | 184.9 | -30.9 | 954.81 |
| 56.0 | 412 | 42.3 | 13.6 | 184.96 |
| 63.0 | 589 | 91.7 | -28.7 | 823.69 |
| 85.5 | 459 | 55.4 | 30.1 | 906.01 |
| 156.0 | 1132 | 243.2 | -87.2 | 7603.84 |
| 221.0 | 953 | 193.3 | 27.7 | 767.29 |
| 163.0 | 813 | 154.2 | 8.8 | 77.44 |
| 115.0 | 727 | 130.2 | -15.2 | 231.04 |
| 85.0 | 516 | 71.4 | 13.6 | 184.96 |
| 141.0 | 750 | 136.7 | 4.3 | 18.49 |
| 333.5 | 1116 | 238.8 | 94.7 | 8968.09 |
| 45.0 | 457 | 54.9 | -9.9 | 98.01 |
| 145.5 | 802 | 151.2 | -5.7 | 32.49 |
| 303.5 | 1061 | 223.4 | 80.1 | 6416.01 |
| 2189.0 | 11750 | | | 36598.69 |

$\Sigma(XY) = 1,952,839$; $\Sigma X^2 = 10,191,992$

* Weights are in grams.

which are clearly separable upon the basis of measurements. Since the population estimate is based upon the female territories found in a unit area it is essential that the tracks of males and females be distinguishable from each other to render the census technique valid.

In order to test the validity of Marshall's method the frequency distributions of the hind foot measurements of 154 minks of both sexes were graphed (see Fig. 12). It is true, as Marshall has stated, that there is a significant difference in the means of the two groups but he ignores the distinct overlap which occurs in the distribution of hind foot measurements of the two sexes. 21.5 percent of the males measured overlapped into the distribution of the females while 57.5 percent of the females measured overlapped into the distribution of the males. In the area of overlap the measurement can not be definitely assigned to either sex although the probability of its being one or the other can be demonstrated. The comparative chances which a given measurement of the hind foot has of being either a male or a female is shown graphically in Figure 13. The ordinates of the (t) values for the normal curves of the male and female distributions have been converted to percentages on the graph for a more ready comparison. The number of animals which can be determined as males with some degree of certainty is seen to be greater than that of the females. Since the census technique which Marshall has proposed is based largely upon the accurate determination of female tracks in the field it appears that the method is subject to a considerable margin of error. Any measurement which falls into the area of overlapping distributions of the two sexes could very easily be misidentified in the field. Hence it seems that the census technique as proposed by Marshall is unreliable. In any

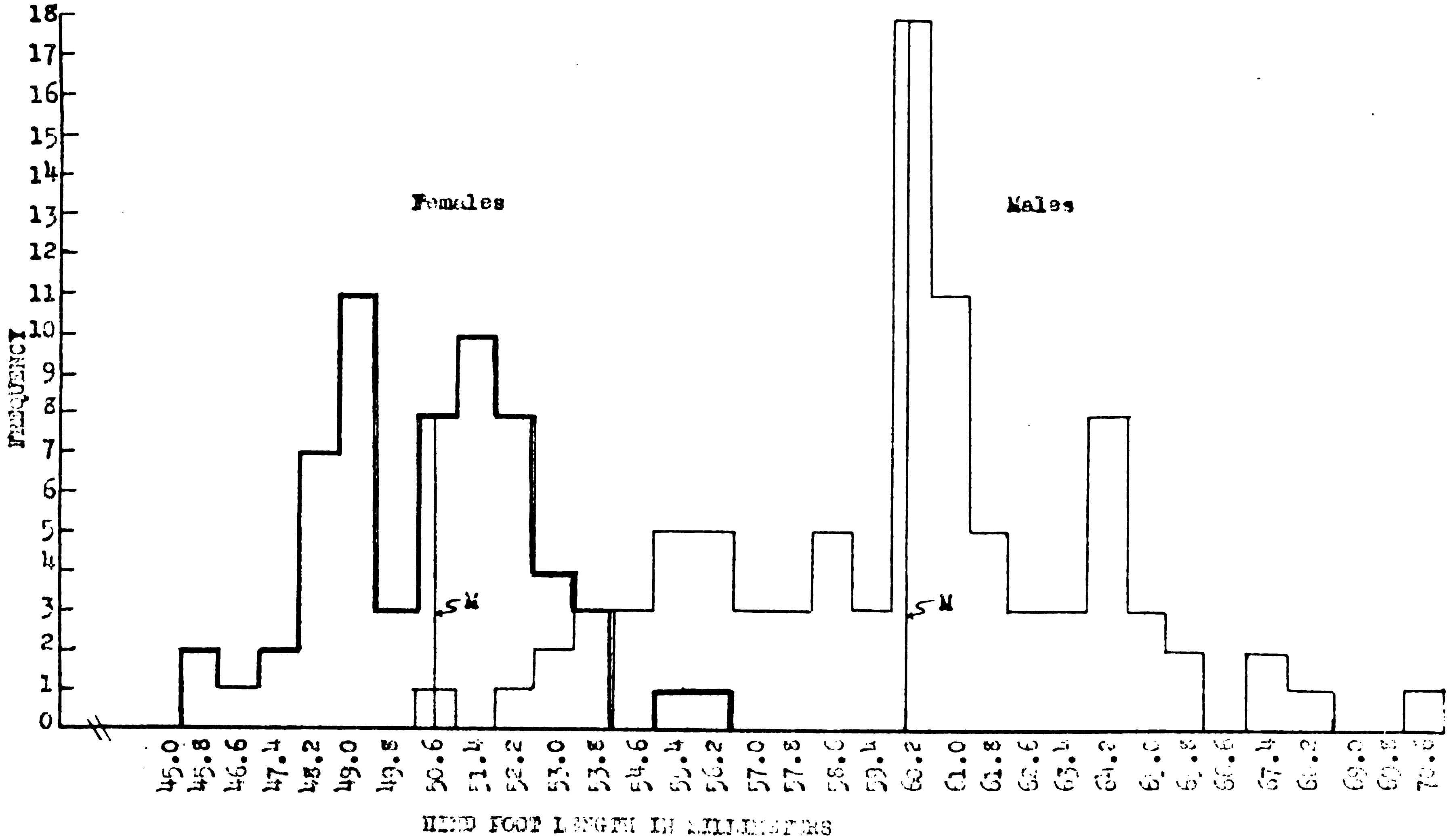



Figure 12. Frequency distribution of hind foot measurements of 61 female and 93 male mice.

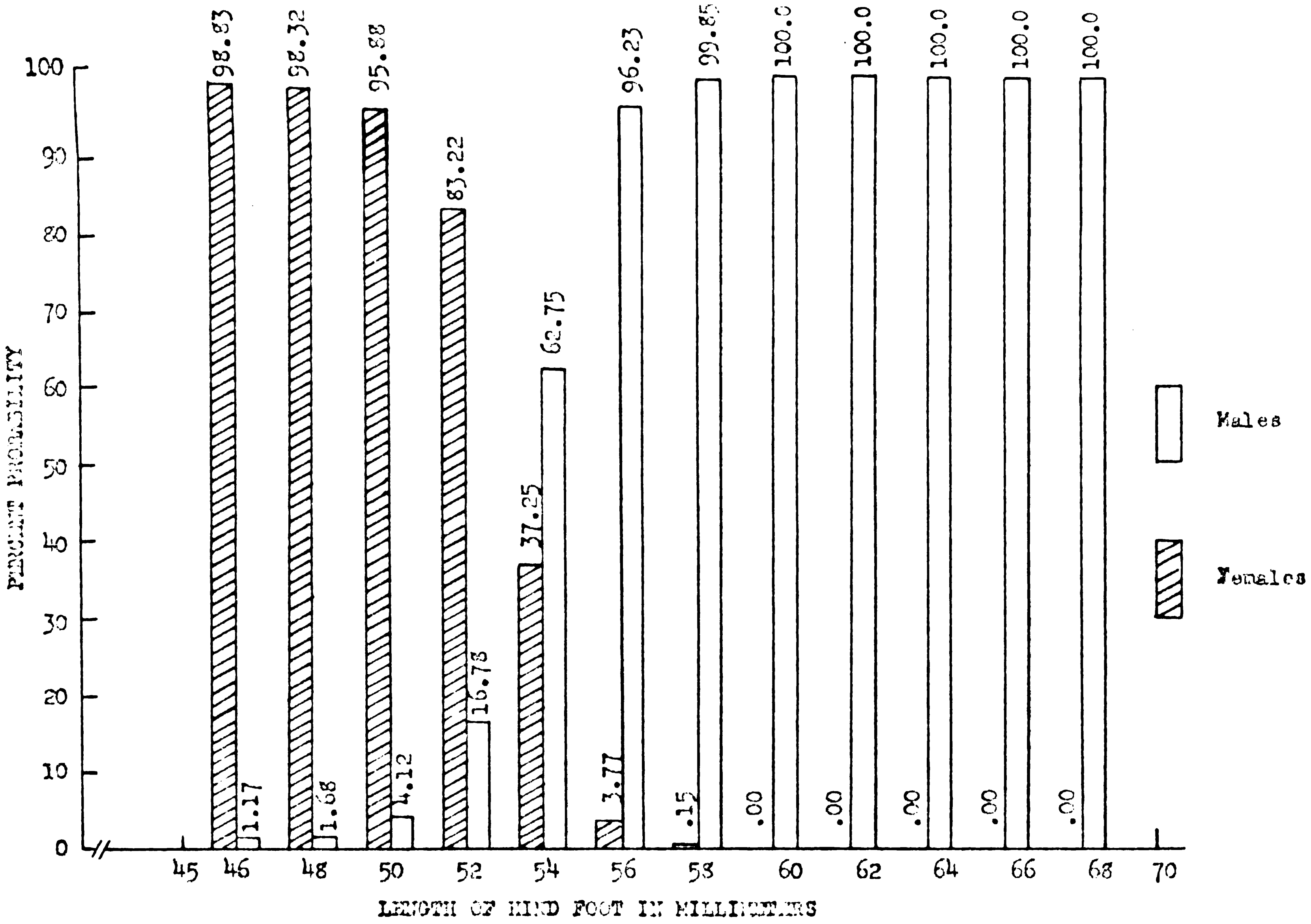



Figure 13. Graph showing the comparative chances which an animal at a given measurement has of being a male or female.

event a great deal of caution must be used in interpreting the results of the method if it is followed.

Separation of age groups

Reliable age criteria are of definite value in evaluating breeding populations and in analysing the kill of trapped animals. Criteria which are most useful for determining age are those which are based on external measurements or superficial appearances, e.g. the condition of the teeth, mammary glands, or external genitalia. Evidences denoting breeding are often used to separate adults from juveniles but since the trapping season on mink occurs prior to the breeding season indications of this sort are meagre. Any separation of the population into age groups must then be based upon body measurements. No references pertaining to growth rates of mink (with the exception of Svihla (1931) who has given weights for the first 50 days growth) could be found in the literature so that no correlations of observed measurements with known ages could be made. Therefore any age criteria and age groupings proposed here must be considered as tentative in view of the obvious lack of information on growth of the mink.

The frequency distributions of body measurements and skull measurements were graphed to see if any of the measurements would fall into natural age groupings. All of the body and skull measurements, however, seemed to follow a normal distribution. A small degree of skewness in some of the distributions suggested that the measurements may have been affected by age. Burt (1936, p. 146) and Sprague (1939, p. 495) have commented on the noticeable age variation which is apparent in the bacula of mice of the genera Perognathus, Dipodomys, and Peromyscus. The possibility suggested itself that this might also hold true for the mink. Measurements were taken on the bacula of a number of mink and these data are summarized in Table 18. It was noted that the proximal ends of some of the bacula were incompletely ossified and appeared to be less bulbous than others. These bacula presumably belonged to young animals. Measurements of the base of the bacula when graphed showed a bimodal type of distribution. This was more pronounced for the measurement of the lateral diameter of the base than for the dorso-ventral diameter. The frequency distribution of the measurements of the lateral diameter of the base of the bacula is shown in Figure 14. A similar grouping was found when the frequencies of the weights of the bacula were graphed (see Fig. 15). A scatter diagram of the lateral diameter of the bacula when plotted against the weight showed a close correlation between the two measurements. The linear measurement then serves as a good index to the weight which is really the more accurate measurement of the two.

Two overlapping age groups seem to be indicated by the frequency distributions of baculum measurements. The largest group shows a definitely skewed distribution and therefore is probably composed of one and two year old animals while the smaller group may represent animals which are older than two years. Most of the measurements of the lateral diameters of the bacula in the first group lie within a fairly narrow range of from 2.0 mm. to about 2.7 mm. These measurements presumably represent the young of the year that have grown rather rapidly and at about the same rate. The ratio of the presumed one and two year olds to those which are probably older is about 4:1. Those in the first group which are presumably young of the year are in the ratio of about 3:2 to the other individuals in that group so that apparently the young

Table 18.

Summary of baculum measurements of 80 mink collected in southern Michigan.

| Measurement | Mean | Range | | Number averaged |
|---|---|---|---|---|
| Weight in grams | 212.40 | 110.0 to 464.0 | 76.11 | 76 |
| Length in millimeters | 40.78 | 35.5 to 46.0 | 2.39 | 80 |
| Dorso-ventral diameter of base in millimeters | 4.03 | 2.7 to 6.4 | .93 | 77 |
| Lateral diameter of base in millimeters | 2.97 | 2.0 to 5.4 | .85 | 77 |
| Dorso-ventral diameter of shaft in millimeters | 2.33 | 2.0 to 3.1 | .84 | 77 |
| Lateral diameter of shaft in millimeters | 2.92 | 2.5 to 3.4 | .20 | 77 |

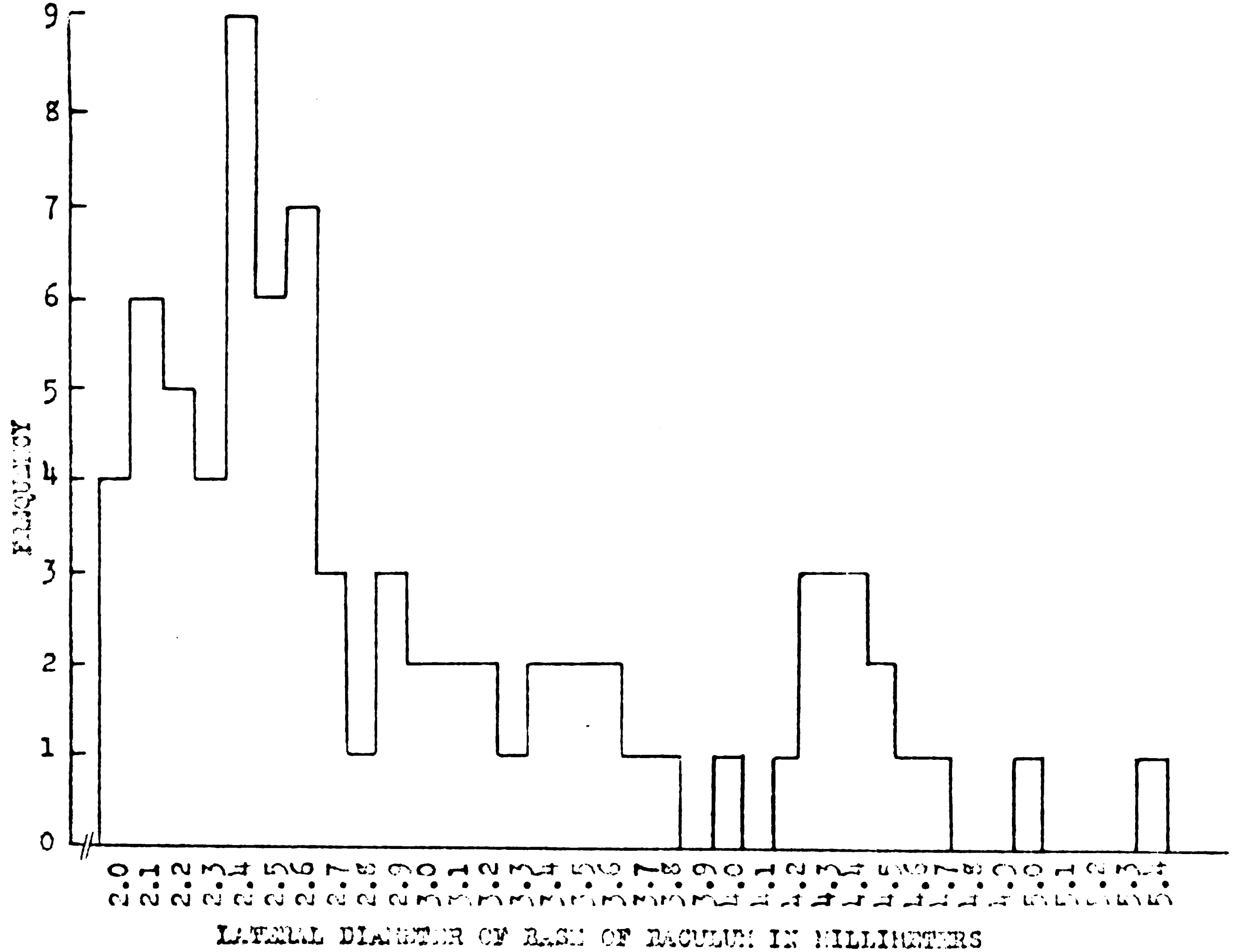



Figure 14. Frequency distribution of the lateral diameters of the base of the bacula of 77 mink.

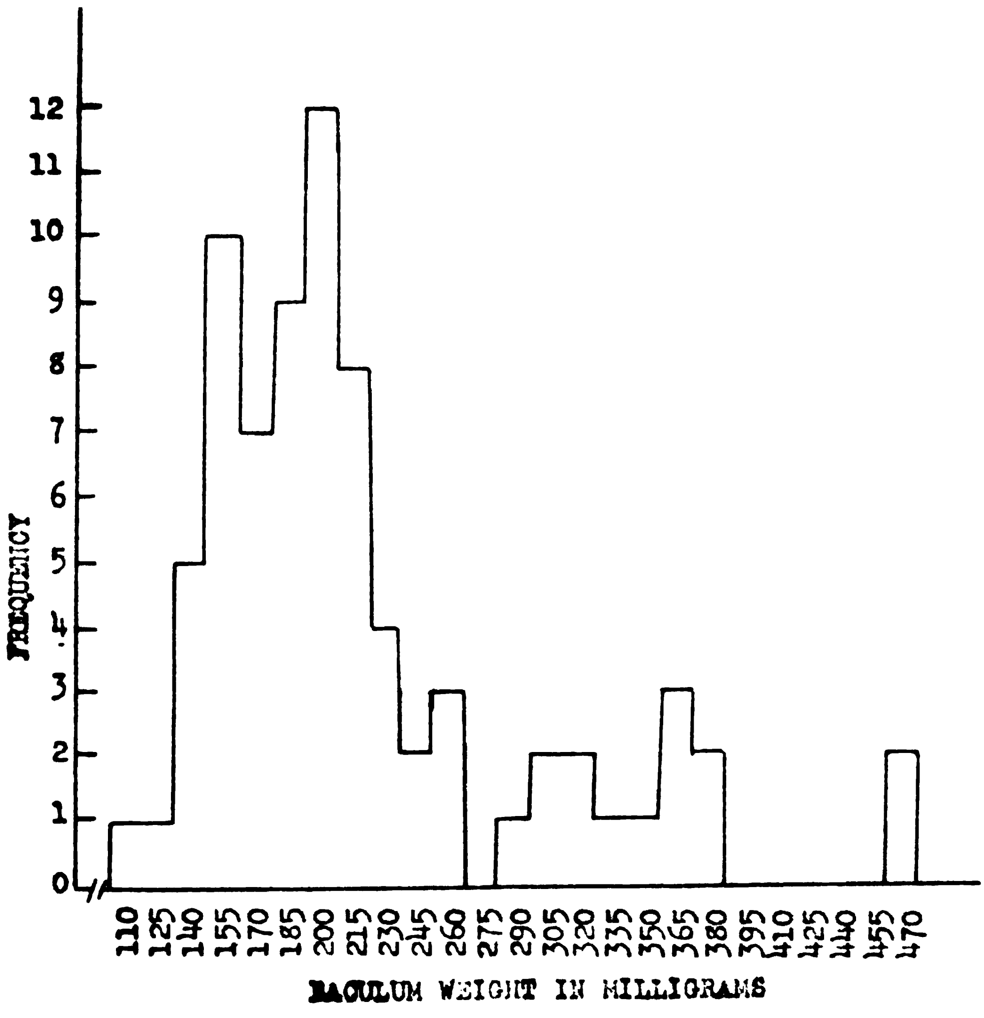



Figure 15. Frequency distribution of the weights of the bacula of 76 mink.

of the year constitute about half of the entire population. This large ratio might account for the rapid increases in the population from year to year as indicated by records of the computed kill during the trapping season.

On the basis of the above evidence it appears that at present measurements of the bacula of considerable numbers of individual mink provide the best criterion for age determination of animals taken out of the breeding season. Some confirmation of age can also be obtained by examining the teeth for signs of wear due to age.

## SUMMARY

1. Mammals constituted well over half of the contents of both stomachs and intestines of winter mink whether rated by bulk or by frequency percentages. The relative percentages by volume and by frequency of other classes of animals varied in the stomachs and intestines.
2. Muskrat was the most important individual prey item represented in both stomachs and intestines with cottontail being the second choice. Mice, birds, frogs, fish, and crayfish were also important constituents of the winter diet. Nonfood items included in the diet were amorphous mixtures of dirt and black protein waste, vegetation, and trap debris.
3. A differential rate of passage of hard and soft parts of prey items was indicated. Hard parts appeared to be passed into the intestines more rapidly than soft parts as shown by a significantly greater occurrence of hard parts in the intestines as compared to the stomachs and a significantly greater occurrence of soft parts in the stomachs as compared to the intestines.
4. Sex differences in selection of prey items were apparent. Males took a significantly greater number of muskrats than did females while females took a significantly greater number of smaller food items than did males. Factors which may effect these differences such as the size disparity of the two sexes, greater cruising radius of the males, unbalanced sex ratio, and approach of the breeding season have been considered.
5. The mink appears to be an important natural predator of the muskrat. Mink-muskrat relations are considered. Frogs and small mammals seem to act as buffers against predation by the mink upon the muskrat.

6. The incidence of a number of parasites of the mink was determined. The sinus worm, Skrabingylus nasicola, appeared to be the most common parasite and lungworms, Filaroides bronchialis, lungflukes, Paragonimus kellicotti, and the giant kidney worm, Dioctophyme renale, also appeared to be of considerable importance.

7. Little evidence of disease in wild mink was found. A jaundiced appearance of several of those which were autopsied may indicate paratyphoid infection but is also an indication of the presence of the gall bladder fluke, Parametorchis canadensis.

8. An unbalanced sex ratio of trapped mink occurred during the trapping month of December. Differential activity of the two sexes at this time may account for the unbalanced ratio.

9. No evidence of breeding in either sex was found.

10. Weights and measurements were taken of mink collected in 1940 and 1941. The measurements for 1940 as compared to 1941 showed no significant differences with the exception of tail length. The significant difference in tail lengths of males is thought to be due to an error in sampling.

11. Marshall's census technique based on measurements of tracks of males and females has been found to be invalid.

12. Baculum measurements appear to offer the best criterion of age of mink trapped out of the breeding season. Tentative age groupings are proposed on the basis of these measurements.

## CONCLUSIONS

Since the nature of this study has limited its scope somewhat the picture which is presented may appear one-sided in some respects. Ideally, field observations should supplement those made in the laboratory in so far as possible in investigations of this kind. The evidence as found may then be evaluated and interpreted on a broader basis. However, in spite of the limitations imposed, some knowledge has been gained which may be useful in determining management policies and in deciding upon the economic status of the mink.

A reasonably clear conception of the winter food habits of the mink has been obtained. The mink appears to be an important predator upon the muskrat and a more thorough study of mink-muskrat relationships would be in order. The economic value which the mink possesses both from the standpoint of fur value and its effect on small mammal populations should also be appraised more completely.

Some indication of the role which parasites and diseases may play in wild mink has been gained from this study. However, a continued study over a period of years should be made in order to determine the part which these factors play in regulating the population.

Very meagre data regarding breeding were obtained in this study. A more adequate knowledge of this is needed for the mink. The writer does not know how far along Enders of Swarthmore is with his investigations at the present time but the paucity of accurate information in the literature attests to the necessity for this type of research.

The growth of the mink should be studied. In order to properly determine age groups and age ratios in a population growth data is essential. At present measurements can not be compared directly with known ages and hence any information along this line must be deduced by analysis of the measurements themselves which may lead in some instances to some tangible errors.

In some respects the evidence in this study has been rather inconclusive but enough information has been gained from it to point out further avenues of investigation which appear to be worthwhile. The present study, which has been somewhat preliminary in nature, suggests that before any sound management policies can be put into effect additional studies of this important fur-bearer must be made.

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# APPENDIX

SPECIMEN RECORD

Cat. No..........
Coll. No.........
Date.................

Species.................................Date Collected.................

__found dead__shot__trapped__trail set__________bait. Collector..........

Locality...........................T....R....S....County.........State....

Habitat:
Weather:
Ecological Notes:

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Spec. Exam:__wild__dead__captive__alive__entire__partial. Specimen No........

Sex....Ad__Juv__, determined by......................................

Weight...........live__dead__preserved__, condition........................

Body measurements..................................................

Skull measurements.................................................

Condition of teeth

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Testes: Volume................measurements..................condition....

Penis: Condition....................baculum measurements................

Vulva...............Cop. plug............Mammae.........................

Vagina..............vag. smear...............Uterus...................

Embryos: No..........R. Horn....L. Horn....Size; mm..........Approx.......

Ovaries: Volume..............measurements..............condition..........

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Pathology

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Ectoparasites: Location........................No......__attached__free.

Species..................................................................

Endoparasites:

| Location | Parasite | Number |
| --- | --- | --- |

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Pelage

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General Notes

# FOOD HABITS

Date....................

Species....................................Coll. No...............Sex......

Locality...................................Collector....................

| Organ | Condition | Item | No | Vol | % | Remarks |
|---|---|---|---|---|---|---|
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General Notes