Food Habits of the Feral Mink
(*Mustela vison* Schreber) in Hokkaido

Kohji URAGUCHI, Takashi SAITOH,
Norihisa KONDO*, Hisashi ABE

Institute of Applied Zoology, Faculty of Agriculture, Hokkaido University,
Sapporo 060, Japan
*The Board of Education of Nemuro City,
Tokiwa-cho, Nemuro 087, Japan
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Abstract. Food habits of the feral mink (*Mustela vison*) were studied in Hokkaido. Four hundred and fifty eight droppings collected from three areas, Barato, Nemuro and Kushiro, from October 1983 to November 1984, were analyzed. Mink ate a wide variety of prey, consisting mainly of mammals and fish. The importance of amphibians was locally variable. Birds, crustaceans, insects and others were supplementary foods. Monthly variations in the food habits was recorded in the level of predation on fish and mammals in Barato. Interspecific competition for food between the mink and the Japanese weasel (*Mustela itatsi*) was suggested.

Key words: Feral mink; Food habits; Hokkaido.

Introduction

American mink (*Mustela vison*) has been introduced to many countries for the fur industry and they have often become feral in the host countries (Lever, 1985). In those countries they have become regarded as pests for fish and poultry farms or as unfavorable predators or competitors for native animals (Lever, 1978). The minks became feral about 1960 in Hokkaido and since then they have markedly increased their population and distribution. The following is a brief note of their naturalization in Hokkaido.

Modern mink breeding started in 1953 in Hokkaido. The number of breeding minks had reached a considerable level by around 1960 which probably was the base for their escape and naturalization in Hokkaido. Various evidence concerning the naturalization of mink, i.e., captures, direct observation or damage to farms, began to appear from the mid-1960’s and became conspicuous in the 1970’s. These facts suggest that the minks might have become feral about 1960 or in the early 1960’s in Hokkaido (see Saitoh, 1985).

According to Köppen’s classification of climate, Hokkaido (41°24’-45°31’N, 139°50’-145°49’E) falls within the zone of a cold snowy forest climate, moist in all seasons, with a warm summer (Dfb), which is similar to that of the native habitat of the mink, the northern parts of North America (Müller, 1982). This
similarity of climates might be important in their successful settlement in Hokkaido.

The present distribution of minks covers almost all over Hokkaido. The relative density, however, regionally varies with relation to that of the Japanese weasel, which also had naturalized in Hokkaido after their introduction from Honshu in late 19th century (Inukai, 1934), or probably with the relation between the physiological trait of the mink and the regional variation in climatic condition. Investigation has shown that the mink dominates the Japanese weasels in almost all regions of Hokkaido except the southern-most areas (Oshima peninsula). A trapping investigation also indicated a similar result (Saitoh, 1985).

Ecological research on the feral mink is requisite to elucidating their ecological status in their new habitat. Food habits, which are the most fundamental component of their ecology have been investigated in European countries (Gerell, 1967, 1968; Akande, 1972) and compared with those in North American or with those of related species in their new habitats (Day & Linn, 1972; Erlinge, 1969, 1972; Chanin & Linn, 1980).

This paper gives information on the food habits of the mink in Hokkaido, and discusses the effect of the mink upon related species, especially the Japanese weasel (M. ilatsi).

Study Areas and Methods

Main study area consisted of a 11 km stretch of the Barato River, near Sapporo City (Fig. 1). This river had been a bending part of the Ishikari River, and was cut off from it in about 1920. At present, the Barato River is connected with the Ishikari River by a channel. Since three tributaries running through urban area flow into the Barato River, it is very eutrophic. The river is 100–400 m wide and slowly flowing. Vegetation on the river bank was dominated with Polygonum sachalinense, Artemisia montana, Phragmites communis, and partially Salix spp. Comparable data were also obtained from the additional habitats in Kushiro and Nemuro (eastern Hokkaido). In Nemuro district, many
rivers flow through rolling hill ranges that consist mainly of pastures and wastelands. In the Kushiro Moor (about 22000 ha), the Kushiro River, the Setsuri River and their tributaries slowly flow through the moor.

The investigation was based upon the analyses of droppings, collected from banks along water courses in Barato (central Hokkaido), Kushiro and Nemuro. The droppings of mink were so similar to those of the Japanese weasel that it was very difficult to distinguish between them. Since, however, only one Japanese weasel was trapped in Barato in contrast with 22 minks captured, we assumed that all droppings collected in this study area were those of minks. Thirty one minks and 11 Japanese weasels were captured in the Nemuro district (4 of the latter were trapped after the removal of minks at the same area), and only one mink was captured in the Kushiro Moor. Therefore the droppings from Nemuro might include some of the Japanese weasel's droppings, although the proportion was not assessed.

Near Barato droppings were intensively searched for at 20 points around sluices of irrigation ditches twice or three times a month during the snowless seasons from April to November 1984. The search yielded 358 dropping samples for analysis. We also collected 35 droppings from river banks near Nemuro from October to December 1983 and 65 droppings from river banks near Kushiro in November 1983. The droppings were oven dried for one hour at 80°C, and were then analyzed by adding 30% alcohol.

Each food item was identified by undigested matter such as hairs, bones and teeth of mammals, feather and bones of birds, bones or scales of reptiles and amphibians, otoliths (Gaemers, 1984), scales, pharyngeal teeth and bones of fish, and so on.

The result of faecal analysis is usually presented in three ways: percentage occurrence, percentage volume, and percentage weight. Lockie (1959) tested these three methods for fox droppings analysis and showed that the most accurate way of assessing the actual diet of the fox was to use the weight of undigested material in the droppings. However, many workers dealing with the food habits of aquatic mustelids have used the percentage occurrence (the percentage of droppings containing that item to the total number of droppings), because of its simplicity (Gerell, 1967; Chanin, 1981; Erlinge, 1969; Day & Linn, 1972). We also adopted this method in order to compare our results with those of other workers. In addition to this method, we measured by eye the relative volume of each item and regarded the item constituting the largest volume class (76–100%) as the dominant one. Using the percentage occurrence of the dominant item method (the POD: the percentage of droppings containing the dominant item to the total number of droppings) may compensate for the drawback of the percentage occurrence method which cannot accurately reflect the weight of ingested material, because it tends to overestimate in the case that a small volume item has a high frequency and to underestimate in the reversed case.
**Results**

*General food habits*

The percentage occurrence of every prey in the diet of mink from Barato is shown in Table 1. The mink ate a variety of prey; out of 556 samples, 18 prey categories could be distinguished.

Fish and mammals were the most frequent items and POD’s of them were

<table>
<thead>
<tr>
<th>Prey item</th>
<th>occurrence</th>
<th>percentage occurrence</th>
<th>occurrence as dominant item</th>
<th>POD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammals</td>
<td><strong>166</strong></td>
<td>46.4</td>
<td>136</td>
<td>38.0</td>
</tr>
<tr>
<td><em>Clethrionomys rufocanus</em></td>
<td>110</td>
<td>30.7</td>
<td>91</td>
<td>25.4</td>
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<tr>
<td><em>C. rutulus</em></td>
<td>5</td>
<td>1.4</td>
<td>4</td>
<td>1.1</td>
</tr>
<tr>
<td><em>Rattus norvegicus</em></td>
<td>25</td>
<td>7.0</td>
<td>22</td>
<td>6.1</td>
</tr>
<tr>
<td><em>Mus musculus</em></td>
<td>1</td>
<td>0.3</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Unidentified mouse</td>
<td>1</td>
<td>0.3</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td><em>Sorex unguiculatus</em></td>
<td>14</td>
<td>3.9</td>
<td>11</td>
<td>3.1</td>
</tr>
<tr>
<td>Unidentified Sorex</td>
<td>3</td>
<td>0.8</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td><em>Mustela nivalis</em></td>
<td>4</td>
<td>1.1</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td><em>M. itatsi</em></td>
<td>3</td>
<td>0.8</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>Unidentified mammals</td>
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<td>0.6</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Birds</td>
<td>29</td>
<td>8.1</td>
<td>17</td>
<td>4.7</td>
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<tr>
<td>Reptiles</td>
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<td>0.6</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Amphibians</td>
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<td>9.5</td>
<td>6</td>
<td>1.7</td>
</tr>
<tr>
<td>Fish</td>
<td><strong>207</strong></td>
<td>57.8</td>
<td>121</td>
<td>33.8</td>
</tr>
<tr>
<td><em>Cyprinidae</em></td>
<td>34</td>
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<td>–</td>
<td>–</td>
</tr>
<tr>
<td><em>Gobidae</em></td>
<td>30</td>
<td>8.4</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><em>Cobitidae</em></td>
<td>5</td>
<td>1.4</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Unidentified fish</td>
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<td>45.3</td>
<td>–</td>
<td>–</td>
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<tr>
<td>Insects</td>
<td>37</td>
<td>10.3</td>
<td>5</td>
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<tr>
<td>Crustaceans</td>
<td>43</td>
<td>12.0</td>
<td>16</td>
<td>4.5</td>
</tr>
<tr>
<td>Vegetation</td>
<td>21</td>
<td>5.9</td>
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<td>0.6</td>
</tr>
<tr>
<td>Unidentified</td>
<td>17</td>
<td>4.7</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>Total number of items found</td>
<td>556</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of droppings</td>
<td>358</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The total number of droppings containing mammal items.
** The total number of droppings containing fish items.
also remarkably high. The following are the items found.

Mammals: Almost all of the mammal remains were related to species (7 genera, 9 species) by the hairs, bones, teeth and claws that were found. The red backed vole (*Clethrionomys rufocanus*) dominated the mammalian part of the diet, forming 65.5% of the mammal items, and occurred in 30.7% of the droppings. The Norway rat (*Rattus norvegicus*) and the large clawed shrew (*Sorex unguiculatus*) followed the vole, occupying 14.9% and 8.3% of the mammal item, respectively. Two mustelid species, the Japanese weasel and the least weasel (*Mustela nivalis*) occurred in a few droppings. Unidentified mammal bones occurred in two droppings.

Birds: The percentage occurrence of birds indicates that these items were less important for the mink in this area. Bird species could not be identified because the remains had been chewed into small pieces.

Reptiles and Amphibians: Vertebrae and snake scales occurred in two droppings. Although two species of snakes (*Elaphe climacophora* and *E. quadrivirgata*) commonly inhabited the study area, it was impossible to identify the species from the remains. All of the amphibian remains were identified to be frogs by the ulnae and vertebrae that were found. They were presumed to be *Rana temporaria*, because this species predominates in the study area.

Fish: Table 1 shows the result of the analysis of 207 droppings which contained fish remains. Most fish remains were from small species. Identified Cyprinid fish seemed mostly to be Japanese dace (*Leuciscus (Tribolodon) hakonensis*). Gobiid fish included the floating goby (*Chaenogobius annularis*) or the chestnut goby (*C. castaneus*). The maximum number of otoliths which were found in a dropping was 16 (14 Gobiids, 2 unknown). This meant that the dropping included at least 8 fish remains.

Insects and Crustaceans: Exoskeletons and wings of insects occurred. Most of them were of Coleoptera or Odonata. Insects occurred in 10.3% of the droppings but the POD of these items was very small (1.4%). Thus insects must not be quantitatively important for the mink's diet in this area. Exoskeletons of shrimps and crabs occurred in 34 and 11 droppings, respectively. Their remains had been chewed into pieces too small for identification, but they were probably of *Palaemon paucidens* and *Eriocheir japonicus*, respectively, because they commonly inhabit this area. POD's of them (3.9% for shrimps and 0.6% for crabs) were small compared with their percentage occurrences (9.5% for shrimps and 3.0% for crabs). Thus they are only supplementary foods of the mink.

Vegetation and others: Although vegetation was found in about 6% of the droppings, the POD of them was very small. Most of them might be inadvertently taken by mink with other foods. Unidentifiable remains occurred in 17 droppings, but the POD of them was small.

**Monthly variation**

Fig. 2 shows the monthly variation in the percentage occurrence and POD of each food item in Barato. The data in November was excluded from this
figure because of the small number of droppings that were found.

Percentage occurrence and POD showed that mammals and fish were the most important foods of the mink in this area during this study period.

Mammals occurred in more than 40% of the droppings throughout the seasons except for June (16.0%) and October (33.3%). The percentage occurrence of this item, however, varied conspicuously, i.e. it was highest in April (73.2%), sharply decreased toward June (16.0%), recovered and was rather stationary at around 50% in July-September, and decreased again in October. The POD of mammals varied similarly and there was relatively little difference between this and the percentage occurrence.

The percentage occurrence of fish also varied conspicuously. It increased

Fig. 2. Percentage occurrence of main prey items in mink droppings collected in Barato from April to October, 1984. The shaded areas show the percentage of the droppings in the cases in which the item occupied the largest volume class (76–100%) in a dropping (POD).
markedly from April (34.1%) to June (84.0%), then decreased toward a stationary level at about 50% in August-October. The POD of fish varied similarly, but the values from July to October were much lower (under 30%) when compared with the percentage occurrence.

The percentage occurrences of birds and crustaceans showed a very similar variation, i.e. their values were low in April-August, then gradually increased toward October (about 25%). The POD's were less than 5% in April-September, and increased to about 15% in October.

The percentage occurrence of amphibians had two peaks in July and September (25.6% and 14.9%), but the values were relatively low throughout the seasons. The POD of this item was usually less than 5% during this study period.

Insect remains frequently occurred in warm months (15–20% in June, July

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**Fig. 3.** Percentage occurrences of prey items and those of the dominant ones in three study areas: Barato from October to November, 1984 (N = 59), Nemuro from October to December, 1983 (N = 35), and Kushiro in November, 1983 (N = 65) (POD = shaded part: see the text).
and August), and the values of the percentage occurrence and the POD were rather similar to those of amphibians. Other items were too few to discuss their seasonal variations.

**Local variation**

Fig. 3 shows the local variation of the food habits from October to December. Amphibia (frogs) were the most common food of mink in Kushiro while they were the least common in Barato. Fish were the most important food of mink in Barato. The mink’s food habits in Nemuro were the most diversified among the three areas.

**Discussion**

The diet of the feral mink in Barato was not principally different from that in North America, Sweden and Britain (Hamilton, 1940; Gerell, 1967; Chanin & Linn, 1980).

The red backed vole was the predominant mammalian item of their diet in Barato. Rodents have been reported to be dominant over other mammal food items in many study areas, although the dominant species taken was different in different areas, e.g., the muskrat (*Ondatra zibethicus*) in North America (Hamilton, 1940; Sealander, 1943), the field vole (*Microtus agrestis*) in Sweden (Gerell, 1968), and so on. These facts suggest that the food habits of the mink reflect the variation and the abundance of prey species inhabiting the area. Although Norway rats were often captured by mink-traps in Barato, their percentage occurrence in droppings was not so high. It suggests that for the mink the Norway rat might not be so easy to catch as the red backed vole and, therefore, that the abundance and vulnerability of prey could affect the mink’s food habits.

In Barato, fish was the mink’s most frequently eaten food, but the volume eaten appeared to be roughly equal to that of mammals. The most of fish vertebrae and other bones in droppings were small in size so that it seemed that most of them were small fish. It might be easier for the mink to catch smaller than larger fish.

Food other than fish and mammals seems to be secondary for the mink in Barato, since both percentage occurrences and the POD’s of them were low.

Many authors have reported the seasonal variation of the mink’s food habits. Day & Linn (1972) showed that the percentage occurrence of fish was highest in summer in England and Wales; Gerell (1967) stated that it was highest during cold months in Sweden; Chanin & Linn (1980) showed that it was high in summer and winter in southwest Britain. In the present study area, minks most frequently took fish in June, when many fish might have come ashore for spawning. In this season, therefore, the fish might have been vulnerable to mink predation.

The percentage occurrence of mammals changes with a somewhat negative correlation to that of fish ($r = -0.698$, NS). The red backed vole occupied more
than 70% of mammal remains in the droppings. Ota (1984) described the usual pattern of the seasonal change in red backed vole populations in Hokkaido, i.e. they increased from spring to summer because of spring breeding; after a little decrease in late summer they increased again in autumn due to autumn breeding; after then they decreased sharply toward early spring. If this seasonal demographic pattern could be applied to the red backed vole population in Barato, mink ate voles most frequently in the period when the vole population was the smallest (April), and ate the least in the period when the vole population was increasing (June). Yoneda (1982, 1983) showed the seasonal change in food habits of the red fox (Vulpes vulpes) in eastern Hokkaido, whose predation of voles was similar to that of the mink in the present study. And he explained the fact as follows: as snow melts in April, the vole become vulnerable due to the decrease of ground cover, but as weeds grow after May or June, the vole is well protected from predation by the vegetation. Although this interpretation can be applied to the present results, it may also be reasonable to consider the following: the decreasing of the percentage occurrence of mammals in June was a reflection of the high availability of fish in this season.

Reptiles and insects frequently occurred in the diet mostly during the warm months, and this can be explained by the seasonal change in activity of these animals. The autumn increase in migrating waterfowl might reflect the increased occurrence of birds in mink droppings in October (20%). The cause of seasonal change in crustaceans is unknown.

Local variation in food habits could also be affected by the abundance and vulnerability of prey. The abundant occurrence of frogs in the droppings from Kushiro may reflect their high density in that habitat (Kondo, 1983). Although seasonal and local variation of food habits is generally explained by the change in availability of prey (Gerell, 1967; Chanin & Linn, 1980) and the present data supports this explanation, we did not have enough data to conclude that. It needs further data on food resources.

In Hokkaido, various carnivores occur: brown bear (Ursus arctos), raccoon dog (Nyctereutes procyonoides), red fox, Hokkaido sable (Martes zibellina), mink, Japanese weasel, least weasel, stoat (Mustela erminea). Although no comprehensive study on carnivores food habits, except for the red fox, has been carried out, it is known that the brown bear, the raccoon dog, the Hokkaido sable and the red fox eat many kinds of vegetable matter together with animals (Aoi, 1985; Abe, 1975; Misawa, 1979; Yoneda, 1982; Nitta, unpublished). In contrast to them, the Japanese weasel, the stoat and the least weasel prefer solely animals (Kishida, 1927; King & Moody, 1982; Day, 1968; Erlinge, 1975). The present study shows that the minks in Barato also ate almost only animal matter.

The Japanese weasel seems to have food habits similar to those of mink in Hokkaido. Yukawa (1968) showed that Japanese weasels ate amphibians (58.0%), insects (23.2%), fish (20.3%), mammals (11.6%), and crustaceans (11.6%) (the figures in parentheses are percentage occurrence of each item as found in the stomach). Inukai (1934, 1935), Kishida (1927) and Otsu (1971) reported that rodents were staple foods of Japanese weasels. The food habits of
this species appears to overlap largely those of the mink. However, those studies on Japanese weasels were carried out in areas where no other species of similar sized weasels occurred. The foraging interaction between the two species has not yet been surveyed.

In the present study, remains of the Japanese weasel were found in three droppings of the mink. Although it is undeniable the mink ate the carcasses of the Japanese weasel, the fact suggests that the two species sympatrically or parapatrically inhabited the common habitats and the former had chances to eat the latter. The above facts also suggest that there may be competition for food between them. To study the food relations of minks and Japanese weasels in a sympatric area, stomach analysis should be done because it is too difficult to distinguish between the two droppings types.

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References

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