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FOOD HABITS OF BROWN BEARS IN HOKKAIDO, JAPAN

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Abstract: Food habits of the brown bear (*Ursus arctos yesoensis*) were studied from 1975 to 1984 in 4 diverse areas on Hokkaido Island. Foods of bears varied seasonally in each area and differed among areas largely because of differences in foods available. Bears ate mainly succulent herbs in spring and summer and fruits in the fall in northern Hokkaido. Hog's-fennel (*Peucedanum multivittatum*) dominated the bears' diet in August and September in the alpine areas of the Daisetsu Mountains. Foods of bears on the Shiretoko Peninsula included those from the sea, but were otherwise similar to northern Hokkaido. The diet of bears on the Oshima Peninsula was dominated by beech (*Fagus crenata*) buds in the spring in terms of frequency of occurrence, and actinidia (*Actinidia arguta*) fruit in the fall.

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Brown bears occur only in Hokkaido in Japan. The population status is largely unknown, though we believe they are generally declining as a result of habitat loss and overharvest.

In 1975, a brown bear ecology project was initiated to gather information necessary to properly manage the species and its habitat (Aoi 1985a, 1985b). Because there are few reports on the food habits of brown bears in Japan (Kadosaki 1983, Aoi 1985a), we collected seasonal food habits information from 4 regions in Hokkaido between 1975 and 1984.

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STUDY AREA

Hokkaido Island is about 79,500 km², and is the most northern territory of Japan. Vegetation on the lowlands consists mainly of mixed forests of conifers and deciduous trees and is in the intermediate zone between the Northern Asiatic Temperate and Subarctic zones (Tatewaki and Igarashi 1971). The Oshima Peninsula, however, is entirely within the Northern Asiatic Temperate Zone. The 4 study areas on Hokkaido are Northern Hokkaido, Daisetsu

Mountains, Shiretoko Peninsula, and Oshima Peninsula (Fig. 1). Black bears (*Selenarctos thibetanus*) are not present of Hokkaido.

The Northern Hokkaido study area included most of Northern Hokkaido, but most searches were conducted on the 220-km² Teshio Exp. For. of Hokkaido Univ. Elevation of the forest ranges from 20 to 580 m, and topography is characterized by rolling hills with gentle slopes in the west and relatively steep mountains in the east. The climate is severe, with temperatures ranging from -36 to 35 C and an annual mean of 5 C. Average annual precipitation is 100 cm. Snow remains on the ground from mid-November to late April in the lowlands. The prevailing vegetation is mixed forests consisting of spruce (*Picea jezoensis*, *P. glehnii*), fir (*Abies sachalinensis*), Mongolian oak (*Quercus mongolica* var. *grosseserrata*), linden (*Tilia japonica*), and birches (*Betula* spp.).

The Daisetsu Mountains study area is in Daisetsu

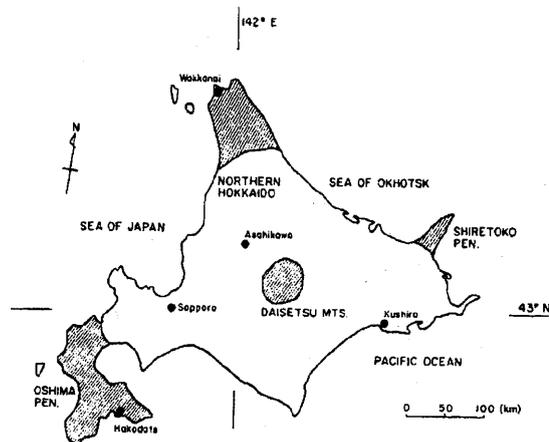


Fig. 1. Hokkaido brown bear food habits study areas.

National Park (2,300 km²) and is confined to the alpine and subalpine zones. Elevation ranges 1,500–2,000 m and topography is characterized by a gently sloping plateau. The annual mean temperature adjacent to the study area, at Tokachidake-onsen (1,000 m), is about 1 C. Average annual precipitation is about 100 cm at Sounkyo (560 m). Snow cover exists from late September to early July. Vegetation includes alpine shrubs such as pine (*Pinus pumila*) and cowberry (*Vaccinium vitis-idaea*), and alpine snow meadows dominated by fauria (*Fauria crista-galii*), hog's fennel, primrose (*Primula cuneifolia*), and sasa bamboo (*Sasa kurilensis*). Vegetation below the treeline is characterized by forests dominated by birch (*B. ermanii*), spruce, and fir.

The Shiretoko Peninsula study area is in Shiretoko National Park (400 km²). Topography is abrupt with steep slopes on both sides, running to the ocean from a central ridge. Elevations of the major peaks range 1,300–1,600 m. The mean annual temperature is 5 C, and average annual precipitation is about 100 cm. Snow cover exists from mid-November to late April. Vegetation below 500 m is characterized by mixed forests of spruce, fir, Mongolian oak, birches, and maples (*Acer* spp.). Birch and pine are common above 500 m. Pink salmon (*Oncorhynchus gorbascha*) and dog salmon (*O. keta*) return to the rivers of the Shiretoko Peninsula to spawn between September and December.

The Oshima Peninsula study area includes the entire Oshima Peninsula, but most work was done in the Yakumo and Mori-cho districts. Elevation in these districts ranges 0–500 m, and the topography is mountainous. The climate is mild, with an annual mean temperature of about 8 C. Average annual precipitation is 110 cm, with snow cover persisting from late November to mid-April. A temperate forest dominated by beech and Mongolian oak dominates the peninsula.

METHODS

We collected scats and digestive tracts between April and November 1975–77 in Northern Hokkaido, 1980–84 on the Shiretoko Peninsula, 1982–84 on the Oshima Peninsula, and between July and September 1982–84 in the Daisetsu Mountains. Bear digestive tracts were obtained from cooperating hunters. Scats and sign of feeding were located by systematic searches.

Scats and material from digestive tracts were pre-

served in alcohol or formalin. A mixed 30-g sample was removed from each scat or digestive tract. These samples were then separated into individual food items, oven-dried for 24 hours at 60 C, and weighed. Results were presented as percent frequency of occurrence of an item in all samples and the percent by dry weight that the item comprised in all samples. Samples from the Shiretoko Peninsula were evaluated on the basis of frequency of occurrence and an ocular estimate of volume. Estimates of volume were ocularly assigned to 1 of 3 categories: high (66.6%–100% of the scat), medium (33.3%–66.6%), or low (0–33.3%).

RESULTS

We obtained 63 scats and 10 digestive tracts from Northern Hokkaido, 23 scats from the Daisetsu Mountains, 121 scats from the Shiretoko Peninsula, and 27 scats and 17 digestive tracts from the Oshima Peninsula.

Bears in Northern Hokkaido emerged from dens between mid and late April (Aoi 1985b) and began to feed along streams and where snow had melted from the slopes. Skunk cabbage (*Symplocarpus renifolius*) dominated the early spring diet along with acorns of Mongolian oak (Table 1). Stems, leaves, and petioles of large forbs such as lagwort (*Petasites japonicus*) and hogweed (*Heracleum dulce*) composed a majority of the summer diet, but skunk cabbage remained important. Berries dominated the fall diet with fruits of actinidia and aralia (*Aralia cordata*) in over 50% of the samples. Animal materials, although comprising only 5% by weight of the annual diet, were consumed during each season. Ants (*Formicidae*) were the most abundant animal material, but Japanese crowfish (*Cambaroides japonicus*) were eaten during each season.

The diet of bears in the Daisetsu Mountains study area was inferred from scats collected only in August and September (Table 2). Hog's fennel, rush (*Juncus beringensis*), cinquefoil (*Potentilla matsumuae*), and grasses dominated the diet during this period. Hog's fennel was the dominant item on the basis of dry weight.

The diet of brown bears on the Shiretoko Peninsula study area was dominated in the spring by leaves and stems (Table 3). Pleurospermum (*Pleurospermum austriacum*) and ligusticum (*Ligusticum hultenii*) occurred most frequently in the examined samples. Items from the surrounding sea, such as seaweed,

Table 1. Frequency of occurrence (F%) and percent dry weight (W%) of food items identified in scats and digestive tracts of brown bears in Northern Hokkaido, 1975-77.

Food item	Spring (Apr-May) N = 15		Summer (Jun-Aug) N = 42		Fall (Sep-Nov) N = 16		Total N = 73	
	F%	W%	F%	W%	F%	W%	F%	W%
Plant origin								
<i>Symprocarpus renifolius</i>	73.3	22.5	47.6	15.1	6.3	0.4	46.6	12.0
<i>Petasites japonicus</i>	—	—	52.4	43.2	—	—	30.1	16.0
<i>Heracleum dulce</i>	—	—	9.5	2.2	—	—	5.5	0.8
<i>Carex</i> spp.	13.3	2.2	4.8	0.7	—	—	5.5	0.8
<i>Angelica ursina</i>	13.3	0.1	11.9	1.4	—	—	9.6	0.5
Graminae	13.3	0.1	2.4	tr ^a	—	—	4.1	tr ^a
<i>Lysichiton camtschense</i>	—	—	2.4	1.6	—	—	1.4	0.5
<i>Sasa</i> spp.	—	—	2.4	0.3	—	—	1.4	0.1
<i>Urtica platyphylla</i>	6.7	0.7	2.4	tr ^a	—	—	2.7	0.2
<i>Quercus mongolica</i>	33.3	43.8	—	—	12.5	6.5	9.6	15.5
<i>Actinidia arguta</i>	—	—	—	—	68.8	57.4	15.1	19.6
<i>Actinidia kolomikta</i>	—	—	2.4	tr ^a	—	—	1.4	tr ^a
<i>Aralia cordata</i>	6.7	tr ^a	—	—	50.5	29.2	12.3	9.7
<i>Prunus ssiori</i>	—	—	—	—	12.5	2.5	2.7	0.8
<i>Prunus salicina</i>	—	—	—	—	12.5	1.9	2.7	0.6
<i>Vitis coignetiae</i>	—	—	—	—	6.3	tr ^a	1.4	tr ^a
<i>Kalopanax septemlobus</i>	—	—	—	—	6.3	tr ^a	1.4	tr ^a
<i>Zea mays</i>	—	—	—	—	6.3	1.0	1.4	0.3
Unidentified fibers	46.7	21.8	50.0	28.5	25.0	1.0	43.8	17.6
Unidentified seeds	—	—	2.4	0.4	2.4	tr ^a	4.1	0.1
Animal origin								
Formicidae	20.0	1.3	40.5	5.4	—	—	27.4	2.3
Vespidae	—	—	2.4	tr ^a	6.3	tr ^a	2.7	tr ^a
Lucanidae	—	—	—	—	25.0	0.1	5.5	tr ^a
Unidentified insects	—	—	2.4	tr ^a	—	—	1.4	tr ^a
<i>Cambaroides japonicus</i>	13.3	0.3	14.3	1.6	6.3	tr ^a	12.3	0.6
Unidentified birds	20.0	4.0	—	—	—	—	4.1	1.2
<i>Lepus timidus</i>	—	—	—	—	6.3	tr ^a	1.4	tr ^a
<i>Clethrionomys rufocanus</i>	—	—	—	—	6.3	tr ^a	1.4	tr ^a
<i>Tamias sibiricus</i>	—	—	—	—	6.3	tr ^a	1.4	tr ^a
<i>Ursus arctos</i>	6.7	2.8	—	—	—	—	1.4	0.8

* Less than 0.1%.

Hanasaki crab (*Paralithodes borevipes*), and shellfish (Mollusca) were also present in the spring diet of bears on the peninsula. Umbelliferae were abundant in the summer diet and graminoids (Graminae, Cyperaceae) were consumed as frequently as they were in the spring. Ants were the most commonly eaten animal material during this season. Fruits of aralia and Mongolian oak dominated the fall diet, and pink salmon were found infrequently in the samples. When salmon remains were found, they generally comprised the entire sample.

Fewer samples ($N = 44$) were analyzed for the Oshima Peninsula than for the other study areas, and only a single scat was collected during the summer (Table 4). Although oak acorns were found infrequently in the spring samples, they comprised 36.9%

Table 2. Frequency of occurrence and percent dry weight of food items identified in scats of brown bears in the Daisetsu Mountains, August and September, 1982-84.

Food item	Frequency of occurrence (%) N = 23	Percent dry weight N = 17
<i>Peucedanum multivittatum</i>		
stems and leaves	87.3	63.3
roots	47.8	8.3
Graminae/Cyperaceae	95.6	11.7
<i>Juncus beringensis</i>	91.3	6.0
<i>Potentilla matsumurae</i>	69.6	0.6
<i>Tilingia ajanensis</i>	13.0	tr ^a
<i>Sasa kurilensis</i>	8.7	tr ^a
<i>Sanquisorba stipulata</i>	9.3	tr ^a
<i>Phyllodoce</i> spp.	43.5	tr ^a
<i>Sorbus matsumurana</i>	26.1	6.4
Unidentified plants	43.5	3.4

* Less than 0.1%.

Table 3. Frequency of occurrence (F%) and estimated volume (V) of food items identified in scats of brown bears on Shiretoko Peninsula, 1980–84.

Food items	Spring (Apr–May) N = 24		Summer (Jun–Aug) N = 54		Fall (Sep–Nov) N = 43		Total N = 128	
	F%	V*	F%	V	F%	V	F%	V
Plant origin								
<i>Pleurospermum austriacum</i>	37.5	M	13.0	M	—	—	3.6	L
<i>Ligusticum hultenii</i>	20.9	M	5.6	L	—	—	6.7	L
<i>Heracleum dulce</i>	8.3	L	42.6	H	9.3	L	24.3	M
<i>Angelica ursina</i>	4.2	L	1.9	L	—	—	1.7	L
<i>Annelica anomala</i>	—	—	18.6	M	2.3	L	9.3	L
<i>Conioselinum filicinum</i>	8.3	L	3.7	L	—	—	3.4	L
<i>Tilingia ajanesis</i>	4.2	L	—	—	—	—	0.8	L
<i>Anthriscus sylvestris</i>	4.2	L	1.9	L	—	—	1.7	L
Umbelliferae	20.8	M	13.0	M	7.0	L	12.4	M
<i>Aralia elata</i>	—	—	—	—	4.8	L	1.6	L
<i>Aralia cordata</i>	—	—	1.9	L	38.3	M	13.8	M
<i>Saxifraga fusca</i>	4.2	L	—	—	—	—	0.8	L
<i>Urtica platyphylla</i>	12.5	L	1.9	L	7.0	L	6.0	L
<i>Filipendula kamschatica</i>	4.2	L	—	—	—	—	0.8	L
<i>Petasites japonicus</i>	4.2	H	7.4	M	2.3	L	4.9	L
<i>Artemisia</i> spp.	—	—	—	—	2.3	L	0.8	L
<i>Thalictrum aquilegifolium</i>	—	—	1.9	L	—	—	0.8	L
<i>Asperula odorata</i>	4.2	L	—	—	—	—	0.8	L
<i>Polygonum sachaliense</i>	—	—	—	—	2.3	L	0.8	L
<i>Polygonum</i> spp.	—	—	—	—	2.3	L	0.8	L
Graminae / Cyperaceae	16.7	M	16.7	L	4.8	L	11.6	L
<i>Sasa</i> spp.	—	—	—	—	—	—	1.7	L
<i>Quercus mongolica</i>	8.3	L	1.9	L	54.5	H	21.5	H
<i>Prunus ssiuri</i>	—	—	—	—	7.0	L	2.3	L
<i>Prunus sargentii</i>	—	—	1.9	L	—	—	0.8	L
<i>Actinidia arguta</i>	—	—	—	—	21.5	M	7.5	L
<i>Actinidia kolomikta</i>	—	—	—	—	12.0	L	1.6	L
<i>Vitis coignetiae</i>	—	—	—	—	28.8	M	9.6	L
<i>Taxus cuspidata</i>	—	—	—	—	7.0	L	2.3	L
<i>Pinus pumila</i>	—	—	—	—	7.0	H	2.3	L
Mushrooms	4.2	L	5.6	L	4.6	L	4.7	L
Seaweed	4.2	L	—	—	—	—	0.8	L
Leaves and twigs	4.2	L	7.4	L	11.7	L	7.8	L
Unidentified plants	83.3	H	76.1	H	50.3	H	68.3	H
Animal origin								
<i>Ursus arctos</i>	4.2	L	9.3	L	7.0	L	7.7	L
<i>Lepus timidus</i>	4.2	L	—	—	—	—	0.8	L
Unidentified mammals	—	—	1.9	L	4.6	L	2.3	L
Unidentified birds	—	—	—	—	2.3	L	0.8	L
<i>Onchorhynchus gorbascha</i>	—	—	—	—	2.3	L	0.8	L
Unidentified fish	—	—	1.9	L	—	—	0.8	L
<i>Paralithodes berevipes</i>	4.2	L	—	—	—	—	0.8	L
Formicidae	—	—	18.5	L	11.8	L	12.5	L
Vespidae	—	—	1.9	L	—	—	0.8	L
Coleoptera	—	—	3.7	L	11.8	M	5.9	L
Mollusca	12.5	L	—	—	—	—	0.8	L

* H=high, M=medium, L=low.

Table 4. Frequency of occurrence (F%) and percent dry weight (W%) of food items identified in scats and digestive tracts of brown bears on Oshima Peninsula, 1982-84.

Food item	Spring (Apr-May)		Summer (Aug)		Fall (Sep-Nov)		Total	
	F% N = 17	W% N = 7	F% N = 0	W% N = 1	F% N = 26	W% N = 23	F% N = 44	W% N = 31
Plant origin								
<i>Fagus crenata</i>	41.2	1.7	—	—	—	—	15.9	0.6
<i>Quercus mongolica</i>								
buds	5.9	5.1	—	—	2.3	1.8		
acorns	5.9	36.9	—	—	—	—	2.3	13.2
<i>Quercus</i> spp.	5.9	11.4	—	—	—	—	2.3	4.1
<i>Prunus siori</i>	—	—	—	—	3.8	0.4	2.3	0.3
<i>Juglans ailanthifolia</i>	—	—	—	2.5	7.7	0.9	4.5	0.7
<i>Viburnum furcatum</i>	—	—	—	39.7	7.7	0.2	6.8	0.6
<i>Actinidia arguta</i>	—	—	—	0.2	88.5	44.7	54.5	21.8
<i>Actinidai polygama</i>	—	—	—	—	38.5	11.0	22.7	8.3
<i>Vitis coignetiae</i>	—	—	—	19.8	7.7	tr ^a	6.8	0.6
<i>Vitis</i> spp.	—	—	—	—	3.8	tr ^a	2.3	tr ^a
Unidentified fruits	—	—	—	16.7	34.6	21.8	22.7	16.6
<i>Aralia elata</i>	—	—	—	—	7.7	tr ^a	4.5	tr ^a
<i>Aralia cordata</i>	—	—	—	17.3	30.8	1.6	20.5	21.4
<i>Heracleum dulce</i>	5.9	2.4	—	—	—	—	2.3	0.9
Umbelliferae	17.6	tr ^a	—	—	—	—	6.8	tr ^a
<i>Symplocarpus renifolius</i>	17.6	22.4	—	—	—	—	6.8	8.0
<i>Petasites japonicus</i>	5.9	tr ^a	—	—	—	—	2.3	tr ^a
<i>Equisetum hyemale</i>	—	—	—	—	3.8	0.1	2.3	0.1
<i>Zea mays</i>	—	—	—	—	11.5	10.2	6.8	7.7
<i>Solanum tuberosum</i>	—	—	—	—	3.8	13.3	2.3	2.5
<i>Oryza sativa</i>	—	—	—	—	3.8	0.2	2.3	0.2
Graminae/Cyperaceae	11.8	11.7	—	—	—	—	4.5	4.2
Mushrooms	—	—	—	—	3.8	0.2	2.3	0.1
Unidentified fibers	41.2	0.1	—	0.3	3.8	1.0	20.5	0.8
Unidentified buds	—	—	—	—	3.8	tr ^a	2.3	tr ^a
Leaves and twigs	23.5	tr ^a	—	3.3	100.0	2.5	70.5	1.9
Animal origin								
Formicidae	5.9	tr ^a	—	—	19.2	tr ^a	13.6	tr ^a
Vespidae	—	—	—	—	15.4	0.2	9.0	0.2
Coleoptera	—	—	—	—	3.8	tr ^a	2.3	tr ^a
<i>Cambaroides japonicus</i>	5.9	tr ^a	—	—	3.8	0.1	9.0	0.1
Unidentified fish	—	—	—	—	11.5	tr ^a	2.3	tr ^a
<i>Nycteretus procyonoides</i>	—	—	—	—	3.8	0.5	2.3	0.4
Unidentified	5.9	8.0	—	—	—	—	2.3	2.9

^a Less than 0.1%.

of the total dry weight of the samples. Beech buds were the most frequently occurring item in the spring diet, but shoots of skunk cabbage and Umbelliferae were also abundant. Fruits of actinidia, aralia, and wild grape (*Vitis coignetiae*) dominated the fall diet. Agricultural crops, including corn, potatoes, and rice were also consumed during this season.

DISCUSSION

Brown bears on Hokkaido Island were principally vegetarians. Although we did not measure availability of foods on the study areas, it appeared that differences in bears diets on the 4 study areas could be largely explained by availability of the various food items. For example, lagwort is more abundant than Umbelliferae in the Northern Hokkaido study area but less abundant than Umbelliferae on the Shiretoko and Oshima peninsulas; the amount of these foods in the bears' diets reflects the differences in abundance. Though all study areas were relatively near the sea, human developments and activities along the coast prevented bear use of such areas except on the

Shiretoko Peninsula. Therefore, food items from the sea were found only in Shiretoko Peninsula scats.

Beech trees were found only in the region of the Oshima Peninsula, explaining why buds and fruits of this species were not found in the diet of bears in the other study areas. Similarly, a number of the plants consumed by bear in the Daisetsu Mountains were found only in this region.

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