Seasonal Change in Food Habits of Ezo Brown Bear (*Ursus arctos yesoensis* LYDEKKER) in Northern Hokkaido*

By

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北海道北部におけるエゾヒグマ (*Ursus arctos yesoensis* LYDEKKER) の食性とその季節変化*

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Abstract

Seventy six brown bear scats and fourteen stomach contents were analyzed from 1975 to 1982. Food remains were examined qualitatively and quantitatively. The percentage importance values of plant and animal matter were 90 and 10, respectively. The plant matter was divided into two groups : green vegetable matter (57.2%) and fruits (32.9) ; and animal matter (10%) included 8.6% of insects, mainly consisting of ants and bees. Mammalian remains were found but sporadic.

Introduction

Ezo brown bear is the greatest game in Japan. In recent years, 300 to 400 individuals are captured every year in Hokkaido, but the ecology or the present condition of the population has been not well surveyed. Inspite of this situation the population of brown bear appers to be on the decrease trend, especially in northern Hokkaido (AOI 1983).

Therefore, detailed studies on the ecology of this animal are urgently needed for the population management.

Food habits of brown bear have not been investigated intensively in this island, though general remarks were reported by KADOSAKI (1983).

The purpose of the present study is to obtain further imformation about the food, and some knowledge concerning the habitat utilization of brown bears.

Study area

Data on food habits were collected mainly in Teshio Experiment Forest of Hokkaido University and the surrounding areas in the northernmost part of Hokkaido (Fig. 1).

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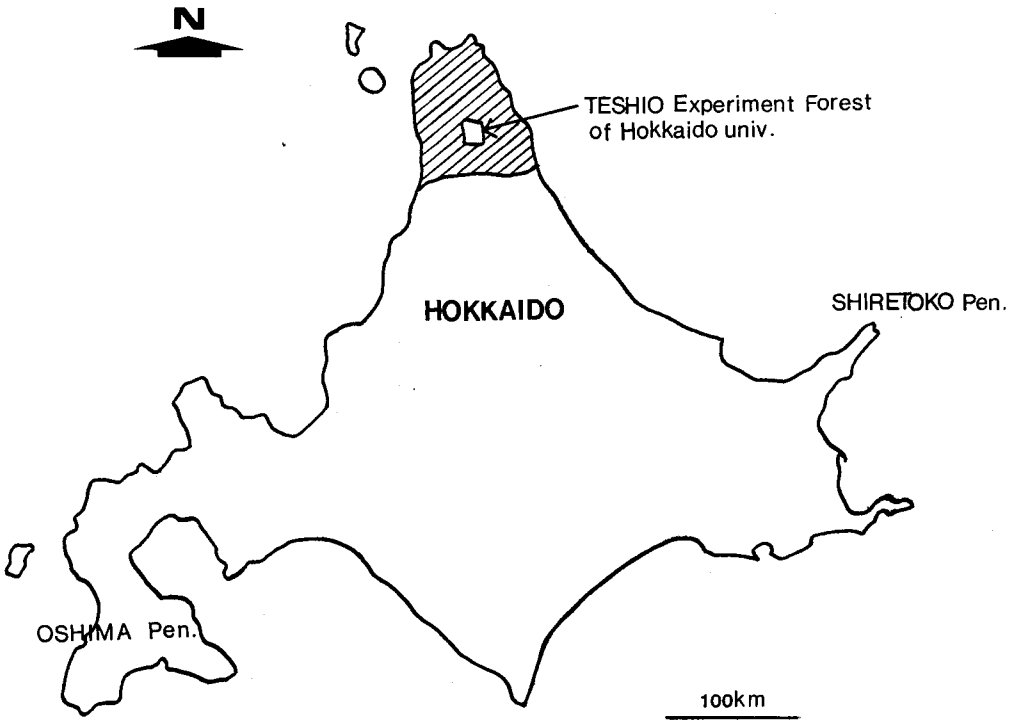

Fig. 1. The study area and location of Teshio Experiment Forest of Hokkaido University.

The experiment forest covers approximately 220 km², and the elevation ranges from 50 m to 580 m along the Toikanbetsu river which is one of the branches of Teshio river.

The climate of this region is very harsh. Extreme temperatures and low precipitation in spring are common. Annual average temperature is 5.7°C, ranging from the highest of 35.1°C to the lowest of −35.9°C. Mean annual precipitation in the area is about 1200 mm, while snowfall averages 1.2 to 1.5 m in depth. The frostfree season is very short, beggining in early June and ending in late September.

This district retains a interesting flora or plant communities belonging to the intermediate zone between the northern Asiatic Temperate-and Subarctic Zones (TATEWAKI et al. 1971). Mixed forest are mainly consist of fir (*Abies sacharinensis*), spruce (*Picea jezoensis*), mongolian oak (*Querqus mongolica* var. *grosseserata*), linden (*Tilia japonica*) and maple (*Acer mono*). Alder (*Alnus japonica*), elm (*Ulmus davidiana*) and willow (*Salix* spp.) forests are found on humid soils along mountain streams. In places oak forests are found on hillsides, and red spruce forest (*Picea glenii*) occur on the serpentine belt. There are many artificial plantations consist of mostly coniferous trees in and around the experiment forest, especially common on the latter.

Characteristic vegetation in this area is the Sasa bamboo bushes (*Sasa* spp.) covering almost all the mountain slopes to the height of about 2 m on the forest

floor. Since there are little grasses in the *Sasa* bushes, food availability except tree fruits is rather scarce in these slopes. However, there occur many species of herbaceous, succulent plants along the stream sides, i. e., *Patasites japonicus, Lysichiton camtchatense, Polygonum sacharinense, Angelica* spp., *Heracleum dulce, Cirsium kamtschaticum* etc.

Methods

Sampling

Brown bear scats, stomach contents and visual observations of feeding signs were used for determining the qualitative identificiation and the quantitative importance of food items used by brown bears.

Seventy six scats and fourteen stomacs were collected for analysis during 1975–1982, but most of the samples were collected in two years, 1976–1977.

Qualitative identification

Analysis of scats and stomach contents was conducted in the laboratory according to the techniques of TISCH (1961).

Examination and separation of materials were done macroscopically and microscopically. A binocular microscope was used for identification of green vegetables.

Quantitative estimations

I referred to the method of MEALEY (1975), and FURUYA et al. (1979) for quantitative estimations.

The occurrence and volume of each food item was recorded. The latter was categorized into four grades: trace-10%, mean 5%; 10~30%, mean 20%; 30~70%, mean 50%; 70~100%, mean 85%; then the mean value was used to calculate total percentage voulme of each item.

Food items were ranked according to Importance Value (SUMMER and CRAIGHEAD 1973).

It was calculated as:

$$\text{Importance Value} = \text{Frequency of Occurrence } (\%) \times \% \text{ of Diet Volume}/100$$

Frequency of Occurrence (F) of a particular food i is

$$F_i\% = n_i/N \times 100$$

where N is total number of samples and n_i is the number of the samples which contain the food i.

Percentage of diet volume is percentage volume of an item occurring in scats of each month, divided by the sum.

Importance value was chosen as indicator of food item importance because it establishes relative equilibrium between items which occurred infrequently but in high volume percentages and those which occurred frequently but in low level of percentage volume (MEALY 1980).

Then Percentage Importance Value were calculated by dividing individual values by the sum.

Results

Numbers of sample were shown in table 1.

Monthly data were grouped into 3 seasons; spring, April-May; summer, Jun-August; Autumn, September-November.

Table 2, 3, 4 and 5 provide seasonal and annual data on frequency and Percentage Importance Value for each food item. Occurring periods of main items are shown in Fig. 2.

Plant materials are divided into two major groups; green vegetables and fruits.

Table 1. Monthly number of sample collected from 1975 to 1982

Month	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.-Dec.	Total
Scats	2	3	11	18	18	4	4	16	76
Stomachs	9	5							14
Total	11	8	11	18	18	4	4	16	90

Table 2. Food contents and their importance values in spring of 1975–1982

Food item	Use	Frequency Occurrence Percent	Percent of Diet Volume	Importance Value	Importance Value Percent (I. V. %)
Symplocarpus foetidus	Shoots, Flowers	57.9	24.929	14.43389	35.4140
Carex sp.	Heads	21.1	1.960	0.41356	1.0146
Heracleum dulce	Shoots	15.8	2.521	0.39831	0.9772
Gramineae	Leaves	15.8	1.680	0.26544	0.6512
Phragmites communis	Stems, leaves	5.3	2.801	0.14845	0.3642
Petasites japonicus	Shoots	6.3	1.120	0.05936	0.1456
Angelica ursina	Shoots	10.5	0.560	0.05880	0.1442
Cirsium kamtschaticum	Stems, leaves	5.3	0.280	0.01484	0.0364
Sasa sp.	Stems, leaves	5.3	0.280	0.01484	0.0364
Quercus mongolica var. *grosseserata*	Acorns	52.6	38.095	20.03797	49.1638
Juglans mandshurica	Kernel	5.3	1.120	0.05936	0.1456
Aralia cordata	Berries	5.3	0.280	0.01484	0.0364
Unknown plant matters	mostly fibers	31.6	7.563	2.38990	5.8637
subtotal					93.9933
Formicidae	Mature chrysalis	15.8	4.201	0.66375	1.6285
Coleoptera	Mature	5.3	0.280	0.01484	0.0364
Unknown insects		5.3	1.400	0.07420	0.1820
Birds	Feather	26.3	4.761	1.25214	3.0721
Cambaroides japonicus	Entire	10.5	2.240	0.23520	0.5770
Lepus timidus ainu	Entire	5.3	2.801	0.14845	0.3642
Ursus arctos yesoensis	Entire	5.3	1.120	0.05936	0.1456
subtotal					6.0058
Total			99.992	40.7575	99.9991

Table 3. Food contents and their importance values in summer of 1975–1982

Food item	Use	Frequency Occurrence Percent	Percent of Diet Volume	Importance Value	Importance Value Percent (I. V. %)
Petasites japonicus	Stems, leaves	46.8	33.861	15.84694	52.8231
Symplocarpus foetidus	Stems, leaves	42.5	13.763	5.84927	19.4975
Heracleum dulce	Stems, leaves	8.5	4.141	0.35198	1.1732
Angelica ursina	Stems	10.6	1.218	0.12910	0.4303
Carex sp.	Leaves	4.2	0.974	0.04090	0.1363
Lysichiton camtschatense	Stems, leaves	2.1	1.218	0.02557	0.0852
Urtica platyphylla	Stems, leaves	2.1	0.121	0.00254	0.0084
Gramineae	Stems, leaves	2.1	0.121	0.00254	0.0084
Morus bombycis	Berries	2.1	2.070	0.04347	0.1449
Actinidia kolomikta	Berries	2.1	0.121	0.00254	0.0084
Unknown seed	Fruits	2.1	0.487	0.01022	0.0340
Unknown plant matter	mostly fibers	44.6	14.738	2.11314	7.0438
subtotal					81.3935
Formicidae	Mature, larvae	36.1	10.840	3.91324	13.0441
Apis mellifera	Mature, larvea	14.8	12.911	1.91082	6.3694
Vespidae	Mature, larvae	2.1	0.487	0.01022	0.0340
Cambaroides japonicus	Entire	12.7	2.923	0.37122	1.2374
subtotal					20.6849
Total			99.994	30.49416	102.0784

Table 4. Food contents and their importance values in autumn of 1975–1982

Food item	Use	Frequency Occurrence Percent	Percent of Diet Volume	Importance Value	Importance Value Percent (I. V. %)
Quercus mongolica var. *grosseserata*	Acorns	58.4	39.097	22.79355	51.0509
Actinidia arguta	Berries	54.1	33.834	18.30419	40.9960
Aralia cordata	Berries	29.1	5.639	1.64094	3.6752
Prunus ssiori	Berries	8.3	2.631	0.21837	0.4890
Viburnum furcatum	Berries	8.3	2.631	0.21837	0.4890
Vitis coignetiae	Berries	12.5	1.691	0.21137	0.4734
Prunus salicina	Fruits	8.3	1.503	0.12474	0.2793
Zea mays	Corns	4.1	0.751	0.03079	0.0689
Kalopanax septemlobus	Berries	4.1	0.187	0.00766	0.0171
Unknown	Seeds	8.3	0.375	0.03112	0.0697
Symplocarpus foetidus	Leaves, shoots	12.5	3.383	0.42287	0.9471
Galium trifloriforme	Stems, leaves	4.1	0.187	0.00767	0.0171
Sasa sp.	Stems, leaves	4.1	0.187	0.00767	0.0171
Unknown plant matter	mostly fibers	12.5	0.563	0.07037	0.1576
Unknown		4.1	1.879	0.07703	
subtotal					98.9199
Unknown insects	Larvae	20.8	0.939	0.19531	0.4374
Lucanidae	Mature	16.6	0.751	0.12466	0.2792
Vespidae	Mature, larvae	4.1	0.751	0.03079	0.0689

Table 4. Continued

Food item	Use	Frequency Occurrence Percent	Percent of Diet Volume	Importance Value	Importance Value Percent (I. V. %)
Unknown mammals	Probably entire	8.3	0.375	0.03112	0.0697
Cambaroides japonicus	Entire	4.1	0.751	0.03079	0.0689
Clethrionomys rufocanus bedfordia	Probably entire	4.1	0.751	0.03079	0.0689
Tamis sibiricus lineatus	Probably entire	4.1	0.751	0.03079	0.0689
Lepus timidus ainu	Probably entire	4.1	0.187	0.00767	0.0171
subtotal					1.0790
Total			99.794	44.64863	99.9989

Table 5. Total food contents and their importance values in northern Hokkaido

Food item	Use	Frequency Occurrence Percent	Percent of Diet Volume	Importance Value	Importance Value Percent (I. V. %)
Symplocarpus foetidus	Shoots, stems leaves	14.0	12.865	1.80040	22.5481
Petasites japonicus	Stems, leaves shoots	9.4	16.491	1.55015	19.4171
Heracleum dulce	Stems, leaves shoots	2.8	2.514	0.07039	0.8817
Carex sp.	Heads, leaves	2.4	0.877	0.02104	0.2635
Angelica ursina	Stems, shoots	2.8	0.701	0.01962	0.2457
Gramineae	Stems, leaves	1.6	0.409	0.00654	0.0819
Lysichiton camtschtense	Stems, leaves	0.4	0.584	0.00233	0.0291
Phragmites communis	Stems, leaves	0.4	0.584	0.00233	0.0291
Sasa sp.	Stems, leaves	0.8	0.116	0.00092	0.0115
Cirsium kamtschaticum	Stems, leaves	0.4	0.058	0.00023	0.0028
Urtica Platyphylla	Stems, leaves	0.4	0.058	0.00023	0.0028
Galium trifloriforme	Stems, leaves	0.4	0.058	0.00023	0.0028
Unknown	mosty fibers	12.3	8.830	1.08609	13.6043
Quercus mongolica var. *grosseserata*	Acorns	9.8	20.116	1.97136	24.6932
Actinidia arguta	Berries	5.3	10.526	0.55787	6.9878
Aralia cordata	Berries	3.2	1.871	0.05987	0.7499
Prunus ssiori	Berries	0.8	0.818	0.00654	0.0819
Viburnum furcatum	Berries	0.8	0.818	0.00654	0.0819
Vitis coignetiae	Berries	1.2	0.526	0.00631	0.0790
Morus bombycis	Berries	0.4	0.994	0.00397	0.0497
Prunus salicina	Fruits	0.8	0.467	0.00373	0.0467
Juglans mandshurica	Kernel	0.4	0.233	0.00093	0.0116
Zea mays	Corns	0.4	0.233	0.00093	0.0116
Actinidia kolomikta	Berries	0.4	0.058	0.00023	0.0028
Kalopanax septemlobus	Berries	0.4	0.058	0.00023	0.0028
Unknown	Seeds	1.2	0.350	0.00420	0.0526
Unknown		0.4	0.584	0.00233	0.0291
subtotal					90.001

Table 5. Continued

Food item	Use	Frequency Occurrence Percent	Percent of Diet Volume	Importance Value	Importance Value Percent (I. V. %)
Formicidae	Mature, larvae	8.2	6.081	0.49864	6.2459
Apis mellifera	Mature, larvae	2.8	6.198	0.17354	2.1737
Vespidae	Mature, larvae	0.8	0.467	0.00373	0.0467
Lucanidae	Mature	1.6	0.233	0.00372	0.0465
Coleoptera	Mature	0.4	0.058	0.00023	0.0028
Unknow insects	Larvae	2.4	0.350	0.00840	0.1052
Cambaroides japonicus	Entire	3.7	2.105	0.07788	0.9755
Birds	Probably entire	2.0	0.994	0.01988	0.2490
Lepus timidus ainu	Probably entire	0.8	0.643	0.00514	0.0643
Tamis sibiricus	Probably entire	0.4	0.233	0.00093	0.0116
Clethrionomys rufocanus bedfordiae	Probably entire	0.4	0.233	0.00093	0.0116
Ursus arctos yesoensis	Probably entire	0.4	0.233	0.00093	0.0116
Unknown mammals	Probably entire	1.2	0.350	0.00420	0.0526
subtotal					9.997
Total			99.975	7.98340	99.998

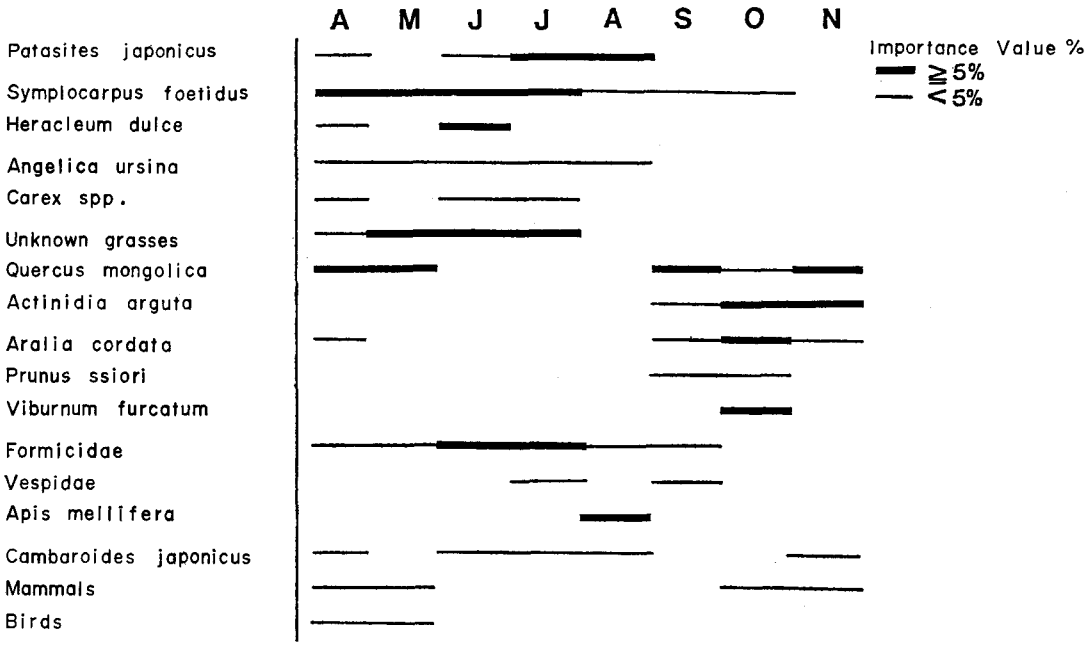

Fig. 2. Periods of occurrence of the staple food items in the diet of brown bears in northern Hokkaido. 1975–1982

Green Vegetables

Green plant material proved to be the most important component of the annual diet of brown bears (57.2% I. V.) in northern Hokkaido.

As bears emerged from their den in early spring, mostly in middle april, they walked around to search young plants along streams where snow melted. One of

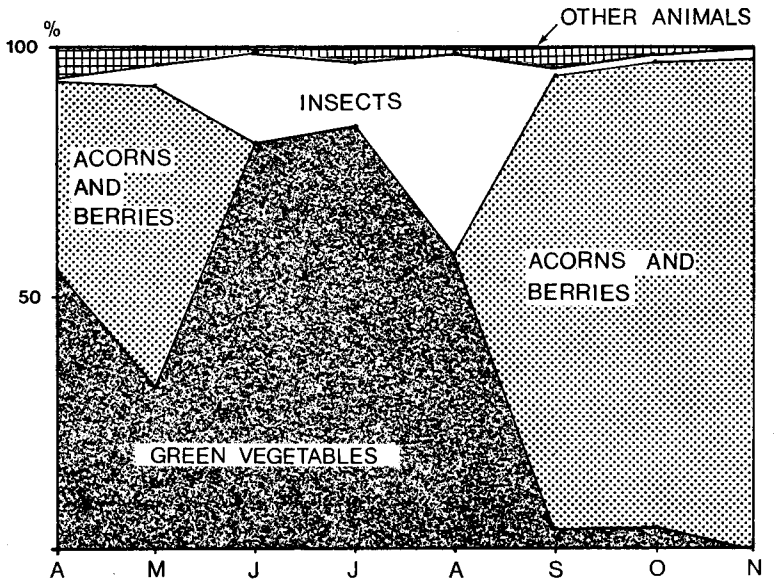

Fig. 3. Monthly trend of Importance Value of each categories of brown bear foods in nothern Hokkaido. 1975-1982

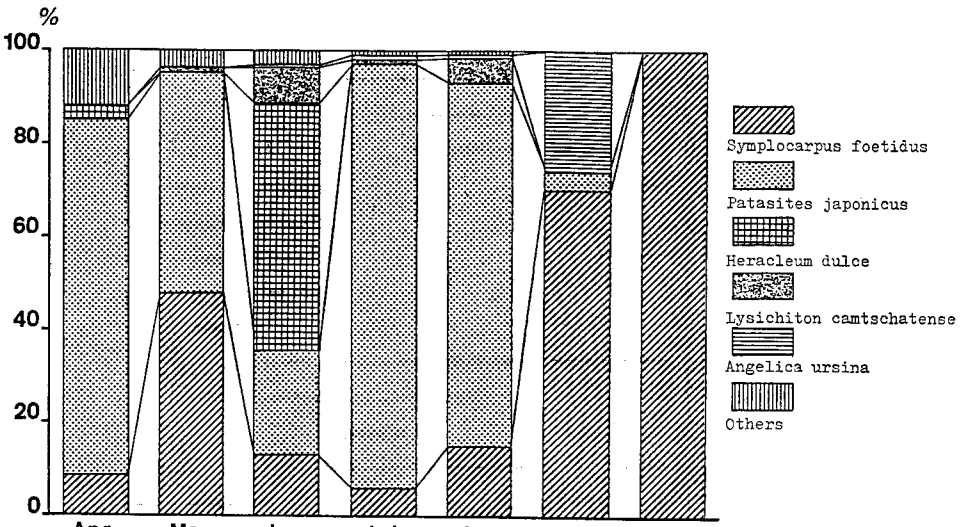

Fig. 4. Monthly change of total amount of herbaceous feeding signs, and their percent composition by visual observation in the field. 1975-1982

the favorite foods was the shoot of the skunk cabbage (*Symplocarpus foetidus*). This food was constantly preferred through the season. Various unidentified sedges (*Carex* spp.) were common, and shoots and succulent stems of *Heracleum dulce*, *Patasites japonicus* and *Angelica ursina* occasionally occured in spring.

In summer, the ratio of succulent green plants became extremely high (81.2%), almost all of plant material was green vegetables (Fig. 3). Stems of *Patasites japonicus* which had often formed big colonies on the streamsides, were most important food (52.8%). The faecal samples which contained this species were usually simple in contents; they contained no more than 1 or 2 items in many cases. *Heracleum dulce* was preferred only in June. Similar to spring, *Symplocarpus foetidus* was common in this season. The bears wandered from the mountain stream to swamp to devour these succulent material. *Angelica ursina*, *Carex* spp. and *Lysichiton camtschatense* occurred occasionally in scats.

Green plants were not eaten except the shoots of *Symplocarpus foetidus* in autumn because almost all plants had withered.

These trends of food habits for the green plants were supported by the visual observations of feeding signs (Fig. 4).

Firuits

Fruits were secondly ranked in Importance Values (32.9%), followed the green vegetables in northern Hokkaido. In particular, however, they had the highest proportion in autumn (98.6% I. V.).

More than 11 species of acorns and berries were listed by the examination.

Acorns of *Querqus mongolica*, when they are available, seem to be the most important food as evidenced by the high values of percentage occurrence, i. e., 53% in spring and 60% in autumn. The acorns, which remained on the forest floor through the winter, were taken by bears on the southern slope where snow melted in early spring. These must contribute much to the spring diet in some areas and also become important in autumn. However, the yield of acorns was much variable according to years.

Another important one was the berry of *Actinidia arguta*, but its availability was confined to a short period in autumn (41.0% I. V.). This berry was exploited by other mammals and many kind of birds, but annual fluctuation in production was not so great as acorns. Other berries, such as Udo (*Aralia cordata*), wild cherry (*Prunus ssiori*), and wild vine (*Vitis coignetiae*), were commonly consumed in autumn. The berries of *Rubs* spp. were not found in this study.

Animals

Animal matters were divided into two broad categories as insects (8.6% I. V.), and others (1.4% I. V.).

Several species of ants (*Formicidae*) including imagos and larvae were the most common in all seasons except late fall. Some kinds of wasps and bees occurred in summer. Bears might obtain these colonial insects by excavating their nests.

Many bees of the hives which had been left at forest edge by beekeepers were often attacked and eaten by bears.

The most preferred item next to the insect was Japanese crawfish (*Cambaroides japonicus*). Because this species lived scattered under rocks in the river water, the volume eaten was little though the frequency was relatively high.

The volume of mammals and birds eaten were very little, only hairs and small pieces of tail or skin were found. Most of these might be derived from carion.

Discussion

Total amount of Percentage Importance Vaule of plant matter was about 90%; animal foods constituted a small portion of the bear's diet. Consequently, the brown bear in northern Hokkaido was almost hervivorous. Bears in Shiretoko peninsula, eastern Hokkaido, were also reported to have similar trends (Aoi 1981).

Bears in northern districts emerge from their winter den in middle april, and go down to the stream side for young shoots and stems of herbs, especially of *Symplocarpus foetidus*, or to slopes without snow for acorns of *Quercus mongolica* which were left over from the previous fall.

In summer, they feed on many kinds of succulent stems and leaves of green herbs such as *Patasites*, *Heracleum*, *Angelica* and *Symplocarpus*, and occasionally on insects.

Several kinds of raspberries (*Rubs* spp.) which had been very important items in eastern Hokkaido in mid summer (Aoi unpublished) were not found in this study. Different from eastern Hokkaido, almost all of the forest floor are covered with *Sasa* bamboo in the study area. Accordingly, the amount and variety of shrubs are less than those of eastern Hokkaido.

This may be the main reason for the less avilability of *Rubus* berry for food in northern Hokkaido.

Murie (1944) reported observations on food habits of grizzlies (*Ursus arctos horribilis* L.) in Mt. Mckinley National Park, Alaska, and concluded that the grizzly was for the most part a vegetarian.

Grazing and use of berries of Kodiak bear (*U. arctos middendorffi*) account for probably three-fourths of yearly diet (Clark 1957).

In Glacier National Park, Canada, the grizzly is more vegetarian than elsewhere, by necessity rather than by choice (Mundy 1963). He described as the reason that the nature of the Park, primarilly with high snowfall, limited the availability of big game species.

Although there occurs only one species of ungulate, Sika deer (*Cervus nippon yezoensis* H.) in northern Hokkaido, the population is so small that its availability to bears is practically negligible.

Instead of wild sika deer, we have a great many domestic cows pastured around the study area and in some cases in the forest. However, bear damages to cows have never happened in these fifteen years or over. In addition, I observed a bear grazing *Lysichiton camtschatense* beside pastured young cows.

The most important animal foods as determined in this study were insects, especially colonial insects such as ants and vespids. This result is principally the same as the reports by MUNDY (1963), BROMLEI (1965), AOI (1981), and SHARAFUTDINOV (1976).

Fishes were not observed in the present sample of scats and stomachs, and it is different from many other works on food habits of brown bears (MEALEY (1975), STONOROV et al. (1972), BROMLEI (1965), VERESCHAGIN (1976)). This may be attributable to the lack of salmons and trouts on the upper reaches of the river because they are entirely caught at the mouth of the river for artificial breeding.

Unnatural foods were quite few. Only two species were found but little; corns (*Zea mays*) and Japanese plums (*Prunus salicina*) which had been derived from the tree planted besides the abandoned farming house near the mountainous area.

From these facts, I suppose the brown bear in nothern Hokkaido is not an active predator but a essentially vegetarians.

However, in spite of this specific characteristic of the animal, there was no evidence in some cases to show that any great amount of chewing had been done, as the seed of most fruits or occasionally acrons contained in the stomachs and droppings examined were entirely intact.

As BERDOCOU et al. (1983) pointed out, coherence between physiological and behabioural versatility must be examined in a separate work.

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要　　約

北海道北部におけるエゾヒグマの食性とその季節変化について調査した。

76個の糞および14個の胃内容物を精査した結果，植物質が90%を占めており，植物質は緑色植物と，堅果・漿果類に大別された。緑色植物は春から夏にかけて好まれ，おもなものは，ザゼンソウ，オオブキ，オオハナウドなどであった。堅果・漿果類は早春と秋に集中して食われており，ミズナラ，サルナシ，ウド，シウリザクラがそのおもなものである。

動物質の食物は全体の10%と少なく，アリ，ハチ類の社会性昆虫がそのほとんどで，哺乳類はきわめてまれであった。また放牧中の牛のすぐ横で植物を採食していた例などもあわせて，この地方のヒグマは，本質的に植食性の極めて高い雑食性動物と見なされた。