The diets of muskoxen and Peary caribou on some islands in the Canadian High Arctic

by Gerald R. Parker

Occasional Paper
Number 35

Canadian
Wildlife Service

The diets of muskoxen and Peary caribou on some islands in the Canadian High Arctic

by Gerald R. Parker[1]

Canadian Wildlife Service
Occasional Paper Number 35

SCF

[1]CWS, Sackville, New Brunswick E0A 3C0

Fisheries and Environment Canada
Pêches et Environnement Canada

Issued under the authority of the
Minister of Fisheries and the Environment

Canadian Wildlife Service

Catalogue No. CW69-1/35
ISBN-0-662-01462-6
ISSN-0576-6370

Contents

List of tables

List of figures

Muskoxen are found throughout the Canadian arctic islands. Sedges and willows are important items in their diet

Acknowledgements

I thank D. R. Gray, M. Gauthier, B. Hubert, and D. C. Thomas for contributing material for analysis and expanding the region sampled. I am especially grateful to F. Brazeau, D. Lamperd, and R. K. Ross for their assistance in the field during the study. Most of the microscopic analysis was performed by B. Agnew and H. Warr.

Abstract

Caribou (*Rangifer tarandus pearyi*) and muskox (*Ovibos moschatus*) rumen and faecal samples were collected from scattered locations on islands within the Canadian arctic archipelago. Samples were analyzed for plant species composition by microscopic examination and identification of cuticular and epidermal fragments. Willow (*Salix arctica*) is the single most important food item of caribou, particularly in the summer. It is supplemented with forbs, grasses, and some sedges in the winter. Muskoxen prefer a sedge–willow diet in the summer. In favourable winters sedges continue to be the single most important food item. Caribou maintain better nutritional and reproductive condition over the winter when on a high wood (willow) diet. Muskoxen maintain better condition over the winter when on a high sedge diet. Under favourable climatic conditions, interspecific competition is negligible. Under severe winter conditions, both species may seek out the limited available willow, grasses, and forbs found on exposed slopes and ridges.

Deep, prolonged, and dense snow cover is believed to be the important climatic factor controlling populations of muskoxen and caribou in the High Arctic.

Résumé

Des échantillons des fèces et du contenu du rumen de caribous (*rangifer tarandus pearyi*) et de bœufs musqués (*ovibos moschatus*) ont été prélevés en divers endroits de l'archipel Arctique canadien. L'examen microscopique et l'identification des morceaux d'épiderme et de cuticule ont permis d'en déterminer la composition végétale. Le saule (*salix arctica*) constitue le seul aliment important du régime du caribou, surtout l'été, alors qu'en hiver, ce dernier s'alimente aussi d'herbacées, d'éricacées et de certains carex. Quant au régime estival du bœuf musqué, il préfère le carex et les saules et durant les hivers cléments, c'est le carex qui continue d'être sa principale nourriture. En hiver, chez le caribou, un régime riche en fibres ligneuses (saule) améliore ses conditions de nutrition et de reproduction, tandis que chez le bœuf musqué, les mêmes résultats s'observent avec un régime riche en carex. Sous un climat favorable, la compétition interspécifique est négligeable. Durant les hivers rigoureux, il arrive que les deux espèces cherchent à se nourrir de petites quantités de saules, d'herbacées et d'éricacées poussant sur les pentes et les crêtes bien exposées.

Il semble qu'une couverture nivale épaisse, dense et durable constitue un facteur climatique important dans la régulation des populations de bœufs musqués et de caribous de l'Arctique septentrional.

Introduction

This study was designed to determine the importance of plant groups and species in the seasonal and regional diets of muskoxen (*Ovibos moschatus*) and caribou (*Rangifer tarandus pearyi*) in the Canadian arctic archipelago.

Caribou and muskoxen are the only large herbivores in the Canadian Arctic. Both species are common and relatively widespread throughout the arctic archipelago. Recent studies have shown that both species may experience sudden fluctuations in numbers (Miller and Russell 1974, Miller *et al.* 1977); such population changes appear to be closely dependent upon annual weather conditions, especially depth and duration of winter snow (Parker *et al.* 1975, Thomas *et al.* 1976).

The daily activity patterns and habitat selectivity by both species have been reported on by Wilkinson *et al.* (1976) and Parker and Ross (1976). Wilkinson *et al.* (1976) also reported on the diets of muskoxen and caribou on Banks Island. Both species normally avoid direct competition for food by selecting different habitats although they may often be found occupying the same general area.

Aside from the study by Wilkinson *et al.* (1976), which examined winter and summer rumens of both caribou and muskoxen, the literature contains only incidental observations of plants fed upon by muskoxen (Tener 1965, Hubert 1974, Gray 1973, Bruggemann 1953 and 1954). Riewe (1973) identified plant species in muskox and caribou feeding craters on Bjorne Peninsula, Ellesmere Island in May, 1973. Preliminary analysis of caribou rumens from several arctic islands has been presented by Parker *et al.* (1975) and Thomas *et al.* (1976). No study had yet used the technique of microscopic identification of cuticular and epidermal fragments in faecal and rumen samples to estimate the seasonal and regional feeding habits of either species.

Study area

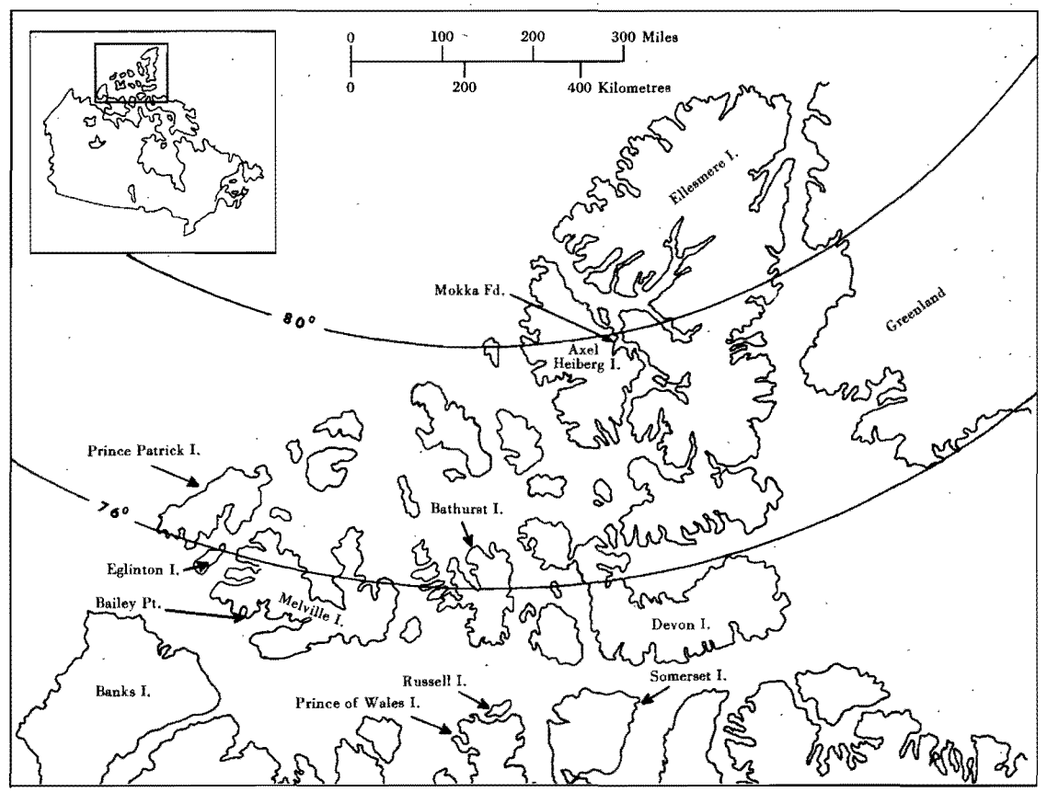
Rumen and/or faecal samples were collected from islands within the Canadian arctic archipelago (Fig. 1). The most intensive collections came from Bailey Point, Melville Island, and Mokka Fiord, Axel Heiberg Island. Although representing a vast geographical area, the climate is typical High Arctic, with low annual precipitation, extremely cold winters and cool, short summers. Mean meteorological readings for representative stations are provided by Thompson (1967).

The geology of the arctic islands is described by Tozer (1956), Thorsteinsson and Tozer (1960), and Craig and Fyles (1960).

Vegetative cover in the High Arctic is sparse relative to more southerly climes. Bare ground and rock are often the dominant features. The two extremes in habitat type are the polar desert and hydric-meadow. The latter type is restricted to areas of late snow cover, the base of slopes and other poorly drained areas, and river, pond, and stream edges. It is the most productive arctic habitat, supporting rapid summer growth of sedges and grasses. Savile (1961), Polunin (1948), and Porsild (1964) provide comprehensive information on the flora and floral ecology of arctic Canada.

Figure 1
Islands within the Canadian High Arctic from which caribou and/or muskox rumen and faecal samples were collected and analyzed for plant species composition

Figure 1



Methods

I studied the daily activity patterns and habitat selection of muskoxen and caribou at Mokka Fiord, Axel Heiberg Island (summer 1973, late winter 1975) and Bailey Point, Melville Island (summer 1974) (Parker and Ross 1976). Fresh muskox faeces were collected at selected intervals from both sites. Caribou faeces were also collected, although the unpredictable presence of that species did not allow a predetermined pattern of collection. A representative sample of winter caribou rumens was obtained in 1974 and 1975 during a collection of that species by the Canadian Wildlife Service (Parker *et al.* 1975, Thomas *et al.* 1976).

I also examined samples from muskox rumens collected from animals shot by Inuit on northeastern Devon Island and southern Ellesmere Island in the winters of 1970–71 and 1971–72, from muskox and caribou carcasses found on Bathurst Island in spring 1974, and muskox and caribou faeces collected near Bracebridge Inlet on Bathurst Island in summer 1975.

Faecal and rumen samples were analyzed for plant species composition by identification of cuticular and epidermal fragments. This technique is widely used in food habit studies and is described by Stewart (1967), Sparks and Malechek (1968), and Hansen (1971). A reference collection of epidermal tissue slides and photomicrographs and a key to the most common food plants was first prepared (Parker, Campbell, and Gauthier 1976).

I have identified all woody fragments as willow. Although there are other woody species in the High Arctic, field observation of feeding animals and examination of large rumenal fragments showed willow to be the one most often ingested.

Prepared slides were examined for identifiable epidermal fragments at 100x magnification. Slides were examined from left to right, beginning at the top, and all fragments of 10 cells or more were recorded. Few fragments had less than 10 cells. Horizontal scans were separated by one vertical field of view to avoid fragment overlap. One hundred epidermal fragments were recorded per sample. Records were also kept of the percentages of moss, woody fibre, and herbaceous fragments in the first 100 fragments examined for winter samples only. Wood fragments constituted only a minor component of the summer samples. "Willow (herbaceous)" refers to leaves and succulent new growth. "Willow (woody)" refers to woody twigs, stems, and roots.

Caribou diet

1. Summer

Twenty-two summer faecal samples of Peary caribou were collected from Mokka Fiord, Axel Heiberg Island from 7 to 21 July 1973 and 13 from Bailey Point, Melville Island between 12 and 28 July 1974.

Salix arctica was the single most important component in the summer diet of caribou (Table 1), accounting for over 80% of the identifiable fragments in samples examined. Sedges and grasses both contributed approximately 3% to the diet, and forbs 5% to 7%. *Dryas integrifolia*, although of minor importance as a summer food, was more common in the samples from Mokka Fiord (2.5%) than those from Bailey Point (0.6%).

A small number (n = 4) of caribou faecal samples were collected from Bathurst Island in summer 1975 (Table 1). Analyses showed willow to be a smaller component of the diet of caribou than on Axel Heiberg and Melville islands ($P < 0.02$). The proportions of sedges in the samples from the three islands were similar although grasses and forbs were more frequent in the Bathurst samples.

Table 1
Plant species composition of caribou (*Rangifer tarandus pearyi*) faecal samples collected in summer at Mokka Fiord, Axel Heiberg Island (1973), Bailey Point, Melville Island (1974), and Bracebridge Inlet, Bathurst Island (1975)

	Mean relative density*		
Plant species	Mokka Fiord (n=22)	Bailey Point (n=13)	Bracebridge Inlet (n=4)
Salix arctica	82.0	89.3	64.2
Dryas integrifolia	2.5	0.6	7.2
Sedges			
Eriophorum triste	0.2	0.5	0.2
Carex stans	0.4	0.6	
C. rupestris	0.3	0.1	0.2
C. nardina	<0.1		
Luzula nivalis	0.2	0.3	0.2
Unid. sedge	2.5	1.0	3.0
Total	3.6	2.5	3.6
Grasses			
Arctagrostis latifolia		0.3	2.0
Festuca sp.			6.0
Alopecurus alpinus	0.1	0.2	
Poa abbreviata	0.9	1.0	
P. alpigena	<0.1		
Puccinellia sp.	0.1		5.7
Unid. grass	2.6	0.7	1.0
Total	3.7	2.2	14.7
Forbs			
Oxyria digyna		0.1	0.7
Pedicularis sp.	2.1	1.1	3.0
Saxifraga sp.			2.0
Unid. forb	4.9	3.9	4.7
Total	7.0	5.1	10.4

*Relative density is the number of recognized fragments of a species expressed as a percentage of the total number of fragments of all species.

2. Winter 1974

Fifteen caribou rumens, five each from the islands of Bathurst, Melville, and Prince of Wales, were examined for forage species content. Rates of reproduction, body size, and general physical condition showed that the animals from Prince of Wales Island were superior to the others. Animals from Bathurst Island were in the weakest physical state (Parker *et al.* 1975). Approximately 85% of the food items in the rumens from Bathurst Island was moss; only 5% was wood. Wood comprised 22.4% of the forage items from the Prince of Wales sample, moss comprised 56.6%. The Melville sample was intermediate: wood and moss accounted for 19.2% and 50.6% respectively (Table 2).

Twenty-three percent of the herbaceous component of the rumen samples from Prince of Wales Island was also willow, while the herbaceous component of rumens from Melville and Bathurst islands contained only 2.8% willow. The amount of grasses in the herbaceous component of samples from both Prince of Wales and Melville islands was high (30%~). The Bathurst Island sample was highest in forbs; the genera *Saxifraga* and *Pedicularis* each accounted for 20% of the herbaceous component. *Saxifraga* spp. were also very high (26%) in the Prince of Wales sample. I believe the species *S. oppositifolia* was the most common representative of the genus in the rumens, based upon crater examination and macroscopic examination of rumen samples.

Table 2
Plant species composition of caribou (*Rangifer tarandus pearyi*) rumen samples collected in the late winters of 1973–74 and 1974–75 from some islands of the Canadian High Arctic, showing (A) the proportions of moss, wood, and herbaceous material in the diet, and (B) the species representation in the herbaceous component (sample size from each island is five per year)

	Mean relative density*							
	Bathurst I.	Melville I.		Prince of Wales I.		Eglinton I.	Somerset I.	Prince Patrick I.
	1974	1974	1975	1974	1975	1975	1975	1975
(A) Food class								
Wood	5.0	19.2	17.8	22.4	41.6	18.0	32.8	27.2
Herbaceous	9.4	30.2	25.2	21.0	37.6	17.4	21.2	14.6
Moss	85.6	50.6	57.0	56.6	20.8	64.4	46.0	58.2
(B) Plant species (herbaceous component)								
Salix arctica	2.8	2.8	1.0	23.0	32.8	1.0	13.4	1.4
Dryas integrifolia	1.0		7.8	1.0	4.6	1.4	3.0	2.0
Sedges								
Luzula nivalis	6.4	21.4	0.8	2.0	2.0	16.8	11.4	32.8
Kobresia myosuroides	18.0	16.2						
Carex stans	1.4			0.6	1.2		3.0	
C. nardina		0.2						
C. maritima							1.2	
C. rupestris				0.6	0.2			
Eriophorum triste				1.4	1.4		1.4	2.0
Unid. sedge	10.6	14.2	8.8	3.8	9.0	18.8	16.0	25.6
Total	36.4	52.0	9.6	8.4	13.8	35.6	33.0	60.4
Grasses								
Puccinellia angustata	5.0	1.0	2.6	0.8	0.6	5.4	2.2	2.6
Poa arctica	0.2	0.4	0.4					
Arctagrostis latifolia	0.2	2.2	0.4	3.0	4.0	29.0	4.6	5.6
Alopecurus alpinus					7.6		0.8	2.4
Agropyron violaceum				0.6		1.0		
Festuca sp.	2.8	15.8	5.0	19.6	2.0	10.6	2.0	1.0
Pleuropogon sabinei		1.2						
Deschampsia brevifolia			1.2			1.8	1.4	
Dupontia fisheri			1.4					3.6
Hierochloe alpina					1.0			
Unid. grass	3.2	9.4	2.8	8.4	4.8	5.6	8.8	8.8
Total	11.4	30.0	13.8	32.4	20.0	53.4	19.4	24.0
Forbs								
Oxyria digyna			8.4	0.4	4.6	1.0	3.4	5.0
Pedicularis sp.	21.8	6.6	11.0	5.6	0.4	6.8	3.8	2.4
Polygonum viviparum			2.0					
Saxifraga sp.	20.0	8.0	31.2	26.0	0.6	0.6	8.6	0.4
Draba alpina			4.2					
Papaver radicatum			6.0		18.8			2.4
Cassiope tetragona							3.4	
Unid. forb	6.6	0.6	5.0	3.2	4.4	0.2	11.6	2.0
Total	48.4	15.2	67.8	35.2	28.8	8.6	30.8	12.2

*Relative density is the number of recognized fragments of a species expressed as a percentage of the total number of fragments of all species.

3. Winter 1975

In the 1975 sample the proportion of wood was once again greatest in the rumens of caribou in the best nutritional condition (Table 2). Rumen samples from Somerset and Prince of Wales Islands contained the greatest amount of wood; the sample from Melville Island contained the least. The proportion of willow in the herbaceous component of the diet followed the same geographical trend in abundance as the woody component. As in 1974, there was no obvious trend for the proportion of sedges and grasses. Forbs, predominantly *Saxifraga* spp., were most abundant in the Melville Island sample.

1. Summer

Fifty-one fresh muskox faecal samples were collected at Mokka Fiord, Axel Heiberg Island from 22 June to 31 July 1973 and 36 samples at Bailey Point, Melville Island from 3 July to 18 August 1974. Results of those analyses are shown in Table 3.

Totals of 25 and 27 plant species were identified in faecal samples from muskoxen collected at Bailey Point and Mokka Fiord respectively.

Table 3
Plant species composition of muskox faecal samples collected in the summer at Mokka Fiord, Axel Heiberg Island (1973), Bailey Point, Melville Island (1974), and Bracebridge Inlet, Bathurst Island (1975)

	Mean relative density*		
Plant species	Mokka Fiord (n=51) (June 22–July 31)	Bailey Point (n=36) (July 3–Aug. 18)	Bracebridge Inlet (n=33) (July 10–Sept. 12)
Salix artica	37.2	43.5	16.8
Dryas integrifolia	3.0	0.8	0.9
Sedges			
Eriophorum triste	1.7	20.3	11.5
E. Scheuchzeri	0.4	5.8	
E. sp.	1.8	0.2	
Carex stans	22.1	11.1	10.3
C. misandra	1.5	<0.1	
C. rupestris	4.0	3.8	3.0
C. nardina	0.5	0.2	
Luzula nivalis	0.2	1.8	0.6
L. arctica	0.5	<0.1	
Kobresia myosuroides	0.1		
Unid. sedge	6.2	5.4	13.6
Total	39.5	49.0	39.2
Grasses			
Puccinellia angustata	1.3	0.1	5.7
P. poacea		<0.1	
P. andersonii	0.1	0.1	
P. vaginata	0.1	<0.1	
Alopecurus alpinus	1.9	0.4	<0.1
Arctagrostis latifolia	0.1	1.8	4.4
Agropyron violaceum	1.5	0.3	
Festuca sp.			27.9
Pleuropogon Sabinei	0.6	<0.1	
Colpodium Vahlianum	0.1	<0.1	
Dupontia fisheri	0.1		
Deschampsia brevifolia	0.1		
Poa abbreviata	0.1	<0.1	
P. arctica	0.1		
Unid. grass	2.4	1.5	3.0
Total	8.7	4.1	41.3
Forbs			
Pedicularis sp.	9.2	0.4	0.9
Oxyria digyna	0.1	<0.1	<0.1
Polygonum viviparum		<0.1	
Draba alpina		<0.1	
Saxifraga spp.			0.1
Taraxacum sp.	0.2		
Unid. forb	2.0	0.9	0.4
Total	11.4	1.6	1.6

*Relative density is the number of recognized fragments of a species expressed as a percentage of the total number of fragments of all species.

Sedges were the most common summer forage, followed closely by willow. The most frequently consumed sedge at Mokka Fiord was *Carex stans* and at Bailey Point *Eriophorum triste*. Plant community sampling found these preferences a function of species availability rather than selectivity. Grasses were more abundant at Mokka Fiord and that was reflected in the faecal samples from that area. *Dryas integrifolia* plays an insignificant role in the summer diet of muskoxen and is probably ingested incidental to feeding on other plant species. The results suggest that the diet of the muskoxen at Mokka Fiord was more varied than the predominantly sedge–willow diet consumed by muskoxen at Bailey Point.

There are several trends in the diets when examined over the summer period. At Mokka Fiord, willow remained important throughout the summer while sedges increased in importance through July. Grasses were important in late June after which they became insignificant in the total diet. Forbs, particularly *Pedicularis* spp., were actively selected through July during peak bloom. The most common species seen to be consumed was *P. sudetica*, a species common throughout the mesic- and hydric-meadows.

At Bailey Point, the most dramatic changes in feeding habits occurred in mid August. Throughout July and early August there was little change in the proportions of plant species intake; willow and sedges predominated. A dramatic shift from sedges to willows occurred during the second week of August. This coincided with the onset of the rut and freezing temperatures. Muskoxen formed larger herds and daily movement increased. Less time was spent in the hydric-meadows where sedges were most abundant. Forbs were less important in the summer diet of muskoxen at Bailey Point than at Mokka Fiord.

Thirty-three samples of muskox faeces were collected near Bracebridge Inlet, Bathurst Island in the summer 1975 (Table 3). Willow was a much smaller component of the diet in the Bathurst samples than the summer samples from Axel Heiberg and Melville islands ($P<0.001$). Conversely, grasses were far more common in the Bathurst samples than in those from Axel Heiberg or Melville islands ($P<0.001$).

2. Winter

Thirty rumen samples were analyzed from muskoxen killed on northeastern Devon Island and southern Ellesmere Island during the winters 1970–71 and 1971–72. Those animals were killed by Inuit from Grise Fiord on southern Ellesmere Island.

In 1970–71 woody and herbaceous fragments were about equal in importance in the rumens analyzed, while in 1971–72, the herbaceous component increased and the woody component decreased (Table 4). Moss played a minor role in the total forage ingested, relative to its importance in the winter diet of caribou. Fourteen plant species were identified in the herbaceous component of the samples. Sedges were the single most important class of plants consumed in both winters: *Eriophorum triste*, *Carex stans*, and *C. rupestris* were the most important sedges.

Seventy-two fresh faecal samples were collected at Mokka Fiord, Axel Heiberg Island during 18 March – 10 May, 1975.

Wood fibre made up over 50% of the identified fragments, followed by moss and herbaceous fragments (Table 4). The most important components of the herbaceous diet, in order of abundance, were sedges, grasses, and willow. Important plants were *Eriophorum triste*, *Carex stans*, and *Luzula nivalis*. The most important grass was *Festuca* sp. Forbs played a minor role in the overall winter diet. Muskoxen at Mokka Fiord show a greater intake of woody material during the winter months than muskoxen on Devon Island, as well as a reduced intake of herbaceous plant species and a greater proportion of mosses.

3. Carcasses, spring 1974

Rumen samples were taken from the carcasses of 16 muskoxen and 5 Peary caribou found on Bathurst Island in spring 1974 and analyzed (Table 5). All animals were believed to have died from malnutrition during the previous winter (Parker *et al.* 1975).

Wood content of rumens from muskox carcasses was significantly higher than that in rumens of apparently healthy specimens taken in winter on Devon Island ($P<0.005$) and in faecal samples from Axel Heiberg Island ($P<0.025$) (Table 4). The herbaceous component of the carcass rumens was significantly lower than the other samples ($P\leqslant 0.05$).

Within the herbaceous component of the carcass rumens, the proportion of sedges was significantly lower ($P<0.005$) and forbs significantly higher ($P<0.005$) than the other samples.

Table 4
Plant species representation in rumen samples from muskoxen collected on Devon and southern Ellesmere islands in the winters of 1970–71 and 1971–72 and in faecal samples from muskoxen at Mokka Fiord, Axel Heiberg Island, in the late winter of 1974–75

	Mean relative density*		
	Devon Island		Axel Heiberg Island
	1970–71 (n=14)	1971–72 (n=16)	1974–75 (n=72)
Food class			
Wood	47.7	30.4	56.6
Herbaceous	44.4	57.8	21.0
Moss	7.6	11.6	22.3
Plant species (herbaceous component)			
Salix artica	10.7	7.0	26.6
Dryas integrifolia	3.6	2.5	6.1
Sedges			
Eriophorum triste	18.5	18.7	8.5
E. Scheuchzeri			0.1
Carex stans	11.1	22.6	5.0
C. rupestris	14.4	15.9	2.3
C. nardina	5.6	6.5	0.1
Luzula nivalis	1.0	1.0	2.9
Kobresia myosuroides			0.5
Unid. sedge	16.4	15.8	14.4
Total	63.6	78.8	34.0
Grasses			
Arctogrostis latifolia	5.3	4.0	1.5
Alopecurus alpinus			<0.1
Agropyron violaceum	0.2	0.2	0.2
Puccinellia sp.	2.0	1.4	0.1
Festuca sp.	3.4	0.3	22.9
Unid. grass	3.3	3.5	4.5
Total	13.5	9.6	29.5
Forbs			
Oxyria digyna	1.4	0.1	0.2
Pedicularis sp.	0.5	0.9	0.3
Saxifraga sp.	1.0	0.4	0.4
Polygonum viviparum			0.1
Unid. forb	3.0	1.2	2.1
Total	4.7	1.9	3.2

*Relative density is the number of recognized fragments of a species expressed as a percentage of the total number of fragments of all species.

Table 5
Plant species representation in rumen samples from 16 muskox and 5 caribou carcasses found on Bathurst Island in spring 1974

	Muskox (n=16)	Caribou (n=5)
	Mean relative density*	Mean relative density*
Food class		
Wood	68.6	19.6
Herbaceous	17.8	32.0
Moss	13.5	48.4
Plant species (herbaceous component)		
Salix arctica	46.4	14.4
Dryas integrifolia	4.3	1.0
Sedges		
Eriophorum triste	3.0	
Carex stans	1.6	
C. rupestris	0.8	
Luzula nivalis	0.8	1.4
Unid. sedge	7.3	6.6
Total	13.7	8.0
Grasses		
Alopecurus alpinus	3.1	25.6
Arctagrostis latifolia	1.4	
Puccinellia sp.	0.6	2.8
Unid. grass	4.8	17.4
Total	10.0	45.8
Forbs		
Oxyria digyna	0.9	3.4
Saxifraga sp.	11.6	10.4
Pedicularis sp.	7.0	9.6
Papaver radicatum	1.6	2.8
Draba alpina	0.1	2.0
Unid. forb	4.3	2.6
Total	25.6	30.8

*Relative density is the number of recognized fragments of a species expressed as a percentage of the total number of fragments of all species.

Discussion

The wood component of the small sample (n = 5) of caribou carcasses from Bathurst Island was similar to samples from Melville Island collected in 1974 and 1975. The wood content in rumens from caribou collected on Somerset and Prince of Wales islands in 1975 was much greater than that in the Bathurst Island carcass samples. The former specimens were all found to be in good physical condition (Thomas *et al.* 1976). The small samples negate the value of statistical analyses of those differences.

Microscopic analysis of rumen and faecal samples provides a convenient means of dietary quantification for arctic herbivores and a high degree of species identification, especially for the small but often voluminous vegetation fragments.

The differential rates of digestion for various plants and plant parts must be considered when evaluating these results. Lichens, although a small component in the diet of Peary caribou (Parker *et al.* 1975, Thomas *et al.* 1976), could not be identified in these analyses. Moss and woody fragments undoubtedly remain longer in the rumen than grasses and sedges, thus increasing their relative density values and apparent importance to the diet. Elaborate feeding trials are necessary to evaluate the importance of these potential sources of error to the data. Although the importance of those two food sources may be exaggerated in the results, conclusions on their relative seasonal importance among insular populations would remain valid.

Wilkinson *et al.* (1976) and Parker and Ross (1976) found no evidence of spatial competition between muskoxen and caribou during the summer in the High Arctic. This study further supports the suspected absence of dietary overlap during the snow-free period.

Where willow is available, it provides the bulk of the summer diet of caribou. That species is supplemented with forbs and grasses growing in xeric- and mesic-habitats.

In contrast to the summer diet of caribou, muskoxen normally consume near equal amounts of willow and sedges and feed predominantly in the mesic- and hydric-meadows. Those two plant groups normally account for 65% to 75% of the summer diet of muskoxen. The species composition of sedges consumed may vary with region and species availability. There are also proportional changes in willow and sedge intake through the summer period, reflecting changes in individual nutritional condition, behavioural patterns (e.g. onset of breeding season), and habitat and plant species availability (e.g. snow cover, plant phenology).

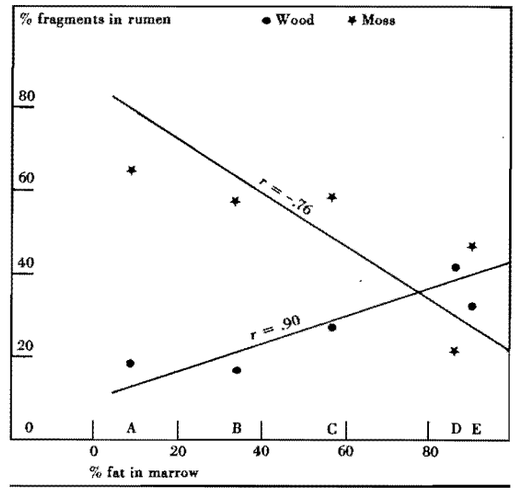
Feeding patterns of caribou and muskoxen on Bathurst Island showed a marked variation from the more uniform summer feeding patterns observed on Melville and Axel Heiberg islands. Caribou on Bathurst consumed less willow and more grasses and forbs. Muskoxen on Bathurst consumed less willow and sedges and more grass.

Severe declines in numbers for both species on Bathurst Island over the past decade have been documented (Miller *et al.* 1977). The high incidence of grasses in the summer diet of muskoxen on Bathurst Island suggests that muskoxen were not utilizing the hydric-meadows to the extent other more productive and stable populations were, or the meadows support less sedges than other arctic locations and the animals were forced to rely on the more xeric plant communities. The lower proportion of willow in the diet of both species suggests that that plant species is not as abundant on Bathurst Island as at Mokka Fiord and Bailey Point. The lower incidence of preferred forage may also reflect range deterioration from past overutilization.

In contrast to the predominantly herbaceous diet in summer, winter brings a greater reliance on the woody growth of willow by both muskoxen and caribou. Willow is vital to caribou in the winter. I found interesting correlations between abundance of wood and moss fragments in rumen samples and the physical condition of the animal (Fig. 2). There was a positive correlation between abundance of wood fragments in the rumen and percentage marrow fat for the caribou collected in late winter, 1975 (Thomas *et al.* 1976). An inverse correlation existed between abundance of moss fragments and percentage marrow fat. Moss is normally ingested incidental to selecting forage species, but in times of low forage availability, moss may be intentionally ingested.

Figure 2
Lines of regression for correlations between moss and wood fragment abundance in rumen samples and marrow fat percentages for caribou collected in winter 1974–75 (A = Eglinton, B = Melville, C = Prince Patrick, D = Prince of Wales, E = Somerset)

Figure 2



The same trend was evident for the smaller sample of caribou collected in 1974 (Parker *et al.* 1975) (Table 2). On Bathurst Island, wood comprised only 5% of the identifiable fragments; moss accounted for 85%. Caribou in the best physical and reproductive condition were collected on Prince of Wales Island. There, wood and moss made up 22% and 56% respectively of the identifiable fragments.

Forbs and xeric sedges (e.g., *Luzula nivalis*, *Kobresia myosuroides*) are important constituents of the winter diet of caribou. To obtain the required willow, forbs, and xeric sedges and grasses, caribou habitually forage on exposed and snow-free ridges and upper slopes. Although lichens are certainly consumed by caribou, their low standing crop values over most of the arctic

islands makes the importance of those plants as a food source doubtful. *Thamnolia* sp., *Cetraria nivalis*, and *C. cucullata* are the fructicose lichens commonly consumed by caribou.

Willow and hydric sedges are the food items consumed most frequently during the summer by viable and productive muskox populations in the High Arctic. The most important sedges are *Carex stans*, *Eriophorum triste*, and *E. Scheuchzeri*. When accessibility permits, muskoxen will continue to feed upon herbaceous vegetation throughout the winter, although increasing their intake of twigs and branches of willow.

Starving muskoxen, however, ingest large amounts of wood because they cannot obtain sedges and grasses: the intake of forbs also increases. Deep or otherwise unfavourable snow conditions force the muskoxen from the preferred low-lying meadows to the slopes and ridges. Willow, grasses, and forbs are more accessible on the latter sites but their abundance is low relative to preferred sedges in the meadows. A greater intake of willow is a symptom of muskox malnutrition, not necessarily the cause.

The conversion of wood into volatile fatty acids is slower than the conversion of herbaceous material and wood is less easily available. Muskoxen must expend more energy to obtain less food, a classic example of the negative energy balance. In ruminants, once the nutritional plane of the animal declines to a critical level, the nutritional plane of the microbial load also declines, with subsequent declines in microbe numbers and digestive efficiency. Once the ruminal microfauna and flora are lost, the animal is doomed regardless of the amount of food intake (Nagy *et al.* 1967).

Woody browse could probably be utilized by a healthy muskoxen with a healthy microbial load, but the difficulty in fermenting high fibre foodstuff, and decreased abundance and health of ruminal microfauna and flora combine to minimize the use made of the woody intake. The stuffed rumens of starved muskoxen and caribou are probably microbe free.

In winters of severe climatic stress, when muskoxen are forced from the meadows to forage for willow, grasses, and forbs on the exposed ridges and slopes, competition with caribou may occur. When high densities of both species (e.g. Bathurst Island, 1961) are found on the same island, interspecific competition may contribute to severe overwinter mortality.

Wilkinson *et al.* (1976) rated the importance of plant taxa in the rumens of muskoxen and caribou collected on Banks Island in 1972 and 1973. They macroscopically separated taxa following straining of the samples through a series of sieves. The winter analyses of samples for caribou and muskoxen in both studies were comparable within the documented variation of intraspecific regional diets. The diet of the Banks Island caribou sample most closely resembled the diets of caribou on Somerset and Prince of Wales islands. This condition is consistent with evidence that caribou on the Peel Islands were on a higher nutritional and reproductive plane than caribou on the Peary Islands (e.g. Melville Island, Bathurst Island). The high incidence of sedges in the winter samples of muskox rumens from Banks Island compared most favorably with the sample from Devon Island and suggests the Banks Island sample was in reasonably good physical condition. The representation of willow in the summer sample of caribou from Banks Island was much less than that in samples from Melville and Axel Heiberg islands. The reason for that discrepancy is not known, but it may be a function of availability. The most important group of plants in the summer diet of muskoxen in both studies belonged to the taxon Cyperaceae.

The author observed this Peary caribou at Mokka Fiord, Axel Heiberg Island in July 1973

More investigation is warranted in correlating muskox and caribou nutritional and reproductive condition in the winter with plant species composition of the diet determined through faecal analyses. If preliminary correlations stand up to expanded field tests, the technique would provide a low-cost means of monitoring the winter nutritional state of arctic ungulate populations without the added expense of extensive animal collections. Such an approach, supplemented by periodic aerial inventories of animal numbers and permanent plots for monitoring changes in the quality and quantity of vegetation, could provide the baseline data required for management of caribou and muskoxen in the High Arctic.

Literature cited

Bruggemann, P. F. 1953. Wildlife observations made in 1953 at Eureka, Fosheim Peninsula, Ellesmere Island, N.W.T. Can. Wildl. Serv. type. rep. 42 p.

Bruggemann, P. F. 1954. Wildlife observations made in 1954 at Eureka, Fosheim Peninsula, Ellesmere Island, N.W.T. Can. Wildl. Serv. type. rep. 45 p.

Craig, B. G., and J. G. Fyles. 1960. Pleistocene geology of Arctic Canada. Geol. Surv. Can. Ottawa. Pap. 60–10. 21 p.

Gray, D. R. 1973. Social organization and behaviour of muskoxen (*Ovibos moschatus*) on Bathurst Island, N.W.T. Ph.D. thesis, Univ. Alta. 212 p.

Hansen, R. M. 1971. Estimating plant composition of wild sheep diets. Trans. North Am. Wild Sheep Conf. Colo. State Univ. April 14–15, 1971. 1:108–115.

Hubert, B. 1974. Estimated productivity of muskox (*Ovibos moschatus*) on northeastern Devon Island, N.W.T. MSc. thesis, Univ. Man. 118 p.

Miller, F. L., and R. H. Russell. 1974. Distribution and numbers of muskoxen (*Ovibos moschatus*) on Western Queen Elizabeth Islands of Arctic Canada. J. Mammal. 55(4):824–828.

Miller, F. L., R. H. Russell, and A. Gunn. 1977. Distributions, movements and numbers of Peary caribou and muskoxen on western Queen Elizabeth Islands, N.W.T. 1972–74. Can. Wildl. Serv. Rep. Ser. No. 40, 55 p.

Nagy, J. G., G. Vidacs, and G. M. Ward. 1967. Previous diet of deer, cattle, and sheep and ability to digest alfalfa hay. J. Wildl. Manage. 31(3):443–447.

Parker, G. R., B. Campbell, and M. Gauthier. 1976. Estimating the diet of Arctic herbivores by stomach, rumen, and faecal analysis. Can. Wildl. Serv. Rep. CWCS-2021. 143 p.

Parker, G. R., and R. K. Ross. 1976. Summer habitat use by muskoxen (*Ovibos moschatus*) and Peary caribou (*Rangifer tarandus pearyi*) in the Canadian High Arctic. Polarforschung 1976(1): 12–25.

Parker, G. R., D. C. Thomas, E. Broughton, and D. R. Gray. 1975. Crashes of muskox and Peary caribou populations in 1973–74 on the Parry Islands, arctic Canada. Can. Wildl. Serv. Prog. Note No. 56. 15 p.

Polunin, N. 1948. Botany of the Canadian Eastern Arctic. Part III. Vegetation and Ecology. Nat. Mus. Can. Bull. 104 (Biol. Ser. 32). 304 p.

Porsild, A. E. 1964. Illustrated flora of the Canadian Arctic Archipelago. Nat. Mus. Can. Bull. (Biol. Ser. No. 50.) 218 p.

Riewe, R. R. 1973. Final report of a survey of ungulate populations on the Bjorne Peninsula, Ellesmere Island. Dep. Indian and North. Aff. (type. rep.) 59 p.

Savile, D. B. O. 1961. The botany of the northwestern Queen Elizabeth Islands. Can. J. Bot. 39:909–942.

Sparks, D. R., and J. C. Malechek. 1968. Estimating percentage dry weight in diets using a microscope technique. J. Range Manage. 21(4):264–265.

Stewart, D. R. M. 1967. Analysis of plant epidermis in feces: a technique for studying the food preferences of grazing herbivores. J. Appl. Ecol. 4(1):83–111.

Tener, J. S. 1965. Muskoxen in Canada. Can. Wildl. Serv. Monogr. No. 2. 166 p.

Thomas, D. C., R. H. Russell, E. Broughton, and P. L. Madore. 1976. Investigations of Peary caribou populations on Canadian arctic islands, March–April 1975. Can. Wildl. Serv. Prog. Note No. 64. 13 p.

Thompson, H. A. 1967. The climate of the Canadian Arctic. *In* The Canada Year Book, 1967. Dom. Bur. Stat. Ottawa, p. 55–74.

Thorsteinsson, R., and E. T. Tozer. 1960. Summary of account of structural history of the Canadian arctic archipelago since Pre-Cambrian times. Geol. Surv. Can. Ottawa. Pap. 60-7.

Tozer, E. T. 1956. Geological reconnaissance, Prince Patrick, Eglinton, and western Melville Island, arctic archipelago, N.W.T. Geol. Surv. Can. Ottawa. Pap. 55-5. 32 p.

Wilkinson, P. F., C. C. Shank, and D. F. Penner. 1976. Muskox–caribou summer range relations on Banks Island, N.W.T. J. Wildl. Manage. 40(1):151–162.

Other publications in the Occasional Papers Series

No. 1
Birds protected in Canada under the Migratory Birds Convention Act. 4th ed. Also available in French.
Cat. No. R69-1/1
No. 2
Canadian bird names, French, English and scientific. Bilingual publication.
Cat. No. R69-1/2
No. 3
Use of aerial surveys by the Canadian Wildlife Service by D. A. Benson. Out of print.
Cat. No. R69-1/3
No. 4
Queen Elizabeth Islands game survey, 1961 by J. S. Tener.
Cat. No. R69-1/4
No. 5
Age determination in the polar bear by T. H. Manning.
Cat. No. R69-1/5
No. 6
A wildlife biologist looks at sampling, data processing and computers by D. A. Benson. Out of print.
Cat. No. R69-1/6
No. 7
Preliminary report on the effects of phosphamidon on bird populations in New Brunswick by C. D. Fowle. Out of print.
Cat. No. R60-1/7
No. 8
Birds of Nova Scotia–New Brunswick border region by G. F. Boyer.
Cat. No. R69-1/8
No. 9
Effects of dietary methylmercury on Ring-necked Pheasants, with special reference to reproduction by N. Fimreite.
Cat. No. R69-1/9
No. 10
Trends in populations of barren-ground caribou over the last two decades: a re-evaluation of the evidence by G. R. Parker.
Cat. No. R69-1/10
No. 11
The Canada migratory game bird hunting permit and related surveys by D. A. Benson.
Cat. No. R69-1/11
No. 12
Observations on duck hunting in eastern Canada in 1968 and 1969 by H. J. Boyd.
Cat. No. R69-1/12

No. 13
Evaluation of ecological effects of recent low water levels in the Peace–Athabasca Delta by H. J. Dirschl.
Cat. No. CW69-1/13
No. 14
The Great Cormorants of eastern Canada by A. J. Erskine.
Cat. No. CW69-1/14
No. 15
Distribution of barren-ground caribou harvest in northcentral Canada by G. R. Parker.
Cat. No. CW69-1/15
No. 16
Bird migration forecasts for military air operations by H. Blokpoel.
Cat. No. CW69-1/16
No. 17
Waterfowl populations on the Peace–Athabasca Delta, 1969 and 1970 by D. J. Nieman and H. J. Dirschl.
Cat. No. CW69-1/17
No. 18
Gammarus predation and the possible effects of *Gammarus* and *Chaoborus* feeding on the zooplankton composition in some small lakes and ponds in western Canada by R. S. Anderson and L. G. Raasveldt.
Cat. No. CW69-1/18
No. 19
A summary of DDE and PCB determinations in Canadian birds, 1969 to 1972 by M. Gilbertson and L. Reynolds.
Cat. No. CW69-1/19
No. 20
Development of a simulation model of Mallard Duck populations by C. J. Walters, R. Hilborn, E. Oguss, R. M. Peterman and J. M. Stander.
Cat. No. CW69-1/20
No. 21
Use of museum specimens in toxic chemical research by A. M. Rick.
Cat. No. CW69-1/21
No. 22
Impoundments for waterfowl by W. R. Whitman
Cat. No. CW69-1/22
No. 23
Minimizing the dangers of nesting studies to raptors and other sensitive species by R. W. Fyfe and R. R. Olendorff.
Cat. No. CW69-1/23
No. 24
Waterfowl damage to Canadian grain: current problems and research needs by L. G. Sugden.
Cat. No. CW69-1/24

No. 25
Census techniques for seabirds of arctic and eastern Canada by D. N. Nettleship.
Cat. No. CW69-1/25
No. 26
Notes on the present status of the polar bear in James Bay and Belcher Islands area by Charles Jonkel, Pauline Smith, Ian Stirling and George B. Kolenosky.
Cat. No. CW69-1/26
No. 27
Limnological and planktonic studies in the Waterton Lakes, Alberta by R. Stewart Anderson and Roderick B. Green.
Cat. No. CW69-1/27
No. 28
Birds and mammals of the Belcher, Sleeper, Ottawa, and King George Islands, Northwest Territories by T. H. Manning.
Cat. No. CW69-1/28
No. 29
Developments in PPS sampling – Impact on current research by A. R. Sen.
Cat. No. CW69-1/29
No. 30
Dynamics of snowshoe hare populations in the Maritime Provinces by Thomas J. Wood and Stanley A. Munroe.
Cat. No. CW 69-1/30
No. 31
Migration and population dynamics of the Peace–Athabasca Delta goldeye population by D. B. Donald and A. H. Kooyman.
Cat. No. CW 69-1/31
No. 32
The effects of fire on the ecology of the Boreal Forest, with particular reference to the Canadian north: a review and selected bibliograph by John P. Kelsall, E. S. Telfer and Thomas D. Wright.
Cat. No. CW 69-1/32
No. 33
The ecology of the polar bear (*Ursus maritimus*) along the western coast of Hudson Bay by Ian Stirling, Charles Jonkel, Pauline Smith, Richard Robertson and Dale Cross.
Cat. No. CW69-1/33
No. 34
Canvasback habitat use and production in Saskatchewan parklands by Lawson G. Sugden.
Cat. No. CW69-1/34