CARIBOU COLLECTION, BANKS ISLAND

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ABSTRACT

A collection of Banks Island caribou was conducted between 27 November and 12 December, 1993 and 9 to 18 February, 1994 primarily to document the physical and physiological condition of adult male and calf Peary caribou (*Rangifer tarandus pearyi*). Ten animals were collected: 3 adult males, 1 adult female, and 6 female calves. All adults and one calf were collected during November/December with the remaining five calves collected in February. We collected the following samples/measurements: blood serum, urine, faeces, rumen, liver, kidney (with accompanying fat), incisor bar (adults only), back fat depth, muscle, and the right hind leg (femur, tibia, metatarsus, and hoof). We collected similar data from two orphaned calves (one male, one female) shot in early November. We present physiological, physical, and diet data from all 12 animals and, where data are similar, compare our findings with those from other collections of Svalbard reindeer, barren ground, and Peary caribou. Adults had more backfat, total dissectible fat (TDF), and higher kidney fat indices (KFI) than calves. Calves collected in early winter had more backfat, TDF, and higher KFI than those collected in mid-winter. Femur marrow fat was similar between adults and calves collected in early winter. Calves collected in mid-winter had significantly ($p<0.01$) less femur marrow fat than those collected in early winter. The ranges of the condition indices we report are comparable to those reported for Peary caribou collected on Banks Island and the Parry Islands in the 1970's. Animals collected in mid-winter had higher urea nitrogen:creatinine ratios in both urine and blood samples than animals collected in early winter. The difference was significant in urine samples ($p<0.02$). There were no age effects. All 6 blood samples were negative for brucellosis. Diet composition was similar for

adults and calves and was dominated by relatively equal proportions of sedge, willow, legume, and rosaceae (mostly *Dryas* spp.). The mid-winter diet showed an increase in legume with a corresponding decrease in willow. Adult rumen contents tended to be higher in nitrogen than that of calves. Calves collected in early winter had higher nitrogen and lower lignin rumen contents than those collected in mid-winter. Calves demonstrated overwinter growth (between November/December and February) in all three legbones (femur, tibia, metatarsus). Only one female calf showed detectable levels of lead-210 and polonium-210. Cesium-137 was not detected.

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INTRODUCTION

An ice survey was conducted on the southern third of Banks Island in October, 1993 to assess the severity and extent of icing caused by freezing rains (Larter and Nagy, 1994). Because approximately one half of the traditional Peary caribou (*Rangifer tarandus pearyi*) wintering range showed severe icing conditions, there was concern that caribou would be unable to find adequate winter forage, and a winter die-off would be imminent. Additional concern was raised when two orphaned calf caribou, that were shot in early November, were considered to be in poor condition by members of the community. Whether their poor condition was a result of orphaning or low food availability was unknown. In response to concerns raised by residents of Sachs Harbour, the Wildlife Management Advisory Committee (N.W.T.) (WMAC(NWT)) recommended that a limited collection of caribou be conducted in order to document the physical condition of adult male and calf caribou. Adult males and calves were expected to be the sex/age classes that would be the first to show signs of severe undernutrition: adult males because they would be rebuilding fat reserves depleted during the rut, and calves because they would have entered the winter with lower fat reserves than adult females and immature animals.

A non-invasive technique that measures the urea nitrogen:creatinine ratio of urine collected from snow has provided a suitable index of animal condition for some cervids (DelGiudice and Seal, 1988; DelGiudice *et al.*, 1991; Case, 1994), but inadequate baseline urea nitrogen:creatinine data from Banks Island caribou precluded use of this index. Snow urine data and physical measures of fat content from various body depots from individual animals were to be collected to determine if there was a correlation between the index and actual physical

condition. This would permit use of the non-invasive technique to assess physical condition in the future. The only previous study that had measured body-fat reserves and the ratio of urea nitrogen:creatinine had found that the ratios did not consistently reflect body-fat reserves in black-tailed deer (*Odocoileus hemionus sitkensis*) (Parker *et al.*, 1993).

The analysis of blood serum provides a range of physiological measures in addition to electrolyte ratios. Serum electrolyte ratios have also been proposed as another technique to assess nutritional condition in deer (DelGiudice *et al.*, 1994). However, because of low variability of serum electrolyte ratios associated with deteriorating nutritional condition, and dehydration as a confounding factor, its use as an index of condition has been limited (Young and Scrimshaw, 1971; DelGiudice *et al.*, 1994). We collected blood serum to document a variety of physiological measures and to assess its utility of electrolyte ratios as an index of condition for Peary caribou.

Given this rare opportunity to collect Peary caribou (*Rangifer tarandus pearyi*) and the paucity of physical and physiological data from this subspecies, we collected as many samples and as much data from each animal as possible. In addition to the ten animals collected, we had gathered similar data from two orphaned calves that were shot 3 weeks prior to the initiation of the collection. This report presents data from all 12 animals, and compares our findings with similar data collected from barren-ground caribou, Svalbard reindeer, and Peary caribou.

METHODS

Sample Collection

Each day that weather permitted travel by snowmobile, we travelled from Sachs Harbour in search of caribou. Animals were stalked and shot in the neck for a quick kill whenever possible (7 of 10 animals were killed almost instantly). Biological samples were collected at the kill site. Blood samples were immediately collected from the jugular vein in 50 ml centrifuge tubes. The tubes were placed inside parkas to prevent freezing. Immediately upon returning to Sachs Harbour, the blood was centrifuged; the serum was decanted and frozen.

Urine samples were collected directly from the bladder whenever possible. Often caribou released urine into the snow or onto the fur during necropsy. If this happened, we either collected snow urine or scraped frozen urine from the fur. Urine samples were stored frozen. A subsample (5 ml) of frozen urine was used for analyses.

Faecal material was collected from the colon and stored frozen. In the laboratory, the frozen samples were thawed, dried in a drying oven at 60° C for 48 hours, and ground through a 1 mm screen with a centrifugal mill. A 1 g subsample of dried ground material was used for the analysis of diet composition.

The rumen was cut open and the entire contents mixed by hand. A sample of rumen material was taken and stored frozen. In the laboratory, the frozen samples were thawed to room temperature, air dried to remove excess moisture, oven dried at 60° C for 48 hours, and ground through a 1 mm screen with a centrifugal mill. A 5 g subsample of dried ground material was used to assess diet quality. A 1 g subsample of dried ground material was used for the analysis

of diet composition.

Both kidneys, with accompanying fat, the liver, the entire right hind leg (femur, tibia, metatarsus and hoof), and a small amount of leg muscle (from the right femur) were collected from all animals. These samples were kept frozen until analysis. The front incisor bar was collected from adult animals only. Backfat was measured to the nearest mm by making a 45° angle cut from the base of the tail (Riney, 1955; Dauphiné, 1971).

Body Condition Indices

Backfat/Total Dissectible Fat

Backfat was measured directly. We estimated the total dissectible fat (TDF) for each animal by using the following linear and polynomial regressions developed by Tyler (1987a) from a sample of culled Svalbard reindeer:

$$\text{TDF of calves} = 0.394 + 0.188x$$

$$\text{TDF of adults} = 1.65 + 0.06x + (3.8 \times 10^{-3} x^2)$$

where x = the depth of backfat in mm

We also estimated TDF following the relationship determined by Adamczewski *et al.* (1987) from a sample of culled Coats Island barren-ground caribou:

$$\text{TDF} = -0.178 + 1.058x + 24.147y$$

where x = the depth of backfat in cm

y = the weight of kidney fat in kg

Body Condition Scores

We determined an index of body fatness for the four adult caribou following Gerhart *et al.* (1992). Briefly one feels the fatness at three different body areas: i) the hollow behind the shoulder hump, ii) along the spine, and iii) across the ribs. For arctic caribou, each area is scored between 1 (lowest) and 4 (highest). The sum of the three scores is called the body condition score (BCS). A score of 1 for these areas would result from: i) no muscle just connective tissue and bone, ii) no back fat and individual vertebrae can clearly be felt from the base of the tail onward, and iii) consistent hollows between the ribs that are as deep as the ribs are thick. Contrastingly, a score of 4 would result from: i) lots of muscle and no hollow behind the hump, ii) extremely padded hips (no bone can be felt) and backfat to the level of the spine (spine cannot be clearly felt), and iii) ribs discernable toward abdomen but rib area behind shoulders is well covered with fat and there are no grooves between the ribs (K. Gerhart, pers. comm.). We attempted to measure this index on calves with little success. This technique had not been successful when tried on barren-ground caribou calves in Alaska (K. Gerhart, pers. comm.), therefore we only present data from adults.

Kidney Fat Indices

Kidneys were collected from all 12 animals. Each kidney and all its associated fat were weighed to the to the nearest 0.1 mg on a Sartorius BA 210S analytical balance. Fat was then trimmed from the anterior and posterior of each kidney (following Riney, 1955) and the kidney with its remaining fat was reweighed. Finally, all fat was removed from each kidney and the organ was weighed. The kidney fat index (KFI) was calculated for each kidney using the

following formula:

(weight of fat remaining after trimming/weight of kidney) x 100

The mean KFI per animal is reported. We also calculated a ratio of the total fat weight to kidney weight for each kidney.

Femur Marrow

Immediately after measuring the femur, we cut out the middle one third of the bone using a hack saw. Femur marrow was photographed and given a visual assignment based upon its colour and consistency following Riney (1955). The four categories were: 1) firm white marrow, 2) soft marrow with pink or red streaking, 3) gelatinous or red marrow, and 4) watery red marrow. Subsequently, the marrow from the middle one third of the femur was removed and split into two approximately equal sized parts. Each part was weighed to the nearest 0.1 mg on a Sartorius BA 210S analytical balance. We determined femur marrow fat content for both subsamples by the drying method (Neiland, 1970), but used two different drying techniques: oven drying and freeze drying. One subsample was placed on a tared petri dish and placed into a drying oven at 60° C for a minimum of 7 days, or until the weight did not change between daily recordings. The second subsample was shipped frozen to Renewable Resources Fort Smith and was freeze dried at -70° C for 5 days before weighing. We present both sets of results.

Urine Analysis

Urine samples from all 12 animals were analyzed for their concentrations of the following components at the Western College of Veterinary Medicine, Saskatoon: cortisol, urea nitrogen

(U), creatinine (C), sodium (Na), potassium (K), chloride (Cl), calcium (Ca), and phosphorus (P). The following ratios are reported in mg:mg x 1000: Na:C, K:C, Cl:C, Ca:C, and P:C. The U:C ratio is reported in mg:mg and the Cortisol:C ratio is reported in ug:mg.

Blood Serum Analysis

Blood sera from the 10 collected animals were analyzed for their concentrations of the following components at the Western College of Veterinary Medicine, Saskatoon: cortisol, urea nitrogen (U), creatinine (C), sodium (Na), potassium (K), chloride (Cl), bicarbonate, calcium (Ca), phosphorus (P), magnesium, and glucose. Anion gap and osmolality were also calculated. The following ratios are reported in mg:mg x 1000: Na:C, K:C, Cl:C, Ca:C, and P:C. The U:C ratio is reported in mg:mg and the Cortisol:C ratio is reported in ug:mg. Adequate amounts of sera remained following the above analyses to screen blood from 6 animals (1 adult male and 5 female calves) for brucellosis, using the buffered plate screening test.

Faecal Analysis

Faecal samples from all 12 animals were analyzed for plant fragments following Hansen *et al.* (1976) in order to determine diet composition. Diet analysis was conducted by the Composition Analysis Laboratory (CAL), Ft. Collins. Percent of the following forage types are presented: sedge, willow, grass, lichen, cassiope, legume, rosaceae, moss, and fern.

Rumen Analysis

Rumen samples from all 12 animals were analyzed for the following at the University of British Columbia Animal Science Department: percent dry matter, nitrogen content, gross energy content, fibre content and lignin content. Nitrogen content was determined by the micro-Kjeldahl technique (Nelson and Sommers, 1973). Percent crude protein was determined using the standard conversion, percent nitrogen content x 6.25. Energy content was determined by bomb calorimetry using a LECO AC-300 Automated Bomb Calorimeter, data are presented as cal/g. Fibre and lignin content were determined by the acid-detergent fibre and acid-detergent lignin techniques following Van Soest (1967) and Van Soest and Robertson (1980). All results are presented as percent dry matter basis.

Rumen samples were also analyzed for plant fragments in order to determine dietary components by CAL, Ft. Collins. Percents of the same forage classes as those used for faecal analysis are presented.

Leg Bone Analysis

The frozen right hind leg bones of each animal were separated and cleaned of muscle tissue. We used calipers to measure the lengths of the femur, tibia, and metatarsus following Langvatn (1977) and Thomas *at al.* (1976).

Age

The age of adult caribou was determined by counting cementum annuli from the root of the first incisor (Matson, 1981). This analysis was conducted at Matson's Laboratory, Milltown,

Montana. The first week in June was used as time zero for the adults. Calving on Banks Island occurs during late May and June, with the majority of calves being born during the first 2 weeks of June (Urquhart, 1973). Following Dauphiné (1976) we also used June as time zero for calves and estimated their age in months.

Radionuclide Analysis

A ≥50 g sample of liver tissue, a ≤5 g sample of leg muscle, and the tibia from each of the 12 animals were analyzed for their radionuclide components and associated concentrations by the Atomic Energy of Canada Limited Research Laboratory (AECL). Additionally, the kidneys of 5 animals were analyzed for their radionuclide components and associated concentrations; 7 kidney samples were spoilt when they were not refrozen.

DNA Analysis

A ≤1 g sample of leg muscle was forwarded to the University of Alberta Zoology Department for DNA analyses. Results of this ongoing DNA study are currently unavailable and will not be presented in this report.

Statistical Analyses

We used a oneway ANOVA to compare the following: bone lengths, backfat, total dissectible fat, kidney fat indices, ratios of kidney fat weight to total kidney weight of calves 5-6 months old with calves 8 months old. We used ANOVA to look at month effects on calf kidney weight. We used ANOVA to look for sample time and sex and age group differences in the

urine electrolyte ratios, blood electrolyte ratios, and the percent femur marrow fat. The last data set was square root transformed prior to analysis.

We used correlation analysis to compare: i) the two estimators of total dissectible body fat, ii) the two techniques used to determine femur marrow fat, iii) drying estimates of femur marrow fat with the visual rating of femur marrow fat, and iv) the electrolyte ratios found in the blood serum and the urine of collected animals. We tested for rank correlation of the paired electrolyte ratios using the Spearman rank correlation coefficient and by calculating Spearman's ρ (Conover, 1980).

We used ANOVA to look for differences in fibre, lignin, nitrogen, and energy content in rumen contents between calves and adults, and between early (November and December) and mid-winter (February). Because no adults were collected in mid-winter we used two separate oneway ANOVA's.

RESULTS

Body Condition Indices

Backfat/Total Dissectible Fat

Adults had more backfat than calves, range 15.5-40.0 mm versus 0.5-6.5 mm respectively (Table 1). The adult female had the most backfat. Calves collected in early winter had more backfat than those collected in mid-winter, but these differences were not significant ($p=0.18$).

Adults had more estimated total digestible fat (TDF) than calves, range 3.5-10.1 kg versus 0.109-1.70 kg respectively (Table 1). The adult female had the most estimated TDF. Calves collected in early winter had more TDF than those collected in mid-winter. This difference was not significant when using Tyler's (1987a) estimator ($p=0.18$), but bordered on significance when using Adamczewski *et al.*'s (1987) estimator ($p=0.05$). Estimated total dissectible fat (TDF) was similar regardless of which estimator was used; estimates were significantly correlated ($R^2_{adj} = 0.89$, $p<0.0001$).

Body Conditions Scores

All adult males had body condition scores of 8. The adult female had a score of 9.

Kidney Fat Indices

Kidney fat indices (KFI) were generally higher in adults than calves, range 46.59-126.40 versus 0-46.95 (Table 2). The percent total kidney fat weight to kidney weight was also higher in adults than calves, range 57.92-150.41% versus 12.83-66.70% (Table 2). Calves collected in

early winter had significantly higher KFI's ($p=0.003$) and ratios of percent total kidney fat weight to kidney weight ($p=0.022$) than those collected in mid-winter: 39.69±3.91 versus 9.68±3.69 and 51.18±8.79 versus 22.18±9.92 respectively (mean±SE) (Table 2).

Femur Marrow

Adults and calves collected in early winter had similar femur marrow fat (plus non-fat residue), range ca. 79-94% (determined by oven drying) and ca. 76-95% (determined by freeze drying) (Table 3). Calves collected in mid-winter had significantly less femur marrow fat than those collected in early winter: range ca. 16-57% versus 79-88%, $p=0.009$, (determined by oven drying) and 19-64% versus 76-93%, $p=0.023$, (determined by freeze drying) (Table 3). Femur marrow fat estimates were highly correlated between the two drying techniques ($R^2_{adj} = 0.960$, $p<0.001$).

The visual rating of femur marrow fat was 2 or 3 for 10 of the 12 animals (Table 3.). Two adult males had watery red marrow indicative of a 4 rating. The correlations between the visual rating and femur marrow content were low, R^2_{adj} of 0.363 and 0.365 for oven drying and freeze drying estimates respectively, but significant ($p=0.022$ and $p=0.029$ respectively). However, the highest estimated femur marrow fat content was found in a male with the lowest visual rating of 4.

Urine Analysis

Caribou collected in early winter had significantly ($p=0.017$) lower U:C ratios (mg:mg) than those collected in late winter, mean (±SE), 8.62:1 (1.58) versus 13.18:1 (1.23) (Table 4.,

Appendix 1.). Adult males had the highest early winter ratios, 15.76, 14.05 and 8.17:1. K:C ratios (mg:mgx1000) were also lower (p=0.053) in early winter 69.25:1 (9.64) than in mid-winter 117.12:1 (10.26) (Table 4., Appendix 1.). There were no significant sex and age class effects in any of the ratios of urine electrolytes measured (Appendix 1.).

A female calf collected in February had extremely high Na:C, Cl:C, and P:C ratios (mg:mgx1000) 2078, 1400 and 532:1, but this animal had the lowest U:C ratio of all calves collected in February, 7.31:1 (Appendix 1.).

None of the electrolyte ratios found in the urine of animals was significantly ($p>0.20$) correlated with those found in the blood with the exception of U:C ($p=0.043$, $R^2_{adj}= 0.346$). The rank correlations test indicated that only the Cortisol:C ratio showed significantly correlated rankings from urine and blood data ($p<0.05$, $\rho = 0.661$).

Blood Serum Analysis

Caribou collected in mid-winter had significantly higher ratios of Na:C, 7.98:1 (0.25), ($p=0.024$), Cl:C, 5.57:1 (0.20) ($p=0.029$), and Ca:C 6.31:1 (0.35) ($p=0.034$) than caribou collected in early winter, 6.84:1 (0.32), 4.71:1 (0.25), and 5.17:1 (0.28) respectively (Table 5., Appendix 2.). All ratios expressed as mean ($\pm$SE) in mg:mgx1000. The Cortisol:C ratio (ug:mg) was significantly ($p=0.042$) higher for animals in early 0.553:1 (0.145) versus mid-winter 0.199:1 (0.021) (Table 5., Appendix 2.). There were no significant sample time or sex and age class effects on the levels of the various blood serum electrolytes (Appendix 2).

All caribou had slightly elevated levels of blood potassium, calcium, and magnesium, possibly indicative of hyperkalaemia, hypercalcaemia, and hypermagnesaemia. Urea nitrogen and

glucose levels also tended to be somewhat elevated. All 6 samples screened for brucellosis gave negative results.

Faecal Analysis

Diet composition was similar for calves and adults collected in early winter (Figure 1.), with sedge, willow, legume, and rosacea (mostly *Dryas* spp.) each representing about 20% of the diet. Calves collected in mid-winter had little willow, and increased legume (ca. 40%) in the diet. Other dietary components were similar over time (Figure 1.).

Rumen Analysis

Mean (±SE) nitrogen content tended to be higher in adult animals than calves, 3.35% (±0.09%) versus 3.11% (±0.09%), and higher during early than mid-winter, 3.31% (±0.06%) versus 3.03% (±0.14%). Mean (±SE) lignin content also tended to be higher in animals collected in early winter than mid-winter, 11.10% (±0.71%) versus 9.06% (±1.15%). These differences were not significant ($p<0.15$). Percent fibre and energy content of the rumen material showed little variation between age class ($p=0.687$, $p=0.703$ respectively) or collection time ($p=0.912$, $p=0.817$): mean (±SE) percent fibre 41.85 (0.87) and energy content 4500.0 cal/g (54.8) (Appendix 3.).

Diet composition was generally similar to that determined from faecal analysis except for the rosaceae and willow proportions. Rosaceae proportions were consistently higher and willow proportions were consistently lower for rumen versus faecal dietary analyses (Figure 2.).

Leg Bone Analysis

Calves aged 8 months had significantly longer leg bones than those aged 5-6 months: mean femur length 21.05 versus 22.34 cm ($p=0.005$), mean tibia length 24.06 versus 25.76 cm ($p=0.002$), and mean metatarsus length 21.82 versus 23.45 cm ($p=0.001$). The differences remained significant when the one male calf, which had the longest bones of those aged 5-6 months, was removed from the analysis: ($p=0.005$, $p=0.002$, $p=0.004$ respectively) (Table 6). Mean bone lengths for adult males ($n=3$) were: femur 26.58 cm, tibia 30.47 cm, and metatarsus 26.59 cm. The 4-year-old adult male had smaller bones than the older males. The adult female had intermediate bone lengths when compared to adult males (Appendix 4).

Age

All adults were 4 or 5 years old, calves were either 5, 6, or 8 months old.

Radionuclide Analysis

Virtually all tissue samples had either barely detectable or non-detectable levels of cesium-137 and lead-210. The exception was one female calf aged 8 months that had detectable levels of lead-210 and polonium-210.

DISCUSSION

Body Condition Indices

The range of backfat depths, kidney fat indices, femur marrow fat content, and visual ranks of femur marrow fat we report were well within the range of those found for similar sex and age animals collected on Banks Island in 1972-1973 (Wilkinson and Shank, 1974) and Prince William, Eglington, and Melville islands from 1974-1977 (Thomas *et al.*, 1976) (Tables 7-10). There were no confirmed die-offs on these islands in any of the winters that samples were collected, with the possible exception of Melville Island during winter 1973-74. Caribou numbers on Bathurst Island and eastern Melville Island were reduced by approximately 60% during that winter (Miller and Russell, 1975; Parker *et al.*, 1975). However, the location of the small sample of animals collected on Melville Island during April 1974 is unknown (Thomas *et al.*, 1976). The 1974 samples do represent the lowest values for the various indices measured and are higher than in other years when die-offs did not occur. Regardless, our data do not indicate an immanent winter die-off of caribou on Banks Island.

Being able to detect poor body condition, or body condition approaching a threshold beyond which the animal is doomed, continues to be a goal for wildlife biologists and an invaluable tool for wildlife managers. We looked at a variety of the standard condition indices. The animal which appeared to be in the best condition, the adult female, consistently ranked highest in all the measures we took. Unfortunately, no one animal consistently ranked lowest.

The visual rating of femur marrow fat was not a reliable indicator. Wilkinson and Shank (1974) found some relationship between the visual rating and marrow fat content at the extremes,

but no relationship in the intermediate range. As in this study, they also had animals with the lowest visual rating having the highest femur marrow content.

Hunt (1979) found that the dry-weight estimations of femur marrow fat content of elk were similar using oven drying method, freeze drying, and reagent drying methods. Our study showed a high correlation between the estimates derived from oven drying and freeze drying. Therefore, the need to access expensive freeze drying equipment in order to get accurate femur marrow fat estimates is unnecessary.

The reliability of the kidney fat index (KFI) as an index of body fatness has been criticized because seasonal variation in kidney size often does not reflect seasonal variation in body weight (Batcheler and Clarke, 1970; Dauphiné, 1975; Van Vuren and Coblentz, 1985; Adamczewski *et al.*, 1987). Dauphiné (1975) found substantial differences in changes of kidney size and the timing of the change in each sex and age group of Qamanurjuaq caribou. We also found significant monthly differences in kidney weights of calf caribou: mean (±SE) kidney weights were 48.70±0.94 g (n=4), 33.04±0.97 g (n=2), and 37.64±1.36 g (n=10) for November, December, and February respectively. Therefore we chose to measure and report the ratio of fat weight to kidney weight in addition to the traditional KFI.

Winter weight loss in wild cervids is frequently regarded as diagnostic of undernutrition despite experimental evidence to the contrary (Kay, 1985; Ryg, 1983). Growth stasis and weight loss effectively reduce an animal's daily requirements (Tyler and Blix, 1990). This may be critical for ungulates in winter when food is scarce, of low nutritional quality and energetically expensive to acquire (Tyler, 1987b). Cuyler and Øritsland (1993) found that Svalbard reindeer, unlike other ungulates including barren-ground caribou, had an impressive capability for reducing

metabolism. Adamczewski *et al.* (1993) found that an insular population of caribou (*Rangifer tarandus groenlandicus*) on Coats Island became fatter and heavier than their mainland caribou counterparts gaining and losing large deposits of fat and protein in a similar fashion to Svalbard reindeer. Given these adaptations, the analyses of snow urine and its use as an index of animal condition may be more appropriate than other previously used indices. Unfortunately urine data from these populations are lacking, and the current sample size from Banks Island Peary caribou is inadequate to document the seasonal range in variation and levels indicative of severely nutritionally stressed individuals.

Urine Analysis

One would expect urea nitrogen:creatinine (U:C) values in urine to increase during the course of the winter as fat reserves become depleted and muscle is catabolized. Calf Peary caribou demonstrated this with significantly higher U:C values in mid- than early winter. Adult males having just finished the rut would be expected to have higher U:C values in November/December than other animals. Adult males collected during this period had the highest U:C values.

The critical question remains: to what levels can U:C values rise in Peary caribou before they are indicative of starvation and ultimate death? DelGiudice and Seal (1988) reviewed data from deer and elk and classified three phases of winter undernutrition with their corresponding range of U:C values: early, <4:1, prolonged-reversible 4-<23:1, and prolonged-irreversible, ≥23:1. Contrastingly, Case (1994) suggested that for barren-ground caribou (Bathurst population), U:C values >0.25:1 were indicative of depleted body reserves. Case used Thomas' (1982)

classification of poor condition which was determined for Peary caribou. Thomas (1982) defined animals with a kidney fat index (KFI) <30 or femur marrow fat <50% as being in poor condition. Whether this level represents the lower bound of the prolonged-reversible stage discussed by DelGiudice and Seal (1988) is unknown.

Using Thomas' (1982) definition, all of the calves we collected in February would be in poor condition. Their U:C values ranged from 7.31-14.80:1, but U:C values for animals collected in November-December ranged from 3.94-15.76:1. Thus, there was considerable overlap in U:C values, over a correspondingly wide range in both KFI values and femur marrow fat. There is still considerable debate as to the utility of KFI as suitable index of condition for caribou (see Body Condition Indices). Tyler (1987b) found that adult female Svalbard reindeer were capable of losing all of their dissectible and intra-muscular fat reserves and up to one half of their skeletal muscle and still remain alive.

Only one study has been conducted to determine if changes in the U:C ratio reflected changes in body-fat reserves. Parker *et al.* (1993) found that U:C did not consistently reflect individual body composition in black-tailed deer (*Odocoileus hemionus sitkensis*). The U:C ratio was more likely to reflect immediate dynamics between fat depletion, protein catabolism, and energy intake rather than long-term changes in body-fat reserves.

The lowest value we found for an animal defined as being in poor condition was 30 fold higher than that found by Case (1994) for Bathurst caribou. All our values fell within the early or prolonged-reversible classifications of DelGiudice and Seal (1988), which is not surprising given the wide range. Data on U:C values from snow urine samples of Banks Island caribou collected in March 1993, were similar to those of calves collected in February, 1994, ranging

from 8.83-20.93:1; the highest value was from a calf (Larter, N.C. and J. Nagy, unpubl. data). There had been no freezing rain during winter 1992-93, but snow depths were greater than average (R. Kuptana, pers. comm.). There was no subsequent winter die-off in 1992-93. It seems reasonable to assume that none of the caribou that we obtained samples from were in a prolonged-irreversible state of undernutrition.

Case (1994) argues that one should be cautious in using the levels of U:C ratios determined as indicative of poor condition for one species as indicative of poor condition of another species. We agree that not only should one be cautious with intraspecific variation, but also interspecific variation, especially when the quality and composition of winter forage are different. Quite possibly the levels that were determined from deer and elk are inappropriate for Peary caribou given their physiological adaptations to extended periods of undernutrition. The substantial differences in levels determined for Bathurst caribou compared to Peary caribou may well be related to both differences in winter ranges and physiology. Bathurst caribou utilize winter ranges dominated by low nitrogen, but highly digestible lichen forage. Banks Island Peary caribou utilized little lichen during winter because of its low availability (Larter and Nagy, 1995). Bluenose caribou also have a winter diet high in lichen. U:C ratios from samples collected in March, 1994, ranged from 0.06-0.75:1 (mean 0.45:1, n=24) (Larter, N.C. and J. Nagy, unpubl. data). These values also were similar to those of Bathurst caribou, but substantially lower than those of Peary caribou. Only continued sampling will determine the prolonged-irreversible level for Peary caribou.

The U:C values found in blood sera and urine were significantly correlated ($p=0.043$), but had a low R^2_{adj} (0.346). Both blood sera and urine consistently detected the animal with the

highest U:C levels. Cortisol:C levels showed marginal significance in correlation between blood and urine ($p=0.08$, $R^2_{adj} = 0.251$). This may have been affected by variation in stress prior to shooting. The animal with the highest blood Cortisol:C values was run prior to shooting. Increased cortisol due to sudden stress would appear in the blood before appearing in the urine.

Blood Serum Analysis

One would expect urea nitrogen:creatinine (U:C) values to increase in blood serum during the course of the winter as fat reserves become depleted and muscle is catabolized. Although the differences we found were not significant, calf caribou demonstrated this trend with mid-winter values being higher than those of early winter. Adult males having just finished the rut would be expected to have higher U:C values in November/December than other animals. Adult males collected during this period had the highest U:C values. This lack of significance in blood electrolyte ratios compared to urine electrolyte ratios and the lack of correlation between blood and urine electrolyte results may be indicative of the reduced variability in serum electrolyte ratios associated with deteriorating nutritional condition reported for deer by DelGiudice *et al.* (1994). Therefore, we would concur with DelGiudice *et al.* (1994) that serum electrolyte ratios have limited use as an index of nutritional condition.

Although the mean levels of potassium, calcium, urea nitrogen, magnesium, and glucose in the blood sera of Banks Island Peary caribou were all somewhat higher than those found in other caribou sera analyzed by the Veterinary Pathology Laboratory, the small sample of caribou recorded by the Veterinary Pathology Lab were not from Banks Island Peary caribou (J. Archer, pers. comm.). Blood electrolyte levels show great interspecific and population variability, which

is often related to differences in, and seasonal changes in diet (B. Elkin, pers. comm.). Higher glucose levels may have been stress related. Other elevated levels may have been diet related. This could imply nutritional stress which was not apparent in the blood cortisol levels, or differences in winter diet between Peary and barren-ground caribou. These differences may also have resulted from inherent physiological differences of Peary caribou. It is unlikely that these somewhat higher values we found reflect anything more than random variability and do not imply that these animals were nutritional stressed (B. Elkin, pers. comm.).

Faecal Analysis

Adult and calf caribou had a diverse diet during early and mid-winter, a finding similar to Shank *et al.* (1978). The lack of a winter dietary lichen component is likely a result of low lichen biomass. The standing crop of lichen in all upland habitats on Banks Island is <3 g/m^2 (Larter and Nagy, 1995). This amount is almost 5 fold lower than the 14 g/m^2 estimated for Coats Island, which is considered to have reduced lichen availability (Ouellet *et al.*, 1994). Previous studies describe diets of Banks Island (Shank *et al.*, 1978) and Peary caribou (Thomas *et al.*, 1976; Parker, 1978; Thomas and Edmonds, 1983), but were based upon the analyses of rumen contents and are discussed in the following section.

Rumen Analysis

The lack of significant differences in fibre, energy, lignin, and nitrogen content of the rumen of collected animals may be a result of small sample size. The trend to lower lignin levels in mid- than early winter may be attributable to a decrease in the dietary willow component. The

mean energy (4500.0 cal/g) and nitrogen (3.19%) content found in the rumen of these animals indicates that all animals were able to secure high quality forage. For comparison, the mean energy content of live grass, sedge, and legume clipped at random in late August 1993 was 4317.8, 4513.8, and 3878.6 cal/g respectively, while the mean nitrogen content was 1.99, 1.85, 2.01% respectively (Larter, N.C. and J. Nagy, unpubl. data).

The difference between rosaceae and willow components found in the faeces and rumen is likely a result of differential digestibilities. Differential digestibility has been acknowledged as a potential problem with diet analysis based upon faecal plant fragments (Johnson and Wofford, 1983; Putman, 1984.). Willow components are likely more lignified and less digestible than are rosaceae components (mostly Dryas spp. leaves and stems). Therefore willow fragments tend to be overestimated and rosaceae fragments tend to be underestimated in faecal material. Digestibility correction coefficients have been determined for some forages (Pulliam and Nelson, 1979; Leslie *et al.*, 1983), however they have specific applicabilities. We are currently collecting data to address differential digestibility for this ecosystem.

When comparing our rumen diet analysis with others there are some striking differences. Shank *et al.* (1978) reported early winter (October and November) and mid/late winter (March) diets in the early 1970's dominated by upland monocots, little use (<2% of diet) of *Dryas* and *Saxifraga*, except for 17% during November, and an increase in dietary willow from 1.2 to 7.7 to 25.0% from October through March. Our data show no dominant component. The use of sedge is similar to that of 21 years previously, but we found only trace quantities of grass in the diet, unlike the 21.5-33.3% found by Shank *et al.* (1978). The amount of rosaceae and legumes in the rumen of caribou collected in our study ranged from *ca.* 50-75% compared to *ca.* 12-38%

found by Shank *et al.* (1978), and our data indicated a lower proportion of willow in the diet which decreased from early to mid-winter. Our results may be affected by reduced sample size in comparison to Shank *et al.* (1978), however data collected from 1991 to present indicates similar trends (Larter and Nagy, 1995).

Whether forage availability has changed on Banks Island over the past 20 years is unknown. However, since 1973 there has been a substantial increase in the muskox population on Banks Island from *ca.* 3,800 to *ca.* 60,000 (excluding calves) in 1994 (Urquhart, 1973; Nagy and Forsythe, 1995). This increase in grazing herbivore density could potentially have changed the distribution and availability of forages on Banks Island from what was present during the early 1970's and documented by Shank *et al.* (1978). Alternatively, high Peary caribou numbers in the early 1970's may have initiated a deterioration in range conditions similar to that documented in Svalbard (Brathen *et al.*, 1995).

Winter (March and April) diets of Peary caribou inhabiting the Parry Islands show considerable between island variation likely related to differences in forage availability. The four major dietary components in decreasing order of use were mosses, willows, monocots, and forbs (Thomas *et al.*, 1976; Parker, 1978; Thomas and Edmonds, 1983).

Leg Bone Analysis

Growth of Peary caribou calves did not cease during winter. Growth occurred at least during a 2-month period (December-February). Whether it continued beyond February is unknown. This finding is contrary to those of Dauphiné (1976) with Qamanurjuaq caribou, but in agreement with Tyler's (1987a) implication with Svalbard reindeer.

Possibly these data are indicative of physiological and growth differences between high arctic and barren-ground caribou. Femur lengths of both 6 and 8-month-old Peary caribou females ranged from 20.84-22.53 cm, and were similar to those of 0 and 1-year-old Svalbard reindeer (range 15.5-22.0 cm)(Tyler 1987a). Metatarsus lengths of newborn (aged 0 months) female Qamanurjuaq caribou ranged from 22.0-25.0 cm, and were similar to those of 8-month-old Peary caribou females (range 23.0-24.1 cm); by five months of age, female Qamanurjuaq caribou metatarsi were 5-12 cm longer (Dauphiné, 1976) than 8-month old Peary Caribou. However, metatarsus lengths of 5 and 11-month old barren-ground caribou females from Southampton Island (Ouellet, 1992) were similar to those of Banks Island Peary caribou. Unfortunately, metatarsus lengths of newborn (aged 0 months) females from these two populations are lacking.

Growth curves of both Qamanurjuaq caribou and Svalbard reindeer indicate that growth of males and females asymptotes by about 3 years of age. For a conservative comparison, we calculated the mean femur, tibia, and metatarsus bone lengths from male and female Peary caribou 4 years and older collected from Prince Patrick, Eglington and Melville Islands between 1974 and 1977 (Thomas, 1978). Legbone lengths for the femur, tibia, and metatarsus bones of adult females ranged from 23.3-26.3 cm, 26.3-29.1 cm, and 25.5-29.0 cm respectively and for the bones of adult males lengths ranged from 25.4-28.4 cm, 28.1-31.5 cm, and 27.6-30.9 cm respectively. Bone lengths of Peary caribou collected on Banks Island were similar to those of Peary caribou collected on the Parry Islands. (Table 11) Both Peary caribou data sets show that legbone lengths are more similar to those of comparably aged Svalbard reindeer than barren-ground caribou (Table 11). Femur lengths of 4 year and older female Svalbard reindeer ranged from 22.5-23.8 cm (Tyler, 1987a) while metatarsus lengths of 4 year and older female and male

Qamanurjuaq caribou ranged from 34.3-38.0 cm and 36.0-41.0 cm respectively (Dauphiné, 1976). The similarity in legbone lengths between Peary caribou and Svalbard reindeer should not be surprising considering that Peary caribou populations have a high frequency of the allele Tf^{G2}, which is the most common allele in Svalbard reindeer (Røed *et al.*, 1986). This suggests a common origin for Peary caribou and Svalbard reindeer.

Age

Local residents have commented that large males used to be common on Banks Island, but now are rarely seen. The average age of collected adult males was 5 years. Adult male caribou were collected on Banks Island during winter 1972-73 (Wilkinson and Shank, 1974). Unfortunately, the age of these animals was not determined. Peary caribou were collected on nearby Melville, Prince Patrick, and Eglington Islands from 1974-77 (Thomas *et al.*, 1976; Thomas and Broughton, 1978). Mean age of a random sample of adult males from these islands was 7.9 years (n=23).

Radionuclide Analysis

Levels of radionuclides in Banks Island caribou were the lowest levels of 14 herds examined across the Northwest Territories (C. Macdonald, pers. comm.). Lichens harbour radionuclides, and are a known source of radionuclides in caribou. The low levels of radionuclides found in Banks Island caribou may be due to the transport of radionuclides (especially lead-210) in the atmosphere which would have deposited lower amounts of radionuclides the further west. More likely it is related to the lack of lichen in the diet of Banks

Island caribou. Only similar tests conducted on Bluenose and/or Porcupine caribou, which inhabit the western arctic but have winter diets dominated by lichen, will elucidate this issue.

RECOMMENDATIONS

1) Postpone i) another caribou collection in late-winter 1993-94 to monitor animal condition and/or ii) an increased harvest of caribou, due to the fact that they are in such poor condition they will not survive the winter, because the majority of the animals collected in mid-winter were not in poor condition as defined by members of the Sachs Harbour Hunters and Trappers Committee.

2) Collect incisor bars from harvested caribou in order to document the ages of adult males.

3) Collect backfat measurements from harvested caribou to monitor and determine the variability in body-fat reserves during winter.

4) Collect longbones from harvested caribou in order to monitor and determine the variability in marrow fat content during winter.

5) Continue to collect rumen and faecal material from harvested caribou in order to document seasonal changes in diet.

6) Continue to collect snow urine samples from known sex/age caribou during early (November), mid- (February), and late (April) winter in order to assess the range of seasonal variation in the urea nitrogen:creatinine values.

7) Discontinue the analysis of cortisol levels in snow urine because of its reduced range in levels and the low correlation between U:Cortisol and U:C.

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Table 1. Backfat depth, and estimates of total dissectible fat calculated following Tyler (1987a)[1] and Adamczewski et al. (1987).[2] Orphaned calves taken prior to the collection.[3]

Sex/Age	Date	Backfat Depth (mm)	Mean±SE	Total Dissectible Fat (kg)[1]	Mean±SE	Total Dissectible Fat (kg)[2]	Mean±SE
Ad. Male	Nov. 28	15.5		3.500		4.965	
Ad. Male	Nov. 29	27.0	26.25±4.47	6.040	6.14±1.23	7.556	6.34±0.71
Ad. Male	Dec. 2	22.5	n=4	4.924	n=4	4.868	n=4
Ad. Female	Dec. 5	40.0		10.115		7.954	
Male Calf[3]	Nov. 8	3.5		1.052		1.715	
Female Calf[3]	Nov. 8	0.5	5.00±0.71	0.488	1.05±0.27	0.754	1.26±0.23
Female Calf	Dec. 5	6.5	n=3	1.616	n=3	1.316	n=3
Female Calf	Feb. 9	0.5		0.488		0.109	
Female Calf	Feb. 10	1.0		0.582		0.189	
Female Calf	Feb. 11	3.0	1.40±0.38	0.958	0.657±0.07	0.806	0.367±0.12
Female Calf	Feb. 15	1.0	n=5	0.582	n=5	0.220	n=5
Female Calf	Feb. 15	1.5		0.676		0.512	

Table 2. Kidney fat indices (following Riney, (1955)) and the percent total kidney fat to kidney weight for collected caribou calculated from both kidneys, except for the second adult male. Orphaned calves taken prior to the collection.[1]

Sex/Age	Date	Kidney Fat Index	Mean±SE	Fat:Kidney x 100	Mean±SE
Ad. Male	Nov. 28	70.20		90.46	
Ad. Male	Nov. 29	111.32	88.62±15.90	151.36	112.53±20.02
Ad. Male	Dec. 2	46.59	n=4	57.92	n=4
Ad. Female	Dec. 5	126.40		150.41	
Male Calf [1]	Nov. 8	39.18		66.70	
Female Calf [1]	Nov. 8	33.44	39.69±3.91	36.33	51.18±8.79
Female Calf	Dec. 5	46.59	n=3	50.52	n=3
Female Calf	Feb. 9	0.00		14.77	
Female Calf	Feb. 10	0.00		12.83	
Female Calf	Feb. 11	18.78	9.68±3.69	40.69	22.18±9.92
Female Calf	Feb. 15	9.52	n=5	15.84	n=5
Female Calf	Feb. 15	19.13		26.76	

Table 3. Visual marrow fat grades and mean±SE percent marrow fat (plus non-fat residue) determined by oven and freeze drying. Orphaned calves taken prior to the collection.[1]

Sex/Age	Date	Visual Marrow Grade	% Marrow Fat Oven Dried	Mean±SE	% Marrow Fat Freeze Dried	Mean±SE
Ad. Male	Nov. 28	3	91.77		83.02	
Ad. Male	Nov. 29	4	92.45	91.76±0.78	92.64	89.98±2.21
Ad. Male	Dec. 2	4	89.30	n=4	89.54	n=4
Ad. Female	Dec. 5	3	93.53		94.71	
Male Calf[1]	Nov. 8	3	88.46		92.71	
Female Calf[1]	Nov. 8	2	79.12	84.91±2.38	75.59	82.57±4.24
Female Calf	Dec. 5	2	87.14	n=3	79.42	n=3
Female Calf	Feb. 9	2	28.02		n/a	
Female Calf	Feb. 10	2	22.67		20.72	
Female Calf	Feb. 11	2-3	55.53	35.82±7.71	46.27	37.58±8.35
Female Calf	Feb. 15	2	15.66	n=5	19.27	n=4
Female Calf	Feb. 15	2-3	57.21		64.04	

Table 4. Electrolyte ratios determined from urine samples collected in early and mid-winter. Orphaned calves taken prior to the collection.[1]

Sex/Age	Date	U:C ratio (mg:mg)	Na:C ratio (mg:mg x 1000)	Cortisol:C (ug:mg)
Ad. Male	Nov. 28	15.76	113.83	0.1532
Ad. Male	Nov. 29	14.05	98.52	0.1003
Ad. Male	Dec. 2	8.17	49.11	0.0170
Ad. Female	Dec. 5	6.24	44.15	0.0573
Male Calf[1]	Nov. 8	5.22	74.99	0.0873
Female Calf[1]	Nov. 8	3.94	47.13	0.0621
Female Calf	Dec. 5	6.98	57.05	0.0246
Female Calf	Feb. 9	7.31	86.58	0.0892
Female Calf	Feb. 10	16.86	151.96	0.0518
Female Calf	Feb. 11	14.80	147.54	0.0319
Female Calf	Feb. 15	14.49	97.96	0.0356
Female Calf	Feb. 15	12.43	101.53	0.0166

Table 5. Electrolyte ratios determined from blood serum samples collected during early and mid-winter.

Sex/Age	Date	Na:C ratio (mg:mg)	Cl:C ratio (mg:mg)	Ca:C (mg:mg x 100)
Ad. Male	Nov. 28	7.37	5.12	537.3
Ad. Male	Nov. 29	7.20	4.97	511.2
Ad. Male	Dec. 2	6.89	4.66	506.8
Ad. Female	Dec. 5	5.65	3.74	428.2
Female Calf	Dec. 5	7.31	5.04	603.0
Female Calf	Feb. 9	7.81	5.57	567.8
Female Calf	Feb. 10	8.89	6.32	765.6
Female Calf	Feb. 11	7.96	5.55	614.0
Female Calf	Feb. 15	7.80	5.16	589.0
Female Calf	Feb. 15	7.42	5.26	620.5

Table 6. Measurements (cm) of three legbones, femur, tibia, and metatarsus, taken from calves aged 5-6 months and 8 months. Orphaned calves shot prior to the collection. [1]

Sex Class	Age (months)	Femur (cm)	Tibia (cm)	Metatarsus (cm)
Male Calf [1]	5	21.46	24.58	21.99
Female Calf [1]	5	20.84	23.41	21.48
Female Calf	6	20.85	24.18	21.99
Female Calf	8	21.93	25.63	23.51
Female Calf	8	21.99	25.70	23.41
Female Calf	8	22.35	25.66	22.99
Female Calf	8	22.53	25.48	23.24
Female Calf	8	23.04	26.33	24.08

Table. 7. Comparisons of the median values and range of backfat depths (mm) from two separate collections of Peary caribou. Larter represents data from the present study. Thomas represents unpublished data from Peary caribou collected from Prince Patrick, Eglington, and Melville Islands from 1974-1977. Early winter is November-December. Mid-late winter is March-April. n=sample size.

	Calves		Ad. Males		Ad. Fem.	
	early winter	late winter	early winter	late winter	early winter	late winter
Larter	0.5-6.5	0.5-3.0	15.5-27.0	n/a	40.0	n/a
median	3.5	1.0	22.5		n/a	
	(n=3)	(n=5)	(n=3)		(n=1)	
Thomas	n/a	n/a	n/a	0.0-1.0	n/a	0.0-12.0
median				0.0		0.0
				(n=23)		(n=55)

Table. 8. Comparisons of the median values and range of kidney fat index measures from three separate collections of Peary caribou. Larter represents data from the present study. Thomas represents unpublished data from Peary caribou collected from Prince Patrick, Eglington, and Melville Islands from 1974-1977. Shank represents data from Banks Island Peary caribou collected during the 1972-73 winter. Early winter is November-December for Larter and October-November for Shank. Mid-late winter is February for Larter and March-April for Shank and Thomas. n=sample size.

	Calves		Ad. Males		Ad. Fem.	
	early winter	late winter	early winter	late winter	early winter	late winter
Larter	33.4-47.0	0.0-19.6	46.6-111.3	n/a	126.4	n/a
median	39.2	10.3	70.2		n/a	
	(n=3)	(n=5)	(n=3)		(n=1)	
Thomas	n/a	n/a	n/a	5.7-37.3	n/a	3.4-65.3
median				12.4		21.5
				(n=20)		(n=48)
Shank	18.0-51.9	4.4-17.4	30.5-37.6	2.4-18.9	19.1-60.4	0.0-26.8
median	28.9	7.4	32.2	4.7	27.1	14.3
	(n=11)	(n=4)	(n=3)	(n=5)	n=(10)	(n=14)

Table. 9. Comparisons of the median values and range of femur marrow fat content from three separate collections of Peary caribou. Larter represents data from the present study. Thomas represents unpublished data from Peary caribou collected from Prince Patrick, Eglington, and Melville Islands from 1974 -1977. Shank represents data from Banks Island Peary caribou collected during the 1972-73 winter. Early winter is November-December for Larter and October-November for Shank. Mid-late winter is February for Larter and March-April for Shank and Thomas. Both Larter and Shank data are determined by freeze drying. Thomas's data are determined by oven drying. n=sample size.

	Calves		Ad. Males		Ad. Fem.	
	early winter	late winter	early winter	late winter	early winter	late winter
Larter	75.6-92.7	19.3-64.0	83.0-92.6	n/a	94.7	n/a
median	79.4	28.0	89.5		n/a	
	(n=3)	(n=5)	(n=3)		(n=1)	
Thomas	n/a	n/a	n/a	1.9-78.9	n/a	2.8-90.2
				33.6		62.8
				(n=23)		(n=55)
Shank	76.2-91.9	13.0-43.2	90.6-93.7	7.1-62.3	88.4-93.2	12.2-82.2
	83.3	23.4	90.9	38.1	90.4	51.5
	(n=11)	(n=4)	(n=4)	(n=5)	(n=10)	(n=14)

Table. 10. Comparisons of the range of visual femur marrow fat ratings (Riney, 1955) from two separate collections of Peary caribou. Larter represents data from the present study. Shank represents data from Banks Island Peary caribou collected during the 1972-73 winter. Early winter is October-November for Shank and November-December for Larter. Mid-late winter is February for Larter and March-April for Shank. n=sample size.

	Calves		Ad. Males		Ad. Fem.	
	early winter	late winter	early winter	late winter	early winter	late winter
Larter	2-3	2-3	3-4	n/a	3	n/a
	(n=3)	(n=5)	(n=3)		(n=1)	
Shank	2-3	3-4	1-2	2-3	1-4	1-4
	(n=11)	(n=4)	(n=4)	(n=5)	(n=10)	(n=14)

Table 11. Mean and SE of legbone lengths (cm) (femur, tibia, metatarsus) of adult (≥ 4 year old) Peary caribou from Banks Island and the Parry Islands. Range of legbone lengths for Svalbard reindeer and barren-ground caribou (Qamanurjuaq). n=sample size.

	Females			Males			
	Femur	Tibia	Meta.	Femur	Tibia	Meta.	Reference
Banks Island	25.78	29.94	26.25	26.58	30.47	26.59	This Study
SE	n/a	n/a	n/a	0.56	0.96	0.34	
	n=1	n=1	n=1	n=3	n=3	n=3	
Parry Islands	24.8	27.6	27.1	26.8	29.6	28.6	Thomas, 1978
SE	0.09	0.10.	0.09	0.17	0.21	0.18	
	n=54	n=54	n=55	n=23	n=23	n=23	
Svalbard	22.5-23.8						Tyler, 1987a
	n=38						
Qamanurjuaq			34.3-38.0			36.0-41.0	Dauphiné, 1976
			n=187			n=107	

Appendix 1. Kidney weights, kidney fat indices (KFI), kidney fat, and the ratio of fat to kidney weight from collected caribou.

Sex/Age	Date	Kidney 1 Wt (g)	Kidney 2 Wt (g)	KFI[1] 1	KFI[1] 2	Overall KFI[1]	Kidney 1 Fat (g)	Kidney 2 Fat (g)	Fat:Kidney x 100
Ad. Male	Nov. 28	76.9807	83.1839	71.25	69.22	70.20	69.4688	75.4206	90.46
Ad. Male	Nov. 29	66.7290	n/a	111.32	n/a	111.32	101.0000	n/a	151.36
Ad. Male	Dec. 2	94.1000	96.5000	40.91	52.12	46.59	47.0000	63.4000	57.92
Ad. Female	Dec. 5	54.4916	53.0021	117.41	135.65	126.40	79.8748	81.8031	150.41
Fem. Calf	Dec. 5	32.0714	34.0124	54.19	40.12	46.95	17.8487	15.5350	50.52
Fem. Calf	Feb. 9	33.8531	31.8149	0.00	0.00	0.00	4.9944	4.7061	14.77
Fem. Calf	Feb. 10	39.5951	44.7255	0.00	0.00	0.00	3.3026	7.5178	12.83
Fem. Calf	Feb. 11	33.9457	33.9458	18.29	18.78	18.54	12.0384	15.5863	40.69
Fem. Calf	Feb. 15	35.7742	40.6024	11.14	9.52	10.27	4.9415	7.1563	15.84
Fem. Calf	Feb. 15	41.5562	40.5842	20.03	19.13	19.59	10.4150	11.5696	26.76
Male Calf[2]	Nov. 8	48.3654	46.2010	37.83	40.59	39.18	31.2584	31.8129	66.70
Fem. Calf[2]	Nov. 8	50.4095	49.8375	36.06	30.79	33.44	18.4815	17.9412	36.33

[1] KFI calculated following Riney (1955).

[2] Orphaned calves shot prior to the collection.

Appendix 2. Urine electrolyte to creatinine ratios from collected Banks Island Peary caribou.

Sex/Age	Date	U:C ratio mg:mg	NaC:C ratio mg:mgx1000	K:C ratio mg:mgx1000	Cl:C ratio mg:mgx1000	Ca:C ratio mg:mgx1000	P:C ratio mg:mgx1000	Cortisol:C ug:mg
Male Calf [1]	Nov. 8	5.22	149.98	74.99	0	272.97	0	0.0873
Fem Calf [1]	Nov. 8	3.94	123.71	47.13	0	153.17	1.77	0.0621
Ad. Male	Nov. 28	15.76	56.92	113.83	0	145.7	0	0.1532
Ad. Male	Nov. 29	14.05	26.27	98.52	0	191.79	1.97	0.1003
Ad. Male	Dec. 2	8.17	9.82	49.11	2.46	367.31	0	0.0170
Ad. Female	Dec. 5	6.24	56.76	44.15	44.15	802.27	0	0.0573
Fem. Calf	Dec. 5	6.98	24.96	57.05	28.52	691.70	0	0.0246
Fem. Calf	Feb. 9	7.31	2077.92	86.58	1399.71	935.06	532.47	0.0892
Fem. Calf	Feb. 10	16.86	14.25	151.96	0	146.26	0	0.0518
Fem. Calf	Feb. 11	14.8	20.75	147.54	0	130.02	0.69	0.0319
Fem. Calf	Feb. 15	14.49	10.88	97.96	0	269.93	0.82	0.0356
Fem. Calf	Feb.15	12.43	32.37	101.53	0	78.87	0	0.0166

[1] Orphaned calves taken prior to the collection.

Appendix 3. Blood serum electrolyte to creatinine ratios from collected Banks Island Peary caribou. If cortisol levels were so low that absolute values could not be determined, the ratio presented (≤) is the highest the ratio could be.

Sex/Age	Date	U:C ratio mg:mg	NaC:C ratio mg:mg	K:C ratio mg:mgx1000	Cl:C ratio mg:mg	Ca:C ratio mg:mgx100	P:C ratio mg:mg	Cortisol:C ug:mg
Ad. Male	Nov. 28	14.18	7.37	439.02	5.12	537.3	3.75	0.6842
Ad. Male	Nov. 29	20.00	7.20	395.60	4.97	511.2	3.73	0.6824
Ad. Male	Dec. 2	9.48	6.89	400.31	4.66	506.8	2.73	≤ 0.1541
Ad. Female	Dec. 5	6.07	5.65	389.27	3.74	428.2	4.32	0.9528
Fem. Calf	Dec. 5	9.73	7.31	494.12	5.04	603.0	5.13	0.2934
Fem. Calf	Feb. 9	10.38	7.81	349.41	5.57	567.8	3.73	≤ 0.1787
Fem. Calf	Feb. 10	24.52	8.89	631.58	6.32	765.6	4.33	0.2812
Fem. Calf	Feb. 11	5.01	7.96	392.16	5.55	614.0	3.14	≤ 0.1833
Fem. Calf	Feb. 15	19.06	7.80	472.53	5.16	589.0	2.98	≤ 0.1798
Fem. Calf	Feb.15	15.15	7.42	489.04	5.26	620.5	3.88	≤ 0.1721

Appendix 4. Percent nitrogen, percent fibre (ADF), percent lignin (ADL), and energy (cal/g) content of the rumen of Banks Island Peary caribou.

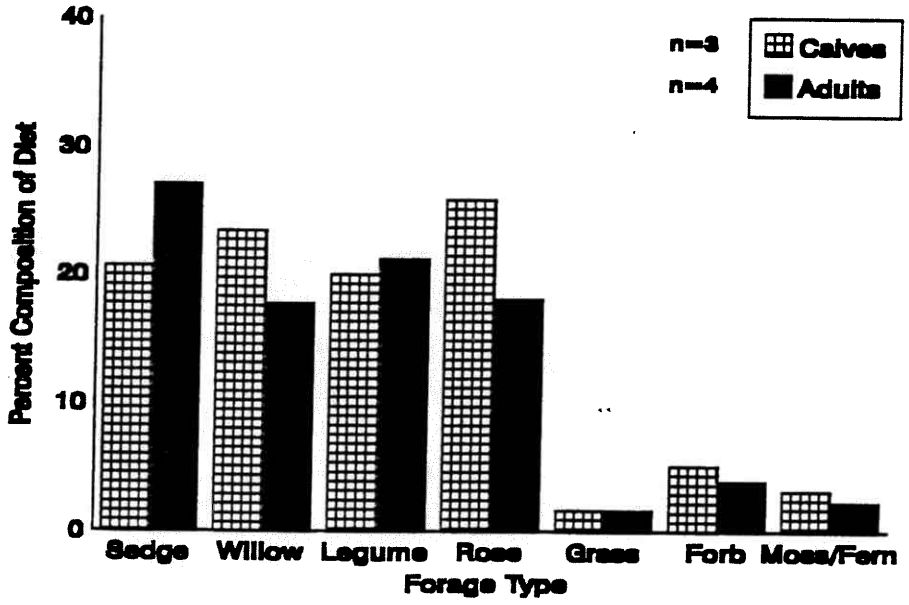
Sex/Age	Date	% Nitrogen	% Fibre	% Lignin	Energy
Male Calf [1]	Nov. 8	3.14	41.93	12.4	4477.2
Fem Calf [1]	Nov. 8	3.26	43.05	12.9	4538.9
Ad. Male	Nov. 28	3.15	45.33	8.2	4059.4
Ad. Male	Nov. 29	3.50	40.65	9.1	4617.8
Ad. Male	Dec. 2	3.23	40.59	12.1	4646.1
Ad. Female	Dec. 5	3.52	38.72	10.4	4550.0
Fem. Calf	Dec. 5	3.35	43.31	12.6	4530.0
Fem. Calf	Feb. 9	3.17	35.30	8.5	4753.3
Fem. Calf	Feb. 10	3.07	44.57	7.4	4500.0
Fem. Calf	Feb. 11	3.42	39.83	13.6	4680.6
Fem. Calf	Feb. 15	2.88	43.22	7.6	4356.7
Fem. Calf	Feb.15	2.62	45.73	8.2	4290.0

[1] Orphaned calves shot prior to the collection.

Appendix 5. Bone lengths of adult Banks Island Peary caribou.

Sex Class	Age	Femur (cm)	Tibia (cm)	Metatarsus (cm)
Adult Male	4-5 yrs	26.73	30.97	27.02
Adult Male	4 yrs	25.32	28.23	25.75
Adult Male	5 yrs	27.69	32.20	26.99
Adult Female	4 yrs	25.78	29.94	26.25

Figure 1. Comparison of percent composition of the diet of calves and adults during early winter, comparison between early and mid-winter for calves.



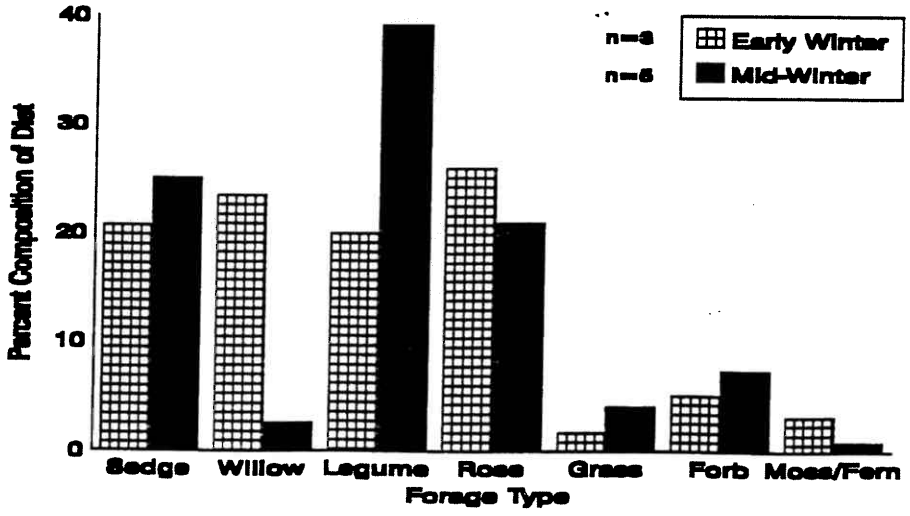


Figure 2. Comparison of diet composition when determined from plant fragments found in faeces versus rumen.