Session five

Nutrition & Physiology

SOME CARIBOU WERE NOT AS POLITE IN PROVIDING GOOD URINE SAMPLES

The Eight North American Caribou Workshop,
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Brief communication

A model for predicting the parturition status of arctic caribou

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Key words: body weight, fecundity, *Rangifer,* reproduction.

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Introduction

Fecundity of reindeer and caribou (*Rangifer tarandus*) varies directly with body weight or condition at breeding (Dauphiné, 1976; Reimers, 1983; Eloranta & Nieminen, 1986; Lenvik *et al.,* 1988; Thomas & Kiliaan, 1991; Cameron *et al.,* 1993; Gerhart *et al.,* 1997). For barren-ground caribou (*R. t. granti, R. t. groenlandicus*), such relationships have been derived for individual herds, but few attempts have been made to expand models across subpopulations or subspecies. Here, we compare parturition/body weight relationships for the Central Arctic herd (CAH) and Porcupine herd (PCH); generate a combined probability model for individual females; and offer a population-level model from which mean parturition rate can be predicted from a sample of body weights in autumn or early winter.

Materials and methods

In late September/October 1987-91 and mid November 1990-94, respectively, 51 female caribou from the CAH and 125 females from the PCH were darted or netted from a helicopter, weighed, and equipped with radiocollars (Cameron *et al.,* 1993; Gerhart *et al.,* 1997). During the following late May/June, CAH females were relocated once or more, as required, by fixed-wing aircraft and classified as parturient or nonparturient based on calf presence, antler retention, and/or udder distention (Cameron et al., 1993; Whitten, 1995). For PCH females, parturition status was based on serum progesterone levels at capture: those with concentrations >1.5 ng/ml were considered pregnant in mid November (Gerhart *et al.*, 1997) and, therefore, parturient in late May/June (Russell *et al.,* 1998). PCH females were further classified as lactating or nonlactating based on characteristics of the milk and udder (Gerhart *et al.,* 1997).

To determine if the body weights obtained for the PCH were reasonable estimates of those ca. 1 month earlier (i.e., consistent with data for the CAH), we compared weights in late September/October with those in mid November 1992-94 for both lactating (n=35 and 39, respectively) and nonlactating females (n=43 and 9, respectively).

Analyses were restricted to sexually-mature females; that is, those either observed with a calf or known to have calved previously. Relationships between parturition status, a binary variable, and body weight were described using univariate logistic regression (Hosmer & Lemeshow, 1989). A model of herd parturition rate was derived by incorporating the normal-distribution parameter of the weight sample into a response surface (Cameron & Ver Hoef, 1994).

Table 1. Body weights[a] ± standard error of the mean, and parturition models for female caribou[b] of the Central Arctic herd (CAH) and Porcupine herd (PCH).

	CAH[c]	PCH	CAH & PCH
Body weight, kg			
Parturient, $\bar{x}\pm s_{\bar{x}}$ (n)	91.0±1.4 (36)	92.0±0.8 (96)	91.7±0.7 (132)
Range	72-106	77-110	72-110
Nonparturient, $\bar{x}\pm s_{\bar{x}}$ (n)	84.9±2.0 (15)	84.9±1.7 (34)	84.9±1.3 (49)
Range	72-97	64-104	64-104
P-value[d]	0.01	<0.0001	<0.0001
Logistic regressions			
Parameters: β_0	-7.690	-8.029	-7.929
β_1	0.097	0.102	0.101
P-value[e]	0.0251	0.0002	0.00001

[a] Sep/Oct (CAH) or mid Nov (PCH).
[b] All sexually mature.
[c] Cameron & Ver Hoef, 1994.
[d] Comparison of means.
[e] Significance of slope, β_1.

Results and discussion

Body weights of PCH females in late September/October were not significantly different from those in mid November, either for lactators (93.2 *vs.* 90.0 kg, P=0.21) or nonlactarors (100.3 *vs.* 99.4 kg, P=0.77). Hence, pooling weight data across herds was justified, despite temporal differences in sampling.

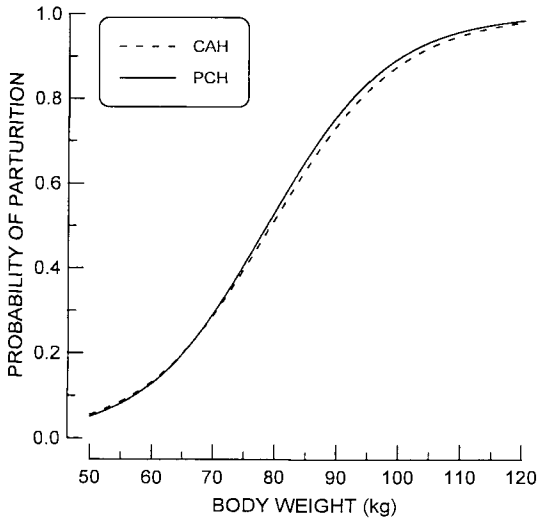

Fig. 1. Logistic regressions (Table 1) relating parturition probability of female caribou to body weight in autumn or early winter, Central Arctic herd (CAH) and Porcupine herd (PCH).

Mean autumn or early-winter weights of subsequently parturient females were significantly higher than those of nonparturient females for the CAH (P=0.01) and PCH (P<0.0001), as well as for the two herds combined (P<0.0001) (Table 1). Univariate logistic regressions for the CAH and PCH (Fig. 1) were significant (P=0.0251 and 0.0002, respectively; Table 1) but not significantly different (P>0.8). Data for the two herds were therefore consolidated, and a single, highly-significant model (not shown) was generated (P=0.00001; Table 1).

A model for predicting herd parturition rate, incorporating the combined logistic regression, was plotted in relation to various means and standard deviations of body weight (Fig. 2). Note that sensitivity varies with the parameters of weight distribution.

These new logistic-regression and population models may also apply to other arctic caribou in Alaska and Canada. In the Western Arctic herd, for example, post-rut weights of females ≥3 years of age ($\bar{x}$=89.5 kg, range 74-109; Skoog, 1968:25) are similar to those reported here (Table 1).

Models encompassing subarctic herds, however, will require additional adjustments. Logically, to achieve the same parturition probability, larger-bodied females must maintain or acquire proportionately more nutrient reserves than their smaller counterparts. Scaling body weight to skeletal size in a multiple logistic regression will therefore be necessary to broaden the application.

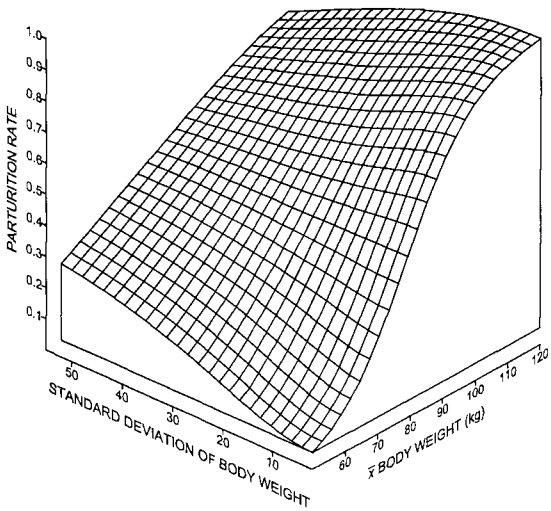

Fig. 2. Response surface of parturition rate of adult female caribou, Central Arctic and Porcupine herds, in relation to the mean and standard deviation of body weight in autumn or early winter.

References

Cameron, R. D., Smith, W. T., Fancy, S. G., Gerhart, K. L. & White, R. G. 1993. Calving success of female caribou in relation to body weight. – *Canadian Journal of Zoology* 71: 480–486.

Cameron, R. D. & Ver Hoef, J. M. 1994. Predicting parrurition rate of caribou from autumn body mass. – *Journal of Wildlife Management* 58: 674–679.

Dauphine', T. C., Jr. 1976. *Biology of the Kaminuriak population of barren-ground caribou. Part 4. Growth, reproduction and energy reserves.* Canadian Wildlife Service. Report Series 38. 71 pp.

Eloranta, E. & Nieminen, M. 1986. Calving of the experimenral reindeer herd in Kaamanen during 1970-85. – *Rangifer,* Special Issue No. 1: 115–121.

Gerhart, K. L., Russell, D. E., Van DeWetering, D., White, R. G. & Cameron, R. D. 1997. Pregnancy of adult caribou (*Rangifer tarandus*): evidence for lactational infertility. – *Journal of Zoology,* London 242: 17–30.

Hosmer, D. W. & Lemeshow, S. 1989. *Applied Logistic Regression.* John Wiley and Sons, New York, New York. 307 pp.

Lenvik, D., Granefjell, O. & Tamnes, J. 1988. Selection strategy in domestic reindeer. 5. Pregnancy in domestic reindeer in Trondelag County, Norway. – *Norsk Landbruksforsking* 2: 151–161.

Reimers, E. 1983. Reproduction in wild reindeer in Norway. – *Canadian Journal of Zoology* 61: 211–217.

Russell, D. E., Gerhart, K. L., White, R. G. & Van DeWetering, D. 1998. Detection of early pregnancy embryonic in caribou: evidence for embryonic mortality. – *Journal of Wildlife Management* 62: 1066–1075.

Skoog, R. O. 1968. *Ecology of the caribou* (Rangifer tarandus granti) *in Alaska.* Ph.D. Thesis, University of California, Berkeley. 699 pp.

Thomas, D. C. & Kiliaan, H. P. L. 1991. *Fire-caribou relationships. II. Fecundity and physical condition in the Beverly herd.* Unpubl. report, Canadian Wildlife Service, Edmonton.

Whitten, K. R. 1995. Antler loss and udder distention in relation to parturition in caribou. – *Journal of Wildlife Management* 59: 273–277.

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24-h activity pattern of wild reindeer in summer with emphasis on behavior compensation at night due to limited grazing during the day

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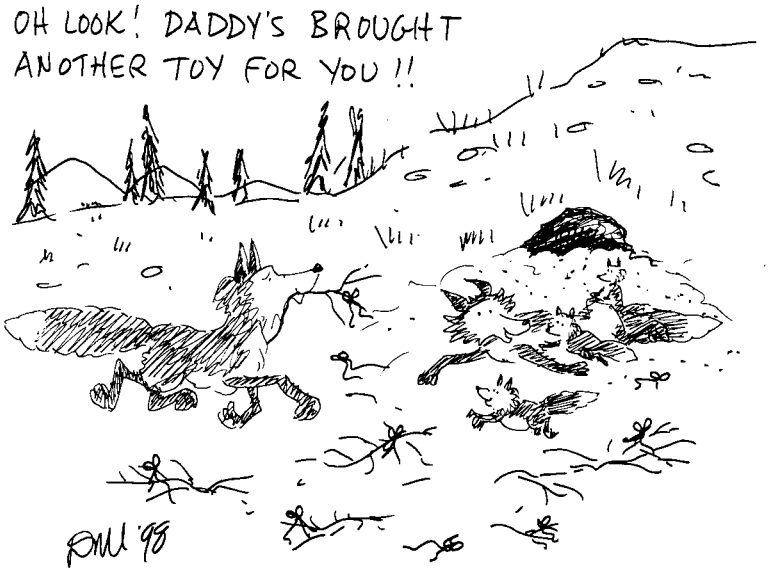
Abstract: It is inaccurate to estimate an animal's energy budget and resources availability without a complete 24-h record of the animal's activity and range use. The purpose of rhis study was to document 24-h activity patterns of wild reindeer (*Rangifer tarandus tarandus*) during summer in a Southern Norwegian mountain range, with special emphasis on feeding behavior and range use. Extreme variation in daily summer activity patterns of reindeer can result from harassment by parasitic insects. This study concentrates on nutrient and energy compensation at night in the form of an optimal activity pattern and forage use as an adaptation to limited grazing and ruminating during the day. We used 3 methods of sampling animal activity; 1) instantaneous scanning of groups at 15 min intervals, 2) riming detailed activity sequences of focal females for ≤30 min, and 3) non-systematic *ad libitum* observations. From approximately June 25-Sept. 1, wild reindeer in Sourhern Norway are harassed by biting and parasitic insects. We hypothesized that on days with severe insect harassment, reindeer will have differenr activity patterns between "day" and "night". This night activity pattern should reflect an energy/nutrient acquiring and energy conserving strategy and support the predictions below. Two assumptions for this are; 1) that insect harassment only occurs during "day", and furthermore, is dependent on appropriate climatic conditions necessary for insect activity, and 2) during "night", climatic conditions do not allow for insect activity and therefore, reindeer are not harassed. We predicted for a night following a day with high insect harassment, that during the night compared to day; 1) reindeer will compensate for the daily constraint of insect harassment by spending more time feeding and feed more intensely, i.e. search less and feed standing still more, during feeding bouts, 2) the choice for reindeer for where ro feed, and thus what to feed on, is limired by the distances to the closest snow patch, thus, the distance to closest snow patch will be greater, allowing for more freedom of choice and use of optimal forage, 3) when feeding, reindeer will urilize the highest quality forage available, 4) reindeer will spend more rime lying (including ruminaring), and 5) reindeer will use less time walking and running and considerably less time standing. This is the first systematic informarion gathered on wild reindeer behavior during summer nights using direct observational methods. Averaged over rhe summer season (1997) for scan samples, reindeer used 30%, 28%, 21%, 14%, and 7% feeding, lying, sranding, walking, and running, respecrively, during rhe day (06:00-23:59), compared to 47%, 42%, 1%, 9%, and 1% in the same activities, respectively, ar night (00:00-05:59). When active during the day, reindeer moved an average of 90 m from the closest snow patch, compared to 126 m at night. These preliminary results from the first season (1997) lend support to predicrions 1, 2, 4, and 5. We could nor distinguish among vegetation types occupied while feeding and vegetation actually ingested.



Climatic influence on forage quality, growth and reproduction of reindeer on the Seward Peninsula I: climate and forage quality

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Abstract: Forage quantity and quality during spring and summer play an important role in rangifer productivity by influencing body condition, rates of growth, breeding success, and winter survivorship. Annual variations in summer weather influence forage availability and digestibility, which in turn, affecr animal productivity. A study investigating the effect of climate on forage plant emergence and quality and subsequent reindeer productivity was conducted during 1996 and 1997 on reindeer ranges of the Seward Peninsula, Alaska. Climatological models were developed using Growing Degree Days (GDD) ro examine the effect of heat accumulation on forage plant emergence and chemistry. Models using temperarure to examine plant chemistry (GDD vs nitrogen, GDD vs. Neutral Detergenr Fiber, GDD vs. Acid Derergent Fiber) were found to be better predicrors of plant quality than models that used date. Fiber concentrations in graminoids were at a minimum during midseason, in contrast, to deciduous shrubs that exhibited low fiber concenrrarions in the spring with progressive increases through midseason to senescence. Fiber concentrations in forbs fluctuated less dramatically than either graminoids or shrubs. We developed a deterministic model relating climate variables to reproductive success of yearling reindeer based on observed relationships between temperature and plant chemistry.

Climatic influence on forage quality, growth and reproduction of reindeer on the Seward Peninsula II: reindeer growth and reproduction

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Abstract: Birth weights and growth rates of caribou and reindeer calves have been shown ro be influenced by summer and winter range conditions. Reproductive performance has been shown ro be influenced by autumn body weight. Unlike reindeer in many herds, reindeer on the Seward Peninsula frequently give birrh ar one year of age. This early breeding requires rapid summer weight gain and thus may be dependent on high quality forage. Yearly variation in forage quality is strongly influenced by weather, therefore age of firsr reproduction should be correlated with climatic variation. We used data collected from reindeer on the Seward Peninsula from 1987-1997 to show that the proporrion of yearlings lactating in June and July is positively related to Growing Degree Days (GDD) the previous May and June, and negatively relared ro both GDD the previous July and snow depth the winter prior to birth. Plant nitrogen and fiber data suggest that this may be due to the effects of GDD on forage plant emergence in May and June and plant fiber formation in July. Our model suggests that low snow years improve female condition at the time ofbirrh, rhereby influencing birrh weight and calf growrh rate during lactation, and that warm spring and cool summer temperatures optimize plant quality and decrease insect harassment. These favorable weather conditions allow calves to reach higher weighrs prior ro the breeding season, thus increasing rhe proportion of pregnanr yearlings the following spring. The model fit is very good, suggesring that these three climatic variables, snow depth, spring temperature, and summer temperature, are the primary factors affecting yearly variarion in age of first reproduction in this reindeer herd.

Development and verification of a fugacity-based bioaccumulation model for terrestrial ecosystems: an application to a lichen-caribou-wolf food-chain of the Northwest Territories

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Abstract: A fugacity-based bioaccumulation modeling approach is presented to assess the exposure of organic contaminants to terrestrial organisms. The essence of the model is to characterize the extent of food absorption and food digestion, which are crucial factors controlling biomagnification. The effect of food digestion on biomagnification is determined through static head-space analyses on field collected food and fecal samples. Dierary intake and absorption data are available from the literature for many terrestrial organisms. These dara, along with head-space analyses resulrs are used to paramaterize rhe gastro-inresrinal magnificarion factors in the model. In June of 1997, lichens and caribou fecal samples were collected from the calving grounds of the Bathurst caribou herd (66°55'N, 109°50'W). Environmental concentrarions of organics in the samples were measured at the Great Lakes Institute and are used for model verification. Our semi-empirical modelling approach is applied to an arcric terrestrial ecosystem to predict internal concentrations of organic chemicals in barren ground caribou (*Rangifer tarandus*), and wolf (*Canis lupus*) from observed concentrations in two common lichen species (*Cladina rangiferina* and *Cetraria nivalis*) found rhroughour the grazing range of the Bathursr caribou herd.

Differences in tissue ^{15}N natural abundance reveal seasonal shifts in diet choice of reindeer and caribou

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Abstract: As part of a comprehensive study of reindeer forage relations on the Seward Peninsula, Alaska, we are investigating ^{15}N natural abundance values for a suite of *Rangifer* forage plants and the resulting isotope chemistry in animal tissue (including antler, hooves, muscle, and blood), to test the hypothesis that vatiation in tissue stable isotope chemistry of *Rangifer* is a reflection of variation in diet composirion over temporal and/or sparial scales. Here we show examples from reindeer, caribou, and moose how enrichment or deplerion of $\delta^{15}N$ in animal tissue can contribure ro our understanding of seasonal shifts in their diet composition, and discuss the strengths and caveats of this methodology. For example, reindeer antler exhibit a marked enrichment $\delta^{15}N$ values over the season (based on core vs. periosteum antler values) reflecting the importance of deciduous shrub-based dietary nitrogen early in the summer, as compared to a graminoid-derived nitrogen later in the season. By contrast, captive reindeer kept on a uniform diet show constant antler values that are grearly enriched in $\delta^{15}N$ due ro a large portion of their diet consisting of isotopically enriched pasture ($(\delta^{15}N = +3.5‰)$) and commercial feed ($\delta^{15}N = +2.1‰$). Comparison of reindeer and moose antler support our conrention that animal isotope signatures are functionally related to diet, rather than to other ecological variables. Reindeer antler exhibit a gradual enrichment in isotopic signature over the season reflecting the increasing imporrance of graminoids in their diet. By comparison, the $\delta^{15}N$ of moose antlers from interior Alaska start out depleted, reflecting a diet of isotopically-depleted woody browse, then show an enrichment of the heavy isotope later in the season consistent with a diet of green biomass, including aquatic plants, and finally exhibir an isotopic depletion as the animals return to feeding on woody shrubs. In contrast to traditional approaches to diet selection (e.g., visual observarion and fecal pellet analyses), measurements of stable isotope chemistry represents an assessment of dietary relationships that integrate dietary history on a weekly, seasonal or yearly basis, depending on the target tissues analyzed. We contend that stable isotope chemistry used singly or in combination with more traditional approaches ro examine forage relationships, represents a potentially powerful merhod to evaluare the foraging ecology of northern, free-ranging ungulares.

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Comparison of physical characteristics of Yukon woodland caribou herds

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Abstract: Information from radio telemetry studies has found that woodland caribou living in the snow shadow region of southwest Yukon spend part of the winter in the subalpine and alpine. Other woodland caribou living in areas with high snowfall in central and eastern Yukon have traditional winter ranges in forested lowlands. We test the hypothesis that those woodland caribou which winter in the alpine are phenotypically differenr than woodland caribou wintering in forested environments. We compared five physical measurements from 382 female woodland caribou in eleven Yukon herds. Results found a significant (14 cm) difference in shoulder height for forest-wintering groups over alpine-wintering groups. But there was no significant difference in other body measurements or in body proportions. It is unlikely the difference in shoulder height is due to winter nutrition since body score did not differ between foresr and alpine-wintering groups. Our results provide no supporr for the hypothesis that condition wintering in deep snow results in selection for caribou with longer legs.

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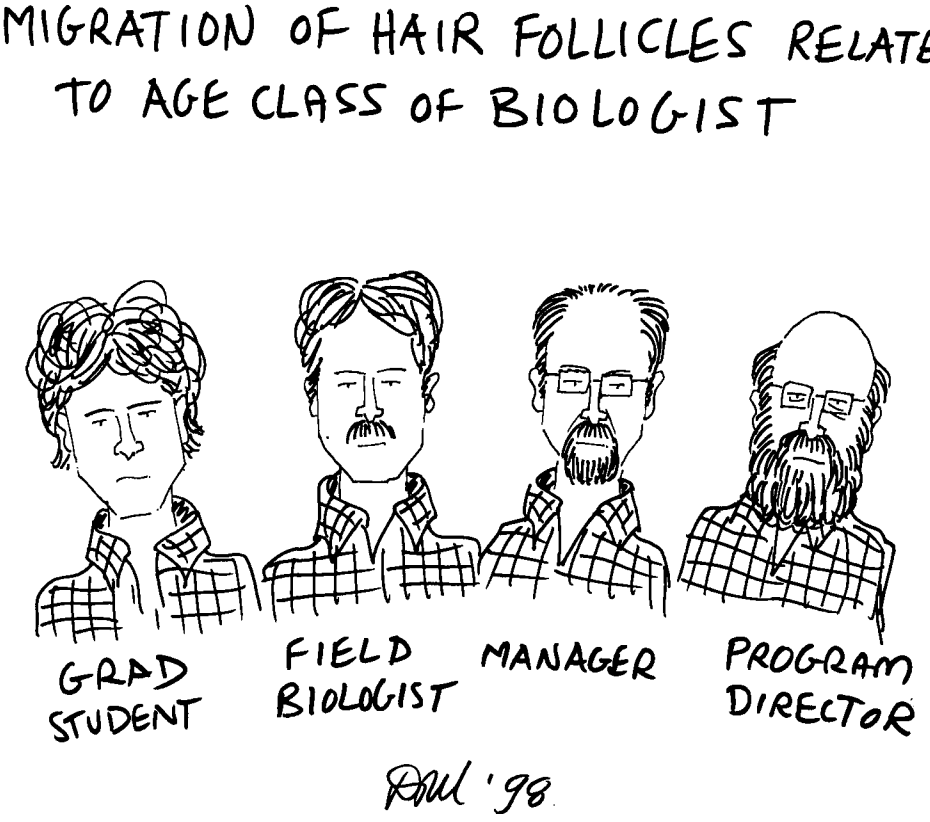

Abstract: The Eight North American Caribou Workshop, Whitehorse, Canada, 20-24 April, 1998.

Antler characteristics of reindeer and caribou

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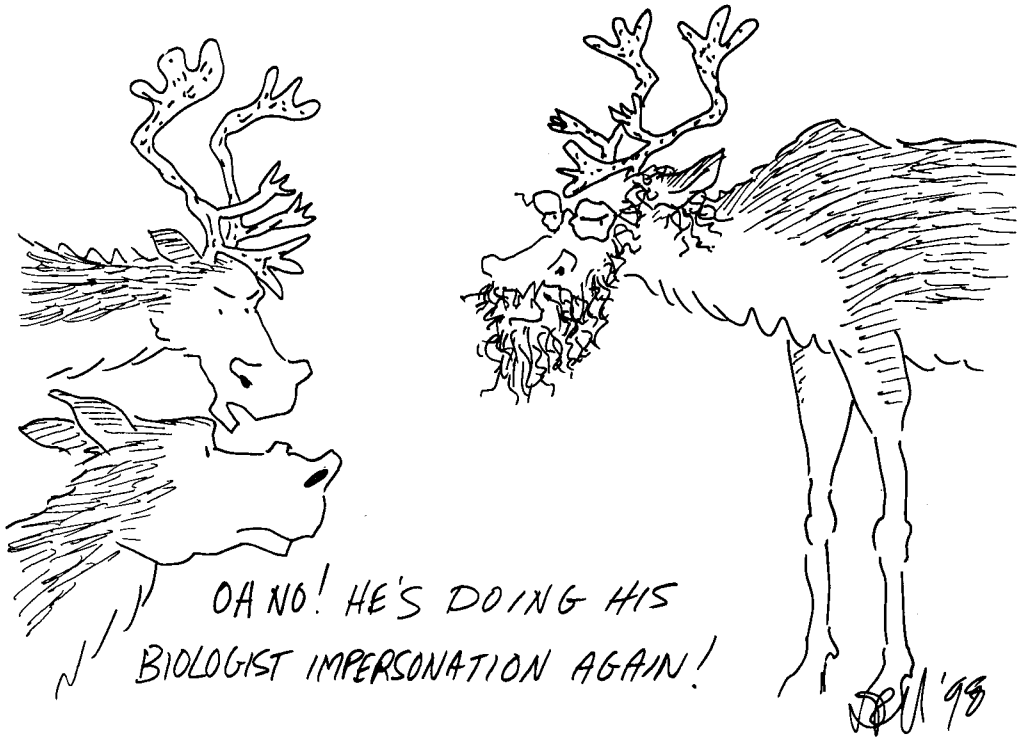
Abstract: Caribou and reindeer are rhe only species of deer in which females and calves are capable of growing antlers. Borh caribou and reindeer are being raised at the Large Animal Research Station (LARS), Institute of Arctic Biology, Universiry of Alaska Fairbanks and provide an opportunity to closely monitor antler growth and compare antler characteristics between sex/age classes and subspecies. Information on antler growth, cleaning, casting and regrowth has been collected on an opportunistic basis over the past 5 years. These dara will be used to depict the annual antler cycle in caribou and reindeer. A subsample of cast antlers has been weighed and measured from the coronet, along the inner curve ro the tip of the inner (longest) tine. Adult male antlers (≥3 yrs old) were heavier ($P<0.05$) and longer ($P<0.05$) than those of adult females in both subspecies. Among females, reindeer had heavier ($P<0.001$) and longer ($P<0.001$) antlers rhan caribou in all age classes. There were not enough male antlers available ro compare between subspecies and age. Pedicle/firsr antler growth was measured from the day of birth through to ossification of the first antler in female reindeer calves (1994) and female caribou calves (1997). Palpable pedicles were evident on the day of birth and measurable pedicle growrh began in borh subspecies by 2 weeks of age. This was followed immediarely by growth of the first antler. Increase in body mass over the first 17 weeks did not differ between female reindeer ($n=4$) and female caribou ($n=5$) calves. However, in the same time frame, reindeer antler growth rate was significantly ($P<0.006$) greater than that of caribou. Only female reindeer calves produced secondary tines in the firsr growing season. Castration of male caribou ($n=2$) and reindeer ($n=2$) on the day of birrh did nor prevent pedicle/antler growth in these calves. In both our reindeer and caribou, housed under the same conditions and eating the same food, pedicle induction was evident at birth and not dependent on post natal steroids. The rapid growth of reindeer calf antlers is consistent with the heavier and longer female reindeer anrlers found in all age classes. This suggesrs a genetic difference rhat may be related to the earlier sexual maturity of the reindeer.



Mechanisms of summer weight gain in northern caribou herds

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Abstract: Northern caribou (*Rangifer tarandus granti*) encounter dramaric seasonal shifts in nutrient availability. Fat and protein reserves depleted during winter are replenished in summer and early autumn. To examine rates and patterns of summer weight gain, 46 Central Arcric herd (CAH)(1988-91) and 76 Porcupine caribou herd (PCH)(1992-94) females were captured and weighed in early July and then recaptured and re-weighed in late September or October. For PCH females, a body condition score was also recorded, allowing estimates of prorein and fat composition. In early summer, non-lacrating females in the PCH were significanrly heavier rhan those in the CAH (87.8 kg *vs.* 79.6 kg, $P=0.001$), while corresponding weights of lactating females were not significantly different (81.8 kg *vs.* 79.8 kg, $P>0.3$). By autumn, however, both lactating and non-lactating females in the PCH were heavier rhan those in the CAH (lactating, 93.3 kg *vs.* 85.4 kg, $P=0.01$; non-lactating, 100.9 kg *vs.* 94.1 kg, $P=0.0006$). Rates of gain for lactating females were significanrly higher in the PCH than in the CAH (120 g/d *vs.* 61 g/d, $P=0.0001$), while rates for non-lactating females were similar (168 g/d vs. 159 g/d, $P>0.4$). For non-lactating females of the CAH, summer weight gain was inversely related to July body weight (gain=0.51*July weight + 55.05, $r=0.75$, $P=0.001$), suggesting a "target" autumn weight of 107 kg (i.e., the x-intercept); lactating CAH females exhibited a similar, but not significant, response (gain=-0.13*July weight+15.77, $r=0.41$, $P>0.16$). For both lactating and non-lactating females of the PCH, summer weight gain and July weight were unrelated ($P>0.7$ and $P>0.9$, respecrively), but there was a significant inverse relationship between the percentage of weight gained as prorein and body protein reserves in July, independenr of lactation status (pgain=-3.23*July protein + 92.7, $r=0.40$, $P=0.0001$). This suggesrs a "target" protein reserve of 28.7 kg. Contrasting mechanisms for replenishing body reserves are discussed in relarion to differences in resource availability of the two herds.

Composition of milk during lactation

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Abstract: We have developed a set of criteria to determine whether a caribou is in full lactation, in the process of weaning or has just weaned her calf, based on milk composirion. Criteria were derived from the analysis of 276 milk samples obtained from females of the porcupine caribou herd (PCH) and rhe central arctic herd (CAH) in the months of June, September, October and November. Milk composition changed markedly with date with a general increase in dry matter (DM), protein (P) and fat (F) and a decline in lactose (L) in November compared with June. These major changes include a linear increase in P with F and non-linear changes of P with L and L with DM. Independent of these relarions we noted four different populations of milk chemistries, Types I...IV, following the producrion of colostrom. Through field observations, and those made at the Large Animal Research Station, we conclude that Type I milk typifies that for females in peak milk production, Type II for early weaning, Type III for weaning and Type IV a clear liquid produced immediately after weaning (see Table). Thus a milk sample taken in October through November can be used to diagnose a female's stage of the weaning process. In rerminal lactation the increase in P and F is associated with a decline in L. Finally, fat is removed and the remaining clear liquid is rich in N, presumably in the form of amino acids given its sweat taste. Three ro 4 weeks postpartum, 90% of 82 caribou with calves were producing Type I milk, and 10% produced Type II. Females that had lost their calves shortly after birth produced Type IV milk. By late September, 98% of 41 females with calves were producing Type II milk. Caribou with a calf at foot in November ($n=99$) were classified as recently weaned (Type IV; 15.1%), weaning (Type III; 48.5%) and extending lactation (Type II; 36.4%).

STAGE	TYPE	DM	LACTOSE	PROTEIN
Peak	I	20-40	>3	4-10
Early W	II	30-40	2-4	10-18
Late W	III	10-48	<2	6-20
Weaned	IV	0-10	<0.5	<7

Meal patterns in reindeer : implications for interpretating feeding behavior in caribou

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Abstract: The seasonal cycle in voluntary food intake in free-ranging and ad libitum fed reindeer and caribou is a well-documented phenomena (White *et al* , 1984: *Can. J. Anim. Sci.* 64 (suppl.): 349-350). Very little is known, however about their daily meal patterns. This information is needed to asses how feeding behavior (i.e. meal size, meal duration, and frequency) is altered to accommodate radical intake changes (1.8 to 2.3 times in magnitude) between summer and winter intake. We analyzed 24-hour feeding behavior using data collected for several weeks (during early and mid winter) from individuals and groups of reindeer. Four adult non -pregnant female reindeer were used for the study. Animals were housed outdoors in a group pen at the Large Animal Research Srarion, Universiry of Alaska, Fairbanks. Reindeer were fed pellered concentrate (QTX, Alaska Feed Company, Palmer) and snow ad libitum. Individuals were rotated on a daily basis through a single feeding pen equipped with an electronic scale and 24 hour feeding activities were recorded. Sampling inrerval was 5 minutes. Food residues were measured daily (nearest 1 g). To assess the influence of socialization on feeding behavior animals were observed randomly 4 times a day. Three criteria were used to define meals: minimum amount eaten (50 g), maximum time during which the minimum amount must be eaten (5 min), and the minimum interval during which no feed was earen (>15 min<30 min). Earing that occurs between meals is designated as nibbling. These criteria determine the initiation and termination of meals and intermeal inrervals (Baile, 1975: *Digestion & Metabolism in the Ruminant*). Relations between variables were determined with polynomial regressions. Significance level was set a $P<0.05$. A total of 246 meals were analyzed. There was no evidence of social facilitation of feeding. Average meal frequency (±standard error of the mean) per day were 7.4±0.33 with a range of 3-11 meals/day. There is a srrong correlation between meal size and % of total number of meals ($r=0.96$; $P<0.001$). Reindeer preferably ate small meals (50-250 g). Meal size increased with duration of the pre-meal interval ($r= 0.99$; $P<0.001$). We found no correlation between meal size and post-meal interval ($r=0.70$; $P>0.05$). However, the after-meal interval does nor exceed on average 200 min, similar to data from concentrate fed sheep. This could suggest some type of underlying feeding rhythm. A possible candidate could be rumination. Resting bouts in caribou during winter have a similar duration on average 126±55 min during daytime bouts and 127±73 min during nighttime bouts (Maier, 1996: Ecological & *Physiological aspects of Caribou activity & responses to aircraft overflights*). Comparison of analysies of meals for reindeer wirh sheep adapted to a 60% concentrate ground suggest striking similarities of feeding behavior berween borh species. Caribou and people, coexistence into the future.

Habitat selection by calving caribou of the Central Arctic herd

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Abstract: This poster presents rhe hypotheses, objective, and methods for a study of habitat selection by the Central Arctic caribou (*Rangifer tarandus granti*) herd (CAH) at calving. The CAH calves between the Colville and Canning River on the Arctic Coastal Plain, Alaska. Research has suggested a change in caribou distribution of the CAH. The primary objective of this project is to estimate how changes in distribution have influenced habitat use and selection. We will examine habitat selection of radio-collared caribou ar calving. Habitat use at calving will be investigated for possible relarionships with vegetation, topography, climate, development, and snow ablation on calving grounds. This study will provide further understanding of dynamic environmental and anthropogenic influences on habitat use of CAH calving caribou.

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Antlers in relation to age, condition, and fecundity of caribou

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Abstract: Considering the importance of antlers in dominance and rank of caribou, few data are available on their size and weight. We examined the relationship between weight of antlers and age, body size, fat reserves, and fecundiry in a sample of 1036 caribou. We also recorded rhe frequency of two, one, and no antlers at two seasons. Samples were obtained in December and March from 1982 through 1987 from rhe Beverly herd of barren-ground caribou (*Rangifer tarandus groenlandicus*) in north-central Canada. Weight of antlers increased with age of female caribou even after age 5 years. Antler weight was significantly but weakly related to body size, condition indices, and fecundity. Therefore, antler weights can be used to predict pregnancy rates and physical condition only if large numbers of antlers are obrained.