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# COMPARATIVE WEIGHT LOSS IN THREE SPECIES OF URSIDS UNDER SIMULATED DENNING CONDITIONS

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**Abstract:** Captive animals were used to conduct 3 simulated denning experiments on each North American Ursid species. One polar bear was studied in its natural maternity den. Initial weight of the study animals ranged from 70 to 285 kg ( $\pm 1$  kg). Although the initial weight between black and grizzly bears and between grizzly and polar bears overlapped, the results provide evidence of a species-specific rate of weight loss. The average body weight loss per day of all of the study animals ranged from 0.18 to 0.91 kg. The present data combined with the previously reported information on metabolic rates are used to calculate the caloric equivalent of weight loss. These calculations indicate that polar bears may have preferential protein catabolism and/or elevated water loss during denning.

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The denning of Ursids is generally interpreted as a strategy to avoid unfavourable environmental conditions and reduce energy expenditures. The black bear (*Ursus americanus*) and the brown bear (*Ursus arctos*) are characterized by denning during the winter by both sexes and all age classes. Comparatively, the polar bear (*Ursus maritimus*) is limited primarily to maternity denning (Harington 1968, Jonkel et al. 1972, Lentfer 1976). The use of winter dens by bears is an example of seasonal starvation and results in dramatic fluctuations in body weight. The present work compares weight loss on captive animals during 3 simulated denning experiments on each of the aforementioned species and 1 natural denning experiment on a polar bear.

Weight loss during starvation is determined by the ratio of protein and fat catabolized and water loss. The combination of these factors determines the specific caloric equivalent of weight loss. The present work uses weight loss information and metabolic data from 3 black bears, 3 polar bears and from 2 grizzly bear denning experiments to estimate the caloric equivalent of weight loss overwinter. A female polar bear in its natural den was also studied.

To survive through the denning period, energy demands must be balanced by energy reserves. Although minimum body composition has not been established for bears, there is evidence that polar bears, in part, also depend on adipose tissue deposits for insulation (Oritsland 1970). The insulative significance of fat deposits in polar bears is probably an adaptation to their unique semi-aquatic lifestyle. The semi-aquatic adaptation of adipose retention may result in a catabolic preference for protein in polar bears. If maintenance requirements are minimized during denning, the lower caloric value of protein would result in a higher rate of weight loss.

## MATERIALS AND METHODS

All of the polar bears used in the study were adult

females; black and grizzly bears were adult males. One grizzly bear was studied during 2 winters. Polar bears that were used in the study came from the region of Churchill, Manitoba, Canada. These female polar bears were selected for the simulated denning experiments from the animals captured each year in the provincial tagging project. Bears captured for the simulated denning experiments were given food and snow *ad libitum* until 2 to 3 weeks before measurements.

On Cape Churchill, polar bear denning occurs on the high peat banks of the lakes and rivers in the area. Den locations have been observed between Hudson Bay and the Canadian National rail line with a northern and southern boundary generally corresponding to the tree line. During September and October 1977, aerial fixed-wing reconnaissance was carried out to locate bears and potential maternity dens. Once the lakes were frozen, a Bell helicopter was taken into the area and bears were immobilized with the drug Sernylan in conjunction with the relaxant, Sparine. While the animals were unconscious, a radio collar was placed around their neck. These radio collars were in the 40MHz range (F. Anderka pers. commun.). One adult female polar bear was successfully tracked to its den and its weight estimated both before and after denning. Weight of the animal in the field was estimated by chest girth measurement and the cattle weight tape method (Stirling et al. 1977).

The 2 male grizzlies were captured as nuisance or problem bears in Alberta and Montana. The 3 male black bears were captured near The Pas, Manitoba, also as problem bears. I would have preferred to have females for comparison with the polar bears, but unfortunately none were available for the study. Grizzly and black bears were shipped to Churchill by rail.

Simulated denning experiments were conducted during the natural Ursid denning season beginning in late November or early December and lasting 27 to 121 days. Further details on individual denning experiments and

study animals are available elsewhere (Watts et al. 1987, Watts and Cuyler 1988, Watts and Jonkel 1988). Food was withheld and ambient temperatures in the laboratory were similar to those in nature (-10 to -25 C). Polar bears were given an opportunity to use the simulated den voluntarily. Black and grizzly bears were shut into the dens at the beginning of the experimental period.

Weight of the bears ( $\pm 1$  kg) was determined before and after simulated denning by use of a balance beam scale, calibrated with known weights. The simulated dens were constructed from steel and covered with insulation. To minimize vibrations resulting from direct contact with the floor, dens were elevated on a wooden platform or rubber tires.

The polar bear simulated den was rectangular, 122 cm x 185 cm x 193 cm, with a volume of approximately 3,000 L. The interior of the den was designed to have a sleeping platform in the rear and a tunnel leading to the adjoining room, with a ventilation hole in the roof. Polar bears were given the choice of using the den or the adjoining room, although none of the polar bears used the den voluntarily. After several weeks in the adjoining room, the bears were placed in the simulated den and the entrance was sealed.

The simulated den for the grizzly bears had a volume of 2,000 L, and was twice the size of the black bear den.

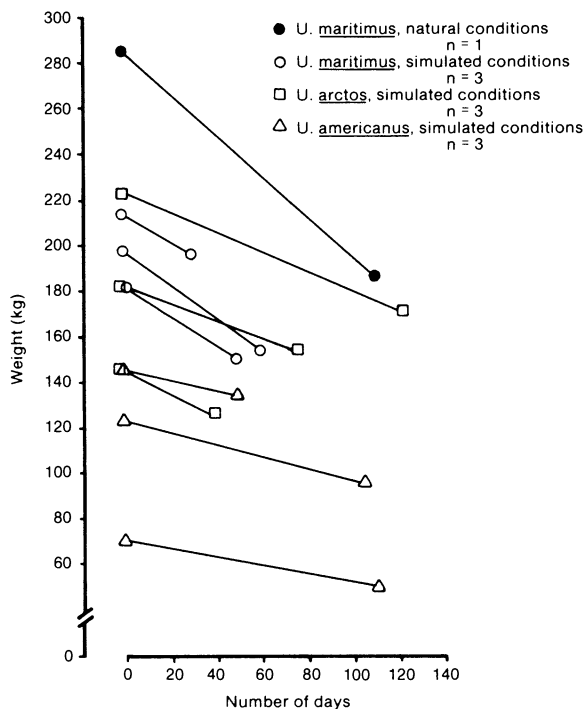


Fig. 1. Weight loss of denning Ursids

The dens were fitted with a door at 1 end and a barred opening at the other. The barred end was sealed by a sheet of plywood and ventilation holes were established at both ends.

## RESULTS

The rate of weight loss was calculated for 9 bears in simulated den experiments and for 1 bear in a natural maternity den. All animals appeared healthy when removed from the dens and there was no indication of feces or urine in the simulated dens or the natural maternity den. Polar bears had the highest rate of weight loss and black bears had the lowest rate (Table 1, Fig. 1). The time between weight determinations in 7 of the 9 simulated den experiments was shorter than 1 in the wild (Table 1).

## DISCUSSION

Conclusions that can be based on the present work are limited by the use of male black and grizzly bears for comparison with female polar bears. Weight loss in denning Ursids will be limited by the fasting potential of individual animals. Morrison (1960) estimated fasting potential by dividing the caloric value of maximum fat content by theoretical basal metabolic rate. Maximum fat content was considered to be 50% of body weight. Morrison's method does not, however, take into account the use of protein or the retention of fat for thermoregulation. The relatively poor insulation of polar bear fur (Scholander et al. 1950) may necessitate the use of fat for thermoregulation (Oritsland 1970). Hayward and Keat-

Table 1. Weight loss of Ursids in dens.

ID <sup>a</sup>	Days	Initial weight ( $\pm 1$ kg)	Weight loss		
			kg	%/day	kg/day
N77	110	285	100	0.32	0.91
M78	27	214	18	0.30	0.67
M77	59	198	43	0.37	0.73
M76	45	182	32	0.40	0.71
G78	40	145	18	0.30	0.45
G77 <sup>b</sup>	121	223	51	0.17	0.42
G76 <sup>b</sup>	76	182	27	0.20	0.36
A78	110	70	20	0.26	0.18
A77	103	122	24	0.19	0.23
A76	45	145	11	0.18	0.24

<sup>a</sup> A = *U. americanus*, G = *U. arctos*, M = *U. maritimus*, N77 = *U. maritimus* in natural maternity dens.

<sup>b</sup> Same animal in different years.

**Table 2. Caloric equivalent of weight loss for denning Ursids (kcal/kg)<sup>a</sup>.**

A76	A77	A78	G77	G78	M76	M77	M78
8,955	4,687	6,836	7,654	4,335	3,217	3,530	4,100

<sup>a</sup> See Table 1 for legend

inge (1981) working on humans, found that subcutaneous fat thickness had a negative correlation on metabolic rate. A similar mechanism may occur in polar bears.

The results on weight loss can be combined with concurrent metabolic measurements reported elsewhere (Watts et al. 1987, Watts and Cuyler 1988, Watts and Jonkel 1988) to calculate the caloric equivalent of weight loss (Watts 1983). Although grizzly bears have a higher rate of weight loss than black bears (Fig. 1, Table 1), the present results do not indicate a similar pattern in the caloric equivalent of weight loss (Table 2). The calculations do indicate that polar bears have a lower caloric equivalent of weight loss than the other 2 species studied (Table 2). The reduced caloric equivalent of weight loss calculated for the polar bears implies an elevated rate of water loss and/or preferential catabolism of protein during denning.

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