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Terrestrial Foraging by Polar Bears during the Ice-Free Period in Western Hudson Bay

ANDREW E. DEROCHER,[1,2] DENNIS ANDRIASHEK[2] and IAN STIRLING[1,2]

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ABSTRACT. Food habits of polar bears on land during the ice-free period in western Hudson Bay were examined between 1986 and 1992. In contrast to previous studies, feeding on vegetation during the ice-free period was common. Between August and October, evidence of feeding was found in 34% of the females and 26% of the males captured over 10 km inland from the coast. The primary forage was *Vaccinium uliginosum* and *Empetrum nigrum* berries. Feeding was most common in subadults and females. The incidence of feeding on berries varied annually from 2 to 41%. We were not able to determine the energetic importance of terrestrial foraging, but the intake may reduce the rate of weight loss of bears on land, particularly in years when berries are abundant.

Key words: polar bears, *Ursus maritimus*, feeding, arctic food web

RÉSUMÉ. On a étudié les habitudes alimentaires des ours polaires à terre durant la période libre de glace dans l'ouest de la baie d'Hudson entre 1986 et 1992. Contrairement aux études antérieures, l'alimentation végétale durant la période libre de glace était commune. Entre août et octobre, on a pu documenter l'alimentation chez 34 p. cent des femelles et 26 p. cent des mâles capturés dans une zone s'étendant jusqu'à 10 km à l'intérieur des terres. Le fourrage principal était constitué des baies *Vaccinium uliginosum* et *Empetrum nigrum*. La nourriture était surtout consommée par les jeunes adultes et les femelles. L'incidence de l'alimentation constituée de baies variait annuellement de 2 à 41 p. cent. On n'a pas été en mesure de déterminer l'importance énergétique de l'alimentation végétale terrestre, mais son absorption pourrait réduire le taux de perte de poids des ours à terre, en particulier les années où il y a une abondance de baies.

Mots clés : ours polaires, *Ursus maritimus*, alimentation, réseau trophique arctique

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INTRODUCTION

Polar bears (*Ursus maritimus*) are the most carnivorous of the ursids, their major prey consisting of ringed seals (*Phoca hispida*) and, to a lesser extent, bearded seals (*Erignathus barbatus*), walrus (*Odobenus rosmarus*), and white whales (*Delphinapterus leucas*) (Stirling and McEwan, 1975; Stirling and Archibald, 1977; Smith, 1980, 1985; Lowry *et al.*, 1987; Calvert and Stirling, 1990; Hammill and Smith, 1991). In Hudson Bay, the marine mammal diet of polar bears is unavailable when the sea ice melts in July and the bears are forced ashore (Stirling *et al.*, 1977; Derocher and Stirling, 1990). All polar bears except pregnant females return to the sea ice in November, when the sea ice reforms. Pregnant females remain on land until February or March, when they return to the sea ice with cubs.

While on land, polar bears have been reported to feed little (Knudsen, 1978; Latour, 1981; Lunn and Stirling, 1985; Ramsay and Hobson, 1991), sustaining themselves for protracted periods on their stored fat (Watts and Hansen, 1987; Derocher *et al.*, 1990; Ramsay *et al.*, 1991). From analysis of the ratio of the concentration of urea and creatinine in the blood, Ramsay *et al.* (1991) suggested that most polar bears on land were not feeding. Ramsay and Hobson (1991), using stable-carbon isotope analysis, also concluded that polar bears consumed a negligible amount of food from terrestrial food webs. However, marine algae, grasses, sedges, mosses, lichen, berries, and various vertebrates were found in the scats of polar bears on land along the coast of Hudson Bay (Russell, 1975). Although unable to determine the frequency of feeding or the nutritive importance of these food items, Russell (1975) concluded that the caloric intake of terrestrial food was not significant.

In this paper, we summarize our observations of feeding by polar bears captured inland from the western coast of Hudson Bay during the summer-autumn, when marine mammals are unavailable but vegetation is abundant.

STUDY AREA AND METHODS

The study population was located south of Churchill, Manitoba, between 57°00′ and 58°50′N latitude and 92°25′ and 94°15′W longitude. The area is an extensive peatland along the boreal forest and tundra ecotone (Ritchie, 1960; Johnson, 1987). Chemical immobilization methods were used to capture bears (Stirling *et al.*, 1989) from August to October in 1986-92. Ages of captured bears older than one year were determined by cementum annuli counts from an extracted vestigial premolar tooth (Stirling *et al.*, 1977). Bears were assigned to four age groups: cubs were 8-10 months old, yearlings were 20-22 months old, subadults were 2-4 years old, and adults were 5 years of age or greater.

Signs of feeding (such as berry-stained teeth, stained hair near the anus, and defecation) or their absence were noted for each bear captured. Whole scats or subsamples were collected when they could be attributed to an individual polar bear and only from the inland denning area, greater than 10 km from the coast. Scats were stored frozen and then washed through a series of screens in the laboratory. Specimen identification and species composition were determined with a stereo-microscope by comparing seeds and leaves from scats to a reference collection. A subjective estimate of the volume of the major components was made using six categories: 100-96%, 95-76%, 75-51%, 50-26%, 25-6%, and 5%-trace. Grasses and sedges were pooled and mosses were not identified.

[1]Department of Zoology, University of Alberta, Edmonton, Alberta, Canada T6G 2E9
[2]Canadian Wildlife Service, 5320 122 Street, Edmonton, Alberta, Canada T6H 3S5

RESULTS

Scats were collected from 60 different bears of known age and sex. The frequencies of occurrence of the four most abundant plants in scats were: *Vaccinium uliginosum* (arctic or alpine blueberry) at 70% (42/60), *Empetrum nigrum* (crowberry) at 58% (35/60), mosses at 30% (18/60), and grasses and sedges at 27% (16/60). Frequency of occurrence by volume of the major components is shown in Figure 1. Trace amounts of other vegetation were found but were considered incidental to the primary forage.

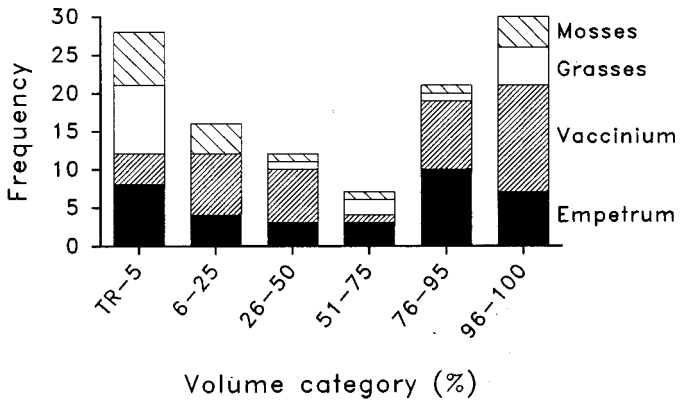

FIG. 1. Percentage of food items by volumetric class in polar bear scats collected in the denning area in western Hudson Bay during the autumn between 1986 and 1990.

Data on feeding or the absence of feeding were available from 748 females ranging from 8 months to 29 years of age and from 436 males ranging from 8 months to 25 years of age. Feeding on terrestrial foods was noted in 34% (254/748) of the females and was common across all female age classes (Fig. 2). Most (81%, 207/254) of the females that were feeding had fed on berries from *Vaccinium uliginosum* and *Empetrum nigrum*. Feeding was recorded in 34% (90/261) of adult females with offspring and in 31% (70/223) of those without offspring and were not significantly different ($G = 0.5$, $df = 1$, $P = 0.47$). Feeding on vegetation was recorded in 26% (115/436) of the males handled, and of those 76% (87/115) had eaten berries. Males 4 years of age and younger showed signs of feeding more often than adult males ($G = 59.9$, $df = 1$, $P < 0.001$) (Fig. 2).

The proportion of bears determined to have been feeding on vegetation varied annually ($G = 75.1$, $df = 1$, $P < 0.001$). From 1986 to 1992, feeding was noted in 10% (7/67), 25% (57/227), 29% (65/226), 34% (95/283), 29% (42/144), 63% (73/115), and 25% (30/122) of the bears handled respectively. The low incidence of feeding in 1986 may have resulted from less detailed examination for signs of feeding. Subjectively, the berry crop was highest in 1991 and lowest in 1992. Correspondingly, feeding on berries was noted in 41% (107/259) of the bears in 1991 and was higher ($G = 78.6$, $df = 1$, $P < 0.001$) than the 2% (3/122) of the bears feeding on berries in 1992. Pooling all years, feeding on berries varied between months ($G = 21.5$, $df = 2$, $P < 0.001$) and was noted in 11% (12/111), 27% (263/960),

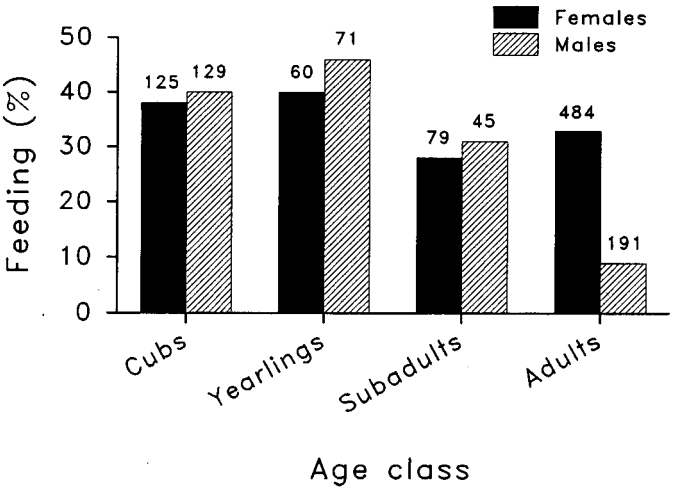

FIG. 2. Proportion of polar bears feeding during the autumn in the inland area by sex and age class. Sample size above each bar.

and 17% (19/113) of the bears handled from August through October respectively.

The stomachs and digestive tracts of two subadult females necropsied in the field were both full of berries from *Vaccinium uliginosum* and *Empetrum nigrum*.

DISCUSSION

Our data indicate that a substantial proportion of the polar bears inland from the coast of western Hudson Bay feed on plant matter during the ice-free period. The berries of both *Vaccinium uliginosum* and *Empetrum nigrum* were particularly common. Terrestrial feeding was noted in approximately 40% of cubs and yearlings, but it was also common in subadults of both sexes and adult females. In comparison, less than 10% of the adult males examined showed signs of feeding. These differences may reflect the greater energetic demands of pregnancy and lactation in adult females and growth in younger bears.

Both *Vaccinium uliginosum* and *Empetrum nigrum* are important food sources for high-latitude brown bear (*Ursus arctos*) populations (e.g., Pearson, 1975; Murie, 1981), and a related berry species, *Vaccinium corymbosum*, was experimentally determined to be highly digestible in brown bears (Bunnell and Hamilton, 1983). Because polar bears are closely related to brown bears (Kurtén, 1964), it is likely that polar bears still have the physiological adaptations necessary to digest berries. In addition, little interspecific variation in digestive efficiencies was found in three ursid species (excluding polar bears) (Pritchard and Robbins, 1990), which suggests that polar bears have similar digestive capabilities. The large volume of berries in the digestive system of the two necropsied bears indicates that at least some individuals consume significant amounts of berries.

At present, we cannot quantify the amount of time individual bears spend feeding or the energy contribution of vegetation to the total energy used during the ice-free period. Nevertheless, the proportion of bears feeding is

inconsistent with the conclusions of previous studies based on observations of bear behavior, analyses of scats, the concentration of urea and creatinine in the blood, and stable-carbon isotope ratios (Russell, 1975; Knudsen, 1978; Latour, 1981; Lunn and Stirling, 1985; Ramsay *et al.*, 1991; Ramsay and Hobson, 1991).

Several important differences in the way data were collected for the various studies may account for the inconsistencies in the conclusions. Most of the data in the previous studies were collected along the coast, where berries are not present, bears spend most of their time inactive (Knudson, 1978; Latour, 1981; Lunn and Stirling, 1985), and adult males, which feed less than all other age classes (Fig. 2), are most abundant (Derocher and Stirling, 1990). For the most part, bears in the inland area in late summer and autumn were not represented. In addition, some of the previous studies were conducted when berries were largely unavailable and our data indicated monthly variation in feeding. The proportion of bears that showed signs of feeding in September was roughly two to three times the proportion in August and October. Consequently, observations or samples collected before or after September would have a lower probability of detecting feeding.

We are uncertain how the fasting state, common in polar bears during the ice-free period (Ramsay and Stirling, 1988; Derocher *et al.*, 1990; Ramsay *et al.*, 1991), may influence physiological data collected to determine the importance of terrestrial feeding. It is not known whether bears feeding on land, likely in a negative energy balance, and bears feeding on the sea ice, in a positive energy balance, would store similar amounts of carbon. For example, are berries ingested on land catabolized directly so that they are never deposited in the carbon pool of tissues? Similarly, would the low ratio of urea and creatinine in the blood, which indicates that a bear is maintaining itself from stored fat reserves (Nelson *et al.*, 1984), be influenced by the intake of carbohydrates, which constitute the majority of the extractable energy in berries? These questions need to be answered before we can reconcile our observations with previous measures of feeding.

Most populations of polar bears do not have access to berries during the autumn, but the patterns found in western Hudson Bay illustrate the physiological and behavioral plasticity of polar bears. It is clear from our data that polar bears inland from the western coast of Hudson Bay during the late summer and early autumn eat terrestrial vegetation. For females with offspring and young bears that are growing rapidly, both of which have high metabolic requirements, foraging on berries may reduce the rate of weight loss through the autumn. We have documented mother bears that have ceased lactation well before freeze-up (Derocher *et al.*, 1993) and feeding on berries may allow mothers to lactate longer into the ice-free period. If so, terrestrial feeding could significantly influence the condition of bears and in turn influence survival, particularly of cubs. However, the question cannot be resolved until the caloric contribution of terrestrial feeding to the total energy budget of polar bears is determined.

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