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Acute Gastric Dilatation and Volvulus in a Free-living Polar Bear

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ABSTRACT: A large, adult male polar bear (*Ursus maritimus*) was found dead on a barrier island north of Prudhoe Bay, Alaska (USA), in June 1987. There were no external signs of trauma. A twisted distended stomach, distinctive parenchymal and fascial congestion, and significant difficulty in repositioning the anterior abdominal organs, indicated that gastric dilatation-volvulus (GDV) was the proximate cause of death. Polar bears frequently consume large quantities of food at one time and have large stomachs that are well adapted to periodic gorging. The scarcity of food in winter and early spring, combined with voluntary fasting and protracted vigorous activity during the breeding season in late spring may have predisposed this bear to GDV. The relationship between GDV and postprandial exercise emphasizes the need for a better understanding of how the present human invasion of arctic habitats may influence polar bear activities.

Key words: Polar bear, *Ursus maritimus*, gastric dilatation, torsion, volvulus, mortality, necropsy, congestion, case history.

Natural mortality factors among polar bears (*Ursus maritimus*) are largely unknown. Hunting by humans is an important mortality factor for polar bears (Stirling et al., 1976; Taylor et al., 1987; Amstrup and DeMaster, 1988) and the only factor quantified for any species of bear (Cowan, 1972; Stirling et al., 1976; Bunnell and Tait, 1985). Predation and agonistic intraspecific behaviors are the most commonly discussed natural causes of death, particularly among young Ursidae (Boyer, 1948; Young and Ruff, 1982; Stringham, 1983; Lunn and Stenhouse, 1985; Dean et al., 1986). The roles of nutritional limitation, parasites and disease in causing deaths of bears are not yet understood (Rogers and Rogers, 1976; Bunnell and Tait, 1981; Yodzis and Kolenosky, 1986; Rogers, 1987). Among free-living adult polar bears, the only reported mortalities, in addition to those caused by humans and conspecifics, are associated with attempts to catch large and dangerous prey (Kiliaan and Stirling, 1978; Stirling, 1984). This report describes the nonviolent death of a large adult male polar bear from the population that occupies the Alaskan Beaufort Sea.

On the afternoon of 23 June 1987, oilfield personnel in a helicopter observed the carcass of a polar bear on a shelf of ice at the beach of Cross Island (70°29.9′N, 148°59.7′W), an uninhabited barrier island 32 km north of Deadhorse, Alaska (USA). They were reasonably sure that the bear had not been at that site when they passed over it that morning. Because of bad weather, the bear was not retrieved until 26 June 1987. It was then shipped to the University of Alaska (Fairbanks, Alaska 99775, USA) where it was necropsied on the morning of 27 June 1987, approximately 4 days after death. Environmental temperatures at Deadhorse ranged from 0 to 9 C for the 3 day period the carcass was known to be on Cross Island.

At necropsy the adult male bear weighed 505 kg. Total body length from nose tip to tail base was 253 cm; girth measured behind the scapulae was 170 cm. The subcutaneous fat layer was shallow (<1 cm) and discontinuous. A small amount of mesenteric fat was present. The coronary fat band was broad, but renal capsular fat was negligible. The bear's pelage was in good condition, but epilation, particularly over the left rump area, had begun (postmortem change). A first lower premolar tooth was pulled, decalcified, and sectioned (Stirling et al., 1977); the bear was determined to be 16-yr-old.

Despite moderate to severe autolysis of

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internal organs, gross changes in the abdominal cavity were striking. A markedly distended stomach nearly filled the anterior abdominal cavity and was rotated 180° in a clockwise direction as viewed ventrally, with the hemorrhagic serosal surface of the pyloric antrum and duodenal bulb and the adjacent base of the pancreas tightly stretched and twisted into the left cranial quadrant. The esophagus and distended fundus were pulled into the right cranial quadrant, and the moderately enlarged, congested spleen was also pulled into the right quadrant and positioned dorsal to the body of the stomach. The stomach, duodenum, pancreas and spleen could be repositioned into their correct sites only with difficulty.

Incision at the gastroesophageal junction allowed an undetermined quantity of nonodorous gas to escape, leaving a thin-walled, collapsed stomach 38 × 56 cm (opened dimensions 50 × 60 cm). Contents were an estimated 1,600 ml of red-yellow (bile-stained), watery fluid with no particulate ingesta larger than 5 mm^3. Occasional focal hemorrhages and rare punctate ulcerations were diffusely distributed throughout the mucosa of the gastric body and pylorus. The mesogastrium, omental bursa area, gastrosplenic ligament, and all other mesenteric attachments adjacent to the stomach and spleen were markedly congested. The ventral epiploic foramen and the area around the base of the portal vein near the hepatic hilus contained suffusive hemorrhage. The parenchyma of the left hepatic lobe was deep red and exuded considerable blood from the cut surface; the right and caudate lobes were only slightly congested. Congestion and diffuse hemorrhages along fascial planes of the right retrolumbar area were also apparent.

Numerous hard, gritty white nodules <1 mm in diameter were diffusely distributed over many of the serosal surfaces, including the liver and spleen, and were particularly prominent on the pericardium and the epicardial and endocardial surfaces. Squash preparations and smears of these nodules, stained with new methylene blue revealed aggregates of crystalline material (postmortem change). There were yellow-white crystalline striae in all renal pelves of the right kidney; severe autolysis obscured changes in the left kidney. The small intestine was moderately distended by gas, but otherwise normal; content of the entire intestinal tract was scanty, with a small amount of fluid and negligible solid material. The gall bladder was distended.

The proximate cause of death of this bear seems to have been gastric dilatation-volvulus (GDV). Rabies, intoxications and other pathologic conditions with more subtle manifestations might not have been detected. Sections of standard preserved tissues were prepared, but were found to be too autolytic for histopathological examination. Nevertheless, supporting the diagnosis of GDV were (1) the distinctive pattern of parenchymal and fascial congestion observed, as distinguished from postmortem imbibition, and (2) the relative difficulty with which the abdominal organs were repositioned, indicating this was not a postmortem artifact. We hypothesized that GDV in this bear occurred after ingestion of water. Ingestion of water, followed by exercise may cause GDV in dogs (Morgan, 1982). The small amount of fluid (and solids) in this bear's stomach seemed contrary to the usual symptoms, however, and cannot be explained. Perhaps some water could have escaped the stomach before necropsy.

In dogs, GDV is most common in males of deep-chested breeds, and is often associated with overeating, excessive drinking, or postprandial exercise (Cornelius and Wingfield, 1975; Morgan, 1982). Also, GDV seems to be inversely related to frequency of feeding (Van Kruiningen et al., 1987). The inevitable outcome of GDV is a sudden and drastic compromise of venous return from the stomach and spleen (Orton and Muir, 1983) leading to severe local edema that exacerbates the compromise (Morgan, 1982). Ventricular arrhyth-

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mias (Muir, 1982; Muir and Weisbrode, 1982), systemic shock, and a rapid death are the common outcomes. Acute gastric dilatation and gastritis are considered common in captive bears because of the wide variety of foods eaten and because of their gluttonous eating habits (Wallach, 1978). Wild polar bears may be particularly susceptible to GDV, because of their large body size, deep chested structure, and capacious stomach, and because certain aspects of their ecology may dispose them to periodic gorging on food or water. Polar bears feed primarily on ringed seals (*Phoca hispida*) (Smith and Stirling, 1975; Stirling and Archibald, 1977). Other species of seals, walruses (*Odobenus rosmarus*) and other marine mammals are eaten in smaller numbers (Kiliaan and Stirling, 1978; DeMaster and Stirling, 1981). Because seals are large prey items and intervals between successful hunts may be long, polar bear feeding is characterized by periodic gorging (Amstrup, 1986). Scavenging also is common among polar bears, and large bears often take food from smaller bears (Amstrup and DeMaster, 1988). Thus, selection favors bears that quickly derive maximum benefit from kills. Best (1977) determined that polar bears could consume up to 10% of their body weight in 30 min, and that the stomach of a polar bear can hold an amount of food equivalent to 20% of its total body weight.

Polar bears are hyperphagic in the summer and fall when young inexperienced seals are easiest to capture. The main activities of polar bears during this period are hunting and resting (Stirling, 1974). Conversely, winter is a difficult time for polar bears. Our data from the Beaufort Sea show that adult polar bears may lose 50% of their peak autumn weights by April of each year.

Nutritional stress initiated by the rigors of winter may be compounded in adult males. The breeding season of polar bears in the Beaufort Sea extends from late March through May (Amstrup and DeMaster, 1988). During the breeding season, adult males compete vigorously for females (Ramsay and Stirling, 1986). Our spring observations of polar bears on the pack ice verify that sexually mature males ignore many hunting opportunities because they are intent on seeking mates. The lean condition of this bear indicated it had eaten little for an extended period. High activity levels in a relatively warm and sunny spring time environment would be expected to promote thirst. Water taken into a stomach long deprived of any contents may have contributed to volvulus in this bear.

This incident may suggest that wild polar bears are susceptible to GDV, and that the peculiarities of their ecological and behavioral patterns may be predisposing factors. As the level of human activity increases in the Beaufort Sea (Amstrup et al., 1986), disruption of the polar bear's normal activities will increase. Because gastric dilatation and volvulus often can be associated with postprandial exercise (Cornelius and Wingfield, 1975; Morgan, 1982), human-associated disturbances to polar bears should be minimized as much as possible to avoid inducing this or other conditions that might be related to stress.

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