Title

Author
Shelby Kaminsky: skaminsky@mail.usf.edu
Abstract

Polar Bears of the species *Ursus maritimus*, inhabit and reproduce within the Arctic Region. Polar Bears have a gestation period ranging from 190-260 days, and give birth from November through January producing an average clutch size of 2 cubs per litter (Ramsay & Stirling, 1988). The cubs are protected by their mother and stay with her for about 2 years learning how to hunt and not dispersing until nearly full grown (Ramsay & Stirling, 1998). When the cubs disperse at about 2 years of age, they are still not half the weight they will reach at adulthood. Offspring quantity and quality were plotted to predict the risk factors that threaten offspring survival of the cub. We concluded that starvation is a far greater threat to offspring survival than predation.
The Polar Bear, *Ursus maritimus*, has a range of distribution within the Arctic Region and adjacent land masses. It is the large carnivorous mammal belonging to the family Ursidae. The average adult male Polar Bear is 8-10 feet in length weighing on average anywhere from 350-700 kg (770-1,500 lbs), whereas a female is about 6-8 feet long and weighs half of what the male weighs. Weight is an important factor because fatter bears produced heavier cubs which would be more likely to survive (Atkinson & Ramsay, 1995). Male and female Polar Bears mate in April and May on the sea ice in the best seal hunting areas. Females build a maternity den in snowdrifts where they give birth from November through January and then nurse their cubs on rich in fat protein milk. The nest will usually be on land a few kilometers from the coast. Females invest their reproductive resources and give birth on average to 2 cubs per clutch, although cubs per litter could range from 1-3 (Ramsay & Stirling, 1998). Males will reach their sexual maturity at 6 years where the females are a bit younger at 5 years. The Polar Bear has an average lifespan of 20 years (Ramsay & Stirling, 1998). Cubs are around 30 cm long and weigh less than 1 kilogram at birth (Derocher & Stirling, 1998).

The lifetime fitness goal of each sexually mature female, like the Polar Bear, is the survival of two sexually mature offspring to replace her and her mate. Given that most offspring perish before reaching maturity, how do mature females of any species—clam, insect, fish, frog or elephant—reach this goal? According to the maternal risk management model (Cassill, D. L., 2013), utopian environments favor investments in a few, low quality offspring, predation environments favor investments in offspring quantity, seasonal environments with periods of scarcity favor investments in offspring quality and multi-risk environments with high predation and periods of scarcity favor investments offspring diversity—usually a few high-quality
offspring and many-low quality offspring. In this study, we measured offspring quality and quantity for the Polar Bear and then used these metrics to predict the environmental risk factors that shaped the evolution of maternal investment strategies.

**Method**

Offspring number and relative offspring body-size were plotted on the inner “x” and “y” axes. The outer “x” and “y” axes are qualitative probabilities of predation or starvation. The relative body size of offspring at independence and thus the probability of starvation was estimated as \( S = \frac{m}{M} \) where \( S \) = expected probability of offspring mortality based on cycles of food scarcity; \( M \) = mass of mother at the time of offspring independence; \( m_x \) = mass per offspring at the time of its independence.

The expected probability of offspring mortality by predation was estimated as \( P = 1 - \frac{2}{N} \) where \( P \) = expected probability of predation; \( 2 \) = expected lifetime fitness per mother; \( N \) = the number of offspring produced by a mother per clutch or lifetime. The expected probability of offspring mortality in multiple-risk environments is estimated as \( PS \).

**Results**

Offspring quality was estimated using 250 kg as the average weight of offspring at independence. Maternal weight was estimated as 350 kg. Relative offspring quality represents the probability of offspring mortality by starvation, which was calculated as \( \frac{250}{350} = 0.71 \). Offspring quantity was estimated at 10 cubs over lifetime. The probability of offspring mortality by predation was calculated as \( 1 - \frac{2}{10} = 0.80 \). To summarize here, the percent of offspring that will die of starvation (71%) is of greater significance than the percent of offspring that will die of predation (80%; Fig. 1). This is shown in Figure 1 with high starvation probability and low
predation probability. Although the 80% predation probability seems high, compared to the other organisms, the Polar Bear predation percentage is categorized as low.

**Figure 1**: The maternal investment strategy by the Polar Bear. P: Predation environments favor investments in offspring quantity rather than quality. S: Seasonal environments that cycle between abundance and scarcity favor investments in offspring quality rather than quantity. R: Multi-risk environments with high predation and periods of scarcity select for a few high-quality offspring and many-low quality offspring. U: Utopian environments favor few, low quality offspring.
Discussion

Polar Bears are opportunistic hunters that are aggressive to any prey in their territory. Cubs feed on seals, mainly ringed and bearded, narwhals, walruses, carcasses, etc. (Anderson, M., Derocher, A.E., & Wiig, Ø., 2002). Adults have the same diet as their cubs and when food is scarce, Polar Bears may attempt to find alternate prey on shore, including muskox, reindeer, small rodents, waterfowl, shellfish, fish, eggs, kelp, berries and even human garbage. Polar Bears have few natural predators’ typically only humans, and rarely wolves.

Based on our calculations, we can deduce that the Polar Bear’s maternal investment strategy, investing more in offspring quality than quantity, evolved in an environment in which offspring did not have readily available food, and were exposed to low predation.
References


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