EVOLUTIONARY IMPLICATIONS OF THE HIGH-PROTEIN MILK OF CAPTIVE XENARTHRANS

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Introduction

The Xenarthra, the orders Cingulata (armadillos) and Pilosa (anteaters and sloths), probably evolved from an insectivorous ancestor. Based on other insectivore milks (e.g. aardvark, elephant shrew), milk of the common ancestor of living Xenarthrans likely was high-protein. Armadillos and anteaters remain insectivorous, but sloths evolved to become herbivores. Phylogeny and adult diet should both influence milk composition. This study explored whether the milk protein content of extant Xenarthrans is consistent across the orders, despite the insectivorous or herbivorous adult diets. Our hypothesis was that phylogeny would be the stronger signal.

Methods

Longitudinal milk samples collected from six nine-banded armadillos (*Dasypus novemcinctus*), two giant anteaters (*Myrmecophaga tridactyla*), and a single two-toed sloth (*Choloepus hoffmanni*) were assayed for water, fat, crude protein, total sugar, ash (total mineral), calcium, and phosphorus at the Nutrition Laboratory of the Smithsonian National Zoological park and Conservation Biology Institute, Washington DC, using standard methods developed at this laboratory. These methods have been used to assay the macronutrient content of milks from more than 100 species of mammals.

Results

Protein concentration was the highest of the milk solids for all species (9.8%, 6.0%, and 7.1% for nine-banded armadillo, giant anteater, and two-toed sloth, respectively) and contributed 47%, 58%, and 40% of milk energy, respectively. Armadillo milk had high mineral content, increasing from 1% to 3% over lactation (Figure 1); calcium and phosphorus accounted for half the mineral content (Power et al., 2018).

Discussion

Calcium and phosphorus in milk are bound in casein protein micelles. Thus, a high calcium milk must also have high casein protein content. The high protein, calcium, and phosphorus content of armadillo milk is consistent with growing their bony carapace. The high protein content of giant anteater milk is consistent with their diet. We predict that giant anteater milk will have a lower proportion of casein proteins, in line with their lower milk calcium levels and the fact that they do not produce bony armor. The high protein content of sloth milk may represent phylogenetic constraint, but it is also consistent with the moderate-protein, low metabolizable energy of the adult herbivorous diet. These data are consistent with the hypothesis that the ancestral Xenarthran was likely an insectivore and had a high protein milk. We suggest that a high-protein milk was a preadaptation allowing the evolution of extensive osteoderm formation in this lineage.

Literature Cited
Power ML, Watts SM, Murtough KL, and Knight FM (2018) Macronutrient composition of milk of captive nine-banded armadillos (*Dasypus novemcinctus*). *J Mammal* 99(2), 498-504.

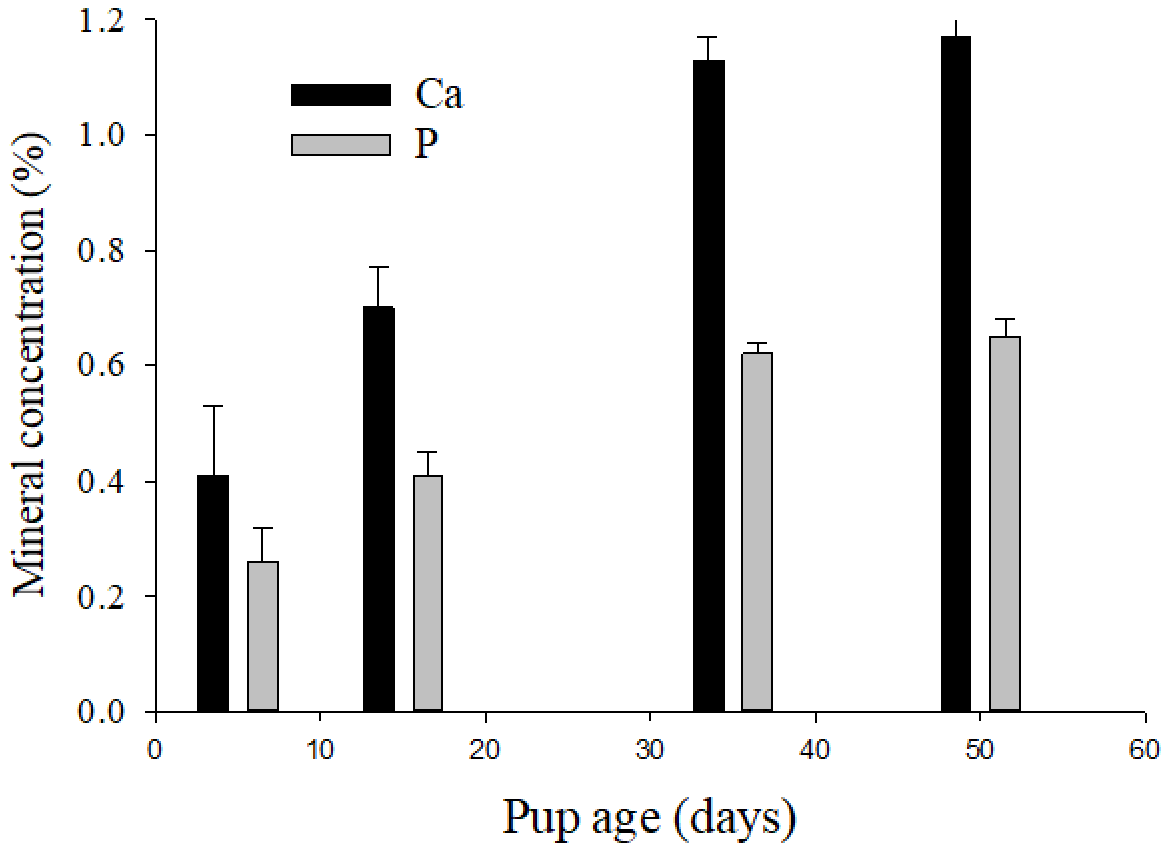

Figure 1. The concentrations of nine-banded armadillo milk calcium and phosphorus across lactation.