Why are lions not as big as elephants?

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Carnivores are some of the widest ranging terrestrial mammals for their size, and this affects their energy intake and needs. This difference is also played out in the different hunting strategies of small and large carnivores. Smaller species less than 15-20 kg in weight specialize on very small vertebrates and invertebrates, which weigh a small fraction of their own weight, whereas larger species (>15-20 kg) specialize on large vertebrate prey near their own mass.

While carnivores around the size of a lynx or larger can obtain higher net energy intake by switching to relatively large prey, the difficulty of catching and subduing these animals means that a large-prey specialist would expend twice as much energy as a small-prey specialist of equivalent body size. In a new article published by *PLoS Biology*, Dr. Chris Carbone and colleagues from the Institute of Zoology, Zoological Society of London reveal how this relationship might have led to the extinction of large carnivores in the past and why our largest modern mammalian carnivores are so threatened.

The authors provide a model of carnivore energetics in relation to predator and prey size, and compare the model predictions with observed estimates of metabolic rates and intake rates taken from animals in the wild. By analyzing the balance between energy intake and expenditure across a range of species, the authors reveal that mammalian carnivores would not be able to exceed a body mass of one ton.

Their model predictions are consistent with the data we have. Most mammalian carnivores are relatively small compared with the largest

extinct terrestrial herbivorous mammals, such as the Indricothere, which weighed around 15 tons. The largest existing carnivore, the polar bear, is only around half a ton, while the largest known extinct carnivores, such as the short-faced bear, weighed around one ton. The authors also note that the largest terrestrial non-mammalian predators, such as Giganotosaurus and Tyrannosaurs, may have achieved their massive size by having a lower metabolic rate. Indeed, previous estimates of total metabolic rate for these species are similar to those of a mammal weighing about a ton.

We know that the largest carnivores that exist today are particularly vulnerable to threats imposed by humans and have been shown to have higher rates of extinction in the fossil record than smaller species even prior to the evolution of man. Carnivores at the upper limits of body mass would have been heavily reliant on abundant large prey to both minimize energy expenditure and maintain high rates of energy intake.

Slight environmental perturbations, anthropogenic or otherwise, leading to lower prey availability, could readily upset this energy balance. It may have also contributed to the extinction of the largest carnivores and explain why the largest modern mammalian carnivores are so rare and vulnerable today.

Source: Public Library of Science