When it comes to mammals, how big is too big?

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The southern elephant seal, Mirounga leonina, is the largest species of the mammalian order Pinnipedia, which is the second largest order of mammals. The males weigh up to 4,000 kilograms. Credit: Dan Costa

(Phys.org) —Mammals vary enormously in size, from weighing less than a penny to measuring more than three school buses in length. Some groups of mammals have become very large, such as elephants and whales, while others have always been small, like primates. A new theory developed by an interdisciplinary team, led by Jordan Okie of Arizona State University, provides an explanation for why and how certain groups of organisms are able to evolve gigantic sizes, whereas others are not.

The international research team comprised of palaeontologists, evolutionary biologists and ecologists examined information on how

quickly an individual animal grows and used it to predict how large it may get over evolutionary time. Their research is published in the journal *Proceedings of the Royal Society B*.

The new theory developed from the observation that some animals live fast and die young, while others take their time and mature much later. This is called the slow-fast life-history continuum, where "fast" animals – such as mice – breed very quickly, while humans mature slowly and are relatively older when they first have children. The theory proposes that those species that are relatively faster are more likely to evolve a large size quicker than slow species, and that their maximum size will be greater.

The research team tested their theory using the fossil records of mammals over the last 70 million years, examining the maximum size of each mammal group throughout that time, including whales, elephants, rodents, seals and primates. They found that their theory was very well supported.

"Primates have evolved very slowly, and never got bigger than 1,000 pounds," said Okie, an exploration postdoctoral fellow in the School of Earth and Space Exploration at ASU. "The opposite was true of whales, which evolved their large size at the fastest rates recorded."

The theory also makes predictions about the relative risks of extinction for large animals compared to small. The maximum size of an animal is limited by the rate of mortality in the population. Because larger animals tend to breed less frequently than smaller animals, if the mortality rate doubles, the maximum size is predicted to be 16 times smaller.

"This is a really surprising finding," said co-author Alistair Evans of Monash University (Melbourne, Australia). "It points to another reason why many of the large animals went extinct after the last Ice Age, and

their high risk of extinction in modern environments."

The research clarifies some of the differences among the main groups of mammals and makes further predictions about how changes in body size affect the evolutionary potential. In the future, this work will be extended to help explain how extinction risk may be reduced in changing climates.

More information: rspb.royalsocietypublishing.or … .1098/rspb.2013.1007

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