# Why sea-faring mammals need to be larger than land lubbers

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(Phys.org) —Ever notice you get cold faster when you're wet? That's why whales are so much bigger than elephants, according to SFI External Professor Aaron Clauset in a recent paper published in the journal *PLoS One* that examines what might have caused mammalian species to evolve to the sizes they did.

Clauset, a computer scientist at the University of Colorado Boulder, set out to understand why a few land-loving mammal species reach elephantine proportions but the most common mammal size is about that of a rat. One popular theory, the reproductive power hypothesis, argues that mammalian species have an ideal size but vary in size because of a complicated mix of competition and other pressures.

Working with former SFI researcher Doug Erwin, Clauset devised another explanation based on simple principles. First, mammals can't be too small, or they lose heat faster than they produce it. Second, as they evolve, species tend to grow larger over time, but the larger they get, the more susceptible they are to extinction—what Clauset calls "a macroevolutionary conveyor belt of death."

Those principles led to a mathematical model of land mammals' sizes with just three uncertain parameters, two of which they already knew. Thermodynamics and a little biology determine how small mammals can be, and the fossil record reveals how fast species grow over time. That left the extinction rate for large mammals, which Clauset and Erwin estimated by fitting their model to data on living mammals.

"We got a really good fit" for terrestrial mammals, Clauset says. Still, they couldn't explain why the smallest sea-faring mammal, the Franciscana dolphin, is 18,000 times larger than the smallest land mammal, the two-gram shrew.

The difference, Clauset explains, is water.

Because water transports heat faster than air, sea-faring mammals have to be much larger to survive—at least 80 pounds. Now Clauset could predict sea mammals' sizes, except this time there was no need to estimate anything from data. Using the 80-pound minimum size with the species growth rate and the extinction rate he'd estimated for land mammals, he could make a prediction without any wiggle room. The model is "either right or it's not," he says.

Right-or-wrong predictions like that are rare, but Clauset's prediction is statistically indistinguishable from real-world species size data. That, he says, suggests "a universal process for all mammals."

He adds that the conveyor-belt aspect of the model may explain something else in the fossil record—cycles of the largest mammal species getting larger and larger, eventually dying off, only to be replaced by another growing species.

**More information:**
www.plosone.org/article/info%3 …
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