

Bigger creatures live longer, travel farther for a reason

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(Phys.org)—A biological mystery about the longer lifespans of bigger creatures may be explained by the application of a physical law called the Constructal Law.

What this law proposes is that anything that flows—a river, [bloodstream](#) or highway network—will evolve toward the same basic configuration out of a need to be more efficient. And, as it turns out, that same basic law applies to all bodies in motion, be they animals or tanker trucks, says Adrian Bejan, the J.A. Jones Professor of mechanical engineering at Duke and father of the Constructal Law.

In his latest theory paper, appearing Aug. 24 in the journal *Nature Scientific Reports*, Bejan argues that there is a universal tendency for larger things, animate and inanimate, to live longer and to travel further.

He starts his argument with an examination of the well-known observation in biology that larger animals tend to live longer. Bejan wanted to see if this general rule might apply to inanimate systems as well and proceeded to mathematically analyze the relationship in rivers, jets of air and vehicles.

He found, as a general rule, that bigger rivers are older and that larger jets of air, such as atmospheric [jet streams](#), last longer. By his calculations, larger vehicles should also last longer, but hard evidence of that is lacking, he says, and there are outliers of course, like Subaru Justys with 300,000 miles.

By being larger and lasting longer, all of these systems also travel farther, he says.

If you look at a moving vehicle or animal simply as a mass in motion, that is, something flowing, "the spreading of the mass of vehicles and animals is completely analogous to the flow of water in [river channels](#)," Bejan says. "It is the same design."

Interestingly, if the [body size](#) and lifespan of known species of animals are plotted on a curve, it falls on a slope of about $\frac{1}{4}$. And then, following a different line of inquiry, if you plot the frequency of breathing to body size, that is a slope of $-\frac{1}{4}$.

When combined, these two insights about animal body size work out to a constant for the number of breaths per lifetime, Bejan says. This gives most creatures about the same number of breaths in their lifetime, but the larger, slower-breathing animals use their breaths up over a longer span of time. "So bigger means a longer [lifespan](#)," he said. "I was looking at this enigma about body size and longevity from a point of view that hadn't occurred to biologists," Bejan said.

The Constructal Law governs how big an engine a truck needs and how big a heart a whale needs. "There's no difference between a vehicle and an animal," Bejan said. "Being larger means two things, not one: you live longer and you travel farther."

There are, of course, notable exceptions to the rule: The 4-ounce Arctic Tern travels more than 44,000 miles a year.

"The size-effect on travel and life time is the same for the animate and the inanimate," Bejan argues. "Everything that moves enjoys the same design."

Provided by Duke University

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