Why are there no animals with three legs?

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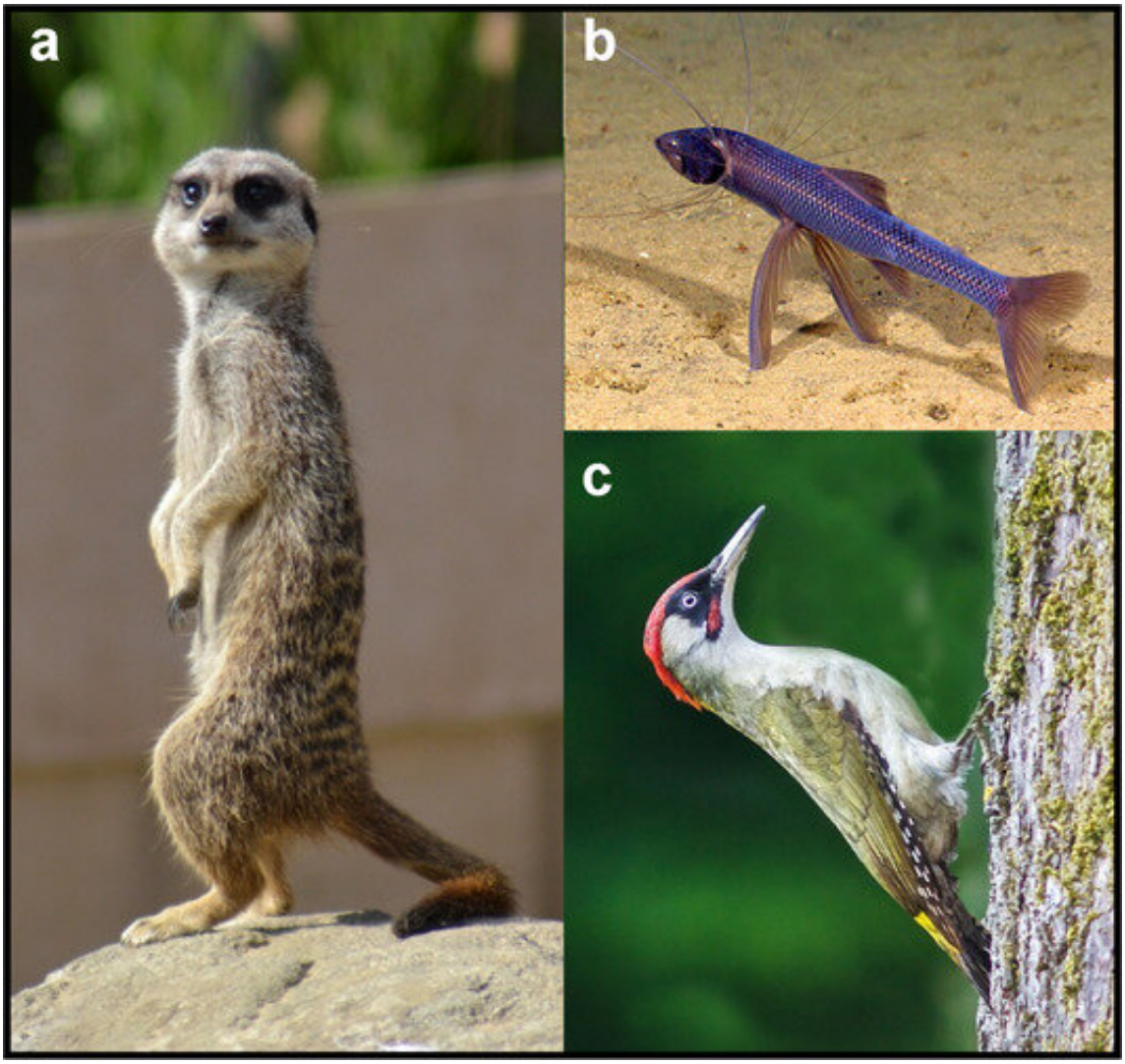

Many animals use a 'tripod stance' at rest, because it is stable and requires little energy. Examples shown here are a meerkat, a tripod fish and a woodpecker. But fewer animals move with three limbs, and a truly three-limbed animal does not exist on Earth. Credit: Tracy J. Thomson in *BioEssays*

If "Why?" is the first question in science, "Why not?" must be a close second. Sometimes it's worth thinking about why something does not exist.

Such as a truly three-legged animal. Tracy Thomson, graduate student in the UC Davis Department of Earth and Planetary Sciences, has been pondering the non-existence of tripeds. He recently published an essay on it, "Three-Legged Locomotion and the Constraints on Limb Number: Why Tripeds Don't Have a Leg to Stand On" in *BioEssays*.

Thomson got the idea after taking a graduate class on evolution with UC Davis paleontologist Geerat Vermeij, who challenged the students to come up with a "forbidden phenotype:" an animal or plant that does not and cannot exist.

Thomson points out that there are lots of animals that use a tripod stance to rest. Meerkats in an upright stance rest on their tail and rear feet; woodpeckers use tail feathers to brace themselves against a tree-trunk.

A tripod stance does not require any energy to be stable, Thomson noted. Unlike, for example, standing upright on two feet, which does require some muscle work as well as relatively large feet.

Three-limbed movement is less common. Insects, which of course have six legs, have a mode of movement where their legs move in sets of three: two legs on one side and one on the opposite side are on the ground, with the opposite legs moving, at any time. This is called the "alternating tripod" gait.

Gripping tails and beaks

Many tree-dwelling animals use their tails for additional gripping, although they may be moving with all four of their limbs as well. Parrots

are quite tripedal, using their strong, flexible beak as an additional grip to maneuver in tree branches.

Long rear feet make it difficult for kangaroos to "walk" like other mammals. Instead, they use their strong tail and front limbs to push the rear feet off the ground and forwards while grazing.

Given that three-limbed movement does seems to work for some animals, why are there no animals with three legs? That might go back a long, long way, Thomson said.

"Almost all animals are bilateral," he said. The code for having two sides to everything seems to have got embedded in our DNA very early in the evolution of life—perhaps before appendages like legs, fins or flippers even evolved. Once that trait for bilateral symmetry was baked in, it was hard to change.

With our built-in bias to two-handedness, it can be hard to figure out how a truly three-legged animal would work—although that has not stopped science fiction writers from imagining them. Perhaps trilateral life has evolved on Enceladus or Alpha Centauri (or Mars!) and has as much difficulty thinking about two-limbed locomotion as we do thinking about three.

This kind of thought experiment is useful for developing our ideas about evolution, Thomson said.

"If we're trying to understand evolution as a process we need to understand what it can and can't do," he said.

More information: Tracy J. Thomson, Three-Legged Locomotion and the Constraints on Limb Number: Why Tripeds Don't Have a Leg to Stand On, *BioEssays* (2019). DOI: 10.1002/bies.201900061

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