Treadmill tests for poison frogs prove toxic species are more physically fit

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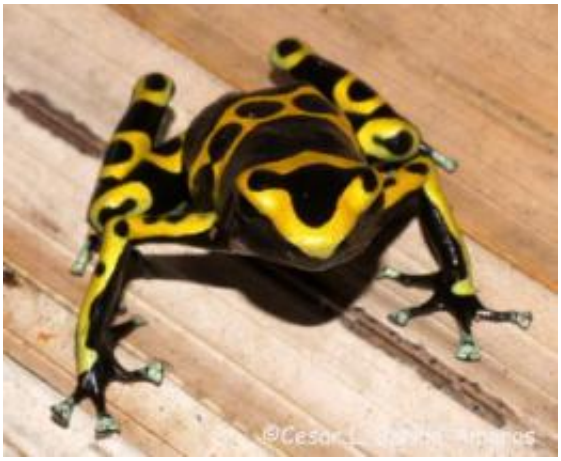

Dendrobates leucomelas, a poisonous frog from Venezuelan Guiana, has higher aerobic capacity than its nontoxic relatives. Credit: Photo courtesy of Cesar Barrio-Amoros (www.andigena.org).

The most toxic, brightly colored members of the poison frog family may also be the best athletes, says a new study.

So-named because some tribes use their skin secretions to poison their darts, the poison dart frogs of the Amazon jungle are well known for their bitter taste and beautiful colors. The spectacular hues of these forest frogs serve to broadcast their built-in chemical weapons: skin secretions containing nasty toxins called alkaloids. Like the red, yellow and black bands on a coral snake or the yellow stripes on a wasp, their

contrasting color patterns warn would-be predators to stay away, said lead author Juan Santos of the National Evolutionary Synthesis Center in Durham, NC.

As it turns out, the most boldly-colored and bad-tasting species are also the most physically fit, the authors report this week in the journal *Proceedings of the National Academy of Sciences*.

In forests in Colombia, Ecuador, Venezuela, and Panamá, Santos subjected nearly 500 poison frogs — representing more than 50 species — to a frog fitness test. He measured their oxygen uptake during exercise using a rotating plastic tube, turning the tube like a hamster wheel to make the frogs walk.

Santos estimated the frogs' metabolic rates while at rest, and again after four minutes of exercise. The result? The most dazzling and deadly species had higher aerobic capacity than their drab, nontoxic cousins.

Dendrobates leucomelas, a poisonous frog from Venezuelan Guiana, has higher aerobic capacity than its nontoxic relatives. Credit: Photo courtesy of Cesar Barrio-Amoros (www.andigena.org)

"They're better able to extract oxygen from each breath and transport it to their muscles, just like well-trained athletes," Santos said.

Poisonous species owe their athletic prowess to their unusual foraging habits, explained co-author David Cannatella of the University of Texas at Austin. Unlike snakes and other poisonous animals which make their own venom, poison frogs get their toxins from their food.

"They acquire their alkaloid chemicals by eating ants and mites," Cannatella said.

Because of their picky diet, poisonous frogs have to forage far and wide for food. "Nontoxic species basically stay in one place and don't move very much and eat any insect that comes close to them," Santos said. "But the bright, poisonous frogs are very picky about what they eat."

"It's not like a buffet where they can get everything they need to eat in one place," Cannatella added. "Ants and mites are patchy, so the frogs have to move around more to find enough food."

This combination of toxic skin and bold colors — a syndrome known as aposematism —evolved in tandem with specialized diet and physical fitness multiple times across the poison frog family tree, the authors explained. In some cases the frogs' physical fitness may have evolved before their unusual diet, making it possible to forage for harder-to-find food. But the specific sequence of events was likely different for different branches of the tree, Santos said.

The findings appear in the March 28 issue of Proceedings of the National Academy of Sciences.

More information: Santos, J. and D. Cannatella (2011). "Phenotypic integration emerges from aposematism and scale in poison frogs." *Proceedings of the National Academy of Sciences.* www.pnas.org/cgi/doi/10.1073/pnas.1010952108

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