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Panama and Madagascar home to similar killer ants, frogs
They evolved 9,000 miles apart yet have 13 of same poisons

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Beware the poison frogs of Madagascar and Panama!

Separated by nearly 9,000 miles across the globe and by millions of years of evolution, both are deadly -- if you're a predator.

And if you are, it's best not to sample the diets of those hopping denizens of the misty rain forests, for both frog tribes thrive on poisonous ants, both have incorporated the ant toxins into their own bodies and both have developed a patchwork of brilliant skin colors to warn their enemies that they are dangerously inedible.

The vivid yellow, purple, orange and green frog bodies virtually shout a warning to would-be predators that they are killers defending themselves.

Two biologists, a 25-year-old frog fancier from Cornell University and a 40-year-old ant fanatic at the California Academy of Sciences in San Francisco, are studying the two widely separated groups of frogs and ants to reveal a striking example of what science calls convergent evolution -- the development over many millennia of similar body forms or behaviors in animals that are unrelated to each other and often widely separated geographically.

Unrelated now, such animals may in fact have descended from common ancestors millions upon millions of years ago, when continents and islands now separated were once part of the same land mass but eventually split away from each other and drifted to the regions where they stand now.

Valerie C. Clark, a Cornell graduate student in biological chemistry, and Brian L. Fisher, chairman of the California Academy's entomology department, together with colleagues in Madagascar and the United States, published details of their unusual frog-and-ant studies last week in the Proceedings of the National Academy of Sciences.

In two months of frog collecting during the rainy season along the

banks of streams in the tropical forest of Madagascar's Ranomafana National Park, Clark focused on the poisonous skins of three species of colorful Mantella frogs, all less than 2 inches long, all native to Madagascar and none found anywhere else in the world.

Together, she and Fisher also deftly wielded specialized entomological forceps to rummage through the leaf litter of the forest floor and gather hundreds of native Madagascar ants, each no more than 5 millimeters long -- barely one-tenth the size of the tiny frogs -- and each filled with similar alkaloid poisons.

In the laboratory, Clark analyzed both the captured ants and the stomach contents of the frogs to determine which ant species dominate the frogs' diets. She then identified which of many poisonous alkaloids the frogs and insects sequester.

Another research team, led by Ralph Saporito of Florida International University and John W. Daly of the National Institutes of Health, had already discovered that the skin of brightly colored poison frogs in Panama hold the same toxic chemicals as the unrelated Madagascar amphibians, and that those frogs, too, are hungry eaters of an ant species unrelated to those favored by the Madagascar frogs.

Comparing their findings with the Saporito team's report, Clark and Fisher and their colleagues found that, despite existing more than a third of the world apart, the frogs and ants shared 13 identical poison compounds. Only three poison compounds found in the subjects were different.

What was most striking to the researchers was that the unrelated frogs in both regions have evolved in nearly identical ways: Both not only eat virtually the same diets of ants containing the same toxic alkaloids, but they have also developed skins containing many of the same poisons emblazoned with varieties of vivid skin color patterns warning any predator that might be stupid enough to try eating one that they are indeed poisonous.

During Clark's field work, she made another interesting discovery: The skin of one species of Madagascar frog, Mantella baroni, contains the toxic alkaloid nicotine, which is known to be synthesized by many plants, including tobacco and the nightshade family of deadly poisonous flowering weeds.

Clark concedes it's just speculation, but says that the finding suggests at least the possibility of a singular evolutionary progression: from a plant containing the poison to an ant that eats the plant and sequesters the poison to a frog that eats the ant and then advertises itself as poisonous and dangerous to any predator on the hunt for tasty cuisses de grenouilles -- frog's legs.

On the other hand, Fisher suggests that the original source of the toxic alkaloids in the ants' bodies might be the even tinier mites on which they feed.

It's a mystery that awaits curious researchers.

Whether or not the plants or the mites play a role in this evolutionary saga, the connection between poison ants and poison frogs is clear, both Clark and Fisher agree. To Clark, the lesson seems evident.

"The frogs have evolved ways to keep the poison down without harming themselves when they eat the ants," she said in a telephone interview. "So they've developed a way to protect themselves by their distinctive coloration. And in a region where selective pressures are high, they've opened up a totally different niche for themselves. Instead of hiding from predators or hunting

their own prey in the dark of night the way many other frogs do, there in Madagascar they can just hop around in the daylight, knowing that predators have learned to stay away."

As for Fisher, who is now seeking to create a new center for biodiversity research in Madagascar, this striking observation of parallel developments in unrelated species of frogs and ants reveals "an obvious example of natural selection."

"Ants have been around for 120 million years, and here's a fascinating instance of biological and chemical evolution," he said during an interview in his Howard Street laboratory. "The frogs in both regions have faced competition in their dangerous world, and they've evolved a way to defend themselves by sequestering toxic chemicals from the ants, and then letting predators know it. It's a beautiful story."

Aiding the research were Valerie Rakotomalalaof the University of Antananarivo in Madagascar, Christopher Raxworthy of the American Museum of Natural History in New York, and Petra Sierwald of Chicago's Field Museum of Natural History.

Similar examples of convergent evolution are widespread throughout the animal world.

The giant pangolin of Africa and the giant anteater of South America, for instance, have developed elongated snouts to suck up entire ant colonies in a single gulp; they resemble each other, and if both had a common ancestor at all, it must have lived millions of years ago, when Africa and the Americas were joined together before continental drift moved them an ocean apart.

Or take Africa's serval cat and South America's maned wolf, who is not a wolf at all, but a member of the dog tribe. They have uncannily similar builds, with tremendously long legs for their slender bodies and large upright ears for acute hearing; neither runs particularly fast, but both can leap and pounce on their similar rodent prey to impale a meal with their long, sharp teeth.

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