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Poison Frogs Losing Their Toxicity, Study Suggests

John Roach
for [National Geographic News](#)
November 7, 2006

Poison frogs may be losing their toxicity as human development fragments their habitats, a recent study says.

The study examined the diversity of alkaloids found in poison frogs in different regions and habitats on Madagascar, an island nation off the southeast coast of Africa ([Madagascar map](#)).



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Alkaloids, such as caffeine, nicotine, and cocaine, are bitter-tasting compounds containing nitrogen. In large doses they can be lethal.

The alkaloids poison frogs ingest with their food accumulate in their skin, which makes the animals toxic to would-be predators.

"We looked at only a limited number of sites but found that frog individuals have more different alkaloids at pristine sites and less at fragmented sites," said Valerie C. Clark, a graduate student in chemistry at Cornell University in Ithaca, New York.

While individual alkaloids vary in their toxicity, frogs with a greater variety of the chemicals in their skin are more likely to pack a lethal punch to their predators, Clark notes.

She and colleagues reported the finding last month in the *Journal of Chemical Ecology*.

The team says future studies need to address the question of whether frogs require a certain number of alkaloids in their skin to maintain their toxicity.

If the answer is yes, some of Madagascar's poison frogs may become defenseless as human development breaks up their habitats, Clark says.

Bug in the System?

According to Clark's study, frogs in pristine forest habitat had about 30 different alkaloids in their skin, whereas frogs in patches of forest surrounded by agricultural fields had only 12 alkaloids.

In a moderately disturbed habitat along the side of a road, the frogs averaged 15 alkaloids.

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"This could be a reflection of the arthropod diversity at these sites," Clark said.

In recent years scientists have learned that poison frogs accumulate their skin toxins by eating alkaloid-containing insects, primarily ants. (Related: ["Toxic Frogs, Birds May Get Their Poison From Beetles"](#) [November 9, 2004].)



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For example, in the August 16, 2005, issue of the journal *Proceedings of the National Academy of Sciences (PNAS)*, Clark and colleagues identified alkaloid-containing insects munched by Madagascar frogs.

"It's really smart for frogs," Clark said. "It gives them a nice defense, and they don't have to waste energy biosynthesizing and making [the toxins] on their own.

"And they're stealing it from their diet, which means they are also able to eat toxic insects other frogs reject as distasteful," she added. "They're able to exploit a whole other niche."

Clark plans to investigate the diversity of toxic insects in Madagascar next year. She expects the pristine forests to have the greatest number of arthropod species.

Diversity Downgrade

John Daly, a pharmacologist at the National Institute of Diabetes and Digestive and Kidney Diseases in Bethesda, Maryland, is an expert in identifying bioactive alkaloids in poison frogs.

For example, in today's issue of *PNAS* he and colleagues report on an alkaloid known as 251D that wards off mosquitoes and flies. (Related: ["Frog 'Juice' May Be Next Big Bug Repellent"](#) [July 24, 2006].)

"It's kind of an exciting paper," Daly said. "But I have to be negative and say that this compound will never have useful purpose as a mosquito repellent. It would probably be too toxic to mammals such as ourselves."

Instead, the researchers are pursuing potential applications of the compound to help treat autoimmune diseases, he says.

According to Daly, who is a member of the National Academy of Sciences, Clark's observation that the diversity of alkaloids in frogs decreases as their habitat becomes more fragmented is potentially of interest.

"We've seen it too," he said. "As habitats change, the alkaloid population goes up and down, and there are things that weren't there before."

For example, as agricultural inroads have increased, he has seen an

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unusual alkaloid appear and become a major frog-skin alkaloid over a ten-year period in frogs from a small Panamanian island ([Panama map](#)).

Daly and colleagues from Florida International University in Miami then identified a small millipede as the source of that alkaloid.

In ongoing work funded by a National Geographic Society grant to Florida International University biologist Maureen Donnelly, Daly says the research team next plans to look for an alkaloid-habitat connection at about thirty different sites in Panama and Costa Rica. (National Geographic News is part of the National Geographic Society.)

According to Cornell University's Clark, if there is a correlation, habitat fragmentation may alter the ecology and geographic distribution of poison frogs.

For example, if the frogs do lose their toxicity, predators currently trained to avoid the brightly colored poison frogs may learn they have nothing to fear and start attacking the newly defenseless amphibians.

In addition, Clark says, the frogs may abandon habitats that lack sufficient alkaloid-containing ants, affecting distribution.

"That makes sense, but it's not fully addressed," she said, noting that years of additional research are necessary.

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