

Independently, Two Frogs Blaze the Same Venomous Path

By NATALIE ANGIER Published: August 9, 2005
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Among frogs and New Yorkers alike, those wearing loud colors are assumed to have very poor taste. As researchers have long observed, the brightest frog species in nature are often the most poisonous, and for good reason.



Valerie C. Clark

The golden poison frog has enough venom in its skin to kill 12 people.

Why else would a creature coveted by everything from snakes and birds to Jacques Pépin evolve an extravagantly colored skin, except to warn any would-be predators of bitter toxins embedded therein?

Now it turns out that it is no mean feat for a frog to earn its mean feet, and that one of the surest routes to optimal toxicity is through a highly specialized form of ant eating.

Writing in the current issue of *The Proceedings of the National Academy of Sciences*, researchers report that poison frogs in Africa and the Neotropics of Central and South America appear to have converged on the same difficult method of harvesting the toxic chemicals they need to defend themselves against predators.

Both the famed poison-dart frogs of the New World and the Mantella poison frogs of Madagascar dine largely though not exclusively on ants, and many of those ants, the researchers have determined, contain toxic chemicals called alkaloids.

Through entirely independent pathways, it seems, the two unrelated groups of frogs evolved a similar capacity to store, or sequester, the ingested alkaloids in their skin sacs without being harmed by the pungent substances themselves. And once the unrelated amphibian clans had succeeded in caching the ant bane in their glands, they autonomously evolved bright coloration to broadcast to potential frog-eaters their possession of distasteful alkaloids.

The evolution of chemical protection and concomitant advertising gave the poison frogs a considerable leg up on the competition. Whereas most frogs dare only emerge at night to feed and will skitter for cover at the slightest breeze, a majority of poison frogs are diurnal, brazenly hopping around the sunlit forest floor like scattered gems on pogo sticks.

The new work offers a striking example of convergent evolution, of different species confronting a similar challenge or opportunity and taking such a similar stepwise approach to the task that, despite their distinct genetic backgrounds, they end up looking like close kin.

More significant still, the scientists said, the convergence in this case did not begin with the frogs. The ants, too, in both Africa and the Neotropics, seem to have independently evolved their possession of alkaloid chemicals, which they either synthesize directly, or somehow wrest from plants they eat.

Most of the 4,500 known ant species are not thought to traffic in alkaloids, and the scientists are still unsure whether the endowed insects under study use the chemicals for defense, communication or something else.

Whatever the incentives, said Valerie C. Clark, a graduate student in chemistry at Cornell and the lead author on the new report, the autonomous advance in antly alkaloid management on each continent very likely served as the requisite precursor to the emergence of the far-flung families of flamboyant amphibians.

"Without the presence of the alkaloid ants," she said, "that nice little evolutionary niche of becoming diurnal and colorful would very likely never have opened up for the frogs."

The power of convergent evolution has fascinated naturalists from Charles Darwin onward, and it helps explain the appearance of the many aesthetic and functional *déjà-vus* that abound throughout nature: the sleekly hydrodynamic silhouettes of sharks and dolphins, the spindly wings of bats, birds and pterosaurs.

As evolutionary biologists see it, the underlying principle of evolutionary convergence - that often there is one right tool for the job, and that selective pressures will reinvent the bio-utensil whenever the need arises - exemplifies just how non-random and ostensibly purposeful natural selection can be, and how readily it may be mistaken for evidence of supernatural "design."

In the case of poison frogs, specific palettes and patterns seem to be so useful for warning off predators that they pop up again and again. On both continents can be found frogs of pure bold Velveeta gold, frogs with glaring spots of red on black.

"Sometimes the resemblance really is striking," said Christopher J. Raxworthy, a curator of herpetology at the American Museum of Natural History and an author on the report. "You'll see two unrelated species of frog, one Madagascan, one Neotropical, and they'll be almost the same size and shape, they'll move in a similar style, and they'll have the same vivid markings in virtually the same place on the body."

The frogs range in their relative toxicity from the merely acrid to the aptly named *Phylobates terribilis*, which packs enough venom in its skin to kill at least a dozen people, and which the Indians of western Colombia use to poison the serrated tips of their blow darts. And then, there are the inevitable mimics: frogs that have evolved the lurid packaging of their poisonous peers, but without the means to sequester alkaloids.

Sure, the copycats may have no ants in their glands, but what wise hunter will take that chance?