New research reveals bats evolved more than one way to drink nectar

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Two nectar-feeding bats in the Neotropical family Phyllostomidae; the glossophagine Pallas's long-tongued bat, Glossophaga soricina, (left) and the lonchophylline orange nectar bat, Lonchophylla robusta, (right). In a new study Dávalos, Cirranello, et al., show that many anatomical features implying a common origin of nectar feeding for glossophagines and lonchophyllines — such as a long, extensible tongue — are related to their shared diet. Their evolutionary patterns are consistent with natural selection. Photo credit: Felineora (left), Marco Tschapka (right)

(Phys.org) -- A team of evolutionary biologists compared the anatomy and genes of bats to help solve a persistent question in evolution: Why do analyses of different features of an organism result in conflicting patterns of evolutionary relationships?

Their findings, "Understanding phylogenetic incongruence: lessons from phyllostomid bats," appear in the August 14 edition of *Biological Reviews*.

To answer this question, Liliana Dávalos, PhD, Assistant Professor in the Department of Ecology and Evolution, and member of the Consortium for Inter-Disciplinary Environmental Research (CIDER) at Stony Brook University, and Andrea Cirranello of the Division of Vertebrate Zoology at the American Museum of Natural History (AMNH), together with colleagues at the AMNH and the New York College of Osteopathic Medicine, examined the skin, skeleton, muscle, tongue, internal organs and a few genes of a family of New World bats, applying statistical models to uncover the genetic and anatomical features that produced the conflicts between evolutionary patterns. This work was funded in part by the National Science Foundation.

Specifically, the team examined why genes suggested that nectar feeding had evolved twice in Leaf-Nosed bats, while the anatomical features strongly pointed to a single origin of nectar feeding in this group. Most bats feed on insects, but New World Leaf-Nosed bats are exceptionally diverse in that they feed on nectar, fruit, frogs, lizards and even blood.

One hypothesis that the team tested is that traits linked to how bats feed have been shaped by natural selection for a nectar-based diet, resulting in the conflicting pattern. As Dávalos and Cirranello explain, connecting the conflicting pattern to the diet requires showing that the evolutionary pattern resulting from anatomical traits is wrong, and that the traits producing the conflict with the genetic data are linked to a shared dietary specialization.

“If a diet specializing in nectar helped shape the anatomy of the two groups of bats, then the traits that support the groups coming together should be related to feeding, and taking those traits out should break up the spurious group of nectar-feeding bats,” the researchers said. They found support for these predictions by analyzing evolutionary trees from two genomic data sets, alongside trees based on more than 200 anatomical traits; and applying a battery of statistical approaches to identify where in the evolutionary tree the conflicts arose and what genetic regions and traits supported the differences.

The team traced the conflict in evolutionary patterns among nectar-feeding bats to traits linked to feeding, such as the shape and number of teeth, gaining a "paintbrush" type tongue tip, and rearranging the tongue muscles to accommodate longer, extensible tongues. All of these traits are thought to be associated with specialized nectar feeding. The grouping of all nectar-feeding bats broke down into smaller groups when those traits were taken out of the analyses. Overall, the team found that anatomical traits and the studied genes tended to agree on many parts of the evolutionary tree, but that the anatomical traits associated with nectar feeding brought nectar-feeding bats together.

Natural selection has shaped the anatomy of organisms, but when specializations evolved long ago, it can be difficult for evolutionary biologists to demonstrate that traits bear its signature. By ruling out other biological processes that produce conflict among evolutionary trees, and tracing the conflict to specific traits that are known to enable drinking nectar, the team was able to narrow the options and discover patterns consistent with the signature of adaptation to diet. "We found that anatomical traits associated with nectar feeding have evolved and been lost several times, so they tend to bring bats from different branches of the evolutionary tree together, in direct conflict with genetic trees," Dávalos and Cirranello said.

More information: onlinelibrary.wiley.com/doi/10 … 85X.2012.00240.x/pdf

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