# Researchers' analysis of perching birds points to new answers in evolutionary diversification

September 21 2023

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When Charles Darwin traveled to the Galapagos Islands almost 200 years ago as a gentleman naturalist, he used the power of observation to

develop his theory that species evolve over time.

Today, evolutionary biologists Donald Miles, Robert Ricklefs and Jonathan Losos have the advantage of huge data sets and the power of statistical analysis to study how species within a group develop their own unique characteristics and become new species.

Their results could change how biologists look at species diversification.

On Darwin's 1831 journey aboard the HMS Beagle, he collected samples of 18 different species of passerine birds, or birds that perch. These species varied widely in size and had different kinds of beaks based on their diet.

A century later biologists dubbed them "Darwin's finches" and used them as a classic example of adaptive radiation, where rapid diversity within a group, also known as a clade, differs on an insular island or archipelago compared with a continent.

But maybe not, according to a new study published in the *Proceedings of the National Academy of Sciences* (*PNAS*) by Miles, Ricklefs and Losos that asks the question, "How exceptional are the classic adaptive radiations of passerine birds?"

Miles is professor and chair of biological sciences in the College of Arts and Sciences at Ohio University. He and co-authors, Ricklefs of the University of Missouri-St. Louis and Losos of Washington University, set out to study existing hypotheses of adaptive radiation. The results suggested a new alternative possibility.

"Traditionally, biologists seek explanations for extraordinary species diversification in both key innovations within a species as well as changes in the environment, akin to Darwin's theory of evolution by

natural selection," Miles said. "Others view adaptive radiations as the tail end of the distribution of evolutionary diversification, where some clades are the result of adaptive radiations and others not."

Miles provides the classic examples of how island passerine birds have been used to illustrate the alternate view that adaptive radiations are simply those clades with the greatest ecological and morphological disparity.

"But an alternative possibility is that morphological diversification in the most diverse clades resulted from the same underlying process of evolution that is common, at least in a statistical sense, to all clades in the comparison group," Miles added.

## Seeking answers from the world's perching birds

The researchers used an extensive data set on passerine bird morphology accumulated by Ricklefs for possible answers, taking several different approaches to test the conflicting theories.

"We chose passerine birds to examine whether some clades present evidence of exceptional adaptive diversification. Many clades are textbook examples of adaptive radiation, with ecological opportunity on oceanic islands often used to explain the diversity of clades," Miles said.

The researchers used the same morphological data but partitioned the bird clades in two different ways. First, they focused on measurements of eight external morphological traits related to movement and diet; this work was taxon-defined and included 2,627 species and spanned nearly half the world's perching birds. Second, they looked at the data defined by age, encompassing 784 clades and 5,598 species. New Zealand, Madagascar and New Guinea were designated as the "island" species.

"We investigated whether celebrated cases of evolutionary radiations of passerine birds on islands have produced exceptional diversity relative to comparable-aged radiations globally," the researchers wrote in their paper.

"Several groups of birds stand out as classic cases of island radiations, including clades restricted to single islands as well as to island archipelagoes," Miles said. "Among the most celebrated of these are the Darwin finches of the Galapagos Islands, which have been the subject of many analyses of evolutionary diversity. Other celebrated island clades include the Hawaiian honeycreepers, the birds-of-paradise of New Guinea, the vangas of Madagascar, and the West Indian tanagers."

The researchers also included lesser-known examples of island radiation—the mockingbirds and thrashers of the Caribbean Basin.

They also analyzed the distribution of "phenotype disparity" (differences in characteristics) among bird clades. And lastly, they "focused on two factors thought to promote adaptive radiation—diversification on islands and in the tropics—and asked whether clades exhibiting these factors are more diverse," they wrote. As part of their statistical analysis, they looked at the exceptional cases, "whether clades observed to exceed the 95th percentile could be considered extreme values."

Among their conclusions include:

- Classic examples of clades thought to be adaptive radiations are not quantitatively distinct from other passerine clades in terms of size disparities. The distributions are similar, but the island clades have higher disparity in size.
- The distribution of phenotypic disparity among the clades of birds conforms closely to normal distribution, raising "the possibility that no special explanation for apparently exceptional

diversity is necessary."

In the end, the researchers say the data points toward their hypothesis.

"Most clades of birds have diversified according to a single underlying process," Miles said. "The data don't preclude the possibility that key innovations or ecological opportunity could account for the high diversity such as in the birds-of-paradise or the honeycreepers, but our findings strongly suggest caution against the widespread interpretation that large disparity is prima facie evidence that a clade has been affected by evolutionary factors not experienced by other bird clades."

Just as the evolutionary diversity of birds has been extensively studied, this analytical approach adds another important contribution to the study of adaptive radiation.

"Our results may surprise many in that they exhibit little evidence for a set of clades qualitatively distinct from the distribution of all clades, but further analysis using larger morphological datasets and more refined statistical approaches would be welcome next steps," Miles said.

**More information:** Donald B. Miles et al, How exceptional are the classic adaptive radiations of passerine birds?, *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.1813976120

Provided by Ohio University