

Mass extinction 66 million years ago triggered rapid evolution of bird genomes, study finds

July 31 2024



Photograph of a Broad-billed Tody, *Todus subulatus*, a member of the bird group Coraciimorphae. In the current issue, Berv et al. identify this group of birds and others as having close ties to the end-Cretaceous mass extinction that occurred in the wake of the Chicxulub asteroid impact ~66 million years ago. Berv et al. propose that groups of birds whose early origins are associated with the mass extinction experienced integrated evolutionary changes across their

genomes, physiology, and life history, adding further support to the idea that modern bird diversity is a product of adaptive radiation that occurred shortly after the extinction of the non-avian dinosaurs. Credit: Professor Daniel J. Field, University of Cambridge

Shortly after an asteroid slammed into Earth 66 million years ago, life for non-avian dinosaurs ended, but the evolutionary story for the early ancestors of birds began.

The [fossil record](#) tells us that the early ancestors of living birds began their evolutionary journey just after the [mass extinction event](#) caused by the asteroid, but researchers weren't sure how they would see that story reflected in bird genomes.

Now, a University of Michigan study has identified important changes in birds' genomes sparked by the mass extinction, called the end-Cretaceous mass extinction event, ultimately contributing to the incredible diversity of living birds.

The study examined the evolutionary trajectory of all major bird groups and found evidence of "genomic fossils" in birds' DNA that mark critical evolutionary steps as birds evolved into more than 10,000 living species. The research is [published](#) as an open-access article in the journal *Science Advances*.

"By studying the DNA of living birds, we can try to detect patterns of genetic sequences that changed just after one of the most important events in Earth's history," said lead author Jake Berv, who completed the study as a Michigan Life Sciences Fellow in the U-M Department of Ecology and Evolutionary Biology.

"The signature of those events seems to have imprinted into the genomes of the survivors in a way that we can detect tens of millions of years later."

A living organism's genome comprises four nucleotide molecules, referred to by the letters A, T, G and C. The order of these nucleotides in a genome defines the "blueprint" of life.

The DNA code can sometimes evolve in a way that shifts the overall composition of DNA nucleotides across the whole genome. These compositional changes are crucial in determining what kind of genetic variation is possible, contributing to an organism's evolutionary potential, or its ability to evolve.

The researchers found that the mass extinction event sparked shifts in nucleotide composition. They also found that these shifts seem to be connected to the way birds develop as babies, their adult size and their metabolism.

For example, within approximately 3 million to 5 million years of the mass extinction, surviving bird lineages tended to develop smaller body sizes. They also changed how they developed as hatchlings, with more species becoming "altricial." This means they are still very embryonic when they hatch, need their parents to feed them, and can take weeks to fledge, Berv says. Birds that hatch ready to fend for themselves, like chickens and turkeys, are called "precocial."

"We found that adult body size and patterns of pre-hatching development are two important features of bird biology we can link to the genetic changes we're detecting," said Berv, now a Schmidt AI in Science postdoctoral fellow with U-M's Michigan Institute for Data & AI in Society.

Berv says one of the most significant challenges in evolutionary biology and ornithology is teasing out the relationships between major bird groups—it's difficult to determine the structure of the tree of life for living birds. Over the past 15 years, researchers have been applying increasingly large genomic data sets to try to solve the problem.

Previously, researchers used genomic data to study the evolution of birds' genomes using statistical models that make strong assumptions. These "traditional" models allow researchers to reconstruct the history of genetic changes, but they typically assume that the composition of DNA, its proportion of A, T, G and C nucleotides, does not change across evolutionary history.

In late 2019, Berv began working with Stephen Smith, U-M professor of ecology and evolutionary biology, who was developing a [software tool](#) to more closely track DNA composition over time and across different branches of the tree of life.

With this tool, the researchers were able to relax the assumption that the composition of DNA remains constant. Smith said that this allowed the "model" of DNA evolution to vary across the evolutionary tree and identify places where there was likely a shift in DNA composition.

For this new research, these shifts were concentrated in time, within about 5 million years of the end-Cretaceous mass extinction, Berv says. Their approach also allowed them to estimate which bird traits were most closely associated with these shifts in DNA composition.

"This is an important type of genetic change that we think we can link to the mass extinction event," he said. "As far as we know, changes in DNA composition have not been previously associated with the end-Cretaceous mass extinction in such a clear way."

Daniel Field, professor of vertebrate paleontology at the University of Cambridge and co-author of the study, has been interested in understanding how the end-Cretaceous mass extinction affected the evolution of birds. He provided guidance related to early bird evolution following the mass extinction.

"We know that mass extinction events can dramatically affect biodiversity, ecology and organismal form. Our study emphasizes that these extinction events can actually influence organismal biology even more profoundly—by altering important aspects of how genomes evolve," Field said.

"This work furthers our understanding of the dramatic biological impacts of mass extinction events and highlights that the mass extinction that wiped out the giant dinosaurs was one of the most biologically impactful events in the entire history of our planet."

The researchers say that by relaxing the typical assumptions used in evolutionary biology, they are building more nuanced insight into the sequence of events that occurred in the early history of birds.

"We have typically not looked at the change in DNA composition and model across the tree of life as a change that something interesting has happened at a particular point of time and place," Smith said. "This study illustrates that we have probably been missing something."

More information: Jacob Berv, Genome and life-history evolution link bird diversification to the end-Cretaceous mass extinction, *Science Advances* (2024). [DOI: 10.1126/sciadv.adp0114](https://doi.org/10.1126/sciadv.adp0114).
www.science.org/doi/10.1126/sciadv.adp0114

Provided by University of Michigan

Citation: Mass extinction 66 million years ago triggered rapid evolution of bird genomes, study finds (2024, July 31) retrieved 31 July 2024 from <https://phys.org/news/2024-07-mass-extinction-million-years-triggered.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.