Avian origins: new analysis confirms ancient beginnings

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Did modern birds originate around the time of the dinosaurs' demise, or have they been around far longer?

The question is at the center of a sometimes contentious "rocks versus clocks" debate between paleontologists, whose estimates are based on the fossil record, and scientists who use "molecular clock" methods to study evolutionary history.

A new analysis by researchers at the University of Michigan, the University of Chicago, the Centre for Biodiversity Conservation Mexico and Central America, and Boston University offers the strongest molecular evidence yet for an ancient origin of modern birds, suggesting that they arose more than 100 million years ago, not 60 million years ago, as fossils suggest.

The research was published online Jan. 28 in the journal *BMC Biology*.

"Scientists typically use two sources of information to date biological events: the fossil record, which contains physical remains of ancient organisms, and molecular genetic data," said graduate student Joseph Brown, who is first author on the paper. In the case of modern birds, however, the two approaches have yielded conflicting results, at times leading to heated debates between paleontologists and molecular biologists. Molecular biologists have asserted that the fossil record must be incomplete, while paleontologists have countered that the genetic data must be suspect.

In fact, both approaches have their weaknesses, Brown said. Fossils tend to underestimate how much time has passed since lineages diverged. That's because fossils preserve only evidence of changes in outward physical appearance, and such changes take some time to accumulate after the actual "speciation event" that marks the divergence.

As for genetic data, the so-called molecular clock isn't quite as precise as once thought. The approach relies on the observation that although mutations occur at random in the genome, when looked at over long stretches of time they occur (or "tick") at a fairly constant rate. Molecular biologists use that rate to reconstruct evolutionary history.

"If we know, for example, that DNA sequences diverge by an average of two percent every million years, and we determine that two species differ genetically by ten percent, we can figure out that they last shared a common ancestor five million years ago," Brown said. The problem is, "different lineages can 'tick' at different rates, so applying a single rate to an entire tree could lead to very suspect results."

Fortunately, new methods exist for compensating for differing rates.

"What my colleagues and I did was apply all of these new methods to the problem of the origin of modern birds, with each method making different assumptions about how mutation rate changes across the tree," Brown said. He hoped the analysis would narrow the gap between fossil and molecular data, but in fact it only reinforced the rock-clock split by underscoring the finding that modern birds arose more than 100 million years ago.

So where does that leave the contentious camps of scientists trying to solve the puzzle of how the world's 10,000 bird species came about?

"Rather than fighting across groups, we now have the joint goal of

explaining this rock-clock gap," Brown said. "Resolution of the issue will be fertile ground for future research for a while to come."

Brown's coauthors on the paper are Joshua Rest of the University of Chicago, Jaime García-Moreno of the Centre for Biodiversity Conservation Mexico and Central America, Michael Sorenson of Boston University and David Mindell, professor of ecology and evolutionary biology at U-M.

Source: University of Michigan