Biggest map of dinosaur tree yet suggests they emerged 20 million years earlier than thought

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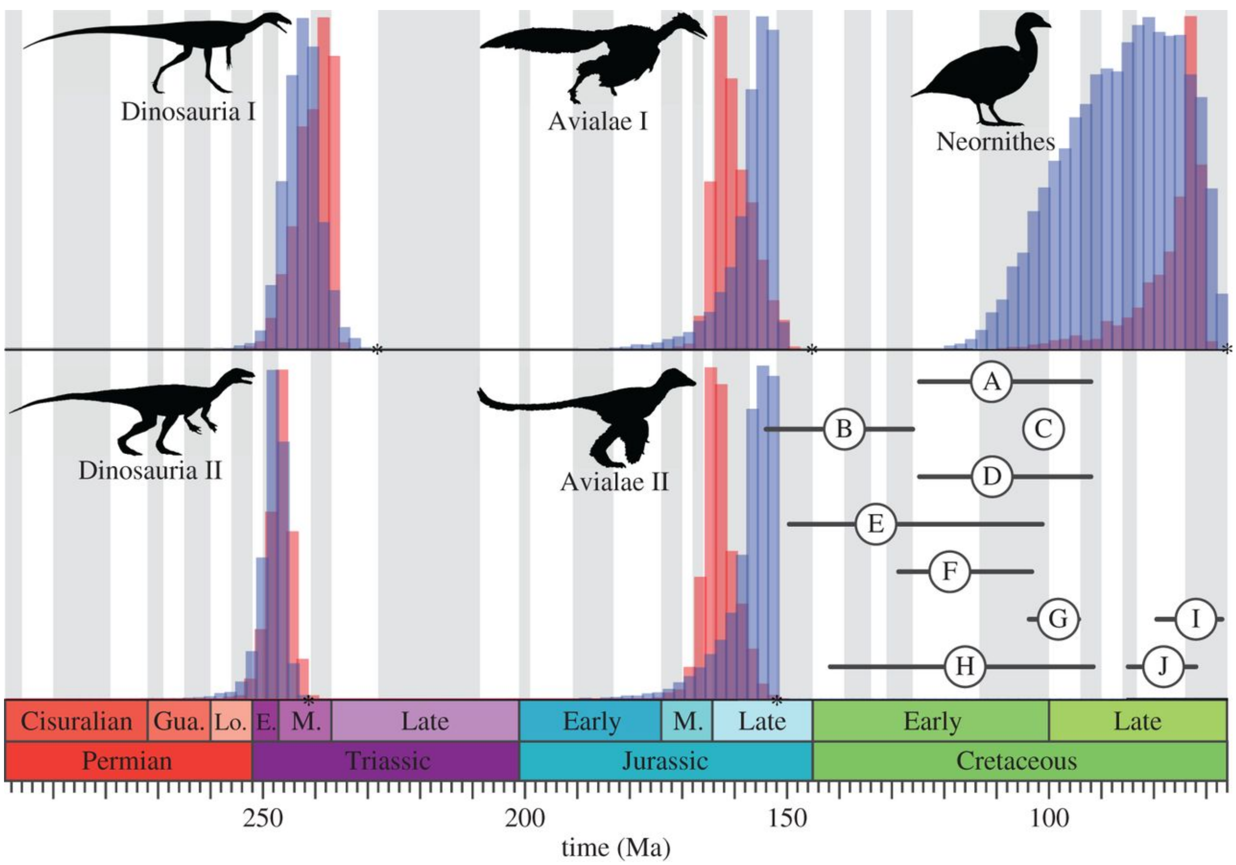

Comparison of probabilistic APT dates (red bars, cal3; blue bars, Hedman; see the text) for key nodes in dinosaur phylogeny: Dinosauria I (Nyasasaurus as sister to Dinosauria), Dinosauria II (Nyasasaurus nested within Dinosauria), Avialae I (Archaeopteryx as first bird), Avialae II (Aurornis as first bird) and Neornithes (crown birds). Asterisks mark minimum bound or 'traditional' palaeontological estimate. Molecular and morphological clock dates for

Neornithes are shown in the lower right corner (A–J; electronic supplementary material, table S3): circles indicate mean and horizontal bars the 95% HPD. Silhouettes were taken from public domain images on phylopic.org (Aurornis, Gareth Monger; Eoraptor, Scott Hartman; Vegavis, Matt Martyniuk), or modified with kind permission from works by Sergio Pérez (Archaeopteryx) and Nobu Tamura (Nyasasaurus). Credit: *Biology Letters* (2016). DOI: 10.1098/rsbl.2016.0609

(Phys.org)—A team of researchers from the U.K. and the U.S. has mapped the biggest dinosaur tree yet, and in so doing, has found that the creatures may have evolved 20 million years earlier than most in the field have thought. In their paper published in the journal *Biology Letters*, the team describes how they created the new tree using probabilistic methods and why the new findings suggest that the dinosaurs might have survived a prior mass extinction.

By examining dinosaur bones, scientists have been able to establish what they believe are reasonable estimates for the time period that dinosaurs existed. But such estimates have always left some room for error. In this latest effort, the researchers used two probabilistic methods to create a massive tree representing almost 1,000 species and calculated the date of first emergence of what we now call dinosaurs. The results from the studies matched, giving credence to the results. Their tree shows dinosaurs first appearing approximately 250 million years ago. Furthermore, the tree shows what are believed to have been the first birds branching off the tree approximately 165 to 172 million years ago. It also shows that the group that includes all known birds came to exist approximately 69 to 108 million years ago—during the Late Cretaceous, which, interestingly, was before the mass extinction that wiped out all the other dinosaurs.

Notably, the tree shows dinosaurs coming into existence during a time prior to the oldest known dinosaur fossil, a Nyasasaurus, which has been dated to just 240 million years ago. This means researchers will have to rely on math and faith if they are to accept the new tree—at least until an older fossil is found. The team also believes that there is some evidence that indicates the timeline could be pushed back another 10 million years.

The new timeline, if correct, would mean that the creatures that evolved into dinosaurs somehow managed to survive the Permo-Triassic extinction—believed to be the largest mass extinction that ever occurred.

More information: G. T. Lloyd et al. Probabilistic divergence time estimation without branch lengths: dating the origins of dinosaurs, avian flight and crown birds, *Biology Letters* (2016). DOI: 10.1098/rsbl.2016.0609

Abstract

Branch lengths—measured in character changes—are an essential requirement of clock-based divergence estimation, regardless of whether the fossil calibrations used represent nodes or tips. However, a separate set of divergence time approaches are typically used to date palaeontological trees, which may lack such branch lengths. Among these methods, sophisticated probabilistic approaches have recently emerged, in contrast with simpler algorithms relying on minimum node ages. Here, using a novel phylogenetic hypothesis for Mesozoic dinosaurs, we apply two such approaches to estimate divergence times for: (i) Dinosauria, (ii) Avialae (the earliest birds) and (iii) Neornithes (crown birds). We find: (i) the plausibility of a Permian origin for dinosaurs to be dependent on whether Nyasasaurus is the oldest dinosaur, (ii) a Middle to Late Jurassic origin of avian flight regardless of whether Archaeopteryx or Aurornis is considered the first bird and (iii) a Late Cretaceous origin for Neornithes that is broadly congruent with other node- and tip-dating estimates. Demonstrating the feasibility of

probabilistic time-scaling further opens up divergence estimation to the rich histories of extinct biodiversity in the fossil record, even in the absence of detailed character data.

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