NEW HOT PAPERS - 2008

July 2008

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Olaf R. P. Bininda-Emonds talks with *ScienceWatch.com* and answers a few questions about this month's New Hot Paper in the field of Multidisciplinary. The author has also sent along images of their work.

Article Title: The delayed rise of present-day mammals
Authors: Bininda-Emonds, ORP;Cardillo, M;Jones, KE;MacPhee, RDE; Beck, RMD;Grenyer, R;Price, SA;Vos, RA;Gittleman, JL;Purvis, A
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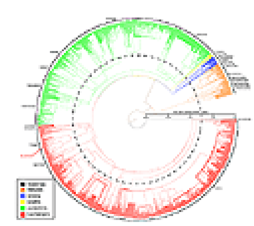
(addresses have been truncated)

SW: Why do you think your paper is highly cited?

In the first instance, it's because the paper tells an interesting story with many interesting ingredients in the mix: mammals, dinosaurs, and the Cretaceous-Tertiary mass-extinction event. Moreover, it apparently dispels the long-held truth that it was the death of the dinosaurs that cleared the way for the present-day mammals. It did, but only indirectly, in that the modern mammals probably had to wait for another group of mammals to get out of the way first. This story, these protagonists, and the contradiction of a long-held truth have attracted a lot of attention.

Figure 1: + details



But somewhat hidden beneath the story the paper tells is the first, nearly complete evolutionary tree of all 4500+ living mammalian species, together with estimates of times of evolution throughout the tree.

This tree represents an incredibly valuable tool to help investigate diverse aspects of the biology of mammals—from their evolutionary history, to their conservation biology, to the rates of evolution of their DNA—and arguably represents the current standard reference for evolutionary relationships among mammals. The tree reveals the increasing power of modern phylogenetic methods to reveal ever-larger branches of the Tree of Life.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

Through the relatively novel phylogenetic method called supertree construction, we synthesized diverse information about the evolutionary relationships of living mammal species to derive a supertree of nearly all the species. It's a bit like a complex jigsaw puzzle, where we put all the pieces together to reveal the final picture (the supertree). The supertree algorithms, however, have to solve the problems that the pieces can both overlap (instead of just snap together) and also show slightly different pictures. We then mapped mutations in 68 different genes onto the tree and calibrated these changes against 30 fossils to derive times of evolution throughout the tree. Nothing like this had yet been attempted on a scale such as this.

The size and comprehensiveness of the tree has the potential to unleash many new discoveries. Our analyses of the timing of important events in mammalian evolutionary history and that the death of the dinosaurs apparently did not play an important, direct role in the evolution of present-day mammals is only one such new discovery.

SW: Would you summarize the significance of your paper in layman's terms?

The paper is primarily important for two reasons.

First, the paper presents an evolutionary tree containing virtually all 4500+ living mammal species, together with estimates of times of evolution throughout the tree. The tree, therefore, is by far the most complete picture that we have of the evolutionary history of the present-day mammals. It represents not only the current standard work in this regard, but also a valuable tool to help us understand how evolution has shaped all aspects of the biology of living mammals. For instance, the tree has formed the evolutionary backbone of numerous studies trying to understand why different species or groups of mammals show different levels of extinction risk and which groups might be the most vulnerable in the future.

Second, in using the tree, we were able to cast doubt on the long-held assumption that the death of the dinosaurs directly cleared the way for present-day mammals, allowing them to flourish. Instead, our analyses reveal that all the major groups of living mammals co-existed with the dinosaurs (and for a minimum of 10 million years, often more) and only began to flourish some 15 million years after the dinosaurs went extinct. As such, the death of the dinosaurs did not impact directly on the present-day mammal groups. Something, or someone, else was keeping them down immediately after and for some time after the Cretaceous-Tertiary boundary 65 million years ago.

SW: How did you become involved in this research, and were there any problems along the way?

> *"But somewhat hidden beneath the story the paper tells is the first, nearly complete evolutionary tree of all 4500+ living mammalian species, together with estimates of times of evolution throughout the tree."*

The root of this research goes back to my time as a doctoral student at the University of Oxford. When I arrived in 1995, Andy Purvis had just published the first comprehensive supertree (for the mammalian order Primates) and suggested that we do one for the order Carnivora together with John Gittleman (then at the University of Tennessee). For the next few years, our research circles were slowly checking off one order after another before we decided sometime in about 2001/2002 to try and do the entire mammalian tree. It then took about five to six years of concerted effort by four different research groups to pull all the data together.

Perhaps the only problem was the sheer scale of the project: trying to create and date a tree with over 4500 species in it. As I said, it took four different research groups to pull all the data together (over 2600 individual evolutionary trees) and we still had to piece the final tree from about 30 different subtrees together in the end because we couldn't analyze all the data simultaneously.

SW: Where do you see your research leading in the future?

My interests lie generally in evolutionary biology and also in deciphering how things are related to one another. So, I'll still be building evolutionary trees for different groups and will think again in a couple of years of the possibility of updating the mammal supertree. At the moment, however, I'm quite excited about tracking the evolution of chemical communication in mammals and carnivores in particular. Chemical ecology is poorly investigated in mammals, at least on a taxonomically comprehensive scale, with many more questions currently than answers, and this area provides a wonderful opportunity to research the interface between ecology, evolution, and physiology.

SW: Do you foresee any social or political implications for your research?

Not directly. Any social or political implications will derive more from how the tree is used, rather than from the tree itself. For instance, the tree has been invaluable for deciphering the factors underlying conservation biology in mammals: why are some species or groups under a more acute threat of extinction than others? That kind of research has obvious social, political, and economic ramifications.

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Keywords: mammals, dinosaurs, Cretaceous-Tertiary boundary, 65 million years ago, evolutionary tree, 4500+ living mammalian species, Tree of Life, supertree algorithms, evolutionary history, extinction risk .

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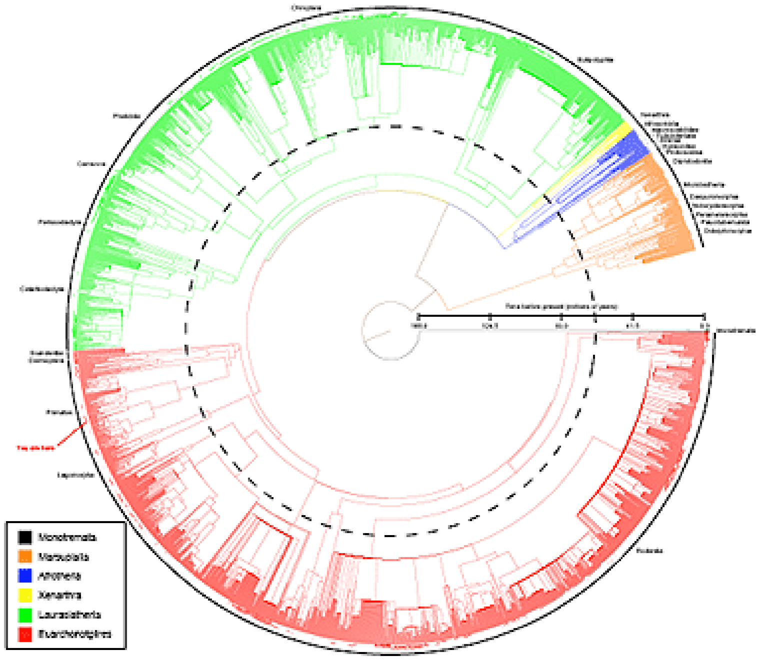

Figure 1: The evolutionary tree of present-day mammals, containing relationships and divergence times for over 4500 species. The black dotted line is the Cretaceous-Tertiary Boundary (65 million years ago) when the dinosaurs went extinct. Image ©Olaf R.P. Bininda-Emonds.

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