Researchers examine the evolution of flight

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Research by post-doctoral fellow Alexander Dececchi challenges long-held hypotheses about how flight first developed in birds. Furthermore, his findings raise the question of why certain species developed wings long before they could fly.

Dr. Dececchi, a William E. White Post-Doctoral Fellow in the Department of Geological Sciences and Geological Engineering, used measurements from fossil records and data from modern birds to test the evolutionary explanation for the origin of birds. Dr. Dececchi and his colleagues determined that none of the previously predicted methods would have allowed pre-avian dinosaurs to take flight.

"By disproving the idea that the predicted models led to the development of flight, our research is a step towards determining how flight developed and whether it can evolve once or developed multiple times in different evolutionary lines," he says.

Dr. Dececchi and his colleagues examined 45 specimens, representing 24 different non-avian theropod species, as well as five bird species. After determining some critical variables from the fossils - such as body mass and wing size - they used measurements from living birds to estimate wing beat, flap angle and muscular output.

These values were used to build a model for different behaviours linked to the origins of flight such as vertical leaping and wing-assisted incline running (WAIR) - a method of evasion for many ground-based modern birds that has become a favoured pathway towards the origin of flapping

flight in the paleontological literature. They also tested if any species met the requirements to take-off from the ground and fly under their own power.

"We know the dimensions and we know how modern birds muscles and anatomy work," Dr. Dececchi says. "Using our model, if a particular species doesn't reach the minimum thresholds for function seen in the much more derived birds - such as the ability to take off or to generate a certain amount of power - it's safe to say they would not have been able to perform these behaviours or fly."

The researchers found that none of the behaviours met the criteria expected in the pathway models. In fact, they found that almost all the behaviours had little or no benefit, outside of those species which evolved right before the origin of birds. When looking at WAIR specifically - the method that has been touted as an explanation for some early wing adaptations - the researchers found that it only was possible in a handful of large winged, small bodied species such as Microraptor, but found no evidence to suggest its use was widespread.

Dr. Dececchi says that the group's findings suggest that wings, even those with large or ornately coloured feathers, could have initially served different purposes rather than flying such as signaling or sexual selection before the development of flight.

Dr. Dececchi explains that the question of whether flight evolved once or multiple times in multiple evolutionary tracks is an ongoing topic of debate. Many of the species studied lived tens of millions of years and thousands of miles apart, with a last common ancestor that existed 50 or 100 million years earlier - leading researchers to wonder if flight evolved once but was lost, or if different species stumbled upon the same solution.

"There is some evidence that they evolved in parallel - there may be some differences in the details between how each taxon flew, but they tend to converge on these same answers," says Dr. Dececchi. "That, to me, is one of the most exciting questions that has come out of the past few decades of work in theropods."

The study, titled "The wings before the bird: an evaluation of flapping-based locomotory hypothesis in bird antecedents," was published in the open access journal *PeerJ* and is available online.

More information: T. Alexander Dececchi et al, The wings before the bird: an evaluation of flapping-based locomotory hypotheses in bird antecedents, *PeerJ* (2016). DOI: 10.7717/peerj.2159

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