Eyeing echidnas: Study models echidna forelimbs to help shed new light on mammal evolution

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These days, mammals can use their forelimbs to swim, jump, fly, climb, dig and just about everything in between, but the question of how all that diversity evolved has remained a vexing one for scientists.

To help answer it, Harvard researchers are turning to one of the most unusual mammals around—echidnas. These sprawling, egg-laying mammals have many anatomical features in common with earlier mammal ancestors, and so can help bridge the gap between extinct and other modern-day mammals.

Using a highly-detailed musculoskeletal model of an echidna forelimb, Sophie Regnault, a Post-Doctoral Fellow and Stephanie Pierce, Associate Professor of Organismic and Evolutionary Biology, were able to not only shed more light on how the little-studied echidna's forelimb works, but also open a window into understanding how extinct mammals might have used their forelimbs. The model is described in a November 14 paper published in *Royal Society Open Science*.

"Echidnas are not very well-studied, and little is known about their biomechanics." Regnault says. "There are few related species, and echidnas themselves can be difficult to study because they have very large spines hiding underlying movements. We made this virtual model using CT scans that allow us to look in closer detail at how the skeleton and muscles interact with one another."

The researchers discovered that the bony anatomy and muscles work together to optimize limb leverage and mobility for certain kinds of movements. In particular, the configuration of muscles support limb rotation important for the echidna's sprawling gait.

"This model gives us unique insight into not only the echidna but can also guide reconstructions of extinct mammals," Pierce says. "The similarities between the echidna forelimb skeleton and transitional animals can help us to understand the evolution of forelimb diversity in modern mammals."

"If we find certain muscles have lots of leverage, it might suggest that certain postures or types of movement are more likely," Regnault add. "We're continuing to add data to our echidna model, and one thing we're hoping to do is to understand how things like mobility and leverage can be used to predict how an animal might have stood or what kind of movements it could have made."

"This study is part of a much larger project," Pierce says. The researchers' ultimate goal is to reconstruct the evolution of the mammal forelimb by building similar models for fossils at key stages. The echidna model is a first step in understanding the relationships between form and function of the forelimb.

By looking at how the mammal forelimb changed through time, they hope to reveal how modifications to the skeleton led to the ecological and behavioral diversity we see today.

More information: Sophie Regnault et al. Pectoral girdle and forelimb musculoskeletal function in the echidna (Tachyglossus aculeatus): insights into mammalian locomotor evolution, *Royal Society Open Science* (2018). DOI: 10.1098/rsos.181400

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