

The evolution of fins to limbs in the land invasion race

July 5 2013



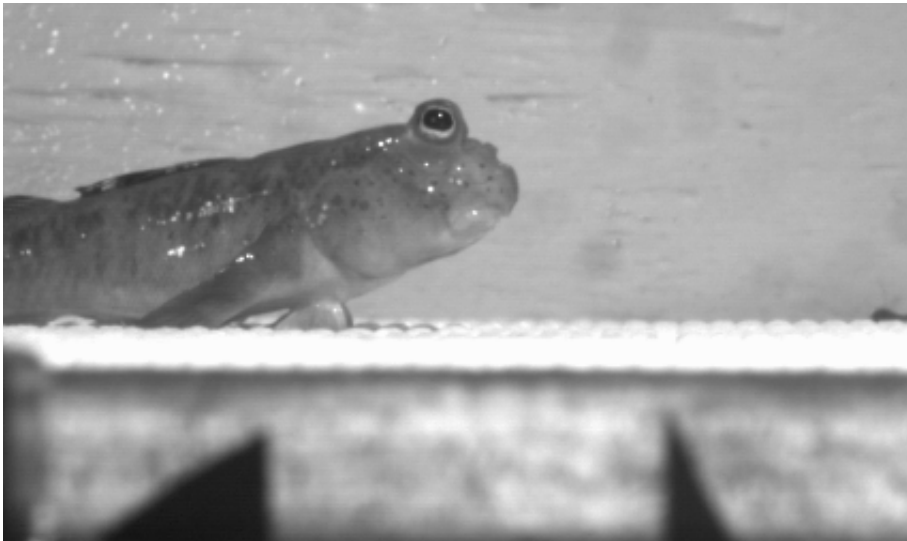
Mudskipper fish and tiger salamanders have similar characteristics to early tetrapod ancestors. Credit: Sandy Kawano

Why did animals with limbs win the race to invade land over those with fins? A new study comparing the forces acting on fins of mudskipper fish and on the forelimbs of tiger salamanders can now be used to analyze early fossils that spanned the water-to-land transition in tetrapod evolution, and further understand their capability to move on land.

Research conducted by Sandy Kawano and Richard Blob at Clemson University compared terrestrial locomotion in tiger [salamanders](#) and mudskipper fish, which have similar characteristics to early tetrapod

ancestors.

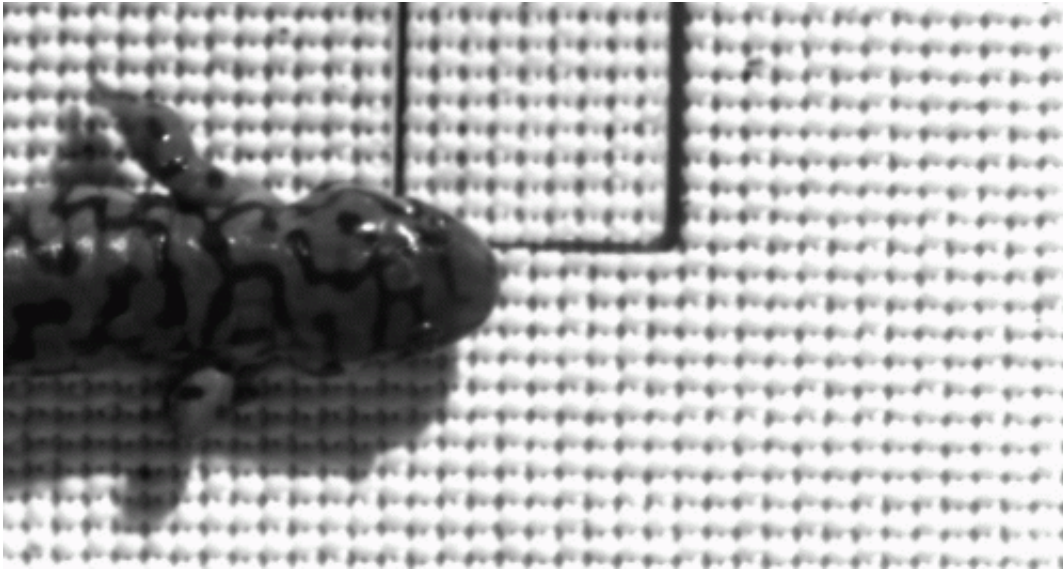
The researchers filmed these organisms as they walked over a force platform which measures forces like a bathroom scale but separates them into 3 directions (upward, fore-aft, and side-to-side). They compared the forces experienced by the pectoral fins of the mudskipper fishes to the forelimbs and hind limbs of walking tiger salamanders. The results showed that that mudskippers' pectoral fins experience more medial forces than the limbs of salamanders, and that the [forelimbs](#) could have played a similar weight-bearing role as the hind limbs.



Mudskippers' pectoral fins experience more medial forces than the limbs of tiger salamanders. Credit: Sandy Kawano and Richard Blob

Sandy Kawano said: "The transition from fins to limbs marks the most dramatic change in orientation of the locomotor forces from contact with the ground. Using these data we can now evaluate the locomotor capabilities of numerous important fossil taxa that spanned the water-to-land transition in tetrapod evolution. We hypothesise that the medial

orientation of the forces on pectoral fins would result in unreasonably high bone stresses in early amphibious fish with fins, which would explain why the evolutionary invasion of land by vertebrates was accomplished instead by tetrapods with limbs with digits."



Salamanders' forelimbs experience more vertical forces than the fins of mudskipper fish. Credit: Sandy Kawano and Richard Blob

Paleontological examinations of the invasion of land by vertebrates suggest that limb-like [appendages](#) likely originated in [aquatic environments](#), but direct comparisons of the functional consequences of using early limbs with digits, rather than fins, for terrestrial locomotion had not previously been performed. Salamanders are used to model the general body form of early tetrapods (e.g., Paleozoic amphibians) since their morphology has remained essentially unchanged for at least 150 million years. Mudskippers are similar to early fossil precursors of the [tetrapods](#): they use "crutching" movements on land similarly to the hypothesised locomotion of *Ichthyostega*, and their [pectoral fins](#) are

similar to elpistostegalids, such as Tiktaalik.

More information: This work will be presented at 13:30 on Saturday 6th July 2013.

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