How the amphibians got their vertebrae

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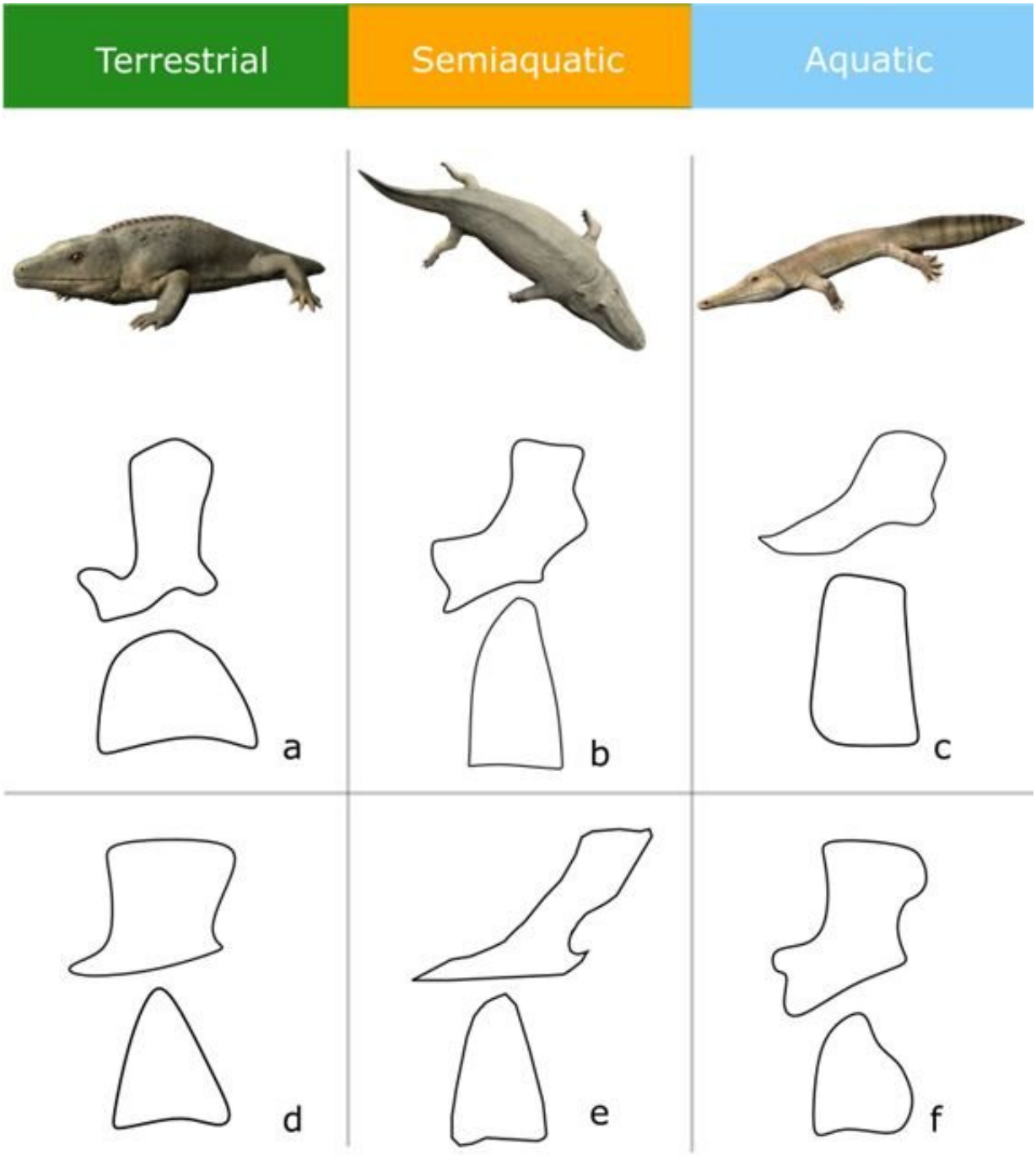

Traces of neural arch and intercentra shape convergence characterized by environment. Top row: Reconstructions borrowed with permission from Nobu Tamura. From left to right: *Cacops aspidephorus Paracyclotosaurus davidi*, *Archegosaurus decheni*. Middle row: a) *Cacops aspidephorus* (ancestrally terrestrial); b) *Paracyclotosaurus davidi* (ancestrally semiaquatic); c) *Metoposaurus diagnosticus* (ancestrally aquatic). Bottom row: d) *Lydekkerina huxleyi* (secondarily terrestrial); e) *Mastodonsaurus giganteus* (variation on semiaquatic form, note no secondarily semiaquatic taxa were reported from this study); f) *Archegosaurus decheni* (secondarily aquatic). Credit: N. Tamura

A group of ancient amphibians called temnospondyls evolved stiffer spinal columns to adapt to aquatic life, contrary to previous hypotheses, according to a study published June 9, 2021 in the open-access journal *PLOS ONE* by Aja Mia Carter of the University of Pennsylvania and colleagues.

Temnospondyls are an extinct group of amphibians, and they were some of the earliest land-dwelling vertebrates, living in terrestrial, aquatic, and semi-aquatic habitats. They therefore provide valuable information on how early vertebrates adapted to the transition from water to land. In this study, Carter and colleagues provide new data on how temnospondyl backbones adapted to changes in their environment and locomotion.

The researchers collected measurements on fossil vertebrae of more than 40 species of temnospondyls. These species ranged in size from half a meter long to six meters, ranged in geologic age from the Carboniferous Period to the Cretaceous, and lived in a diverse array of habitats from arid upland to ocean.

The researchers found that the lower portion of vertebra (an element called the intercentrum), the shape of which determines the flexibility of the spinal column, varied most in correlation with species' habitat. More aquatic species had more rigid backbones. Comparing species across the evolutionary history of this group suggests that the earliest temnospondyls were terrestrial, and their descendants transitioned to the water multiple times, with corresponding changes in their vertebral shape.

These results are in contrast to previous hypotheses that increased spinal rigidity was important for terrestrial locomotion. These findings additionally indicate that the intercentrum is correlates more with environment than than the upper portion of vertebrae (a region called the neural arch). The difference between the two parts has never before been investigated and there are noprevious interpretations. Further investigation will enhance our understanding of how animals adapt during the transition between swimming and walking lifestyles, including our oldest land-dwelling ancestors.

The authors add: "We demonstrated that the temnospondyls, a group of ancient, diverse, stem amphibians, repeatedly converge on vertebral shapes upon invasion and reinvasions of new habitats. We overturn previous hypotheses suggesting that rigidity was necessary for terrestrial locomotion in crucial vertebral elements in all temnospondyl taxa."

More information: Carter AM, Hsieh ST, Dodson P, Sallan L (2021) Early amphibians evolved distinct vertebrae for habitat invasions. *PLoS ONE* 16(6): e0251983. doi.org/10.1371/journal.pone.0251983

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