What can 3D limb-bone reconstructions tell us about the posture of the first terrestrial vertebrates?

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The appearance of limbs 400 million years ago (My) permitted the vertebrates to gradually colonize the land. During this process, the limb-bones evolved in response to the characteristics of the new environment, leading to the appearance of a range of different postures and gaits. To study the posture of the first completely terrestrial vertebrates (not amphibious), I analysed the bones of *Seymouria sanjuanensis*, a fossil species that lived approximately 270 My. *S. sanjuanensis* was a terrestrial animal with features of both amphibians (salamanders, frogs and caecilians) and amniotes (lizards, turtles, crocodiles, birds, mammals…), and it is believed that it had a sprawling posture similar to the one of salamanders.

Bones are not inert structures. On the contrary, bones are organs full of living cells. The bone cells constantly reshape the internal organization of the bones in response to the stresses are under. Like a muscle will grow if we train it in the gym, a bone will become stronger as well, reflecting our activity. The fossilized bones then, can tell us about the activity of long-time dead species. That means that on an evolutionary context, it is possible to infer the lifestyle of a species by looking at the histology and microanatomy of their limb-bones. Until very recently, the only way to have access to this kind of information was to cut the fossils in thin slices observable under the microscope. This comported the destruction of the fossil, and therefore was not used when studying rare or unique material. Now is possible to scan bones at very high resolution using synchrotron radiation and, by means of a complex computer algorithm, to obtain a three dimensional dataset. Later, this dataset can be used as a template to build 3D models of the samples. With this technique, it is not necessary to cut the fossils anymore, as it can be done virtually on the reconstructions.

I made 3D models of the humeri (the bones of the upper arms) of a juvenile and an adult specimens of *S. sanjuanensis*. Using statistical analyses I compared their microanatomy with the one of modern day terrestrial species. Within 129 species analysed only one, the echidna, has a similar pattern. Echidna is a monotrem, a mammal that lay eggs, with a hedgehog-like appearance. It is part of the order that includes the platypus, so it is a far relative of *S. sanjuanensis*. It was surprising that not only the internal anatomy of their bones were similar, but also their external shape. Studies on the locomotion of echidnas showed that the shape of their humerus doesn't allow the animal to walk like salamanders do. Instead, echidnas adopt a characteristic semi-erect sprawling posture. The fact that the humerus of *S. sanjuanensis* is similar to the one of echidnas suggest that *S. sanjuanensis* didn't have a posture and gait similar to the one of salamanders, as previously thought, but that it rather had an echidna-like sprawling posture. In the same way, other fossil species with similar humerus may have walked like echidnas do. In the future would be good to look into the histology and microanatomy of the humerus of these species in order to clarify if the similarity between S. sanjuanensis and echidnas is a long-time inherited feature or it is a case of convergent evolution.

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