Earliest ancestor of land herbivores discovered

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The smallest and largest caseid: this is a reconstruction of 300-million-year-old tiny carnivorous *Eocasea* in the footprint of 270-million-year-old largest known herbivore of its time, *Cotylorhynchus*. Credit: Danielle Dufault

New research from the University of Toronto Mississauga demonstrates how carnivores transitioned into herbivores for the first time on land.

"The evolution of herbivory was revolutionary to life on land because it meant terrestrial vertebrates could directly access the vast resources provided by terrestrial plants," says paleontologist Robert Reisz, a professor in the Department of Biology. "These herbivores in turn became a major food resource for large land predators."

Previously unknown, the 300-million-year old fossilized juvenile skeleton of *Eocasea martini* is less than 20 cm long. Found in Kansas, it consists of a partial skull, most of the vertebral column, the pelvis and a hind limb.

By comparing the skeletal anatomy of related animals, Reisz and colleague Jörg Fröbisch of the Museum für Naturkunde and Humboldt-University in Berlin, discovered that *Eocasea martini* belonged to the caseid branch of the group Synapsid. This group, which includes early terrestrial herbivores and large top predators, ultimately evolved into modern living mammals.

Eocasea lived nearly 80 million years before the age of dinosaurs. "*Eocasea* is one of the oldest relatives of modern mammals and closes a gap of about 20 million years to the next youngest members of the caseid family," says Fröbisch. "This shows that caseid synapsids were much more ancient than previously documented in the fossil record."

It's also the most primitive member and was carnivorous, feeding on insects and other small animals. Younger members were herbivorous, says Reisz, clear evidence that large terrestrial herbivores evolved from the group's small, non-herbivorous members, such as *Eocasea*.

"*Eocasea* is the first animal to start the process that has resulted in a terrestrial ecosystem with many plant eaters supporting fewer and fewer top predators," he says.

Interestingly, Reisz and Fröbisch also found that herbivory, the ability to digest and process high-fibre plant material such as leaves and shoots, was established not just in the lineage that includes *Eocasea*. It arose independently at least five times, including twice in reptiles.

"When the ability to feed on plants occurred after *Eocasea*, it seems as though a threshold was passed," says Reisz. "Multiple groups kept re-evolving the same herbivorous traits."

The five groups developed the novel ability to live off plants in staggered bursts with synapsids such as *Eocasea* preceding reptiles by nearly 30 million years. This shows that herbivory as a feeding strategy evolved first among distant relatives of mammals, instead of ancient reptiles – the branch that eventually gave rise to dinosaurs, birds, and modern reptiles.

The adoption of plant-eating also caused dramatic shifts in the size of early herbivores. When the team mapped the animals on an evolutionary tree, they found that four of the groups showed a tremendous increase in size during the Permian Period, at the end of the Paleozoic Era.

Caseids were the most extreme example of this size increase, says Reisz. The oldest member of the group, *Eocasea*, was very small, less than 2 kilograms as an adult, while the youngest, last member exceeded 500 kilograms.

Reisz says that the discovery of *Eocasea* creates questions even as it answers them. "One of the great mysteries to my mind is: why did herbivory not happen before and why did it happen independently in several lineages? That's what's fascinating about this event. It's the first such occurrence, and it resulted in a colossal change in our terrestrial ecosystem."

The research is published online in *PLOS ONE*.

More information: Reisz RR, Fröbisch J (2014) The Oldest Caseid Synapsid from the Late Pennsylvanian of Kansas, and the Evolution of Herbivory in Terrestrial Vertebrates. PLoS ONE 9(4): e94518. doi:10.1371/journal.pone.0094518 .
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