How the chameleon climbed to the top of the tree

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Adult lizards. Credit: Diaz and Trainor, BMC Evolutionary Biology 2015

The chameleon's exceptional tree-climbing ability is dependent on vital ball-and-socket joints in its wrists and ankles, according to research published in the open access journal *BMC Evolutionary Biology*. The study also finds that chameleons have twice the number of wrist and ankle skeletal elements than previously thought, and explains how they evolved to live in the trees.

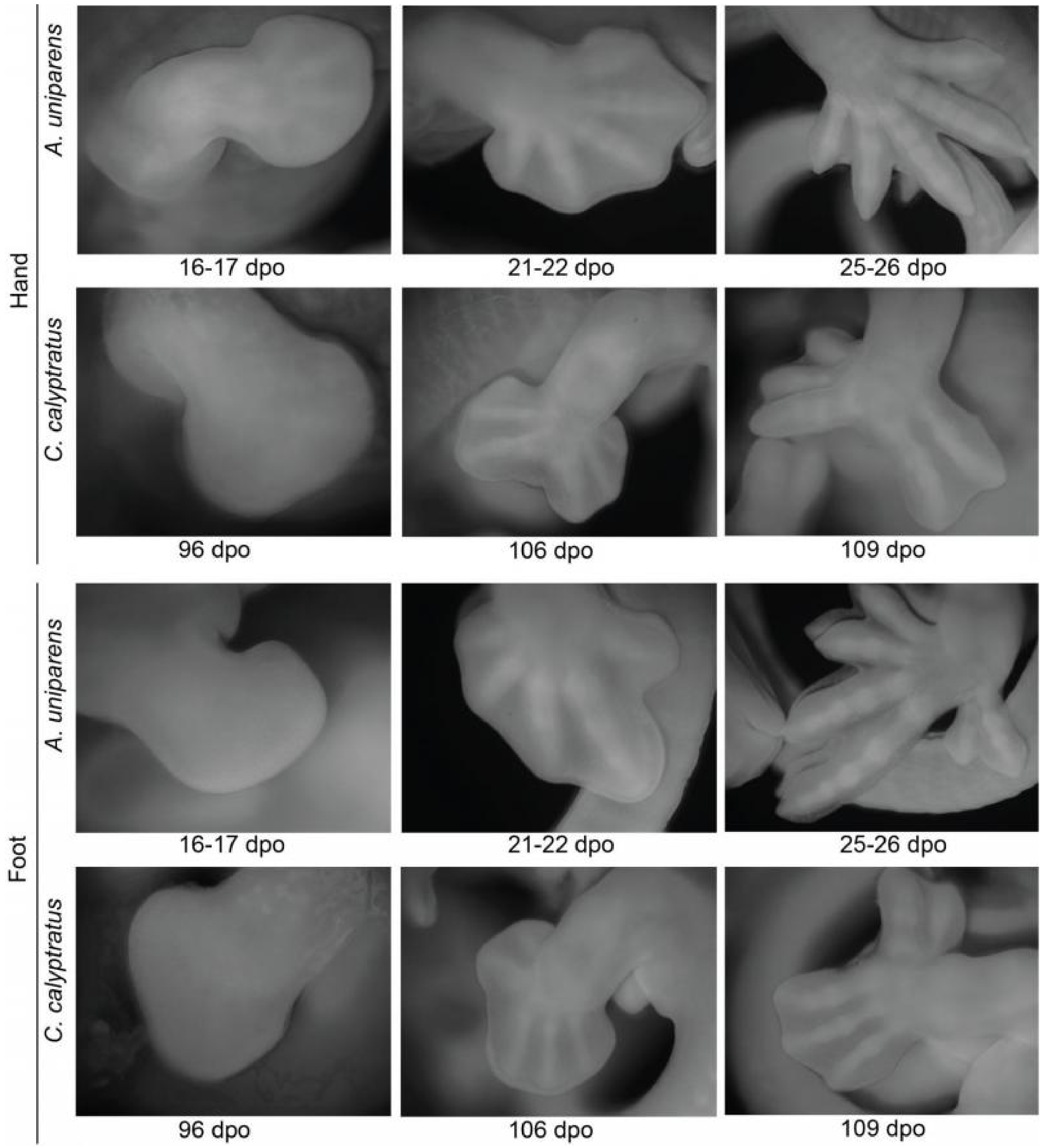
No other living reptile is as well adapted to a tree-climbing lifestyle as the chameleon. One of the animal's most distinctive traits is its 'two-toed' feet, which are actually bundles of digits bound together by connected tissue, similar to duck feet and bat wings. This hand and foot shape aids in precision, security and mobility in the tree environment, relying on gripping branches rather than the use of claws and specialized skin as in other lizards.

To find out more about these unique adaptations and how they develop, researchers studied embryos of the Veiled Chameleon (*Chamaeleo calyptratus*) collected at various time points.

The species has a particularly slow rate of embryo development (around 200 days) allowing the team to gain detailed insights into the development of its hands, feet and limbs, and compare them with eight other chameleon species and two non-chameleon lizards.

Lead author Raul Diaz from La Sierra University, USA, said: "Most of what we know about vertebrate development comes from zebrafish, frogs, chickens, mice and humans. Looking at atypical species, such as the Veiled Chameleon, forces us to begin to think within an evolutionary framework to try and figure out how a unique chameleon body was made. This provides us with a deeper appreciation for the evolution of the animal biodiversity we see today."

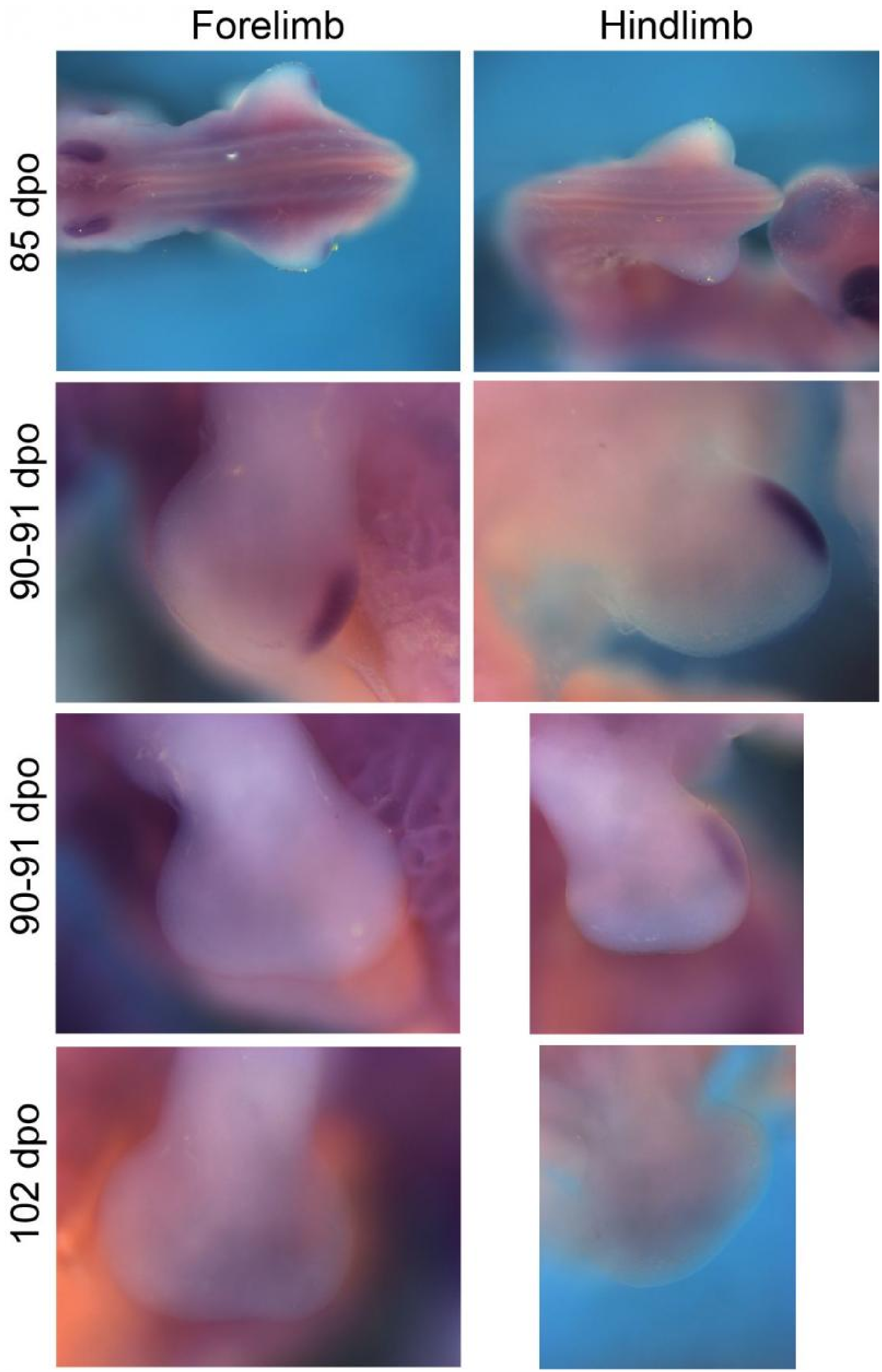
The study showed that to develop the chameleon's unique hands and feet, the most important aspect is the remodeling of the wrist and ankle skeleton in order to make a ball-and-socket joint. This allows for greater rotation of the wrist and ankle, which is important while climbing.



Morphogenesis of Autopodia. Credit: Diaz and Trainor, BMC Evolutionary Biology 2015

The larger, more recently evolved, tree-climbing chameleons were also found to have more individual skeletal elements in their wrists and ankles (up to eight) than the smaller, earlier diverged species that are generally ground and bush climbers (four skeletal elements).

The authors explain that more wrist and ankle components may have facilitated greater wrist flexion and provided a biomechanical advantage which allowed later species to leave the ground cover and occupy the trees.


Forelimb
Hindlimb
85 dpo
90-91 dpo
90-91 dpo
102 dpo

SHH. Credit: Diaz and Trainor, BMC Evolutionary Biology 2015

The chameleons with reduced numbers of wrist and ankle skeletal elements had a larger angle between their two bundles of digits. They appeared to move slower while climbing and take more careful steps in their environment of grasses and bushes, rather than living up in the trees.

The authors say that studying organisms in the lab with unique developmental characteristics complements biomedical studies of development and malformations in humans and other more broadly studied species.

More information: Diaz and Trainor, *BMC Evolutionary Biology* 2015. dx.doi.org/10.1186/s12862-015-0464-4

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