UABDIVULGA
BARCELONA RECERCA I INNOVACIÓ

13/09/2023

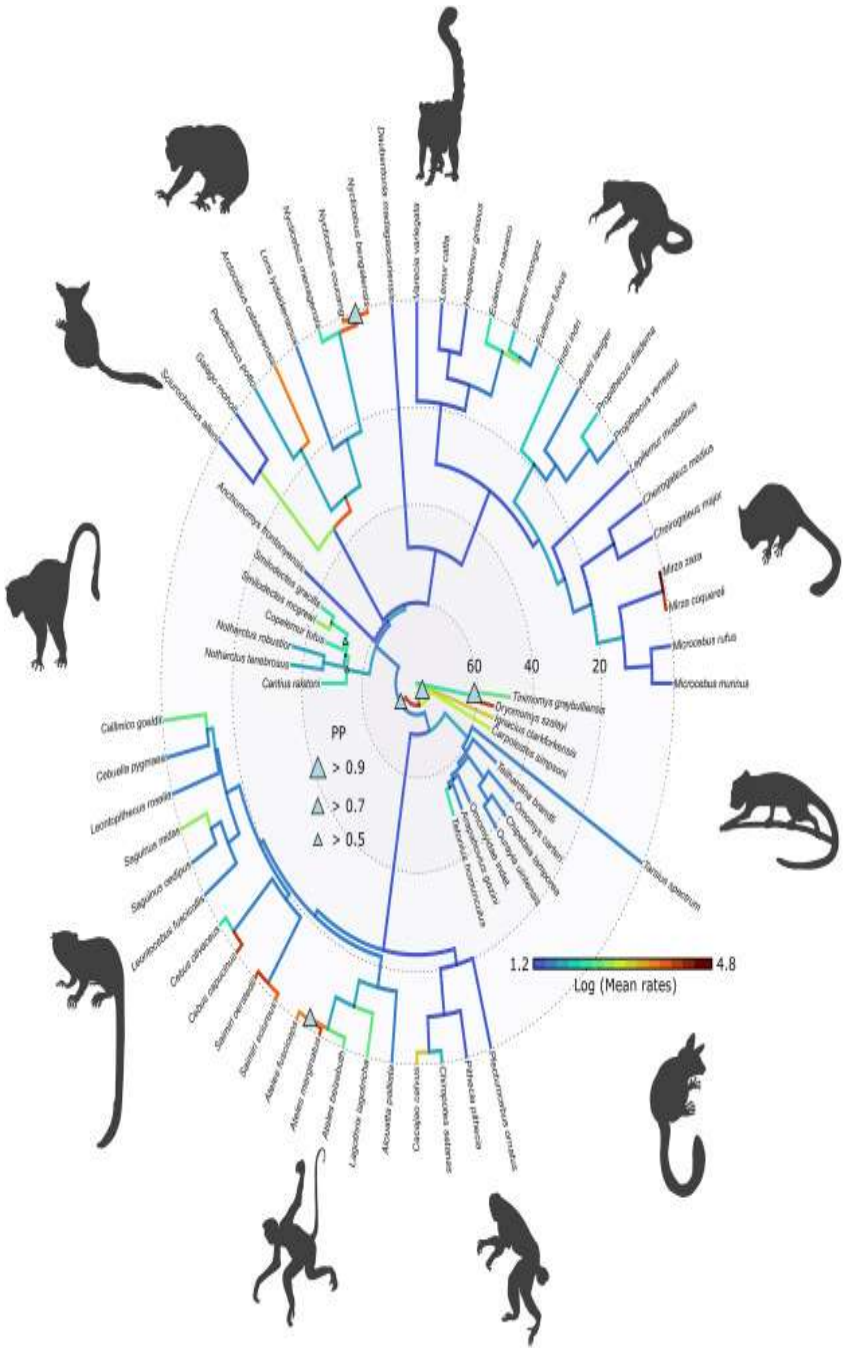
A tarsal bone sheds light on the locomotor behaviour of early primates

Researchers of the Institut Català de Paleontologia, the UAB, the Naturhistorisches Museum Bern and the Université de Lyon has conducted a paleobiological study on the locomotor diversity of the first euprimates. This work, that has analysed the navicular bone, located in the tarsal region, in the foot, proposes that the first euprimates already displayed a wide range of locomotor repertoires, allowing them to exploit different niches in the arboreal milieu.

Reconstruction of several early primate representatives from the Paleogene period. Starting from left to right and above to down: *Dryomomys szalayi*, *Ignacius clarkforkensis*, *Cantius ralstoni*, *Notharctus robustior* and *Omomys carteri*. Author: Roc Olivé Pous.

The first primates with a moder appearance, or euprimates, appeared at the beginning of the Eocene, 56 million years ago, during a sudden warming event that affected the whole planet and has been named Paleocene-Eocene Thermal Maximum. During this context of high temperatures at a global scale, tropical forests were able to develop even in high latitudes, propitiating the dispersion of several animal groups, including the first representatives of the order to which humans belong: primates.

The first primates euprimates already displayed a series of characteristic traits that distinguished them from other animals: nails instead of claws, stereoscopic vision, larger brains and opposable hallux and pollex. Different scenarios have been proposed to explain the acquisition of these adaptations, suggesting that diet, locomotion, or the combination of both factors were their main causes.



Evolutionary rates and rate shifts for navicular shape in extant and extinct primates. Branch rates are color-coded (warmer colors indicate faster evolutionary rates while cooler colors represent slower evolutionary rates). High probability shifts in evolutionary rates are indicated by blue triangles. [Adapted from Monclús-Gonzalo, O. et al. DOI: 10.1016/j.jhevol.2023.103395. Under a Creative Commons License (CC BY-NC-ND 4.0)].

Although postcranial remains (the skeletal parts excluding the skull) are scarce in the fossil record, their study has provided a better understanding of the locomotor behavior of these animals. In particular, the analysis of the tarsus (the hindfoot region that connects to the leg bones) is especially interesting due to its relative abundance in the fossil as well as the valuable information about locomotor behavior that it provides. However, most studies have

been limited to descriptive and comparative analyses of the morphology of these bones, and very few address the problem from a more quantitative and macroevolutionary perspective.

Recently, a research team led by Oriol Monclús Gonzalo, predoctoral researcher at the research group in Paleoprimatology and Paleoanthropology of the the Institut Català de Paleontologia Miquel Crusafont (ICP) and PhD student of the doctorate program in Geology at the Universitat Autònoma de Barcelona, has conducted a study published at *Journal of Human Evolution* in which the evolution and diversification of the locomotor behaviour of the first euprimates is analysed through the morphology of a tarsal bone: the navicular.

Using geometric morphometrics, a technique that quantifies the shape of anatomical elements and visualizes their morphological variation, it was demonstrated that there is a significant relationship between the shape of the navicular and the type of locomotion in primates, thus, indicating the potential of the navicular as a proxy to shed light on the locomotor adaptations of future findings. In addition, the locomotor repertoire of up to 13 species of early euprimates has been reconstructed, including representatives of the two main groups that inhabit Eurasia, Africa and North America: adapiforms (related with extant lemurs and lorisoids) and omomyiforms (close relatives of tarsiers). The results indicate that these first modern aspect primates already shown a wide range of locomotor behaviours, yet they did not reach the diversity displayed by extant species. Finally, it has also been discovered that the morphological evolutionary rates of the navicular increased just before the appearance of the first euprimates, proving the importance of this bone (and of the whole tarsal region) during the initial radiation of euprimates.

This study confirms that changes in locomotion played a key role during the early evolution of primates. Future studies using advanced morphometric techniques (such as geometric morphometrics) and comparative phylogenetic methods will be essential to continue investigating relevant paleobiological aspects of major organism groups and to obtain a better understanding of the causes and processes that facilitated their evolution.

In addition to Monclús-Gonzalo, the research team includes David M. Alba (ICP), Judit Marigó (ICP and UAB), Anaïs Duhamel (Université de Lyon), and Anne-Claire Fabre (Naturhistorisches Museum Bern).

Oriol Monclús (1), Judit Marigó (2)
(1) Research Group of Paleoprimatology and Paleoanthropology, Institut Català de Paleontologia Miquel Crusafont (ICP)
(2) Paleontology Area, Departament of Geology, Universitat Autònoma de Barcelona
oriol.monclus@icp.cat, judit.marigo@uab.cat

References

Monclús-Gonzalo, O., M. Alba, D., Duhamel A., Fabre A., Marigó J., 2023. **Early euprimates already had a diverse locomotor repertoire: Evidence from ankle bone morphology**, *Journal of Human Evolution*, 181, https://doi-org.are.uab.cat/10.1016/j.jhevol.2023.103395