PERISSORIGIN

Origin and early radiation of perissodactyls based on precious fossil collections

Contract - B2/233/P2/PERISSORIGIN

SUMMARY

Context

Perissodactyls comprise 17 extant species today, including horses, rhinoceroses and tapirs. Most species are greatly endangered and close to extinction. However, in the past, perissodactyls were one of the most diverse orders of large mammals, comprising iconic extinct creatures such as brontotheres or chalicotheres. Yet, the origin and early diversification of perissodactyls is still poorly understood, due to the sudden appearance of several major groups just after the Paleocene-Eocene transition (around 56Ma), on several continents (North America, Europe and Asia). In addition, several recent discoveries have brought a new light to their possible origin, such as new perissodactyls from the earliest Eocene (e.g., Erihippus from China or Chowliia europea from Europe), or the discovery of Cambaytheres from India, a group very closely related to perissodactyls. Finally, the recent development of a new large-sized microCT-scanner in Lyon ("DTHE") has allowed us to CT scan for the first time three complete large sized skeletons of perissodactyls from Messel, which would have been nearly impossible before.

Objectives

The project PERISSORIGIN aimed at understanding the origin and early radiation of perissodactyls, the odd-toed ungulates. The project proposed to reinvestigate these early perissodactyls and provide a new phylogenetic framework to discuss their paleobiogeography based on the collections from the IRSNB. In addition to these early perissodactyls, complete skeletons from the UNESCO world heritage Messel site (Middle Eocene) of two early representatives of Equoidea have been CT-scanned and segmented to observe their morphology in three dimensions. These exceptional specimens will permit us to better understand the evolution of perissodactyls in Europe. The objectives of this project were as follows:

Collection objectives:

1. Valorize the heritage and the RBINS paleontological collections;
2. Describe almost complete unpublished remains with high scientific potential;
3. Undertake the digitization of exceptional specimens and holotypes and make them available on Virtual Collection and Morphosource platforms to facilitate access for scientists;
4. Increase international cooperation via the partners included in the project that can benefit the Heritage collections.

Scientific Objectives:

1. Decipher the first steps of the evolutionary history of Perissodactyla by establishing a phylogenetic synthesis of early perissodactyls, with a particular attention on the relations within the European and North American equoids;
2. Investigate the paleobiogeographic origin of Perissodactyla;
3. Study the evolutionary trends (synapomorphies) within each superfamily.

Conclusions

The project PERISSORIGIN was successful in many aspects. The Collection objectives have been mostly fulfilled, since four specimens from Messel have been fully CT-scanned and segmented: a juvenile skull and two complete skeletons of Eurohippus, as well as the complete skeleton of Hallensia. They have been partially described, and presented to congresses, and publications are in preparation. Surface scans of the five perissodactyls specimens from the RBINS Messel collections have also been made. Other specimens from the RBINS collections (casts and originals) have been integrated in the phylogenetic analysis of early perissodactyls, and some have been reidentified. Finally, international collaborations have been established, via participation to field works in the Bighorn Basin (Wyoming) and exchanges with researchers from the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing (Pr. Bai Bin) and from Des Moines University, Iowa (Pr. Rachel Dunn).

The Scientific objectives have also been succeeded, since a comprehensive phylogeny of perissodactyls has been obtained. This phylogeny necessitated the creation of a new morphological character's matrix, and the scoring of 71 taxa (representing the largest sample of early perissodactyls, to date). This phylogeny is mostly based on dental characters, as well as a few cranial and mandibular ones, but postcranial characters were excluded from this study, as they require a thorough revision to confirm their taxonomic identification. This part will be further investigated in a future project, developed by the same collaborators (Jérémy Tissier and Thierry Smith) and already funded by the Swiss National Science Foundation. The phylogeny obtained in the project PERISSORIGIN has also permitted to discuss the palaeobiogeography of early perissodactyls. It supports new hypotheses showing that early perissodactyls very quickly dispersed on the three continents from the Northern hemisphere (North America, Europe and Asia) during the Paleocene-Eocene Thermal Maximum (PETM; 56Ma), contrary to other scenarios that implied a strong endemism of early perissodactyls during the earliest Eocene. Finally, this phylogeny has also permitted to newly identify several taxa, based on morphological characters, and to discuss evolutionary trends of the two major groups of perissodactyls: Tapiromorpha and Hippomorpha. The topology suggests that contrary to previous hypotheses, Equoidea (horses) appeared later than previously expected, at around 49Ma rather than 56Ma, and were thus more derived than previously thought. It also supports the relationship of Lophiodontidae with Chalicotheriidae within Ancylopoda and shows that brontotheres were the sister group of equoids. Finally, paleotheres may have been paraphyletic, and some branches possibly gave rise to brontotheres and horses. However, this would necessitate further investigation, as the systematics of paleotheres is poorly understood and needs complete revision.

Keywords

Perissodactyla; Phylogeny; Palaeobiogeography; Messel; CT-scan