The Evolution and Biogeographic History of Notosuchian Crocodylomorphs

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The 24 species of living crocodylians (alligators, caimans, crocodiles and gavials) are the remnants of a once much more diverse and widespread clade, Crocodylomorpha. One crocodylomorph group, Notosuchia, which went extinct ~10 million years ago (Ma), was especially diverse on the southern continents (South America, Africa, Indo-Madagascar) during the middle–Late Cretaceous (120–66 Ma), including hyper-carnivorous and even herbivorous species. Unusually for crocodylomorphs, many of these terrestrial species lived in hot, arid environments. Along with crocodylians, one group of notosuchians survived the Cretaceous/Paleogene (K/Pg) mass extinction (66 Ma) that killed off the non-avian dinosaurs.

Despite their predominantly southern hemisphere distribution, one of the geologically oldest known species comes from the mid-Cretaceous of China, and putative notosuchians are known from fragmentary remains from the latest Cretaceous–early Cenozoic of Europe. As such, their biogeographic history, in terms of the timing and route of dispersals, is of interest, especially given the increasing fragmentation of the continents during the Cretaceous. It has also been suggested that the distribution of many notosuchians might have been constrained by a preference for high temperatures and aridity.

Skeleton of the notosuchian *Simosuchus*

Reconstruction of two notosuchians

To quantitatively reveal the evolutionary and biogeographic history of a group requires an evolutionary tree. Although trees already exist for Notosuchia, there are disagreements regarding species inter-relationships, most notably in terms of the position of the group that survived the K/Pg extinction. Furthermore, the data underpinning these trees have historically been biased by features of the skull, with the postcranial skeleton receiving relatively little attention. In addition, the affinities of the fragmentary European remains have received little attention in a phylogenetic framework. Many of these issues are tractable through improved taxon and character sampling, including via standardized approaches to character construction.

The student will build a revised morphological character dataset to determine the phylogenetic interrelationships of Notosuchia, based on detailed, first-hand study of specimens in museum collections around the world, as well as an extensive survey of the literature. Particular focus will be on developing novel character data for neglected regions of the notosuchian skeleton (e.g. the postcrania), as well as illustrating characters. As part of this, the student will also produce a detailed investigation to test the affinities of fragmentary European specimens that have been referred to Notosuchia.

Once this dataset is complete, phylogenetic analyses will be implemented within a Parsimony and Bayesian framework, and the resultant trees will be used to analyse macroevolutionary patterns in notosuchians, including: (1) the biogeographic history of the group, including the incorporation of possible geographic and climatic barriers to dispersal; and (2) correlates of survival versus extinction in species across the K/Pg boundary, 66 Ma.

The ideal candidate will have a good degree in the biological or geological sciences. During the course of this project, the student will learn vertebrate anatomy and will receive training in the collection and management of data from fossil material, taxonomy and systematics, phylogenetic and biogeographic analysis, and the oral and written presentation of scientific results. The student will also join a thriving community of palaeobiologists at Imperial College London, as well as a wider London network (including the Natural History Museum, University College London), working on a wide variety of subjects, including the evolution of dinosaurs, mammals, crocodylians and squamates. Lastly, the student will spend time visiting the second supervisor in Argentina, with the possibility of participating in fieldwork.

Key reading:

Carvalho, I. S., Gasparini, Z. B., Salgado, L., de Vasconcellos, F. M. and Marinho, T. S. 2010. Climate's role in the distribution of the Cretaceous terrestrial Crocodyliformes throughout Gondwana. *Palaeogeography, Palaeoclimatology, Palaeoecology* **297**: 252–262.

Pol, D. and Leardi, J. M. 2015. Diversity patterns of Notosuchia (Crocodyliformes, Mesoeucrocodylia) during the Cretaceous of Gondwana. *Publicación Electrónica de la Asociación Paleontológica Argentina* **15**: 172–186.

Pol, D., Leardi, J. M., Lecuona, A. and Krause M. J. 2012. Postcranial anatomy of *Sebecus icaeorhinus* (Crocodyliformes, Sebecidae) from the Eocene of Patagonia. *Journal of Vertebrate Paleontology* **32**: 328–354.

Pol, D., Nascimento, P. M., Carvalho, A. B., Riccomini, C., Pires-Domingues, R. A. and Zaher, H. 2014. A new notosuchian from the Late Cretaceous of Brazil and the phylogeny of advanced notosuchians. *PLoS One* **9**: e93105.