

Morphology, microstructure, and isotopes as a source of taxonomic and ecological information in the teeth of Mosasauridae from the Upper Cretaceous of Europe

Mosasurs (Mosasauridae) are a species-rich group of ecologically diversified and mostly marine lizards. They first appeared during the early phases of the Late Cretaceous and became extinct by the end of this period. In contrast to most of their closest relatives, mosasurs were fully adapted to an aquatic lifestyle. Due to the gigantic size of some of their representatives, mosasurs occupied the highest levels of the food chain. Except for being known from a high number of species, the evolution, biology and ecology of mosasurs is still relatively poorly known. This stems, in part, from the fact that their fossil record is dominated by isolated teeth, which are the most durable parts of the mosasaurid skeletons. However, most studies that aim to explore the evolutionary relationships of mosasurs are usually focused on their skulls, vertebrae, and limbs. Although being very variable morphologically and have good fossil record, mosasaur teeth have never been studied from a complex perspective.

The aim of the proposed project is to determine the variability in the shape and microstructure of mosasaur teeth on the basis of detailed assessment of the teeth located at different positions in the jaws, in a number of specimens belonging to several mosasaur species. The material will come from different horizons in the upper Cretaceous sedimentary successions from Europe. The expected results of this study will include a database containing morphological and microstructural data that will enable precise taxonomic and ecological interpretation of the isolated teeth assemblages. This will be of crucial importance for the study of mosasaurids as teeth are often the only available evidence of the presence of these predatory lizards in the fossil record. The studies will be supplemented with geochemical analyses that will provide new insights into the mosasaurid habit and habitats and ecological relations between vertebrates in the Late Cretaceous shallow-marine ecosystems across Europe.

The material for the proposed project will come from the Upper Cretaceous (mainly Campanian-Maastrichtian) deposits of the Netherlands and Belgium. These strata have been selected because they represent the richest source of mosasaur remains in the uppermost Cretaceous of Europe. The material is housed at leading European museums (Maastricht, Brussels, Paris, London). Additional material from other regions of Europe (for example, Poland and England) will be used for comparison.

The first stage of the planned research will be dedicated to render detailed anatomical descriptions and precise measurements of teeth preserved in complete (and almost complete) jaws of unambiguously identified mosasaur specimens. The obtained data will be analyzed using statistical methods to determine the variability in the shape of particular teeth within single jaws of different specimens belonging to separate species. In the next stage, the teeth will be studied from the microstructural perspective. The studies will concentrate on the characters observable on thin sections of the tooth crowns, such as the lines of von Ebner and Andresen, that enable the establishment of the growth and replacement rates in the teeth of particular species. Further research will focus on extracted parts of the enamel. The obtained samples will be studied to appraise the three dimensional arrangement of the enamel types (called Schmelzmuster) which might have a potential value for reconstructing evolutionary relations among mosasurs.

The knowledge obtained during the morphological and microstructural studies will serve as a basis for identifying and ecological interpretations of isolated tooth material. In the final stage of the studies, geochemical analyses of carbon and oxygen isotopes present in enamel will be provided. The results arising from these analyses will help to determine the migrations of the tooth-bearers through the water column and within habitats, as well as their diet and position in trophic chains of the Cretaceous ecosystems.

The results that are expected to stem from the research will increase our knowledge of the evolutionary connections, species diversity and ecology of the mosasurs that lived shortly prior to the mass-extinction the end of the Cretaceous. The obtained data will be also useful for interpretations of the abundant assemblages of isolated mosasaur teeth that form, in many regions and stratigraphic units, the only evidence of the presence of these predatory lizards. Then, new ecological reconstructions will have a significant impact on the interpretation of the predator-prey relations within Cretaceous ecosystems and ecological interactions between the Late Cretaceous vertebrates.

The results may also affect the overall understanding of the scientific value of teeth which have become increasingly popular objects of different types of studies during recent years. Finally, big extinct lizards, that are unlike anything that lives today, are one of the most attractive topics when popularizing paleontology and evolutionary history of life.