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Finite Element Analysis of stress patterns in the stephanodont crown of murine rodents: palaeobiological significance

Análisis de Elementos Finitos sobre los patrones de estrés en la corona estefanodonta en los roedores de la subfamilia Murinae: importancia paleobiológica

Samuel Mansino[1], Oscar Sanisidro[2], Beatriz Soriano[3], Vicente Daniel Crespo[1], Adolfo Alonso[3] & Francisco Javier Ruiz-Sánchez[1]

[1]Departament de Geologia, Àrea de Paleontologia, Universitat de València, Doctor Moliner 50, 46100 Burjassot, València. samuel.mansino@uv.es, vicente.crespo@uv.es, francisco.ruiz@uv.es

[2]Departamento de Paleobiología, Museo Nacional de Ciencias Naturales - CSIC, C/José Gutiérrez Abascal 2, 28006 Madrid, Spain. osanisidro@mncn.csic.es

[3]Mecánica de los Medios Continuos, ETSAV, Universitat Politècnica de València, Campus de Vera, 14, 46022.

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The Finite Element Analysis (FEA) has proved to be a useful tool for biologists and paleontologists when dealing with different biomechanical hypotheses by reconstructing the strain, stress and deformation in the bio-structures of interest. We have used this methodology to test the biomechanical performance of the molars of two species of the extinct murinae genera, *Stephanomys* and *Paraethomys*.

One upper and one lower molar of *Paraethomys* and *Stephanomys* respectively have been digitalized by composing two images of the oclusal surface taken with a Scanning Electronic Microscope (SEM) with a tilt of five degrees, in order to obtain a 3D model. The stress analyses have been performed by means of the FEA software packages AV-Cid (Alonso Durá, 2011) and Salome-Meca 6.4.0.

The group of murine rodents appeared during the Late Miocene of Asia, spreading from there to Europe and Africa. Along time, some lineages of murines developed a specialized crown structure, known as stephanodonty, from a primitive murine dental pattern. This term refers to the development of longitudinal ridges or crests connecting the teeth cusps, increasing the wear surface of the molars. It is generally assumed that fossil rodents with stephanodonty evolved this particular dental pattern as an adaptation to an herbivorous and abrasive diet mainly on the basis of comparison with extant faunas. Following this trend,

the *Progonomys-Occitanomys-Stephanomys* lineage underwent an increase of size and stephanodonty along the Miocene, following the long term climatic shift towards a dry and subtropical climate and a more open landscape at the end of the Miocene (Renaud & Dam, 2002). In a similar way, the *Paraethomys* genus developed stephanodont molars during the Plio-Pleistocene climatic fluctuations (Renaud et al., 1999). In this work, we have used fossil material from the locality of Alcoy 2D (AL2D), of a Lower Ruscinian age (MN 14). *Stephanomys cordii* from AL2D presents a complete joint of the cusps in both the upper and the lower molars, whereas *Paraethomys* aff. *abaigari* from the same locality, a form close in size to *Stephanomys*, shows an incipient state of stephanodonty, as can be deduced by the presence of some traits like the presence of longitudinal spurs in the upper first molars.

Our preliminary results point to a better dissipation of the masticatory strains in *Paraethomys*, where the stress is focused on the cusps, contrasting with *Stephanomys*, where the strains spread on the whole oclusal surface (Figure 1). Even though, further analyses are needed to outline the main differences in mechanical behaviors between *Paraethomys* and *Stephanomys*.

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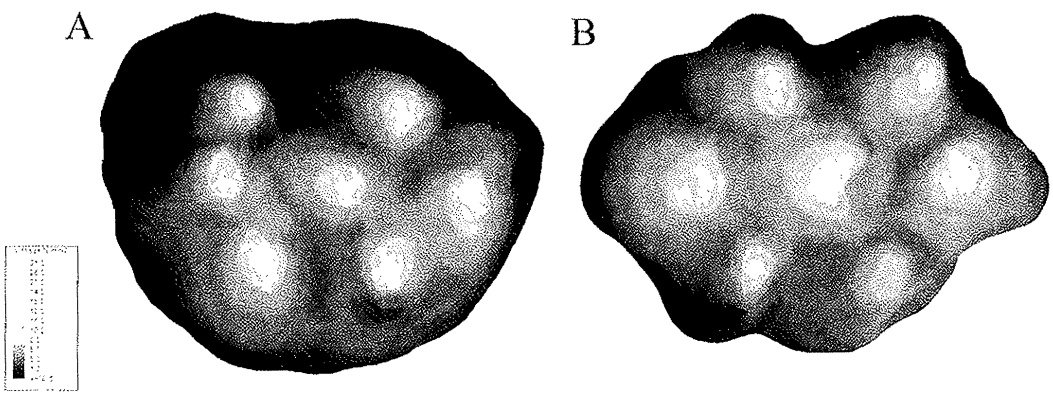

Figure 1. Occlusal view of a 3D-scanned model of two upper first murid molars: AL2D-101, adscribed to *Paraethomys* aff. *abaigari* (A) and AL2D-98, belonging to *Stephanomys cordii* (B), from Alcoy 2D; 1B, Von Misses stress patterns in the same individual under perpendicular forces to their occlusal surfaces. Scale bar in N/mm^2.