

Hypsodonty in Mammals: Evolution, Geomorphology, and the Role of Earth Surface Processes

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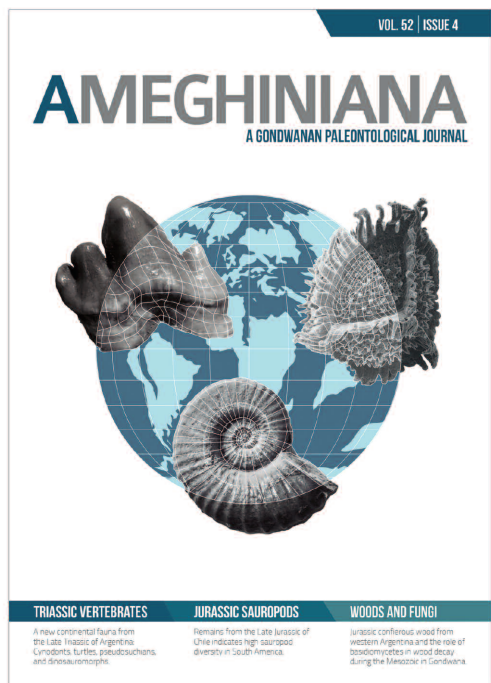
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HYPSODONTY IN MAMMALS: EVOLUTION, GEOMORPHOLOGY, AND THE ROLE OF EARTH SURFACE PROCESSES

Richard H. Madden, 2015, 423 p.
Cambridge
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HYPHODONTY IN MAMMALS: EVOLUTION, GEOMORPHOLOGY, AND THE ROLE OF EARTH SURFACE PROCESSES.

Richard H. Madden, 2015, 423 p. Cambridge University Press, UK. ISBN 978-1-107-01293-6. Price \$130.00.

This book is testimony to Madden's life quest to search for an understanding of why so many South American mammals evolved "elodont" (i.e., ever-growing) cheek teeth, and to link it with the hypothesis that this relates to excessive tooth wear due to the greater amount of volcanic material in that continent than elsewhere in the world. I found myself pretty convinced by the correlation a couple of pages into the text, but Madden stresses the problems with providing a tight causal correlation between events in the deep past, and the book appears to be as much about convincing himself as convincing the reader.

The book is written in the style of a hero's tale adventurer: Madden takes us on a voyage through the data, inviting us to see it through his eyes. The mixture of the personal with the scientific is a bit like watching a documentary where the narrator breaks off from the official narrating and turns to face the audience with his own insights (e.g., on p. 234: "At this point in time, you may ask, what am I talking about?"). This approach is sometimes endearing and at other times rather irritating.

There is a lot of data in this book, encompassing many tables and diagrams as well as the text, some of it from the research of others, some from Madden's own (apparently unpublished) research. Some of these figures are useful and informative, others less so (for example, I could have done without Figure 5.1, of a mechanical dust flocker for sheared sheep's wool).

Chapter 2 provides a nice overview of the evolution of South American mammals, focusing on the notoungulates: there is a lot of documentation about the incidence of hypsodonty and elodonty in different taxa at different times, much of which appears to be an original compilation. Yet this chapter would have greatly benefitted from a diagram showing the time scale of the South American Land Mammal Ages, with a range chart of the different taxa discussed (perhaps with different patterning of the lines to show differences and changes in tooth crown height). Chapter 3

presents a lot of data on hypsodonty in extant sigmodontine rodents, and an analysis of possible causal environmental factors.

Perhaps the most useful chapter (to my mind) is Chapter 4, an extended discussion of the voluminous data on the effect of soil on the wear of sheep's teeth. As Madden notes in the summary chapter (p. 357) "precedence is easier to manage at ecological time scales", and so he devotes much time and energy to documenting what we can know about the effect of ingested soil and mineral particles on dental wear in living animals, mainly sheep and goats. In contrast, the following chapter, on similar studies in Australia, is less conclusive (although the study on the teeth of aboriginal people is interesting). I was disappointed that Madden did not consider further the issue of why there is so little incidence of hypsodonty (let alone elodonty) in the native Australian fauna. The explanation of molar sequential eruption in some kangaroos (principally species of *Macropus*) as an adaptation to resist wear cannot really account for this problem, as there is no overall greater production of tooth volume (except for the case of the Nabarlek, *Peradorcas concinna*, where there is a production of supernumerary molars). Note that it's not just the marsupials (apart from the wombat) that fail to develop hypsodonty: the native rodents, that invaded the continent at least 5 million years ago, are also apparently not notably hypsodont.

Chapters 6 and 7 provide case studies from the fossil record, respectively the late Neogene Mediterranean islands and the Plio-Pleistocene of East Africa. Chapter 6 uses the multiple examples of ungulates isolated on relatively small islands to link the evolution of high-crowned teeth to the issue of volcanic origin of the islands and/or soil erosion. Studies of sheep and goats on present-day islands round out this chapter. Chapter 7 provides a lot of data and data analysis on the marine sediment record of erosion in correlation to dental changes in suid and primate lineages. However, ultimately the correlations are rather unsatisfactory,

as they involve appeal to the visual inspection of graphs (rather than statistical analysis), and the observed change in molar size through time is not decoupled from changes in body size. Nevertheless, the amount of data presented is impressive, and generally unavailable elsewhere.

Chapter 8, on the middle Cenozoic of Patagonia, is an immense compendium of environmental factors (including volcanic dust) that might have influenced the evolution of the mammals' dentitions. This chapter might be of particular interest to the readers of this journal, although I found it rather superfluous to a general consideration of mammalian hypsodonty. Chapter 9, on ever-growing teeth, starts off with a useful discussion, but then segues into a long soliloquy on whether or not rabbits, with their ever-growing molars, contribute to soil erosion in the habitats where they are found naturally or introduced, which was eventually rather inconclusive. I found myself wishing that Madden had considered the potential *problems* rather than the benefits, of ever-growing cheek teeth, in particular the loss of the surface occlusal pattern and what impact that might have on masticatory efficiency. Or perhaps the potential reasons why rabbits and rodents can "easily" gain elodonty, but this is only seen in notoungulates among large mammals (with the notable exception of the Pleistocene rhino *Elasmotherium*).

In general, this is a book packed with data and analysis, much of it unpublished elsewhere, and this makes the book useful for people interested in mammalian hypsodonty, especially for the evolution of the South American fauna. However, despite its title, this book is *not* is a review about hypsodonty in mammals in general: it omits many key general references, ranging from the classic (*e.g.*, Van Valen 1960) to the recent (*e.g.*, Williams and Kay, 2001; Ozaki *et al.*, 2010).

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