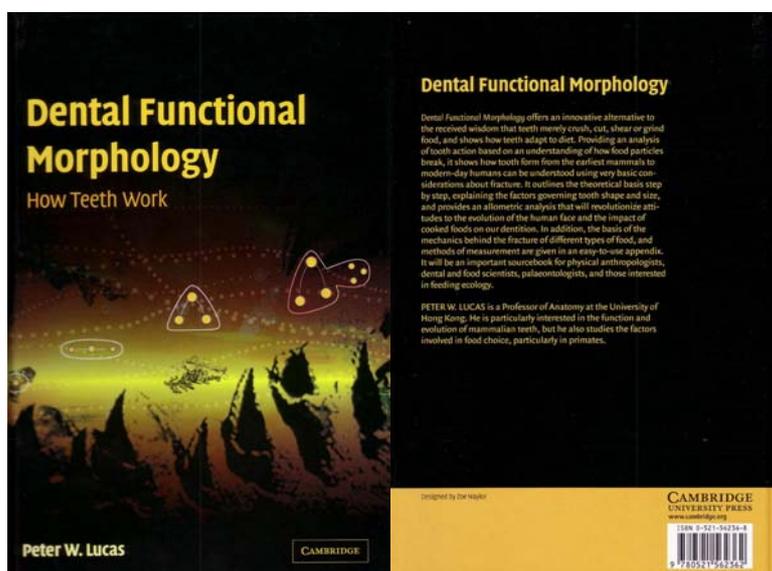


Lucas, P.W. 2004. **Dental functional morphology. How teeth work.** – Cambridge, Cambridge University Press

Book review by B.L. Beatty



First and foremost, there is no other up-to-date single-authored book on the subject of dental functional morphology, so in this right this book is valuable. Many edited volumes concerning the subject have been published over the years (Kurten, 1982; Teaford, *et al.*, 2000), some of which are quite comprehensive and some which are spotty in coverage reminiscent of a symposium proceedings. This book is by no means spotty; it is thorough and clear. One might say that with such a general title its only weakness is its primary focus on mammalian dentitions, particularly those of primates. This is certainly understandable considering that the majority of the audience and courses taught on the subject of dental function are in anthropology.

To start, Lucas includes a brief explanation of a recurrent image at the bottom corner of each right page: that of a profile of a tooth. For 159 pages, this little tooth image changes ever so slightly depicting the minor changes in cusp morphology from primitive acrodont dentition to a human molar. This is intended to be flipped through as a 'flip-book', making a moving picture of the changing morphology of dentition. While a minor bit of detail, this is just one of the many aspects of this book that make reading it so enjoyable.

This description of imagery is immediately followed by a chapter appropriately titled, 'How to get excited about teeth'. This is not just an introduction to the subjects more thoroughly dealt with in the following chapters, but also a brief coverage of the aspects of dental functional morphology not covered in this text due to its focus on mammals. In simple language, Lucas covers topics such as the origins of teeth in vertebrates, human dentitions, basic oral and dental functions, and a basic model of functional morphology of dentitions. His basic model figure (figure 1.2, p. 11) is sure to be seen in many of my future talks and courses.

The introductory chapter is followed by a descriptive anatomical study of the mammalian mouth (chapter 2). This is no mere description of teeth, muscle and bones. Lucas delves into tooth occlusal alignment, tissues (enamel, dentine, etc.), alveoli, tooth migration, the temporomandibular joint, and glands. For a largely anatomical description, Lucas manages to maintain this chapter's readability. For those with preexisting knowledge of human anatomy, this chapter still serves as a useful summary of concepts and differing points of view of oral functions, and a place in which these different views and terms are applied in a known context so that the reader can follow in further chapters.

Chapter 3, 'How the mouth operates' is by far one of the clearest explanations of ingestion, mastication, comminution and deglutition I have ever seen. While the act of ingesting, chewing and swallowing food is generalised for mammals, Lucas clearly states that he derives this mostly from what is known of humans. While he acknowledges that humans are unique in some specialisations for vocalisation that complicate the interaction of the air and food pathways, he accounts for it briefly by describing the difference and pointing the way to more thorough references of the variations found in other mammals by Hiiemae and Crompton (Hiiemae & Crompton, 1985) and others.

In chapter 4, titled 'Tooth shape', we find Lucas tackling a subject of paramount importance to a large number of vertebrate palaeontologists with a clarity and simplicity wanting in most other literature on the subject. I wish I had read this as an undergraduate student; my research life would have developed more

smoothly. This chapter entails a large number of formulae, but in an understandable context in which functional constraints and mechanics of teeth and foods are clearly explained. Here we begin to see one of Lucas's research strengths and perhaps one of his major contributions to the science in a condensed form: the importance of food texture in shaping tooth morphology in mammals. Along with appendices A and B, the reader begins to get the full story of tooth functional morphology in the context of tooth and food mechanical interactions. Any vertebrate palaeontologist considering tooth function should definitely read this and its primary sources.

Chapter 5, 'Tooth size', tackles the popular problem of the relationship of tooth size to function and other concerns, including metabolic rates and prey capture. Starting with discussions of earlier work on allometry and scaling of metabolism to tooth morphology and size, Lucas quickly gets to the importance of studies of bite force and food intake rates. This leads to some discussions that should be enticing to palaeontologists; geometric scaling of dentitions is compared to the scaling of a dentition to match fracture abilities. This leads to further explanations and questions about the role of diet in related animals of different sizes and the functional differences between herbivory and carnivory that relate to size as well. This, along with a brief note on the role of sexual dimorphism in this context, is something that could permit the development of evolutionary scenarios based on more sound reasoning than what is usually written.

'Tooth wear', the title of chapter 6, provides a clear, generalised and widely applicable summary of what is known of the mechanical life of a tooth, the essence of tooth function. Lucas makes a strong argument for the importance of tooth size in the evolutionary response to increased abrasion from food that goes beyond the classic story of ungulate hypsodonty that we all know and love. In addition to a clear description of the terminology and mechanics of indentation and wear, Lucas addresses some other features of tooth wear often not brought up in the literature: dentine wear. Lucas only briefly delves into the role of dentine in wear studies and briefly explains the reasons behind the avoidance of its study by others. Another topic he briefly addresses is the importance of enamel microstructure in tooth wear, something of key interest to me. His page on the subject introduces the small body of literature that exists on the subject of enamel microstructure's functional role in wear, then goes on to indicate the need for further study. Lucas finishes the chapter with brief discussions of non-occlusal dental wear and tooth efficiency at different wear stages. Non-occlusal dental wear appears to me a largely unstudied topic; his brief discussion does a good job of bringing this useful and neglected subject to light. As for tooth efficiency throughout the life of a tooth and the ways that animals adapt to wear in teeth, he starts a brief explanation of why dental wear can be so important. He cites some anecdotal incidences of dental senescence as causes of starving and death, then goes on to discuss some ways that animals have solved the problem. This is where hypsodonty gets its recognition, although Lucas also points to some other possible scenarios such as incisor and canine enlargement and postcanine tooth enamel thickening. Although Lucas writes off this chapter as having not said much, one would be hard pressed to find such a thorough review of the subject of tooth wear anywhere else.

The last chapter, titled 'The evolution of the mammalian dentition' delves into some of the details of decades of research on the subject as well as Lucas's own investigations into how his uniquely straightforward perspective of tooth function and its relationship with food texture fits with the fossil record. This section starts with some short discussions of early examples of mastication, such as that dinosaur herbivory and early mammal insectivory. What comprises the majority of the chapter is a look at the changes that have gone on during the course of evolution in primates. Finally, Lucas finishes this off with a thorough look at the impact of agriculture and cooking in human tooth evolution and function, including a more in-depth look at the modern research in food texture studies.

Lastly, Lucas treats the readers to two appendices that together could have been a book of their own. Appendix A details the methodological necessities and protocols for assessing the mechanical properties of food items and dentitions themselves in an approach that matches the practical nature seen in engineering texts without the jargon and complexity that usually deters us palaeontologists. Appendix B is a huge set of tables listing the mechanical properties of a number of common food items that most readers of this book (noticeably with a primatological bias) would need. This essentially saves the reader the time of using the methodologies described in appendix A for a large number of items that Lucas and others have already studied in depth. With these appendices and the body text preceding them, this is quickly becoming my regular reference and guide to my work in gathering the same sort of data and understanding for the aquatic world.

In summary, Lucas delivers a text worthy of use as a textbook and a primary source that will last for years to come. While noticeably biased toward primatological uses, many of its concepts are applicable to a wide variety of gnathostomes. It is clear, easy to read, with concepts explained in a sensible, logical manner that should appeal to students and researchers. His sparing use of jargon makes this an uncommonly accessible book; something that I anticipate will make this internationally cited and read. As for myself, I have rarely read such a book that has inspired me to add so much marginalia of future research ideas! If your work has *any* involvement of the function of dentitions or oral anatomy, you need to read this book.

Lucas, P. W. 2004. Dental functional morphology. How teeth work. – Cambridge, Cambridge University Press. 355 pp. ISBN 0–521–56236–8. Price \$130.00/£88.00 (hardback).

#### **Cited literature**

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