

DEVELOPMENT, FUNCTION AND EVOLUTION OF TEETH. Edited by Mark F. Teaford, Moya Meredith Smith and Mark W.J. Ferguson. New York: Cambridge University Press. 2000. 314 pp. ISBN 0-521-57011-5. \$100.00 (cloth).

With the advent of new technologies and new methods of analysis, there has been an exponential increase in the quantity of information resulting from scientific investigation. These advances have opened new perspectives in research, as well as facilitating new approaches to old questions. Such developments have led to the burgeoning of new fields of inquiry and areas of increased specialization. Unfortunately, with this expansion, it is ever easier as editor Teaford points out, to 'lose sight of the forest among the trees' and dental research is not exempt from this myopia. This ambitious volume, edited by Teaford, Smith and Ferguson, successfully counters this situation by broadening the channels of communication between diverse disciplines and clearly demonstrating the interrelatedness of the multiple perspectives addressing questions of dental morphology. Resulting from the symposium "Teeth: homeoboxes to function" at the 4th International Congress of Vertebrate Morphology at the University of Chicago, the editors have united the contributions of experts from a wide range of perspectives on the morphology of teeth. With chapters that provide overviews of "a wide range of dental topics, linking genes, molecules and developmental mechanisms within an evolutionary framework", this volume demonstrates the numerous approaches that the field of dental morphology now encompasses.

The book is divided into four parts, reflecting the study of increasing levels of organization; molecules and genes, tissues, teeth and dentition, and "macrostructure". In this way, each section provides a foundation for subsequent levels of analysis. Part one, "Genes, molecules and tooth initiation" contains four chapters that attempt to move beyond descriptions of developmental processes at the molecular level to discern the mechanisms involved in tooth formation. In the first chapter, Sharpe discusses the role that homeobox genes play in organogenesis and the potential function these genes and homeoproteins have in the development of the orofacial region, particularly the regulation of tooth position and shape. Chapter two furthers the discussion of developmental control in teeth. Jernvall and Thesleff focus on epithelial enamel knots and their function as mediators of cusp development. Though these structures have long been described, their role in the morphogenesis of single and multicusped teeth has only recently begun to be understood. In the third chapter, Ruch and Lesot discuss the molecular signaling involved in the terminal differentiation of odontoblasts and their role in the formation of dentine. This section concludes with a chapter by Fincham et al.,

in which the authors review the strides made to date in understanding the role of enamel genes in the assembly and disassembly of the organic extracellular matrix during enamel formation and maturation.

Part two addresses the evolution and development of dental tissues. Building on the third chapter, chapters five and six focus on dentine. Smith and Sansom begin with a synthetic presentation of the evolution of dentine, considering the possible functional advantages of this tissue in the dermal armor of early vertebrates. Chapter six, by Smith, examines the functional interdependence of dentine and pulp during reactionary dentinogenesis (initial tissue formation) and reparative dentinogenesis (repair after injury to the tissue). Sander's provides an overview of the diversity of enamel in reptiles and presents a model for the evolution of prismatic enamel in Mesozoic mammals. In chapter eight, von Koenigswald's paper continues the discussion of mammalian enamel, comparing the enamel microstructure of marsupials and placentals. He asserts that the enamel of both subclasses is formed by the same enamel types, reflecting their common heritage. However, the frequency of these types and the structural elements they form differ. This further differentiation of enamel types between Eutheria and Marsupialia is considered the result of convergent evolution. This section ends with Dean's chapter on the utility of incremental growth marks in enamel and dentine in both fossil and extant species. It is noted that the differential rates of enamel formation in humans and apes are identifiable, yet the rates of dentinogenesis do not vary.

Continuing the pattern of increasing organizational complexity, part three is entitled "Evolution of tooth shape and dentition." This section begins with Smith and Coates' argument that the previously established theories of tooth and jaw development as a functional unit are not supported by more recent data. Based on fossil evidence, they claim that the development of jaws and teeth were distinct events, with "jaws originating for suspension or suction feeding and teeth for food apprehension or sampling...." Zhao et al. provide an overview of the evolution of dentition patterns (number, location and arrangement of differently shaped teeth) and review various models (e.g., gradient, clone, homeobox genes) put forth to explain the developmental mechanisms behind these patterns. The authors find that none of the current models are established by "convincing experimental data", yet assert that ongoing genetic and molecular advances (such as those reported in part one of this volume) will continue to shed light on the mechanisms of dentition pattern formation. Gaengler focuses on the periodontal attachments that have been developed in vertebrates to contribute to an understanding of the phylogeny of dentition "in its broadest sense". In an examination of the polyphyodontic dentition of

non-mammalian vertebrates, Berkovitz reports that patterns of replacement in these teeth are related to continuous growth in body size. The most common pattern involves waves of alternating teeth, preventing the organism from an extensive lack of teeth at any point in the process. In chapter 14, Butler presents a detailed review of the variation in primate tooth shape and discusses how these variations are functionally adaptive for an arboreal lifestyle. In the final chapter of the section, Smith reevaluates 'Schultz's Rule' ("the tendency for replacing teeth to come in relatively early in slow-growing, longer-lived species") in light of new data from primates. Additionally, she examines the applicability of this rule to the tooth emergence patterns of other mammals, specifically ungulates. According to her research, Schultz's rule is supported by recent primate data, as well as data from insectivores. However it cannot explain the variation present among the ungulates, particularly the more specialized species.

The focus of the final section is the "Macrostructure and function" of teeth. It begins with Huysseune's exploration of the environmentally induced variability of phenotypes in the dentition of African cichlids. In this case, phenotype varies in relation to the hardness of diet. Chapter 17, by Shellis and Dibdin, addresses the influence of enamel pores on the optical and mechanical properties of this tissue. Rensberger provides a review of the morphologies of mammalian enamel, examining the functional basis for this differentiation. He then examines how the attributes of abrasion and fracture resistance at the microscopic level create selection pressures at the macroscopic level. Jernvall et al. present a case in which they apply their method of classifying molars to the dental evolution of hooved mammals. Based on their analysis, the authors establish five patterns in this evolutionary history and suggest relationships between these trends and patterns of ungulate radiation. The function of postcanine teeth in mastication is the foundation of Lucas and Peters'

chapter, in which they examine the advantages of certain tooth shapes in the mastication of particular foods. By comparing the material properties of food (strength, toughness and Young's modulus) and the shape of teeth, specifically the sharpness or bluntness of the occlusal surfaces, the authors highlight the selective advantages of both tooth shapes relative to diet. Teaford's final chapter in the book reintroduces many of the themes presented in the contributed papers of this volume. By reviewing the microscopic and macroscopic perspectives, the insights each has provided and the promise of future contributions, the editor again underscores the importance of the integrative approach to the study of *dental functional morphology*.

By design, this book is relevant to many with research interests in teeth, regardless of specialization. Though the contributing authors come from a wide range of disciplines, most of the papers do not require highly specialized knowledge of the particular field. Many papers begin with an introduction in which terminology is standardized or taxonomic relationships are indicated, making the paper accessible to those outside the author's immediate area of specialization. At the first scan of the book the direct relevance of some of the papers to a dental anthropologist may not be readily apparent. However, upon reading the text, one is continuously reminded of the necessity of being familiar with these many perspectives relating to tooth morphology. With the likelihood of continued advancements in these many related areas, such collaborative endeavors as the book are necessary to make best use of this new information and should be commended and emulated.

ELIZABETH A. NEWELL  
Department of Sociology  
and Anthropology  
Elizabethtown College  
Elizabethtown, PA 17601

### Dental Symposium at 2003 AAPA Meeting

Heather Edgar and Loren Lease, from the University of Ohio, have organized a poster symposium through the auspices of the *Dental Anthropology Association* for the 2003 meeting of the American Association of Physical Anthropologists to be held in Tempe, Arizona, this coming April. Details will be printed in the next issue of *Dental Anthropology*. Please make plans to attend this official DA function.