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Human growth in the past: studies from bones and teeth

Until now, studies of dental and skeletal growth and development have often been treated as independent disciplines within the literature. *Human growth in the past* takes a fresh perspective by bringing together these two related fields of enquiry in a single volume whose purpose is to place methodological issues of growth and development in past populations within a strong theoretical framework. Contributions examine a variety of aspects of human growth in the past, drawing from both palaeoanthropological and bioarchaeological data. The book covers a wide spectrum of topics, from patterns of growth in humans and their close relatives, innovative methods and applications of techniques and models for the study of growth, to estimation of age at death in subadults and infant mortality in archaeological samples. *Human growth in the past* will be of interest to biological anthropologists and those in the related fields of dental anatomy, evolutionary biology and developmental biology.

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Human growth in the past

studies from bones and teeth

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Both editors are friends who have shared much of their experience in higher education. We would like to mutually dedicate this book to two groups of people special to us, many of whom we hold in common: to our teachers and mentors, who through their encouragement or example have had the greatest impact on our developing careers in this field; and to our families who have given us their support and loyalty throughout:

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Preface

In the past, studies of dental and linear growth and development have too often been treated as independent entities within the literature. Frequently such publications have also been prone to a manual or catalogue approach. This book takes a fresh perspective by bringing together these two related fields of enquiry in a single coherent volume that places methodological issues of growth and development within a strong theoretical framework. Individual contributions illustrate the potential benefits of growth and development studies for understanding and interpreting past populations, as well as some of their problems and pitfalls. The contributors are researchers in biological anthropology, and it was an explicit goal of the editors to ensure that there was a mix of well-recognised authors and new scholars in the field. A total of 20 scholars from Canada, the USA and the United Kingdom have contributed to the volume.

We hope that this monograph will serve as an exemplar, demonstrating the advantages of bringing together researchers in the field of growth and development whose focus is on humans who lived in the past. Specifically, this book is intended to integrate areas of study that for a number of reasons (explored in Chapter 1) have tended to remain separate. One obvious way to have structured a volume of this nature would have been to group all of the dental papers together and all of the skeletal papers together. However, such an approach would of course have flown in the face of the purpose of this book. While we fully acknowledge the importance of individual studies in each of these fields, we think that there are significant benefits to be had by integrating studies from bones *and* teeth. Indeed, in no other way can a complete picture of the evolutionary processes of human growth and development be painted. We have therefore opted to organise the volume in a fashion that follows a more chronological approach, although in so doing we have also tried to avoid creating another obvious (and related) schism: dividing studies into palaeoanthropological and bioarchaeological categories. The theme of this book is the gathering together of all researchers interested in growth and development of past populations under one umbrella. In fact, in Chapter 1 the editors propose the use of the term 'palaeoauxology' for such studies. In

this first chapter we explain the book's motif and establish its overall tone, with an overview of the state of studies of growth from bones and teeth. A brief summary of the development of the two fields within biological anthropology provides a basis on which to build an argument for the natural integration of dental and skeletal studies.

Chapters 2 to 6 broadly examine various aspects of the evolution of human ontogeny. Dainton and Macho (Chapter 2) explore methodological issues related to heterochrony in humans, chimpanzees and gorillas. They examine patterns of growth in body mass and carpal and dental development, observing that heterochronic processes can be determined from analysis of patterns alone. They also caution researchers about substituting other variables as estimates of body mass and the inclusion of adults in studies of ontogenetic allometry, since both of these practices can lead to serious biases and misinterpretations of the data.

Humphrey examines mandibular growth, tooth emergence and chronological age in gorillas, chimpanzees and modern humans in Chapter 3. In her analysis, all three species show variation in the pattern of growth of the different parts of the mandible, and while the sequence of growth is similar among these species, clear differences between humans and the apes are noted. She concludes from this study that it is not possible to adequately predict skeletal growth attainment on the basis of chronological age or dental emergence, and cautions other researchers about making inferences regarding the rate of development of extinct hominids based solely on dental evidence.

Nelson and Thompson, in Chapter 4, investigate Neandertal growth and development. They examine two juvenile males (Teshik-Tash 1 and Le Moustier 1) in detail to try to assess whether Neandertals experienced an extended period of slow childhood growth and a rapid adolescent growth spurt. They focus on estimates of chronological age from dental development, and estimate stature as a basis for comparison with other cold-adapted populations. These authors observe that, in contrast to studies of *Homo erectus* juveniles, the Neandertal juveniles have a dental age that exceeds their proportional height age and therefore do not demonstrate a primitive ape-like pattern of growth and development. However, because the Neandertal age estimates differ, on the basis of developmental standards, it is argued that they also contrast with modern humans. Two alternative hypotheses are explored to explain the observed results: delayed skeletal growth or advanced dental development.

Dean, in Chapter 5, reviews the use of dental microstructures in dentine as a method of assessing development of both extinct and extant hominoid species. Most workers in the field are familiar with Dean's pioneering work

on dental enamel incremental microstructures, which are now accepted as incremental markers of growth. These structures provide endogenous developmental information and many studies in the last 18 years or so in anthropology, a significant number of which have involved Dean, have utilised them to explore various aspects of hominid (and hominoid) growth. Once again Dean is a trailblazer, this time initiating the use of microstructural growth markers in dentine, the bulk of the hard tissue of teeth and therefore a potentially even more useful tool for exploring development than enamel. However, dentine presents a greater technical challenge to researchers, and in this chapter Dean provides an excellent primer on its use. He presents a solid basic introduction to dentine's structure, function and the nature of the regular chronological periodicity of its microstructures, and he also offers practical techniques for histological analysis of dentine and illustrates the advantages of utilising it with examples from recent studies.

O'Higgins and Strand Vidarsdottir present some recent approaches to assessing morphological variation in Chapter 6. They illustrate the use of geometric morphological techniques through a case study of comparative craniofacial growth in Aleutian and Alaskan population samples. The results of their case study suggest that the influences on postnatal facial development are identical between these closely related populations, although a fundamental difference in facial morphology is established during infancy. Of particular interest is the observation of differences in facial morphology between the two study populations that are independent of age. Their review of the methods available to researchers demonstrate the potential for understanding the ontogenetic development of morphological variation and its relationship to evolutionary adaptation and divergence.

In Chapter 7, King and Ulijaszek examine the basis for growth reduction as a measure of reduced health and well-being from archaeological studies. They argue that, despite some problems inherent to archaeological material, comparisons of skeletal growth profiles between different archaeological groups and/or modern populations can provide information on the timing and extent of growth faltering. This chapter provides an overview of bioarchaeological studies of skeletal growth, and discusses previous interpretations of growth faltering in the light of current literature on environmental factors that can influence growth. In particular, they note that many previous interpretations of growth faltering have been influenced by the types of archaeological evidence available and the prevailing interpretations of palaeopathological indicators of stress. From their review of the growth literature, they suggest that interpretations of archaeological studies may need some reconsideration.

Saunders and Barrans (Chapter 8) review the potentials and the problems of examining the infant cohort in skeletal samples. They begin by defining the infant category demographically (i.e. those who have died prior to their first birthday) and call on all researchers in the field to universally apply this definition. Placing infancy in the context of studies of growth and development, they address issues of variation in infant mortality, determination of sex from infant skeletal remains, identification of feeding practices, causes of death, and seasonality in infant mortality. The authors argue that research into the skeletal biology of infant morbidity, mortality and growth offers great hope for the future, and that the most promising and exciting areas of research will be studies of 'cause of death' and dietary reconstruction.

Chapters 9 and 10 both examine issues of enamel hypoplasia and interpreting episodic periods of stress during the growing years. Traditional approaches to estimating the timing of these developmental insults have come under some criticism recently and the authors of these two chapters have both confronted these concerns in different and innovative ways. In Chapter 9, Goodman and Song provide a brief historical survey of studies utilising linear enamel hypoplasias (LEH) and the methods that have been employed to time their formation, the accuracy of which is key to their utility as stress indicators. The authors then deconstruct the possible sources of variation between estimated and true ages of formation of LEH, taking account of some of the most recent studies in the timing of dental development. Having assessed the impact of each of the factors identified, they make a number of important recommendations to future researchers on how to correct or minimise variances when estimating timing of formation of LEH.

Simpson in Chapter 10 looks at two types of structure defects in teeth, LEH and pathological striae (or so-called Wilson bands). He employs a case study approach to illustrate the methodological modifications that he advocates that will improve the analysis of both types of defect and the accurate timing of their formation. Utilising a large sample of Native American mandibular canines from individuals who lived between AD 1 and AD 1704, he records the frequency and location of enamel defects. The sample is divided into four distinct periods corresponding to major changes in culture and subsistence through this period and Simpson verifies the hypothesis that the frequency of microdefects can be related to expected outcomes in each of these periods. Most interestingly, rather than taking a traditional approach using exogenous standards developed on the assumption of linear growth throughout crown formation, he establishes the chronology of defects by utilising microstructural growth markers of

enamel in unworn crowns in the sample to generate development standards specific to this archaeological population. Simpson also discusses the nature and possible aetiology of these two defect types and concludes that they should not be considered different responses to a similar underlying cause, but are products of physiological disruptions with different courses, timings and durations.

In Chapter 11, Konigsberg and Holman present a rigorous statistical approach to estimating age in juveniles from dental eruption data. They discuss issues related to the use of standards of ageing to generate skeletal growth profiles in bioarchaeological studies. In particular, these authors argue that most studies of growth in the past do not adequately address the error in age estimation, and as such, many observed differences in skeletal growth profiles are probably methodological biases. Presenting a technique that accounts for the uncertainty in age estimates, they conclude that, while it is possible to get relatively unbiased estimates of growth from prehistoric populations, larger skeletal samples are necessary to make meaningful statistical statements regarding growth in the past.

Mays (Chapter 12) provides a case study of skeletal growth in the Mediaeval sample from Wharram Percy, England. Mays asserts that while assessments of linear growth are common, studies of appositional growth in bioarchaeology have been less frequent. The author notes that many archaeological assemblages from Roman times to the early modern era show very similar patterns of longitudinal bone growth that do not necessarily reflect similarities in childhood nutrition and disease experience. However, differences in the present study are highlighted when appositional growth is taken into account. The author advocates measurements of cortical bone in conjunction with longitudinal bone growth when investigating skeletal growth in earlier populations.

We think that no better case for the advantages of an integrated approach can be made than the consummate volume of chapters presented by our contributors. The book offers readers an opportunity to learn about some of the most current and interesting methodological and theoretical research activities occurring at the moment in the field of palaeoauxology. We hope that they get as much enjoyment from their reading as we the editors had in assembling this volume and working with its authors.

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Charles FitzGerald

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