reduced if the increment in height over a 1-year period is included as a predictor.

In addition to a brief discussion on the applicability of the method in the clinical context, the revision also includes a CD. The CD has two utilities, the RUS height predictor utility for the calculation of adult height prediction, and the RUS bone age utility for the calculation of skeletal or bone ages, z-scores, and percentile status from RUS maturity scores.

TW2 and TW3 provide for separate maturity scores and, in turn, skeletal ages for the carpal bones (Carpal SA) and for the radius, ulna, and short bones (RUS SA). This is useful, especially in adolescence, because the carpals attain maturity by about 13 years, whereas the radius, ulna, metacarpals, and phalanges continue to mature into late adolescence. However, limiting an assessment to only the long bones may omit some relevant information. Some individuals present dysharmonic maturation in which some centers of ossification (e.g., the carpals) are more advanced or delayed than others (e.g., the long bones). Such dysharmony in maturity is commonly a genetic characteristic.

The revised edition of the TW method provides a reasonably comprehensive discussion of studies that have used the method in its earlier formats and also in comparison with the Greulich-Pyle method. Unfortunately, the revision does not mention the Fels method for the assessment of skeletal maturity of the hand–wrist which was developed in the 1980s (Roche et al., 1988). It would have been interesting to compare TW3 and Fels skeletal ages. The methods are similar in principle, but differ in scoring. The Fels method uses the same 20 bones as TW1 and TW2 and the pisiform and adductor sesamoid of the first metacarpal. The Fels method also utilizes ratios between linear measurements of epiphyseal and metaphyseal widths of the long bones. Criteria for long bones in the TW method include observations of the widths of the epiphyses and corresponding metaphyses, e.g., the epiphysis is as wide as the metaphysis or the epiphysis is wider than the metaphysis, but ratios of linear measurements of epiphyseal and metaphyseal widths are not used.

The scoring system in the Fels method statistically weights the contributions of specific indicators depending on the sex and age of the child. For example, epiphyseal union of the radius may occur over several years, while the appearance of a specific shape of another bone may be present only for a short period of time. Hence, the radius is given less statistical weight and the other bone more weight in calculating the SA at this point in time. The Fels method provides a standard error of the estimate for the SA.

Methods for the assessment of skeletal maturity will continue to evolve. The concept of skeletal age is central in studies of growth in healthy children and adolescents and is an essential diagnostic tool for pediatricians and endocrinologists. An important development in the assessment of skeletal maturity from hand–wrist radiographs is the use of computer-based protocols, which are briefly discussed in this revision of the TW method. Although experimental results are reasonably consistent with ratings of expert assessors, further refinements are necessary. There are, for example, errors in interpretation associated with positioning of the hand–wrist on the radiograph, or problems of misclassification of stages.

Although hand–wrist radiographs are not as commonly used in human biology studies as in the past, understanding of advances in methods of assessment is necessary. This volume is essential reading for those interested in growth and maturation. It should be read in its own right and as a complement to Roche et al. (1988).

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Human Evolution through Developmental Change. Edited by Nancy Minugh-Purvis

and Kenneth J. McNamara. xx + 508 pp. Baltimore, MD: The Johns Hopkins University Press. 2002. $58.00 (cloth).

Not just organisms evolve, but so do ideas in science: concepts can change their content and reorganize themselves in varying juxtapositions to other concepts and empirical research. And just as organismal evolution takes place in changing environments, conceptual change is situated in the social arena of scientists. The concept of heterochrony has a particularly long and turbulent history of change from its invention in the 19th Century to its multifarious current uses (Gould, 1992; Klingenberg, 1998). Originally coined by Ernst Haeckel as a supposedly rare exception to his "law" of recapitulation, heterochrony has come to encompass all evolutionary change in the timing or rate of developmental processes (McKinney and McNamara, 1991). Following this very broad concept of heterochrony, the editors of *Human Evolution through Developmental Change* have assembled a diverse roster of contributors to survey the role of developmental change in human evolution.

The first section of the book deals primarily with conceptual issues. Chapter 1, by Hall, suggests that the cell and the genetic control of development are the fundamental issues in evolutionary developmental biology. Hall therefore stresses that heterochrony is one among many other classes of evolutionary changes to development. Most of the remaining chapters are quite remote from this principally mechanistic view and follow a more phenomenological approach to the analysis of whole ontogenies. A notable exception is Chapter 6, by Crockford, who suggests that thyroid hormone has had a key role in the origin of domestic species of animals and also in human evolution. Although mostly based on circumstantial evidence, this chapter proposes a testable hypothesis that should stimulate further research. Together with the evidence on the role of growth hormone and insulin-like growth factors (e.g., Shea, 1992), Crockford's chapter suggests that endocrine changes can be a particularly potent mechanism for generating the ontogenetic alterations responsible for evolution by heterochrony.

The other chapters of the first section are more in keeping with traditional analyses of heterochrony. Chapter 2, by Alba, reviews the terminology of heterochrony and adds to it, whereas Eble (Chap. 3) presents multivariate analyses of variation in hominoid ontogenies and clearly shows the complex evolutionary changes in their growth trajectories. Shea (Chap. 4) explores which heterochronic changes are most likely and emphasizes the role of ontogenetic scaling, which is facilitated by the action of endocrine changes. However, Shea also emphasizes that these global changes occur together with regional ones that can affect each part of the body separately, and therefore he concludes that no easy generalizations emerge. Finally, Rice (Chap. 7) presents a detailed analysis of growth curves for brain size and concludes that apes and humans are set off from other primates by the introduction of a novel growth phase.

A central theme of the volume is the linkage of human evolution to life-history theory. This theme is elaborated in various forms in the chapters by McNamara (Chap. 5), exploring the consequences of the temporal extension of several growth phases, and by McKinney (Chap. 8), who suggests that this extension is achieved by a general delay of a global "mitotic clock." Jablonski et al. (Chap. 9) explore the ecological aspects of this delay with ecological information and demographic simulations for African apes. German and Stewart (Chap. 10) discuss sexual dimorphism in growth curves and emphasize the requirement for longitudinal growth data to consider the variation in growth dynamics appropriately. Their conclusion is similar to many others; there appears to be a tantalizing complexity of patterns in the data, both among traits and among species.

A substantial part of the book is devoted to dental development, the prime source of comparative information on developmental stages and even of estimates of absolute age in fossil and extant primates (Chap. 11–15 by Kelley, Anemone, Kuykendall, Parker, Ramirez Rozzi, respectively). Some of these chapters are broad surveys of methodology and results, whereas others are more focused analyses of key cases. The data emerging from these studies document the pronounced slowing down of life history that is the predominant feature in the human lineage, but also suggest that there was no constant evolutionary trend from "ape-like"

to "human-like" life history, but that this transition was a multifaceted process that occurred in multiple steps with extensive phases of stasis. The study of life histories with detailed timing information from dental data makes it possible to look at the evolution of ontogeny in its ecological and functional contexts.

The final chapters deal with the evolution of ontogeny in various skeletal structures; that is, various parts of the skull (Antón, Chap. 16; Williams et al., Chap. 18; Maureille and Braga, Chap. 20; Minugh-Purvis, Chap. 21), pelvis and femur (Berge, Chap. 17), and the limb bones (Nelson and Thompson, Chap. 19). These studies reveal a mosaic of evolutionary changes in the ontogenies of different members of the human lineage. The findings are much more multifaceted than the global changes that fit the simplistic categories of "neoteny" or "sequential hypermorphosis" as they have been offered in the literature on human heterochrony. These chapters are a rich resource of specific data on variation and evolutionary change in the ontogenies of fossil and recent primates and I recommend the book for its wide range of perspectives on human evolution and its relationship to development.

Heterochrony is a theme that appears throughout the entire book. However, many of the examples gave me the impression that the concept of heterochrony no longer can adequately characterize the diverse changes in ontogeny. To me, therefore, the emphasis on heterochrony in this book seems to look back on past battles. Moreover, the chapters differ somewhat in their concepts of heterochrony, as some (e.g., Rice, Chap. 7) use narrower definitions than others (e.g., McNamara, Chap. 5). In general, however, most authors seem to agree that heterochrony has played a major role in human evolution. It is interesting to make the comparison with another recent multiauthored book on a similar topic, edited by Zelditch (2001). The authors of that collection consistently use much more stringent definitions of heterochrony. It is therefore up to the reader to check carefully what it means in each specific case when an author either asserts or denies that heterochrony had an important role for a given evolutionary change.

Whether phrased in terms of heterochrony or not, the evolution of human ontogeny remains a field that offers many more challenging questions. The way forward seems to be a better understanding of the developmental mechanisms, the functional context, and the ecological circumstances that were responsible for specific evolutionary changes. The chapters of this book show that answers are forthcoming.

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Causes and Effects of Human Variation. Edited by Maciej Henneberg. 164 pp. Adelaide, Australia: Australasian Society for Human Biology. 2001. $10.00 plus postage and handling fee of $8.50 (paper).

This volume includes selected papers presented at the 14th Annual Conference of the Australasian Society for Human Biology (ASHB) held 11–13 December, 2000, in Camp Coorong, South Australia. Brown begins with a biography of the life of Thomas Draper Campbell, a pioneer physical and dental anthropologist, who with F. Wood Jones started anthropological studies in South Australia. The articles that follow illustrate the breadth and richness of the physical anthropology whose foundations they helped establish. The articles are quite diverse.

Sigmon argues that language originated after pictorial representation as narrative. Rayner and Bulbeck analyze 15 crown traits on 210 dental casts gathered from five West Malaysian Orang Asli communities and determine that some are likely ancient and shared with circum-Mediterranean and