AGE MARKERS IN THE HUMAN SKELETON

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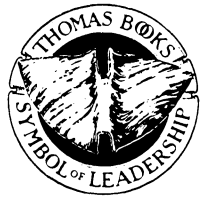
Edited by

MEHMET YAŞAR İŞCAN, PH.D., D-ABFA

Department of Anthropology
Florida Atlantic University
Boca Raton, Florida



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CONTRIBUTORS

Robert P. Andrews received an M.D. from Tufts University in 1963 and is currently the Chief Diagnostic Radiologist at St. Joseph Hospital, Bangor, ME, as well as Chief of Aerospace Medicine for the Maine Air National Guard. He is Board Certified in both diagnostic radiology and Nuclear Medicine and is the author of "Cold Injury," *J. Military Med.,* 1987. Doctor Andrews is the recipient of the American Medical Association Continuing Medical Education Recognition Award and is a member of the American Medical Association, the American College of Radiology, and the Radiology Society of North America.

Gisle Bang earned M.D., D.D.S., and Dr. Med. (Ph.D.) degrees from the Universities of Oslo and Bergen, Norway, and is currently Professor of Oral Pathology and Forensic Odontology at the University of Bergen, Norway. Specializing in pathology and forensic odontology, he has published numerous articles, including "A comparison between the incidence of dental caries in typical coastal populations and inland population with particular regard to the possible effect of a high intake of salt water fish," *Odont. Tidsskrift,* 1964; "Determination of age in humans from root dentin transparency" (with Ramm), *Acta Odont. Scand.,* 1970; "Analysis of tooth marks in a homicide case. Observations by means of visual description, stereo-photography, scanning electron microscopy and stereometric graphic plotting," *Acta Odont. Scand.,* 1976; and Morphological characteristics of the Alaskan Eskimo dentition" (with K. Hasund), *Am. J. Phys. Anthropology,* 1986. Doctor Bang was the recipient of Nyco's Medical Award, the Norsu Taunvern Award, and the Dr. Voss Forensic Medicine Award. He is a member of the International Association of Oral Pathology, the International Society for Forensic Odontostomatology, and the Scandinavian Society for Oral Pathology and Oral Medicine.

Don R. Brothwell is a Professor at Institute of Archaeology, London. His expertise ranges from zooarchaeology to dental anthropology, and his distinguished list of publications includes *Dental Anthropology* (editor),

Pergamon Press, 1963; *Diseases in Antiquity* (edited with A.T. Sandison), Charles C Thomas, 1967; *Animal Disease in Archaeology* (with J. Baker), Academic Press, 1980; and *Digging Up Bones,* Cornell University Press, 1981.

Jane Ellen Buikstra received a Ph.D. from the University of Chicago in 1972 and is now Professor of Anthropology at the University of Chicago, IL. Specializing in skeletal biology and mortuary site archaeology, her extensive list of publications includes *Human Identification: Case Studies in Forensic Anthropology* (co-edited with T. Rathbun), Charles C Thomas, 1984; "Demography, Diet, and Health" (co-edited with J. Mielke), in *Diet and Nutrition in the Archaeological Record,* Academic Press, 1985; "Fertility and the Development of Agriculture in the Prehistoric Midwest" (with L. Konigsberg and J. Bullington), *American Antiquity,* 1986; and *Prehistoric Tuberculosis in the Americas* (editor), Northwestern University Archaeological Program, 1981. Doctor Buikstra was named to the National Academy of Sciences, is a past president and acting director of the Center for American Archeology, and a past president of the American Anthropological Association and the American Association of Physical Anthropologists. She is a member of these organizations and the Society for American Archaeology.

Douglas K. Charles received a Ph.D. in 1985 from Northwestern University and is currently Assistant Professor of Anthropology at Wesleyan University, Middletown, CT. Specializing in mortuary site archaeology and skeletal biology, his publications include "Cementum annulation and age determination in *Homo sapiens.* I. Tooth variability and observer error" (with Condon, Cheverud and Buikstra), *Am. J. Phys. Anthropol.,* 1986; "Cementum annulation and age determination in *Homo sapiens.* II. Estimates and accuracy" (with Condon, Cheverud and Buikstra), *Am. J. Phys. Anthropol.,* 1986; "Behavioral implications of terminal Archaic and Early Woodland mortuary practices in the lower Illinois valley" (with Buikstra and L. Konigsberg) in *Early Woodland Archeology,* K. Farnsworth and T. Emerson (editors), Center for American Archeology Press, 1986; and "Archaic mortuary sites in the central Mississippi drainage: distribution, structure and behavioral implications" (with Buikstra), in *Archaic Hunters and Gatherers in the American Midwest,* J. Phillips and J. Brown (editors), Academic Press, 1983. Doctor Charles was awarded a Leverhulme Trust Commonwealth/United States Visiting Scholar Fellowship in 1985–86 and is a member of the American Anthropological

Association, the American Association of Physical Anthropologists, and the Society for American Archaeology.

James M. Cheverud earned a Ph.D. in 1979 and is now Associate Professor in the Departments of Anthropology and Cell Biology and Anatomy at Northwestern University, Evanston, IL. Specializing in biological anthropology, his publications include "Finite-element scaling applied to sexual dimorphism in rhesus macaque (*Macaca mulatta*) facial growth" (with J. Richtsmeier), *Syst. Zool.,* 1986; "Cementum annulation and age determination in Homo sapiens. I. Tooth variability and observer error" (with Charles, Condon, and Buikstra), *Am. J. Phys. Anthropol.,* 1986; "Cementum annulation and age determination in *Homo sapiens*. II. Estimates and accuracy" (with Charles, Condon, and Buikstra), *Am. J. Phys. Anthropol.,* 1986; and "Epiphyseal union and dental eruption in *Macaca mulatta,*" *Am. J. Phys. Anthropol.,* 1981. Doctor Cheverud has been awarded funding from NSF and is a member of the American Association for the Advancement of Science, the American Association of Physical Anthropologists, and the Society for the Study of Evolution.

Keith Condon received a Ph.D. from the University of Illinois at Chicago in 1987 and is now a research associate in the Department of Zoology at the University of Texas, Austin. Specializing in anatomy, he has published "Cementum annulation and age determination in *Homo sapiens*. I. Tooth variability and observer error" (with Charles, Cheverud, and Buikstra), *Am. J. Phys. Anthropol.,* 1986; "Cementum annulation and age determination in *Homo sapiens*. II. Estimates and accuracy" (with Charles, Cheverud and Buikstra), *Am. J. Phys. Anthropol.,* 1986; "Skeletal changes in the hindlimbs of bipedal rats," *Anatomical Record,* 1987; and "A kinematic analysis of mesokinesis in the Nile monitor, *Varanus niloticus,*" *Experimental Biology,* 1987. Doctor Condon was the recipient of the 1984 Earnest Hooton Award and is a member of the American Association of Physical Anthropologists, the American Society of Zoologists, and the Society for American Archeology.

Aly A. El-Nofely received a Dr. Med. Sci. from the Central Institute of Advances Medical Studies, Moscow, U.S.S.R., and is currently Research Professor at the National Research Centre, Cairo, Egypt. Specializing in dentofacial orthopedics, his numerous publications include "Some observations on the dentition of an isolated group in Northeast Poland," *Am. J. Phys. Anthropology,* 1976; "Anthropometric study of growth of Egyptian Nubian children," *Human Biol.,* 1978; "The influence of some socio-

demographic factors on body weight and stature of 6–18-year-old boys from Cairo," *Anthropol. Anzeiger*, 1985; and "Two improved anthropometric indices for assessment of adiposity and muscularity," *Acta Medica Auxologica,* 1986. Doctor El-Nofely was awarded the Shield and Honorary Certificate of the Egyptian Association of Dental Surgeons. He is a member of Egyptian Association of Dental Surgeons, the Society for the Study of Human Biology, and the Human Biology Council.

Mehmet Yaşar İşcan received a Ph.D. from Cornell University in 1976. Currently a Professor and Chairman of Anthropology at Florida Atlantic University in Boca Raton, FL, he is a Diplomate of the American Board of Forensic Anthropology. Specializing in human osteology and forensic anthropology, he has published numerous books and articles, including *The Human Skeleton in Forensic Medicine* (with Krogman, W.M.), Charles C Thomas, 1986; "Rise of forensic anthropology," *Yrbk. Phys. Anthropol.,* 1988; "An odontometric profile of a prehistoric southeastern Florida population," *Am. J. Phys. Anthropol.,* 1989; and *Reconstruction of Life from the Skeleton* (co-edited with Kennedy, K.A.R.), Alan R. Liss, 1989. Doctor İşcan was awarded the Aleš Hrdlička Fellowship, as well as grants from Florida Atlantic University and the Smithsonian Institution. He is the founder and past president of the Dental Anthropological Association and is a member of the American Anthropological Association, the American Association of Physical Anthropologists, and is a fellow of the American Academy of Forensic Sciences.

Jan Kilian received his MUDr. DrSc. from Charles University (Prague) in 1986 and is now an Assistant Professor at the Faculty Hospital Pilsen, Czechoslovakia. Specializing in pedodontics and forensic stomatology, his publications include "Age determination on teeth by means of Gustafson's method," *Scripta Medica,* 1975; "Traumatic injuries of temporary teeth, therapy and sequelae" (in Czech), *Avicenum,* 1977; "Reliability assessment of criteria for age determination according to teeth in persons above fifteen" (in Czech), *Cs. Stomat.,* 1982; and *Age determination of adult individuals from the teeth* (in Czech), Plžen, 1986. Doctor Kilian has received a number of prizes and honors from the Czech Stomatological Society. He is a member of the board of the Czech Stomatological Society and is currently president of the Pedostomatological Section.

Ferenc Kósa received a C. Sc. Med. from the Hungarian Academy of Sciences, Budapest, in 1971 and is currently Associate Professor and Deputy Director of the Department of Forensic Medicine and Head of

the Laboratory of Paternity Serology at the Albert Szent-Györgyi Medical School, Szeged, Hungary. Specializing in Forensic Pathology, his long list of publications include *Forensic Fetal Osteology* (with Fazekas, I.G.), Akadémiai Kiadó, 1978; "Identifikation des Feten durch Skelettunter suchungen," in *Identifikation,* Hunger, H., Leopold, D. (editors), *Johann Ambrosius Barth,* 1978; and "Atomabsorptions-Spektrophotometrische Untersuchung des Gehaltes archeologischer Knochenfunde an anorganischen Substanzen zur Bestimmung des chronologischer Alters" (with Marcsik, A. Virágos Kis, E., Rengei, B.) *Humanbio.,* 1982. Doctor Kósa was the recipient of the Highest Gold Medal awarded by the Minister of Internal Affairs in 1979 and in 1987 for services rendered in the field of criminalistics. He is a member of the Gesellschaft für gerichtliche Medizin der Deutsche Demokratische Republik, the Deutsche Gesellschaft für Rechtsmedizin, the International Academy of Forensic Medicine, and the European Anthropological Association.

Susan R. Loth received a B.A. in biology from New York University and is a 1989 M.A. candidate in the Department of Anthropology at Florida Atlantic University, Boca Raton, FL. She currently serves as editor of the *Dental Anthropology Newsletter.* Specializing in human skeletal biology, her numerous publications include "Age estimation from the rib by phase analysis: White males" (with M.Y. İşcan and R.K. Wright), *J. Forensic Sci.,* 1984; "Metamorphosis at the sternal rib end: A new method to estimate age at death in White males" (with M.Y. İşcan and R.K. Wright), *Am. J. Phys. Anthropol.,* 1984; "Age estimation from the rib by phase analysis: White females" (with M.Y. İşcan and R.K. Wright), *J. Forensic Sci.,* 1985; and "Racial variation at the sternal extremity of the rib and its effect on age determination" (with M.Y. İşcan and R.K. Wright), *J. Forensic Sci.,* 1987. Ms. Loth was the recipient of the Lambda Alpha National Scholarship Award and Certificate of Distinguished Achievement, a Grant-in-Aid of Research from Sigma Xi, a Short-Term Visitor's Grant from the Smithsonian Institution, and has been inducted into the Honor Society of Phi Kappa Phi. She is a member of the American Association of Physical Anthropologists and the Dental Anthropological Association.

C. Owen Lovejoy received a Ph.D. from the University of Massachusetts (Amherst) in 1970 and is currently Professor of Anthropology at Kent State University, Kent, OH. Specializing in physical anthropology, fossil man, and taxonomy, his numerous publications include "The origin of man," *Science,* 1981; "Chronological metamorphosis of the auricular

surface of the ilium" (with Meindl, R.S., Pryzbeck, T.R., and Mensforth, R.), *Am. J. Phys. Anthropol.,* 1985; "Dental wear in the Libben population: Its functional pattern and role in the determination of skeletal age at death," *Am. J. Phys. Anthropol.,* 1985; and "The radiographic preauricular groove: Its nonrelationship to past pregnancy" (with Spring, D.B.), *Pub. Univ. Cal.* San Francisco, 1987. Doctor Lovejoy is a member of the American Association of Physical Anthropologists, the Institute of Human Origins, and the Human Biology Council.

Claude Masset earned a Ph.D. in 1975 and a Doctorate in Physical Anthropology in 1982. At the present time, he is Chargé de Recherches of the Groupment de Recherches at the Centre National de la Recherche Scientifique (C.N.R.S.), Paris, France. Specializing in paleodemography and prehistory, his extensive list of publications includes "Prehistoire de la Famille," in *Histoire de la Famille, t.I Mondes lointains, mondes anciens,* Burguiere, A., Klapisch-Zuber, C., Segalen, M., Zonaben, F. (editors), *Armand Colin,* 1986; "Paleodemography: Resurrection or ghost?" (with Bocquet-Appel, J.P.), *J. Human Evol.,* 1985; "Demographie des cimetieres? Incertitude statistique des estimateurs en paleodemographie" (with Parzysz, B.), *L'Homme,* 1985; and *Methodes d'etude des sepultures* (editor), C.N.R.S., 1987.

Richard S. Meindl received a Ph.D. from the University of Massachusetts (Amherst) in 1979 and is now an Associate Professor in the Departments of Biology and Anthropology at Kent State University, Kent, OH. Specializing in physical anthropology, demography, and quantitative methods, his publications include "Demographic structure of early human populations," in Jones, J.S. (editor), *Cambridge Encyclopedia of the Human Species,* 1987; "A revised method of age determination using the os pubis, with a review and tests of accuracy of other current methods of pubis symphyseal ageing" (with Lovejoy, C.O., Mensforth, R.P., and Walker, R.A.), *Am. J. Phys. Anthropol.,* 1985; "Hypothesis: A selective advantage for cystic fibrosis heterozygotes," *Am. J. Phys. Anthropol.,* 1987; and "Components of longevity: Developmental and genetic responses to differential childhood mortality," *Soc. Sci. and Med.,* 1982. Doctor Meindl is a member of the American Association of Physical Anthropologists, the American Statistical Association, and the Human Biology Council.

Marcella Harnish Sorg received a Ph.D. from Ohio State University, Columbus, in 1979 and is now a Faculty Associate in the Department of Anthropology, University of Maine, Orono, ME. Specializing in physi-

cal anthropology, she is a Diplomate of the American Board of Forensic Anthropology. Her publications include "Scavenger modification of human remains," *Current Research in the Pleistocene,* 1985: "La formation d'une communaute a Old Town, Maine, 1835–1930: Endogamie et origines natales parmi les Acadiens," in *L'Emigrant Acadien vers les Etats-Unis: 1842–1950,* C. Quintal (editor), Le Conseil de la vie Francaise en Amerique, Quebec, 1984; "Patterns of infant mortality in the upper St. John Valley French population: 1791–1939" (with Craig, B.C.), *Human Biol.,* 1983; and "Isonomy and diabetes prevalence in the Vinalhaven Island population," *Human Biol.,* 1983. Doctor Sorg has served as vice-president of Northeast Research, Orono, ME since 1980 and was the Associate Director of the Center for the Study of Early Man, Institute of Quaternary Studies at the University of Maine. She is a member of the American Association of Physical Anthropologists, the Human Biology Council, and the American Academy of Forensic Sciences.

Sam D. Stout received a Ph.D. from Washington University, St. Louis in 1975 and is currently Professor and Head of Anthropology at the University of Missouri—Columbia, MO. Specializing in skeletal biology, bone histomorphometry, forensic anthropology, he was a member of the scientific team commissioned by the government of Peru to authenticate the remains of Francisco Pizarro. His publications include "Histological structure and its preservation in ancient bone," *Current Anthropol.,* 1978; "The effects of long-term immobilization on the histomorphology of human cortical bone," *Calcified Tissue Int.,* 1982; "Use of histology in ancient bone research" (with Simmons, D.J.), *Yrbk. Phys. Anthropol.,* 1979; and "Histomorphometric determination of formation rates of archaeological bone" (with Teitelbaum, S.L.), *Calcif. Tissue Res.,* 1976. Doctor Stout is a member of the American Association of Physical Anthropologists, the American Academy of Forensic Sciences, and the American Association for the Advancement of Science.

Douglas H. Ubelaker earned a Ph.D. from the University of Kansas (Lawrence) in 1973 and is currently Curator of the Department of Anthropology at the Smithsonian Institution, Washington, DC, and Professorial Lecturer in anatomy and anthropology at George Washington University. Specializing in physical and forensic anthropology, he is a Diplomate of the American Board of Forensic Anthropology and serves as a consultant to both the FBI and the District of Columbia. His distinguished record of publications includes *Reconstruction of Demographic Profiles*

from Ossuary Skeletal Samples, Smithsonian Contributions to Anthropology, Smithsonian, 1974; *Human Skeletal Remains: Excavation, Analysis, Interpretation,* Taraxacum, 1989; *The Ayalan Cemetery: A Late Integration Period Burial Site on the South Coast of Ecuador,* Smithsonian Contributions to Anthropology, 1981; and "Biological History of the Aboriginal Population of North America" (with Jantz, R.) in *Rassengeschichte der Menschheit,* Schwidetzky, I. (editor), Oldenbourg, 1985. Doctor Ubelaker is a Fellow of the American Academy of Forensic Sciences, a member of the American Association of Physical Anthropologists, and the Society of American Archeology.

Emanuel Vlček received his M.D., D.Sc. from Charles University (Prague) and is now Head of the Department of Paleoanthropology at the National Museum of Natural History in Prague, Czechoslovakia. Specializing in paleoanthropology, historical anthropology and forensic anthropology, he has done extensive research on fossil man in central Europe, age and sex determination, facial reconstruction, and paleopathology. His publications include "A contribution to the anthropology of the Khalkha Mongols," *Acta F.R.N. Univ. Comen.* IX, 1965; *Neandertaler der Tschechoslowskei,* Academia Prague, 1969; "Modification of the Gustafson method of the determination of age according to the teeth on prehistorical and historical osteological material" (with Mrklas), *Scripta Medica,* 1975; and "Estimation of age from skeletal material based on the degree of thyroid cartilage ossification" (in Czech), *Soud. Lék.* 1980. Doctor Vlček has won numerous awards including the Prix Broca de la Soc. d'Anthropol. de Paris, the Czech Anatomical Soc. Prize, Medaile A. Hrdlička, and Slovague Academia prize. He is a member of the Society for the Study of Human Biology, the Czechoslovak Anthropological Society, and an honorary member of the Institut Grand-Ducal de Luxembourg.

To
My beloved mother, Ayşe
and
daughter, Meryem Ayşe, my pride and joy

PREFACE

Every so often it is imperative that our knowledge in a particular area of science be reviewed and synthesized in order to gain a clear perspective of the degree of development and direction of a scientific field. In disciplines like paleodemography and forensic anthropology, progress depends on the accuracy of skeletal assessment techniques, and one of the most difficult of these is the estimation of age from the skeleton and dentition. Therefore, this book was planned to provide a comprehensive presentation and evaluation of available technology in this specialty. The chapters provide reviews of the literature with emphasis on recent advances in the methodology of age determination and, where appropriate, actual aging standards. This information should be very helpful to a number of professionals, including forensic scientists, anatomists, biological anthropologists, etc.

It is important to keep in mind that progress, innovation, and expertise are not limited by the borders that separate one country from another. In human osteology, the pursuit of knowledge and excellence is an international objective. Therefore, when the list of individuals with the best qualifications and backgrounds for this book was compiled, the authors chosen represented three continents and seven countries, including Czechoslovakia, Egypt, England, France, Hungary, Norway, and the United States. All of the authors are internationally known and have published significant empirical research on the subject.

The author is most grateful to Susan R. Loth for her editorial work throughout the book and for composing the "Contributors" section from the data provided by each author. William Sheehan helped proofread and check references and figures. Some of the manuscripts were word processed by Leona Glass and Marjorie Wolf, and several papers were first image processed for the computer by Paula Fainberg and Pauline Kartrude. My students and associates, Carol Sheikh, Raymond Martucci, Morton Kessel and Frederick Rose were very helpful with last-minute adjustments of the manuscript. William King and Mahesh Neelankanta

developed a program to index the book. I thank all of these individuals wholeheartedly for their assistance.

Without the diligence and hard work of the contributors themselves, this book would not have materialized. Therefore, they deserve many thanks for their enthusiasm and full support. The cooperation of their publishers in granting permission to reprint their tables and illustrations is also appreciated. As with all editions of this nature, there were unavoidable delays in publication. I am grateful for the patience and understanding of Mr. Payne Thomas, the publisher, and particularly, the authors themselves, especially those who finished promptly and had to wait so long.

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AGE MARKERS IN THE HUMAN SKELETON

PART I: INTRODUCTION

Chapter 1

ASSESSMENT OF AGE AT DEATH IN THE HUMAN SKELETON

Mehmet Yaşar İşcan
Florida Atlantic University
Department of Anthropology
Boca Raton, Florida

In order for a discipline to grow and evolve, it is essential that we periodically assess what has been done and provide for an exchange of methods, ideas, and experiences. One area in which such an assessment is seriously needed is the development and evaluation of criteria for the determination of age from the skeleton and dentition. In forensic, archaeological and demographic studies, the estimation of age at death from the analysis of human skeletal and dental remains is crucial. This has been stressed in a number of books (Acsádi and Nemeskéri, '70; Stewart and Trotter, '54; Stewart '79; Rogers, '82; Krogman and İşcan, '86; Zimmerman and Angel, '86) and review articles (Todd, '39; Cobb, '52; Krogman, '62; Kerley, '70; McKern, '70; İşcan and Loth, '89). Many aspects of the subject of aging have been investigated by various biological scientists (Shock, '60; Woolhouse, '67; Dirken, '72; Behnke et al., '78; Bittles and Collins, '86). However, there are few, if any, books dealing solely with the discovery and delineation of age markers in the human skeleton and the assessment of the morphological variation inherent in the aging process. Furthermore, this decade has witnessed a resurgence of research activity in skeletal aging.

With the advancement of the forensic sciences in the last two decades, a number of "new and improved" skeletal aging techniques have been developed. These include updated studies on bone histology, tooth transparency, histology, and cementum annulation, radiography, gross morphological observations of new structures (e.g., sternal extremity of the rib and auricular surface of the ilium), and adjustments of traditional methods (e.g., pubic symphysis, dental attrition, cranial sutural

closure). Thus, it is essential to have a book whose sole purpose is to integrate the sum total of our knowledge of age assessment and critically reexamine our expectations and perspective in light of new advances.

To this end, this book presents 15 chapters dealing with aging from the skeleton and dentition. Its treatment of traditional as well as the most modern assessment techniques range from fetal beginnings to the extremes of old age.

This book is divided into two parts. The first section contains seven chapters focusing on age estimation from the skeleton beginning with the fetus and continuing with the three major forms of assessment in the adult: direct morphological analysis, radiology, and histomorphometry. The second part presents five chapters analyzing the aging process in the dentition from eruption through tooth wear.

With the exception of growth studies (Flecker, '32; Tchaperoff, '37; Hill, '39; Noback and Robertson, '51; Drennan and Keen, '53), analyses of the fetal and neonatal skeleton have been rather limited, especially in the area of age estimation (Redfield, '70; Weaver, '79). Weaver's work on an American Indian sample shows age-related changes in the development of the tympanic plate until the age of 2.5 years. Redfield classified the development of the occipital bone into four stages, however, only two appear in the fetal period and all four bones of the os occipitalis unite by the age of 7 years. Others associated age with crown rump length estimated from the long bones (Balthazard and Dervieux, '21; Olivier and Pineau, '58; Scheuer et al., '80). By far the major work in not only age estimation but total fetal skeletal analysis is **Forensic Fetal Osteology** by Fazekas and Kósa ('78). In Chapter 2, Ferenc Kósa gives us the benefit of his many years of experience in the field to discuss bone size variation in relation to body size and, in turn, the age of the fetus. Besides his landmark book, the author published numerous papers on this topic and many others. The results presented in this article are based on a simple anthropometric method applied to 138 fetuses ranging in age from the 3rd to the 10th lunar months. Kósa used regression analysis for measurements from the bones of the skull, ribs, shoulder and pelvic girdles, vertebrae, and extremities to relate them first to body height, then to age.

In contrast to the fetal period, bone growth and associated age-related changes in infancy and childhood have been studied extensively (Ubelaker, '87). In Chapter 3, Douglas Ubelaker presents a synthesis of what has been accomplished including the latest advances in the field. His analysis begins with the appearance of ossification centers and concludes with

the union of epiphysis. Along with these gross morphological or radiographic determinations, Ubelaker also discusses the relationship of long bone length to age in subadults. He reviews a number of techniques and warns of the numerous external factors that may affect the skeletal system and, thus, the assessment of age. Some of these derive from psychological stress, hunger, and nutritional inadequacy. For utilitarian purposes, a number of tables with regression formulae are provided for use in actual paleodemographic and forensic cases. Finally, Ubelaker sagely suggests that all appropriate techniques be employed before reaching a decision in order to minimize the effects of factors not directly related to the aging process.

In essence, age estimation in the early years is based on the progression of growth and development which follows similar and predictable sequences across human populations. In the adult, the pattern of aging is not so obvious or easily recognized even from one individual to the next. There are many possible explanations for the unpredictable irregularity of the aging process in adulthood. First, it is characterized by the subtle remodeling of the bones. Furthermore, each adult skeleton is "imprinted" with that individual's experiences and varies further by the complexity of external factors like culture and environment. One example of the extreme variability in this process are the age-related changes in cranial suture closure. In the early part of this century, a number of encouraging studies indicated that age can be estimated from this region of the skeleton. These were followed by equally numerous studies vehemently denouncing suture closure as being totally unreliable (Todd and Lyon, '24; Cattaneo, '37; Singer, '53; McKern and Stewart, '57). In spite of these conflicting opinions, Claude Masset points out that in certain situations this site can be of value when proper methodology is used. Masset's mathematical approach, presented in Chapter 4, is the first to correct for systematic statistical errors resulting from sex differences, the age structure of the reference population in relation to the unknown group, and "attraction of the middle." He indicates that while cranial suture closure cannot provide a precise estimation of age, it can be useful to uncover major demographic shifts over time in a particular cemetery or a skeletal population.

From the 1920s on, most skeletal biologists have relied almost solely on the cranial sutures and pubic symphysis for age estimation in the adult. The 1980s has seen an unquestionable increase in interest in forensic anthropology (İşcan, '88) as well as the introduction of the first aging