

**A FIELD GUIDE FOR
HUMAN
SKELETAL IDENTIFICATION**

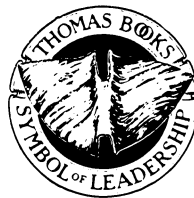
A FIELD GUIDE FOR HUMAN SKELETAL IDENTIFICATION

Second Edition

By

KENNETH A. BENNETT, PH.D.

*Department of Anthropology
University of Wisconsin
Madison, Wisconsin*



CHARLES C THOMAS • PUBLISHER
Springfield • Illinois • U.S.A.

Published and Distributed Throughout the World by

CHARLES C THOMAS • PUBLISHER
2600 South First Street
Springfield, Illinois 62794-9265

This book is protected by copyright. No part of
it may be reproduced in any manner without
written permission from the publisher.

© 1993 by CHARLES C THOMAS • PUBLISHER

ISBN 0-398-05884-9

Library of Congress Catalog Card Number: 93-14458

First Edition, 1987
Second Edition, 1993

With THOMAS BOOKS careful attention is given to all details of manufacturing and design. It is the Publisher's desire to present books that are satisfactory as to their physical qualities and artistic possibilities and appropriate for their particular use. THOMAS BOOKS will be true to those laws of quality that assure a good name and good will.

Printed in the United States of America
SC-R-3

Library of Congress Cataloging-in-Publication Data

Bennett, Kenneth A.

A field guide for human skeletal identification / by Kenneth A.
Bennett.—2nd ed., rev. and expanded.

p. cm.

Includes bibliographical references.

ISBN 0-398-05884-9

1. Forensic anthropology—Tables. 2. Anthropometry—United
States—Tables. 3. Human skeleton—Tables. I. Title.

GN69.8.B46 1993

573'.6'0212—dc20

93-14458

CIP

INTRODUCTION AND PREFACE TO THE SECOND EDITION

The identification of unknown human skeletal remains should ideally be carried out under laboratory conditions, where sufficient time and equipment are available for the forensic anthropologist to arrive at the most carefully reasoned set of estimates possible. Over the last 25 years of practice in this area, however, a significant number of my examinations have been performed in the open field, in basements of rural funeral parlors and city morgues, in small non-equipped rooms at state crime laboratories and other law enforcement agencies, sometimes in animal health care facilities, and in various other locations where conditions were far less than optimal. In addition, examination times have often been limited due to the sensitivity of the particular case, to hasty funeral arrangements by relatives who for personal reasons resist having their kin subjected to post-mortem trauma, and at times by law enforcement officials who were understandably anxious to begin their investigations. As unfortunate as this may be, it is nevertheless a practicality that is unlikely to change. Under such conditions, therefore, it would seem advantageous for forensic anthropologists to have quick access to information pertinent to procedures involved in human identification, especially of the sort that is not easily consigned to memory.

This manual attempts to serve that purpose. It is designed solely as a reference guide for the professional forensic anthropologist to utilize in the field, and it thus presupposes an expert knowledge of human skeletal and dental anatomy, including the ability to identify small fragments and the side of the body to which they belong. It also assumes a mastery of measurement techniques and thorough familiarity with bony landmarks, as well as observational skills necessary for identifying changes in the hard tissues due to trauma, disease or age. It likewise presumes a working knowledge of the past and present literature in forensic anthropology, especially with respect to the advantages of some techniques and inherent limitations of others. Indeed, most professionals should be quite familiar with the information contained here, because it has been either abstracted or reprinted from the available literature.

This manual is divided into the four most fundamental areas of human

identification: ethnic affiliation, attribution of sex and estimations of age and stature. I have tried to be comprehensive in each of these sections, but make no rash claims about completeness of coverage. Efforts were made to be judicious in the selection of the most appropriate and accurate methods and techniques and, in this context, there are some conspicuous omissions. Methods that have been shown to be generally unreliable or that have low predictive capabilities, such as age determination by cranial suture closure, are not mentioned. Nor are techniques that can be carried out only in the laboratory, including age determinations by dental histological methods, cumulative microstructural changes in the bone cortex and x-ray analysis of the resorption of cancellous bone. Also not included are the many studies of discriminant function sexing of individuals from populations with no records of sex, as among prehistoric American Indians, because there is an element of circularity in these analyses. Finally, the methods presented here have been developed almost exclusively from population samples in the United States and may not be applicable to individuals from other populations.

The field of forensic anthropology has reached a stage where nearly all major bones of the body, and even parts of those bones, can be used in a wide variety of different combinations to estimate with high degrees of accuracy the sex, age and ethnic affiliation of unidentified human skeletal remains. Because many new techniques and modifications of older ones have been developed since first publication of *A Field Guide for Human Skeletal Identification* in 1987, it seemed appropriate to bring the guide up-to-date by incorporating these new advances into a revised edition.

Among the more important changes in this edition are the following:

1. Cranial and post-cranial discriminant function coefficients for determining ethnic affiliation and sex, generated from measurements taken on individuals represented in the Forensic Data Bank at the University of Tennessee in Knoxville. These coefficients are particularly welcome in light of the growing evidence that they are more applicable to modern individuals than those developed from the older anatomical collections, perhaps because of a secular trend over the last several generations toward gracility among modern groups.

2. Substitution of the Suchey-Brooks method for the Gilbert-McKern method for age determination by pubic symphysis maturation, especially because the former appears to be more accurate for females.

3. Inclusion of age estimates for males and females by sternal rib metamorphosis, which allows estimates to be made on individuals older than allowed for by pubic symphysis maturation.

It is hoped that these and other additions, including new corrections for age in estimating stature in older adults, will make the guide more useful during the process of human identification.

CONTENTS

| | <i>Page</i> |
|---|-------------|
| <i>Introduction and Preface to Second Edition</i> | v |
| METRIC DATA FOR THE ATTRIBUTION OF ETHNIC AFFILIATION | |
| Table 1. Discriminant Function Weights for Distinguishing American Whites from American Blacks on the Basis of Cranial Measurements | 5 |
| Table 2. Discriminant Function Coefficients for the Assessment of Ethnic Group by Pelvic Measurements | 6 |
| Table 3. Unstandardized Discriminant Function Coefficients and Structure Coefficients for Distinguishing American Whites from American Blacks and the Sexes on the Basis of Pelvic and Femoral Dimensions | 7 |
| Table 4. Unstandardized Discriminant Function Coefficients for Distinguishing American Whites from American Blacks: Functions from the Forensic Data Bank, University of Tennessee, Knoxville | 9 |
| Table 5. Discriminant Function Coefficients for Distinguishing American Whites from American Blacks on the Basis of Cranial Measurements | 12 |
| NON-METRIC AND METRIC DATA FOR THE ATTRIBUTION OF SEX | |
| Table 6. Traits Diagnostic of Sex in the Skull | 15 |
| Table 7. Sex Differences in Pelvic Morphology | 16 |
| Table 8. Phenice's Criteria for the Attribution of Sex | 17 |
| Table 9. Discriminant Function Sexing by Cranial Measurements | 18 |
| Table 10. Discriminant Function Sexing by Mandibular Measurements | 19 |
| Table 11. Discriminant Function Sexing of American Blacks by Combined Cranial and Mandibular Measurements | 20 |
| Table 12. Multiple Regression Equations for Predicting the Sex of Crania by Cranial Base Measurements | 21 |
| Table 13. Discriminant Function Sexing by Post-Cranial Measurements | 22 |

| | |
|---|----|
| Table 14. Discriminant Function Sexing of American Blacks by Pelvic Measurements | 23 |
| Table 15. Discriminant Function Sexing of American Whites by Pelvic Measurements | 24 |
| Table 16. Discriminant Function Sexing of the Tibia | 25 |
| Table 17. Discriminant Function Sexing of the Calcaneus and Talus | 27 |
| Table 18. Discriminant Function Coefficients for Distinguishing American Whites and American Blacks on the Basis of Cranial Measurements | 28 |
| Table 19. Discriminant Function Coefficients for Distinguishing Sex of American Whites on the Basis of Humerus Measurements | 29 |
| Table 20. Discriminant Function Coefficients for Distinguishing Sex of American Whites on the Basis of Femur Measurements | 30 |
| Table 21. Unstandardized Discriminant Function Coefficients for Distinguishing Sex: Functions from the Forensic Data Bank, University of Tennessee, Knoxville | 31 |
| Table 22. Unstandardized Discriminant Function Coefficients for Determining Sex in American Whites: Radius and Ulna | 34 |
| Table 23. Regression Coefficients for Predicting Sex of Tibias | 35 |

METRIC AND NON-METRIC DATA FOR THE ESTIMATION OF AGE

| | |
|---|----|
| Table 24. Approximate Times of Union of Primary Centers of Ossification from Birth to About Six Years | 39 |
| Table 25. Tooth Formation Stages and Their Coded Symbols Relative to Figures 1, 2, 4 and 5. The Deciduous Canine and Molars | 40 |
| Table 26. Root Resorption Stages and Their Coded Symbols Relative to Figures 3, 6 and 7. The Deciduous Canine and Molars | 41 |
| Table 27. Tooth Formation Stages and Their Coded Symbols Relative to Figures 8 Through 13. The Permanent Dentition | 49 |
| Table 28. Mean Ages and Sex Differences in Tooth Calcification and Eruption of the Permanent Premolars and Molars | 58 |
| Table 29. The Age Distribution of Stages in Closure in the Spheno-Occipital Synchronosis | 59 |
| Table 30. The Age Distribution of Complete Union for the Long Bone Epiphyses (in %) | 60 |
| Table 31. The Age Distribution for Stages of Union for the Long Bone Epiphyses (in %) | 61 |
| Table 32. Epiphysis on Iliac Crest: Age Distribution of Stages of Union (in %) | 62 |
| Table 33. Epiphysis on Ischium: Age Distribution of Stages of Union (in %) | 63 |
| Table 34. Age Distribution of the Stages of Union for the Medial Clavicular Epiphysis (in %) | 64 |

| | |
|--|----|
| Table 35. The Age Distribution of Stages of Union for the Superior and Inferior Epiphyseal Rings of the Pre-Sacral Column as a Whole (in %) | 65 |
| Table 36. Age Distribution of Stages of Union for the Epiphyses of the Vertebral Spines (in %) | 66 |
| Table 37. Age Distribution of Stages of Epiphyseal Union for the Acromion, Inferior Angle, and Medial Border of the Scapula (in %) | 67 |
| Table 38. Progress of Fusion Between Second and Third Segments of the Corpus Sterni—At Level of Attachment of Fourth Ribs (in %) | 68 |
| Table 39. Progress of Fusion Between First and Second Segments of the Corpus Sterni—At Level of Attachment of Third Ribs (in %) | 69 |
| Table 40. Progress of Maturation of the Clavicular Notch (in %) | 70 |
| Table 41. Age Distribution for Stages of Union Between the Segments of the Sacrum (in %) | 71 |
| Table 42. Rib Head Epiphyses: Age Distribution of the Percentage of Complete Union | 72 |
| Table 43. Age Distribution of the Stages of Union for Epiphyses of the Medial Clavicle in Males (in %) | 73 |
| Table 44. Age Distribution of the Stages of Union for Epiphyses of the Medial Clavicle in Females (in %) | 74 |
| Table 45. Age Distribution of the Stages of Union for Epiphyses of the Anterior Iliac Crest in Males (in %) | 75 |
| Table 46. Age Distribution of the Stages of Union for Epiphyses of the Anterior Iliac Crest in Females (in %) | 76 |
| Table 47. Descriptions of the Developmental Stages for Each of the Three Components of the Pubic Symphysis According to the McKern and Stewart System. Males | 77 |
| Table 48. Male Ages and Standard Deviations Predicted from Symphyseal Scores in the McKern and Stewart System by Regression Equations | 79 |
| Table 49. Descriptions of the Developmental Stages for Age Determination by Pubic Symphysis Maturation According to the Suchey-Brooks System. Unisex | 80 |
| Table 50. Descriptive Statistics Related to the Suchey-Brooks Pubic Age Determination System | 81 |
| Table 51. Descriptions of Sternal Rib Metamorphosis in Males | 86 |
| Table 52. Descriptions of Sternal Rib Metamorphosis in Females | 90 |

EQUATIONS AND TABLES FOR THE ESTIMATION OF STATURE

| | |
|---|----|
| Table 53. Equations to Estimate Living Stature (cm)—with Standard Errors—from the Long Bones of American Whites and Blacks between 18 and 30 Years of Age | 97 |
|---|----|

| | |
|---|-----|
| Table 54. Expected Maximum Stature from Long Bone Lengths (maximum) for American White Males | 98 |
| Table 55. Expected Maximum Stature from Long Bone Lengths (maximum) for American Black Males | 100 |
| Table 56. Expected Maximum Stature from Long Bone Lengths (maximum) for American White Females | 102 |
| Table 57. Expected Maximum Stature from Long Bone Lengths (maximum) for American Black Females | 104 |
| Table 58. Amounts, in Millimeters, that Should be Subtracted from Maximum Stature Estimates to Compensate for the Decline in Stature due to aging for ages 46 to 85 | 106 |
| Table 59. Calculation of Stature (in cm.) from Long Bones of Indigenes of Central Mexico | 107 |
| Table 60. Ratio of Long Bones to Stature Among the Indigenes of Central Mexico. Males | 108 |
| Table 61. Ratio of Long Bones to Stature Among the Indigenes of Central Mexico. Females | 111 |

**A FIELD GUIDE FOR
HUMAN
SKELETAL IDENTIFICATION**

**METRIC DATA FOR THE ATTRIBUTION
OF ETHNIC AFFILIATION**

TABLE 1
Discriminant Function Weights for Distinguishing American Whites from
American Blacks on the Basis of Cranial Measurements

| Measurement | Male Weights | Female Weights |
|--------------------------|--------------|----------------|
| Basion-prosthion | + 3.06 | + 1.74 |
| Glabello-occipital lgth. | + 1.60 | + 1.28 |
| Max. width | - 1.90 | - 1.18 |
| Basion-bregma hgt. | - 1.79 | - 0.14 |
| Basion-nasion | - 4.41 | - 2.34 |
| Max. bizygomatic dia. | - 0.10 | + 0.38 |
| Prosthion-nasion hgt. | + 2.59 | - 0.01 |
| Nasal brdth. | + 10.56 | + 2.45 |

Notes: The test sample included 108 White males, 79 White females, 113 Black males and 108 Black females from the Terry and Todd collections. Age, sex and ethnic group were known.

Male sectioning point: Above 89.27 = Black; below 89.27 = White

Female sectioning point: Above 9.22 = Black; below 9.22 = White

Stated accuracy: White males = 80%; White females = 88%

Black males = 85.4%; Black females = 88%

Source: Giles, Eugene and Orville Elliot 1962 Race identification from cranial measurements. *J. For. Sci.* 7: 147-157. Copyright ASTM. Reprinted with permission.