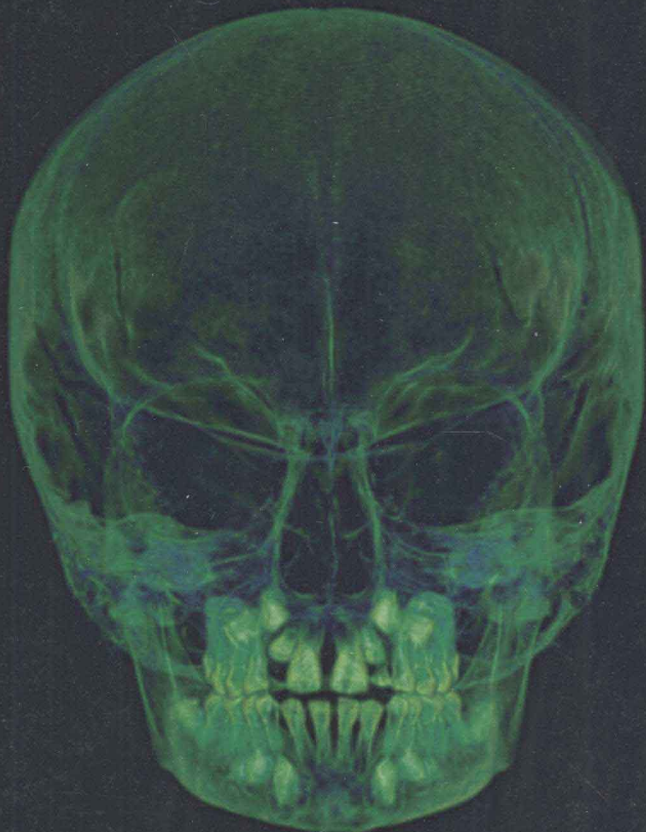


FORENSIC ANTHROPOLOGY

2000 TO 2010



**EDITED BY
SUE BLACK AND EILIDH FERGUSON**



CRC Press
Taylor & Francis Group



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Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

Taylor & Francis
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

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Taylor & Francis is an Informa business

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Printed in the United States of America on acid-free paper
10 9 8 7 6 5 4 3 2 1

International Standard Book Number: 978-1-4398-4588-2 (Paperback)

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Library of Congress Cataloging-in-Publication Data

Forensic anthropology : 2000 to 2010 / editors, Sue Black and Eilidh Ferguson.

p. cm.

Includes bibliographical references and index.

ISBN 978-1-4398-4588-2

1. Forensic anthropology. I. Black, Sue M. II. Ferguson, Eilidh. III. Title.

GN69.8.F645 2011

614'.17--dc22

2010034505

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Foreword

A summit of world leaders meeting at Lyon in 1996, when Bill Clinton was U.S. president, decided to establish an International Commission on Missing Persons (ICMP). The heads of government had agreed that if there was ever to be reconciliation in the former Yugoslavia, it would be necessary to investigate the fate of those who had disappeared during the conflict and to identify the remains of as many as possible of those who lost their lives. Senator Robert Dole, whom Clinton had defeated for the U.S. presidency, took the chair, and after an interval I was appointed a commissioner, having been U.K. secretary of state for defense during the last phase of the wars. The ICMP embraced a task unprecedented in its scale, seeking to identify up to 40,000 bodies using blood samples taken from 100,000 relatives, many of whom were refugees living abroad.

A little later, I became aware of the important work being undertaken by Professor Sue Black at the University of Dundee and was honored to launch her BSc honors course in forensic anthropology in 2003.

The usefulness of identifying victims had by then been underlined in Kosovo, where Sue had served. The ICMP had also offered its services to New York City after September 11, 2001, and to Iraq after the Allied invasion. Identification became an issue in Chile, Argentina, and even Spain, as it dealt with the secrets of its civil war and postwar repression. This interested me because my father was a refugee from that war, being on the losing side. Not that identification always seems to me to be the right course of action: as they exhumed the remains presumed to belong to Federico García Lorca, I yearned for the poet to be allowed to rest in peace. At least we now know where his bones do not lie.

On the Dundee campus, Sue Black was wrestling with a paradoxical and unsatisfactory phenomenon. Television programs about forensic work in criminal cases were producing a flood of applicants for undergraduate courses, but the students' preparation and academic quality were often poor. She was determined to change that by establishing the BSc course on rigorous academic lines, and as a result her department, current students, and former students have earned a reputation for excellence.

Even so, it is an admirable achievement that a cohort of undergraduates can produce a textbook for their peer group: a collection of topic reviews that prove how much they have learned and that passes that knowledge to contemporaries

in their field and to future cohorts. The students are to be congratulated heartily, but they will know well that their work is a tribute to Sue Black and her colleagues in the Centre for Anatomy and Human Identification.

Advances in our ability to capture DNA from skeletal remains and the development of forensic anthropology make it possible to identify more of the victims of homicide, mass-fatality disasters, and genocide. Establishing an identity helps to define a crime, and that makes it possible for a criminal investigation to be launched. I believe that this scientific progress makes detection, prosecution, and conviction more likely, and it is essential that we remain current with the scientific literature. That, I hope, makes warlords and tyrants ponder, for now the most abominable crimes are not beyond the reach of justice.

Rt. Hon. Michael Portillo

Foreword

I am so pleased to be able to provide a Foreword to this book. In thinking about what to say, I remembered my first accepted writings in the early 1980s and what a supreme pleasure it gave me to complete a manuscript, to receive correspondence of its acceptance, and then to see proofs of how it would look in print. It was for me an exciting accomplishment, and I imagine it will be so for the student authors who have worked so hard on this book.

This volume is based on selected themes that are fundamental to contemporary forensic anthropology. Each chapter gives an overview of the theme under discussion, identifies present trends in research, and suggests areas in which future research could be developed. Chapters conclude with bibliographies focused on the past decade of publications dealing with advances in chapter themes, as well as key readings prior to 2000. The bibliographies in some ways are the heart of the book, assembled with students in mind to provide them a foundation for a reference library. And, the book will no doubt be helpful to professionals as well.

What better gift to students on the part of their professors than to encourage and support them in developing their first publication, as undergraduates no less, and what better learning experience than to actually complete the project? This opportunity is a sign of trust in their students and their future contributions. It is hoped that this publication will be an inspiration and sign for students around the globe: They also have much to contribute.

William D. Haglund, PhD

Preface

In 2002, when I was in my fourth year of duty as a forensic anthropologist in Kosovo, the Foreign and Commonwealth Office funded some studentships for individuals to gain practical experience in a mass fatality mortuary. Watching, listening, and working with those students made me realize a number of things, and when the University of Dundee offered me the opportunity to develop a degree program in forensic anthropology in 2003, I decided that it would be an undergraduate and not a postgraduate program that would include a full year of gross anatomy dissection. I had realized in Kosovo that although the students' understanding of the osteology side of our subject was admirable, their depth of knowledge in relation to soft tissue anatomy was largely poor, and I felt that anatomically trained forensic anthropologists would provide a skills base for our students that would prove highly beneficial—as it had to me in my training. Even though there may not be many jobs out there for forensic anthropologists, there is a world shortage of gross anatomists, and this not only would offer the best opportunity for future employment for our students but also would serve well to enhance the skills of our future practitioners in forensic anthropology.

In 2003, the Right Honourable Michael Portillo launched the bachelor of science (honours) program in forensic anthropology at the University of Dundee. His understanding of the importance of identification was a driving force behind his commitment to the exhumations and identifications associated with the Spanish Civil war in particular and entrenched his association with the International Commission on Missing Persons (ICMP). He has proved to be a great supporter of the Dundee program.

The undergraduate degree in forensic anthropology was the first of its kind in the United Kingdom, and its aim was not to graduate hundreds of students every year but rather to train a small and selective number of students who would exit with a solid understanding of science, biology, anatomy, and osteology and its application to matters of forensic relevance. We restrict our intake to only 25 students every year, and we have over 300 applications a year to gain entry to the program. While studying, the student must maintain a high pass rate to remain in the program. This results in a highly motivated student group that is academically capable and committed to the subject.

Each year, I have watched as our undergraduate students submit essays and literature reviews that rival the quality seen in many master's programs,

and it was felt that so much more could be achieved if the students did not have to cover the same ground every year in searching out the basic literature. The idea for this project was born during a lecture given to our students by the inspirational Bill Haglund, who has been a firm supporter of the project; I am inordinately grateful to him. Persuading a publishing company to take on an undergraduate text written by undergraduates was actually easier than I could have imagined. Becky Masterman at Taylor and Francis is an ambitious, accomplished, and inspirational editor who is not afraid to take a risk on new challenges, so a tight deadline was set to ensure that publication was within the 2010 academic year to fulfill the requirements for the decade-long literature review.

A member of staff was assigned to each chapter to ensure that the quality was suitable for publication and that the full spectrum of the subject, if possible, was addressed. However, the basis for each section was student initiated, and they decided the headings to be addressed and the partnerships for each chapter that would be submitted as a part of their in-course assessment. As a result, there is some variation in the way in which the students (and staff) have chosen to present their part of this review. Some have included all the references in the text, some have produced an additional reading list, and some have chosen to provide a full review list but omit individual references from the text simply because it broke the text up into an almost unreadable, fragmented format. Therefore, we ask that you, the student reader, accept that this text was produced by students to assist your literature search, and it is not intended to be an erudite and academic discourse on forensic anthropology. Of course, there are areas that are not covered, and certainly there are some parts that are better written than others, but with patience, please realize that these chapters represent coursework from an undergraduate program, and the aim is purely to provide a literature review from the decade 2000 to 2010. Its true value lies in the accumulation of references.

I have been fortunate to lead the Centre for Anatomy and Human Identification (CAHID; <http://www.lifesci.dundee.ac.uk/CAHId/>) for the past seven years, and I am inordinately proud of the achievements of all of our students and none more so than the class of 2010, who have been responsible for this text.

Professor Sue Black, OBE, BSc, PhD, DSc, FRSE, FRAI, HFRCPSG
Director, CAHID

Acknowledgments

I would like to acknowledge the good grace with which each member of the Centre for Anatomy and Human Identification (CAHID) undertook this task at a time in their academic year that was already fraught with pressures. In particular, my thanks go to Eilidh Ferguson, who willingly accepted the role of coeditor, and to Caroline Needham, who designed the cover of this text. Warm thanks are extended to Becky Masterman at Taylor and Francis, who was prepared to take the brave step of publishing a text produced by undergraduate students (a first, we think), and to Jill Jurgensen and Jay Margolis, also at Taylor and Francis, who made the transition as pain free as they possibly could.

Contributors

All participants in this text either worked or studied in the Centre for Anatomy and Human Identification (CAHID) at the University of Dundee.

At the time of writing, the following students were studying for their undergraduate honours bachelor of science degree in forensic anthropology:

Neal Archibald BSc	Iain Armstrong BSc
Joanne Bristow BSc	Sally Carr BSc
Louise Cullen BSc	Kylie Davidson BSc
Catriona Davies BSc	Charlotte Dawson BSc
Susan Edmond BSc	Eilidh Ferguson BSc
Rachel Gilchrist BSc	Natalie Kerr BSc
Nicholas Lockyer BSc	Aymie Maxwell
Stacey Purves BSc	Duncan Ross BSc
Zoe Simms BSc	Sarah Voogt BSc
Kayleigh Wood BSc	Lianne Woodley BSc
Katie Nicoll Baines BSc	

All other participants are members of staff within CAHID:

Sue Black is the professor of anatomy and forensic anthropology and director of the centre. She is a founder and director of the Centre for International Forensic Assistance (CIFA), founder and past president of the British Association for Human Identification, and advisor to the Home Office on issues pertaining to disaster victim identification (DVI). She is a Fellow of the Royal Society of Edinburgh, a Fellow of the Royal Anthropological Institute, and an honorary Fellow of the Royal College of Physicians and Surgeons of Glasgow. She was awarded an Order of the British Empire (OBE) in 2001 for her services to forensic anthropology in Kosovo, the Lucy Mair medal for humanitarian services in anthropology, and a police commendation in 2008 for DVI training.

Jan Bikker is a postdoctoral researcher working on an FP7 research grant partnered with Interpol. He holds a doctoral degree from the University of Sheffield on the subject of disaster victim identification, with the research carried out in the Department of Forensic Pathology and the School of Medicine. He has gained experience in the recovery, examination, and identification

of fresh, decomposed, fragmented, burned, and skeletal remains in international disasters, including those in Thailand, Peru, and more recently the 2010 earthquake in Haiti. He has also been working for Her Majesty's Coroner and local police forces in the United Kingdom. Jan is currently a council member for the British Association for Human Identification (BAHID). Research interests include disaster and mass grave victim identification, soft tissue identification of human remains, biological human variation, and taxonomical models.

Craig Cunningham is a lecturer in anatomy and forensic anthropology. He holds a joint honors bachelor of science degree in anatomical and physiological sciences and a doctorate in anatomy and forensic anthropology. He is module leader for the juvenile human osteology course undertaken by all forensic anthropology undergraduates at the University of Dundee and has responsibility for the curation of the unique Scheuer collection of juvenile skeletal remains housed at the center. His research involves investigating the microarchitecture of the developing skeleton through the use of noninvasive imaging techniques.

Roos Eisma is currently a postdoctoral researcher, having achieved a first-class degree in forensic anthropology at the centre. Her work focuses on establishing Thiel soft-fix embalming at CAHID and exploring the use of Thiel-embalmed cadavers in training and research. Due to her previous background in physics and computing, her further research interests include virtual forensic anthropology based on computed tomography (CT).

Eilidh Ferguson was nominated to be coeditor for this text by her student peers. She graduated with a first-class honours bachelor of science degree in forensic anthropology from the Centre for Anatomy and Human Identification at the University of Dundee. Eilidh served as class representative during her period of study at the university, and this is her first venture into publications.

Lucina Hackman is the National U.K. DVI program coordinator for the advanced mortuary training program. She teaches undergraduate and postgraduate students and supervises research projects. She is studying parttime for a doctoral degree under the supervision of Professor Black, and her area of specialty is in the assessment of age in the living for the purposes of assisting investigations in asylum seekers and refugees. She has coauthored a chapter in a recent text on this subject and is coeditor of two texts related to DVI. She holds a master of science degree in biological and forensic anthropology and is a consultant on the Virtual Anthropology Service run by the University of Dundee. She has worked a significant number of forensic cases both within

the United Kingdom and overseas and is a registered expert on the National Police Improvements Agency register.

Won-Joon Lee is a graduate of Chonnam National University in the Republic of Korea. Following graduate work in human identification at the University of Dundee, he is now undertaking doctoral research on the accuracy of forensic facial reconstruction and recognition of the human face.

Stenton MacKenzie graduated with a master of science in human identification from the centre. He completed a postgraduate certificate in human anatomy and is currently a Greenhouse-funded doctoral student at the centre studying craniofacial changes in transsexuals.

Xanthé Mallett is a lecturer in forensic anthropology. She holds a first-class bachelor of sciences (honours) degree, a master of philosophy (Cantab), and a doctorate in forensic facial recognition. She has considerable experience as a forensic anthropologist, undertakes casework and research, and teaches both undergraduate and postgraduate students in techniques of human identification. Her research largely relates to human biometrics, looking at quantifiable analysis of both the face and the hands; currently, her main direction is the development of a research stream relating to hand comparison analysis. She has also worked on a major collaborative biometrics project in association with the U.S. Federal Bureau of Investigation (FBI).

Stella McClure is a lecturer in anatomy and lead in undergraduate clinical anatomy with a special interest in medical and dental education.

Caroline Needham is a lecturer in medical art for the master of science programs in medical and forensic art. As well as teaching, she is responsible for much of the course planning and coordination. She completed a two-year master of philosophy in medical art in 2002. Since this time, she has been working as an artist in the fields of medical, forensic, and archaeological sciences. Her previous research included the reconstruction of individuals whose archaeological skeletal remains showed evidence of disease or trauma. These were presented as two-dimensional reconstruction illustrations. Her research interests are currently focused around a parttime doctoral degree in medical visualization, looking at the use of virtual reality technologies and haptic feedback in anatomy teaching.

Patrick Randolph-Quinney is lecturer and course leader for the undergraduate program in forensic anthropology. He holds a bachelor of science degree in archaeological sciences and a doctoral degree in biological anthropology. He originally started his academic life as an archaeologist specializing in the

recovery and analysis of human skeletal remains and has directed long-running excavations in southern Africa, investigating human evolution during the Middle Pleistocene. His research interests include the forensic quantification of modern human variation through the use of geometric morphometrics and statistical analysis of shape, the analysis of skeletal trauma using three-dimensional (3D) imaging and experimental biomechanical analyses, and the effects of burning on the human body. He is actively involved in forensic casework and acts as a consultant to U.K. police forces in the areas of forensic anthropology, forensic archaeology, and body recovery.

Christopher Rynn has a background in anatomy and medicoforensic art and a doctoral degree in forensic facial reconstruction, specifically dealing with the prediction of the nose from the skull. Since 2007, he has worked in CAHID on the U.K. DVI police training courses, the master of science forensic and medical art course, and a number of facial reconstruction and forensic image enhancement and comparison cases. He is currently researching the facial imaging component of the FASTid project at Interpol.

Roger Soames is the principal anatomist for the University of Dundee and currently holds the Cox Chair of anatomy. His main interest is in the maintenance and promotion of anatomy as a discipline in terms of teaching, research, and training. During his career, he has been involved in the development of several new programs of study, as well as a large number of anatomy-related individual modules, the most recent new program being the master of science degree in human anatomy at Dundee. His main research interests focus on the musculoskeletal system, although he remains interested in all aspects of clinical and surgical anatomy.

Caroline Wilkinson is a senior lecturer in forensic anthropology. She is an expert in facial anthropology and author of *Forensic Facial Reconstruction*. Her main research focuses on the relationship between the soft and hard tissues of the face, juvenile facial reconstruction, facial recognition, anthropometry, and facial image analysis. Previous research has included the analysis of juvenile facial tissues using ultrasound measurements, facial reconstruction standards, facial reconstruction accuracy studies, skull reassembly, the use of facial reconstruction in Egyptology and archaeology, and juvenile facial reconstruction. She developed and assessed a computerized facial reconstruction system employing “virtual” sculpture, which is now in use within the United Kingdom for forensic identification and internationally for archaeological investigation.

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Age Determination in the Juvenile

1

KAYLEIGH WOOD
DR. CRAIG A. CUNNINGHAM

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Introduction

Age determination is a principal element in both anthropological and archaeological investigations (Cattaneo 2009a). It is generally assessed through the analysis of maturational milestones that manifest in the skeleton and dentition. Indicators of skeletal maturity can be used in both clinical and forensic examinations to assess developmental status; from this, chronological age may be inferred (Lewis and Ruttly 2003). In a forensic context, the estimated age at death of the deceased constitutes a fundamental component of the biological profile, which is used by anthropologists to narrow the range of potential matches during the process of identification (Scheuer and Black 2007). Indeed, when presented with juvenile remains, the age at death is often the only biological parameter that can be determined with any degree of accuracy (Scheuer and Black 2000). However, age determination is not limited to situations involving individuals who are deceased and can also be utilized to assess age in the living (Cattaneo 2009b). This can be important in certain judicial circumstances, when authorities require age to be established

to determine an appropriate course of action (Lewis and Rutty 2003). Such circumstances can be civil or criminal and can include cases involving pedo-pornography; sex with a minor; lack of legitimate identification; and criminal culpability (Lewis and Rutty 2003; Cunha et al. 2009). Age determination can also be important in clinical cases for the diagnosis of pathological versus normal growth and development (Scheuer and Black 2000). This chapter provides a review of the literature that has addressed age determination in the juvenile skeleton for the purposes of the objectives mentioned. This includes a discussion of the increasingly sophisticated investigative methods employed in juvenile age assessment combined with an evaluation of the accuracy and limitations inherent in the utility of these techniques.

Prior to discussion of the recent juvenile age assessment literature, it is appropriate to define the developmental boundaries addressed. The term *juvenile* refers to a minor and, for the purposes of this chapter, encompasses all subadult stages of maturation. In the literature, the juvenile life span is commonly divided into the following developmental phases: prenatal (prior to birth); infancy (birth to 1 year); childhood (1 year to adolescence or puberty); and adolescence (Ritz-Timme et al. 2000; Scheuer and Black 2004). In the United Kingdom, the age of 18 years is the threshold that legally defines adult status; therefore, this chapter only considers the age assessment literature dealing with individuals below this age. Details regarding postadolescent events are described in Chapter 2.

Trends in the Literature

The common methods available for juvenile age assessment are perfunctorily discussed in textbooks on the general subject of forensic anthropology (Scheuer and Black 2007; Lewis 2007; Cattaneo 2009a) and in numerous reviews (Ritz-Timme et al. 2000; Schmeling, Olze, et al. 2004; Schmeling, Reisinger, et al. 2006; Schmeling et al. 2007; Konigsberg et al. 2008; Cunha et al. 2009; Franklin 2010). Such texts, particularly the concise contributions by Saunders (2000), Scheuer and Black (2007), Cattaneo (2009a; 2009b), Cunha et al. (2009), and Franklin (2010), provide general overviews of the area and are useful as summaries for both students and practicing anthropologists. However, the remaining majority are repetitive and simply reiterate information previously available. For example, certain articles combine the discussion of techniques available for adult and juvenile material without providing an adequate coverage of the range of techniques specific to juveniles (Ritz-Timme et al. 2000; Schmeling, Reisinger, et al. 2006; Schmeling et al. 2007). Fortunately, core texts have been produced that go some way to alleviate this inadequacy in the anthropological literature (Scheuer and Black 2000, 2004; Baker et al. 2005; Schaefer et al. 2009).