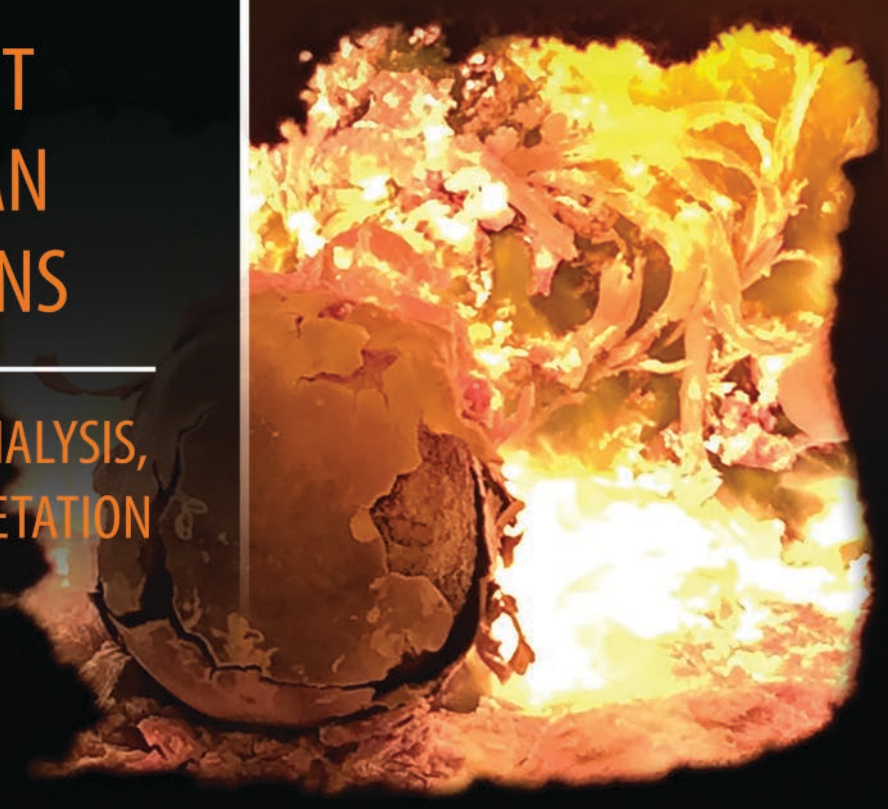
FORENSIC SCIENCE IN FOCUS

BURNT HUMAN REMAINS

RECOVERY, ANALYSIS, AND INTERPRETATION



Edited by

Sarah Ellingham, Joe Adserias-Garriga, Sara C. Zapico and Douglas H. Ubelaker

AAFS AMERICAN ACADEMY OF FORENSIC SCIENCES

WILEY

Burnt Human Remains

Published and forthcoming titles in the Forensic Science in Focus series

Published

The Global Practice of Forensic Science
Douglas H. Ubelaker (Editor)

Forensic Chemistry: Fundamentals and Applications
Jay A. Siegel (Editor)

Forensic Microbiology
David O. Carter, Jeffrey K. Tomberlin, M. Eric Benbow, and Jessica L. Metcalf (Editors)

Forensic Anthropology: Theoretical Framework and Scientific Basis
Clifford Boyd and Donna Boyd (Editors)

The Future of Forensic Science
Daniel A. Martell (Editor)

Forensic Anthropology and the United States Judicial System
Laura C. Fulginiti, Kristen Hartnett-McCann, and Alison Galloway (Editors)

Forensic Science and Humanitarian Action: Interacting with the Dead and the Living
Roberto C. Parra, Sara C. Zapico, and Douglas H. Ubelaker (Editors)

Disaster Victim Identification in the United States in the 21st Century: An Evolving Discipline
John A. Williams and Victor W. Weedn (Editors)

Anthropology of Violent Death: Theoretical Foundations for Forensic Humanitarian Action
Roberto C. Parra and Douglas H. Ubelaker (Editors)

Burnt Human Remains: Recovery, Analysis and Interpretation
Sarah Ellingham, Joe Adserias-Garriga, Sara C. Zapico and Douglas H. Ubelaker (Editors)

Forthcoming

Artificial Intelligence (AI) in Forensic Sciences
Katrin Franke and Zeno Geradts (Editors)

An Illustrated Guide to Forensic Skeletal Trauma Analysis
Donna C. Boyd

Burnt Human Remains

Recovery, Analysis, and Interpretation

EDITED BY

Sarah Ellingham
International Committee of the Red Cross, Geneva, Switzerland

Joe Adserias-Garriga
Mercyhurst University, Pennsylvania, USA

Sara C. Zapico
New Jersey Institute of Technology, New Jersey, USA
Smithsonian Institution, Washington, DC, USA

Douglas H. Ubelaker
Smithsonian Institution, Washington, DC, USA

AAFS AMERICAN ACADEMY OF FORENSIC SCIENCES

WILEY

This edition first published 2023

Registered Offices
John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA
John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

For details of our global editorial offices, customer services, and more information about Wiley products visit us at www.wiley.com.

Wiley also publishes its books in a variety of electronic formats and by print-on-demand. Some content that appears in standard print versions of this book may not be available in other formats.

A catalogue record for this book is available from the Library of Congress

Hardback ISBN:9781119682608; ePub ISBN: 9781119682745; ePDF ISBN: 9781119682646;
oBook ISBN: 9781119682691

Cover Image: Courtesy of Joe Adserias-Garriga
Cover Design: Wiley

Set in 10.5/13.5pt MeridienLTStd by Integra Software Services Pvt. Ltd, Pondicherry, India

Contents

About the Editors

Sarah Ellingham, PhD, is a Forensic Coordinator for the ICRC. Since joining the ICRC in 2016, she has worked in several contexts in Asia, Africa, and the Middle East in active and post-conflict settings. Sarah is a forensic anthropologist, certified by the Royal Anthropological Institute of Great Britain and Northern Ireland (Cert-FA-II), a Steering Committee Member of the British Association for Forensic Anthropology (BAFA), and an active member of the Interpol DVI Sub-Working Group for Anthropology and Pathology. Sarah obtained her PhD. on the biochemical analysis of burnt bone from Teesside University in 2015. She further holds an MSc in Forensic Anthropology, a BSc in Forensic Sciences, and is working towards an MSc in Psychology. Her research interests mainly focus on the analysis of burnt remains, disaster victim identification, and forensic humanitarian action. Sarah has authored several peer-reviewed scientific publications and was awarded the J.L. Angel Award for her research in 2016.

Joe Adserias-Garriga, PhD, DDS, D-ABFO, is a forensic anthropologist and odontologist from Spain. She received a Police Decoration for her contribution to casework from the Mossos d´Esquadra (Catalonian Police). Dr. Adserias-Garriga was involved in the identification of decedent border crossers as a forensic anthropologist at the Forensic Anthropology Center, Texas State University. She is a member of the ADA Standards Committee on Forensic Odontology and OSAC. Diplomate of the American Board of Forensic Odontology, member of the Board of Governors in the American Society of Forensic Odontology (ASFO), and ASFO President (2022). Member of the Board of Directors of the International Association of Coroners and Medical Examiners and a member of the INTERPOL DVI Odontology as well as Pathology-Anthropology Sub-Working Group. She is a Forensic Odontology consultant for the National Center of Missing and Exploited Children. Dr. Adserias-Garriga is an Assistant Professor of the Department of Applied Forensic Sciences at Mercyhurst University.

Sara C. Zapico, PhD, ABC-MB, is an assistant professor at the Department of Chemistry and Environmental Science at New Jersey Institute of Technology, Newark, New Jersey. She is also a research collaborator in the Department of Anthropology at the National Museum of Natural History, Smithsonian Institution in Washington, DC. Before NJIT, she was the graduate program director of the Professional Science Master's in Forensic Science (PSM-FS) and assistant teaching professor at Florida International University, in Miami, Florida. She also served as an associate at the International Committee of the Red Cross in Geneva, Switzerland. She has authored 30 peer-reviewed scientific publications and edited

two books in the fields of biomedical sciences, forensic biochemistry, forensic anthropology, and humanitarian forensic action. Her research interests focus on the application of biochemical techniques to forensic anthropology issues such as age-at-death estimation and the determination of post-mortem interval, with implications on aging and biomedical sciences.

Douglas H. Ubelaker, PhD, D-ABFA, is a curator and senior scientist at the Smithsonian Institution's National Museum of Natural History in Washington, DC, and an adjunct professor at Michigan State University He has reported on over 980 forensic cases in his specialty of forensic anthropology and testified in numerous legal proceedings. Ubelaker has published extensively in the general field of human skeletal biology, with an emphasis on forensic applications and has served on the editorial boards of numerous leading scientific publications. He was the elected 2011–2012 President of the American Academy of Forensic Sciences and has received numerous honors from international organizations.

List of Contributors

Eric Bartelink, PhD, D-ABFA, is a Professor of Anthropology and co-Director of the Human Identification Laboratory at California State University, Chico. He is a Diplomate of the American Board of Forensic Anthropology, a certified instructor for California's Peace Officers Standards and Training, and current Vice-chair of the Organization of Scientific Area Committees' Anthropology Subcommittee under NIST. He is co-author of *Forensic Anthropology: Current Methods and Practice*, *Introduction to Physical Anthropology*, *Essentials of Physical Anthropology*, and co-editor of *New Perspectives in Forensic Human Skeletal Identification*.

John Berketa, PhD, is a senior forensic odontologist and scene team leader in Disaster Victim Identification in South Australia. Following the 2009 Victorian bushfire disaster he has conducted intensive research into maximizing post-mortem information of severely incinerated victims. He has attended many fire disaster scenes and has published various articles in national and international journals and book chapters. As well as a PhD., he has been recognized with various awards and is known as a global authority in the application of stabilization of incinerated dental remains. He is a postgraduate supervisor at the University of Adelaide, is on the scientific committee of International Organization of Forensic Odonto-Stomatology (IOFOS) and a peer reviewer of over a dozen forensic journals. He is a member of many forensic societies and regularly presents to both national and international organizations including Interpol, the Australian Society of Forensic Odontology, the American Academy of Forensic Science (AAFS) and the International Organization of Forensic Odonto-Stomatology (IOFOS).

Mary A. Bush, DDS, is an Associate Professor and Associate Dean for Students, Community, and Professional Initiatives at SUNY at Buffalo School of Dental Medicine. She is Past President of the American Society of Forensic Odontology and is a Fellow of the American Academy of Forensic Sciences. She is on the Editorial Board for the Journal of Forensic Science, has published numerous articles, has contributed to various textbooks, and lectures widely on the topic of forensic odontology, including an invited presentation at a congressional hearing on Capitol Hill. Dr. Bush has served on NIST's OSAC Odontology Subcommittee and the American Academy of Forensic Sciences Standards Board for Pattern Evidence.

Peter J. Bush, BS, is Director of the South Campus Instrument Center at the State University of New York School of Dental Medicine. He is a co-founder for the Laboratory for Forensic Odontology Research and a Fellow of the American

Academy of Forensic Sciences. He is a member of the Research Committee for the American Society of Forensic Odontology. Peter Bush has worked in many scientific fields, including Forensic Odontology. He has published over 80 articles and his work is referenced in numerous sources, including the NASA website.

Luis L. Cabo, PhD, received his Bachelor of Science degree in Biology, with a specialization in Zoology, from the University of Oviedo (Asturias, Spain). He also earned his master's degree in Biology, in addition to receiving his National Pedagogy and Teaching Certificate, from the University of Oviedo. His position as a researcher in both the Biology and Geology departments of The University of Oviedo provided Cabo with a vast amount of experience and knowledge in the fields of biology, paleoanthropology, archaeology, and geology. He has participated in over two dozen archaeological and paleontological field and laboratory projects. Cabo began his career at Mercyhurst, participating in the Summer Forensic Anthropology Short Courses. Since joining the Mercyhurst staff in 2003, Cabo, the Director of the Forensic and Bioarchaeology Laboratory, has assisted in the recovery and analysis of more than 200 forensic cases. He currently also serves as the primary graduate student research advisor.

Melina Calmon Silva, PhD, is a Brazilian forensic anthropologist. She is the vice-coordinator of the research group *Forensic Anthropology and Identification of Persons*, at the National Academy of Police, Federal Police of Brazil. She has worked as a Forensic Specialist for the International Committee of the Red Cross (ICRC) in Baghdad, Iraq, and as a Forensic Consultant for ICRC in Brazil. Dr. Calmon obtained her MA and PhD. in Anthropology from Tulane University in 2019, focusing on the role of forensic anthropology in the investigation of missing and unidentified persons cases. She is the Co-PI of the first taphonomy facility project in central Brazil. She holds the position of Executive Secretary at the Brazilian Association of Forensic Anthropology (ABRAF) 2020 / 2022 and is a member of the Anthropology Consensus Body at the American Academy of Forensic Sciences Standards Board. Dr. Calmon authored several peer-reviewed scientific publications and book chapters.

Rachael M. Carew, PhD, is a UK Certified Forensic Anthropologist (Cert-III) with the Royal Anthropological Institute and specializes in 3D printing skeletal models. Currently a lecturer in forensic science at Coventry University, Rachael gained her PhD. in Forensic Anthropology and Forensic Science from University College London (UCL) where she investigated the metrology and ethics of 3D printing for forensic anthropology evidence reconstruction. She also holds a BSc (Hons) in Forensic Science from University of the West of England (UWE), an MSc in Forensic Archaeology and Anthropology from Cranfield University, and is an Associate of the Chartered Society of Forensic Science and Secretary of the British Association for Forensic Anthropology (BAFA). With multiple publications in 3D

reconstruction techniques, Rachael co-founded a 3D expert network group with the UK Forensic Capability Network to develop protocols for police casework. Rachael also consults internationally on 3D modelling and 3D printing research and applications in forensic science.

Eugénia Cunha, PhD, C-FASE, is a forensic anthropologist and the Director of the South Delegation of the National Institute of Legal Medicine and Forensic Sciences, Lisbon, Portugal. She has been a full professor at the University of Coimbra since 2003, where she created and co-coordinates the Laboratory of Forensic Anthropology. She is a co-founder and former President of FASE-Forensic Anthropology Society of Europe (2009–2016); Vice-President and founder member of ABRAF (Associação Brasileira de Antropologia Forense); Fellow of the American Academy of Forensic Sciences; Member of the Pathology and Anthropology Sub-group at the Interpol DVI Working Group; Roster member of JRR, Justice Rapid Response.

She has published extensively on forensic anthropology and skeletal biology. She has reported on about 500 forensic cases. To this date, 20 PhD. students have already completed their PhD. under her supervision. Her research interests include, among others, identification and age at death.

Cassandra M. DeGaglia, MA, is a PhD. student in the Department of Anthropology at Tulane University. She holds a BS in Biological Anthropology from the George Washington University and an MA in Anthropology from Mississippi State University. Additionally, she has been involved with research at the Smithsonian Institution's National Museum of Natural History in Washington, DC, since 2014. Her work spans a variety of topics in biological anthropology and includes projects relating to forensic anthropology, paleopathology, and paleodemography, and the ethical use of museum collections in anthropology.

Dennis C. Dirkmaat, PhD, D-ABFA, has been a board-certified forensic anthropologist since 1996. He was awarded the first (2020) Outstanding Mentor Award in the Anthropology Section of the AAFS. He is the 2021 winner of the AAFS' T. Dale Stewart Award for lifetime achievement in Forensic Anthropology. Dr. Dirkmaat is the Chair of the undergraduate program in Applied Forensic Sciences and the Master of Science in Anthropology graduate program at Mercyhurst University. Since 1986, Dr. Dirkmaat has conducted nearly 1000 forensic anthropology cases and has testified in court over 28 times as an expert witness. Chair of the Search and Recovery Committee of the Scientific Working Group-Disaster Victim Identification (SWG-DVI) group and co-chair of the Anthropology Committee of SWG-DVI (FBI, NIJ). Committee member of the Disaster Victim Identification Subcommittee OSAC. Dr. Dirkmaat has participated as a primary forensic anthropologist with the US Federal Government's Disaster Mortuary Operational Response Team (DMORT).

Peter Ellis, OAM, MB, FRCPA, is a forensic pathologist who has worked in Sydney and Queensland, Australia. He has extensive experience in all aspects of forensic pathology and is Adjunct Professor in Forensic Medicine and Pathology at Griffith University.

He has a special interest in identification science and has actively participated in numerous mass fatality incidents in Australia, New Zealand, and in SE Asia. He was the lead Australian pathologist for the Tsunami response in late 2004 and has also worked on forensic operations in Kosovo, East Timor, and Sri Lanka. He was the consulting forensic pathologist to the WW1 Fromelles mass grave project based in northern France. He has worked as the Chair of the Interpol DVI Pathology / anthropology sub-working group and has lectured extensively in Australia and SE Asia.

David Errickson, PhD, is a senior lecturer in forensic archaeology and anthropology at Cranfield University, United Kingdom. He is a certified forensic anthropologist (Cert-III) with the Royal Anthropological Institute of Great Britain and Northern Ireland (RAI), an Associate of the Chartered Institute for Archaeologists (ACIfA), and a lead archaeologist for Cranfield's Recovery and Identification of Conflict Casualties Team (CRICC) who partner with the Defense Prisoner of War / Missing in Action Accounting Agency (DPAA). David gained his PhD. from Teesside University, UK, where he investigated the application of 3D imaging to forensic anthropological context, including the display of information within the court. He further holds an MSc in Forensic Archaeology and Crime Scene Investigation, a BSc in Archaeology, and a Diploma in Professional Archaeology Studies. David has a substantial number of publications relating to 3D documentation in both anthropological and archaeological contexts.

Maria Teresa Ferreira, PhD, holds a PhD. in Anthropology, branch of Forensic Anthropology, and is Assistant Professor in the Department of Life Sciences at the University of Coimbra. At present, she is Coordinator of the Master of Forensic Anthropology and Vice-Coordinator for the branch of Forensic Anthropology of the PhD. in Anthropology; Vice-coordinator of the Center for Functional Ecology – Science for People and the Planet; Co-curator of the 21st Century Identified Skeletal Collection, Laboratory of Forensic Anthropology, Department of Life Sciences, University of Coimbra. She investigates mainly in the areas of Forensic Anthropology (namely, Forensic Taphonomy) and Bioarchaeology (in particular, slavery in the early days of Portuguese maritime expansion).

Hanna Friedlander, MA, is the Human Remains Analyst and Unidentified Remains Coordinator for the Michigan State Police (MSP), Missing Persons Coordination Unit. Her duties as the in-house forensic anthropologist include aiding federal, state, and local law enforcement in the search, detection, recovery,

and identification of missing persons and unidentified remains within the State of Michigan. This includes cold case work, Native American (NAGPRA) repatriations, and the development and implementation of forensic anthropology trainings for law enforcement and other stakeholders. She is a responder for the Emergency Management Assistance Compact (EMAC) Program through the MSP Emergency Management Homeland Security Division and Forensic Anthropological Consultant for Kenyon International Emergency Services. She completed her MA in Biological Anthropology at the University of Alberta. Her interests include heat-related bone alteration, trauma analysis, 3D technology pertaining to trauma analysis, and skeletal marker assessment utilized for the identification of unidentified remains.

Alison Galloway, PhD, D-ABFA, is Professor Emerita, University of California, Santa Cruz and a board-certified forensic anthropologist. Her research focuses on time since death, effects of traumatic injury, and the consequences of thermal damage to human remains. She is co-editor of *The Evolving Female: A Life History Perspective*, *Broken Bones: Anthropological Analysis of Blunt Force Trauma*, and *Forensic Anthropology and the U.S. Judicial System*. She continues to practice forensic casework in central California.

David Gonçalves, PhD, is a biological anthropologist at the Portuguese Directorate-General for Cultural Heritage. At the Archaeosciences Laboratory, he currently undertakes research in human bioarchaeology and provides expertise on the management of archaeological activity involving human remains. He has dedicated most of his research career to the study of burnt human bones and teeth and is the co-developer of the first ever reference collection composed of experimentally burnt skeletons which is housed at the Laboratory of Forensic Anthropology of the University of Coimbra. By combining macroscopic with physical-chemical analyses, David has been attempting to find new and more reliable methods of retrieving relevant information from human bones and teeth subjected to heat.

Denice Higgins, PhD, is a researcher and forensic odontologist at the University of Adelaide. She received her doctorate in forensic biology on DNA identification from degraded human teeth. Dr. Higgins also holds a Bachelor of Dental Surgery and a Graduate Diploma in Forensic Odontology. She is the Director of the Forensic Odontology Unit in Adelaide, providing services to Australian Government and Policing Agencies. She worked on several large-scale DVI events and further coordinates and teaches a Graduate Diploma course in Forensic Odontology and supervises research students. She chairs the Medical Sciences Scientific Working Group for the National Institute of Forensic Science, Australia and New Zealand Policing Advisory Agency and is the President of both the Australian Society of Forensic Odontology and the South Australian Branch of the Australian and New Zealand Forensic Science Society. Dr. Higgins is a fellow of both the International

College of Dentists and the Pierre Fauchard Academy and is a member of the Australian Dental Association and the International Society for Forensic Genetics.

Kalyna Horocholyn, MA, was born and raised in Winnipeg, MB. From a young age, she has always been fascinated with stories, the connections between people, and the different ways that life histories are shared. Kalyna completed her Bachelor of Science in Bioarchaeology at the University of Winnipeg in 2010. She completed her Master of Arts in Anthropology at the University of Alberta in 2013, with her research focus on examining cremated remains for the purpose of microscopically identifying human remains from other larger mammalian remains. She attended McMaster University in Hamilton, ON, and obtained the title of PhD. Candidate before seeking new ways of connecting with people, as her interest in the dead had waned and she yearned to work with the living once more. Kalyna lives in Kitchener, ON, with her wife, Erin Horocholyn, and their three cats and one dog. Kalyna is now pursuing a professional career in social work with ambitions to become a counselor.

Ashley Kendell, PhD, is an Associate Professor of Anthropology and the Coordinator for the Certificate in Forensic Science at California State University, Chico. Having worked as a death investigator for five years, she offers extensive experience in medicolegal death investigation and her research spans the sub-disciplines of bioarcheology and forensic anthropology. She is also a certified POST instructor, teaching homicide investigation courses to regional and state law enforcement. Currently, she is a co-editor of a volume focused on wildfire response and victim recovery, which is nearing completion.

Haley Khosrowshahi, MA, is a museum professional living in Washington, DC. Her work at the Smithsonian National Museum of Natural History in the Anthropology Department under forensic anthropologist Dr. Douglas H. Ubelaker fostered a passion for research and further exploring the forensic contributions to human rights. After finishing a BA in Archaeology at the George Washington University, Haley moved to California to pursue an MA in Museum Studies at the University of San Francisco. Her studies focused on cultural heritage, museum law, and different ways museums could engage visitors. Her thesis titled: "Transparency through Display: Using Orphaned Collections to Reconnect with Museum Audiences," focused on how museum objects with unclear ownership could still be informative and tell a compelling narrative that museums should explore with new curatorial models.

Alexandra R. Klales, PhD, D-ABFA, is an Associate Professor of Forensic Anthropology at Washburn University and is the founder / director of the Washburn University Forensic Anthropology Recovery Unit (WU-FARU), which conducts forensic anthropological casework in Kansas and Missouri. She earned

a BA in Anthropology from the University of Pittsburgh, MS in Forensic and Biological Anthropology from Mercyhurst University, and a PhD. in Anthropology from the University of Manitoba. Dr. Klales is a board-certified Diplomate (#123) of the American Board of Forensic Anthropology, a Member of the Anthropology Section of the American Academy of Forensic Sciences, and editor of the journal Forensic Anthropology. Her research focuses on improving biological profile methods, understanding skeletal sexual dimorphism, and developing protocols for the forensic archaeological recovery of human remains. She teaches courses in biological anthropology, forensic anthropology, human skeletal biology, and forensic archaeology at Washburn University and as continuing education forensic anthropology short courses.

Calil Makhoul, MSc, is PhD. student in Anthropology, branch of Forensic Anthropology, in the University of Coimbra. He is an invited lecturer in the Superior Institute for Social and Political Sciences at the University of Lisbon. Currently, he is a forensic autopsy technician and a member of the DVI Portuguese team in the National Institute of Legal Medicine and Forensic Sciences, Center Branch, in Coimbra. He is a level II certified forensic anthropologist of FASE-Forensic Anthropology Society of Europe. He investigates mainly in the areas of Forensic Anthropology (namely, commingled Human Burnt Remains) and Forensic Entomology (in particular, successional entomofauna).

Pamela Mayne Correia, MA, Pamela completed her MA at the University of Alberta. She is an academic at the University of Alberta, Anthropology Department. Her research interests are in the area of the analysis of cremated human skeletal material, trauma analysis, bone taphonomy and in human identification, problems related to cremation, taphonomy, and the identification of human remains using traditional histological methods. She is curator for the three museum collections managed by the Department of Anthropology. Pamela provides the core courses and instruction in forensic anthropology. She was the Chair of the Anthropology / Medical / Odontology Section of the Canadian Society of Forensic Sciences for ten years. She is a consulting forensic anthropologist for the Office of the Chief Medical Examiner and has contributed to numerous cases for the RCMP, Medical Examiner, and Archaeological Survey since 1989. As part of this work, Mayne Correia is involved in the Missing Children / Persons and Unidentified Human Remains Project in Alberta, as well as ongoing identification of human remains.

Alexandria McDaniel, MS, holds a BS in Anthropology with a minor in Criminal Justice and an MA in Bioarchaeology from the University of Indianapolis. She is a Medicolegal Investigator I at the Office of Chief Medical Examiner in New York City. She believes that investigating the death of an individual is important in providing crucial information that is essential for the criminal justice system

and public health, but also providing a voice for those who cannot speak for themselves. She has her ABMDI Board Certification. She studied low thermal alterations of pig bone at sub-ignition point.

Raymond Miller, DDS, is the forensic dental consultant to the Office of the Erie County Medical Examiner in Buffalo, NY, and a Clinical Associate Professor at the University at Buffalo School of Dental Medicine. He is a member of the Disaster Mortuary Operational Response Team and deployed to the World Trade Center, Hurricane Katrina, and the crash of Flight 3407. Dr. Miller is a retired Lieutenant Colonel and served as the Base Dental Surgeon for the 107th Attack Wing of the New York Air National Guard. He has served as the Odontology Section Chair of the American Academy of Forensic Sciences and is the Vice-chair of the American Dental Association's Standards Committee on Dental Informatics for Forensic Odontology. He has served as a forensic dental representative to the Disaster Victim Identification Subcommittee for the federal Organization of Scientific Area Committees and the American Academy of Forensic Sciences Standards Board.

Colleen Milligan, PhD, D-ABFA, is Professor and Chair of the Department of Anthropology at California State University, Chico. She is also Co-Director of the Human Identification Laboratory at Chico State. Dr. Milligan is a Diplomate of the American Board of Forensic Anthropology and a certified instructor for California's Peace Officers Standards and Training. She has assisted California sheriff-coroner's offices, state agencies, and federal agencies in casework and field recoveries. She is also currently a co-editor of two upcoming volumes focused on wildfire response and mass fatality management, and a bioarchaeological study of an anatomical waste deposit in post-Civil War San Francisco.

Megan Moore, PhD, D-ABFA, is an Associate Professor of Anthropology at Eastern Michigan University in Ypsilanti, Michigan. She is Diplomate #140 of the American Board of Forensic Anthropology and she is the Forensic Anthropology Consultant for southeastern Michigan. She received the Ronald W. Collins Distinguished Faculty Teaching Award in 2019 and the Distinguished Honors Faculty Award in 2017. She completed her PhD. in Biological Anthropology at the University of Tennessee in Knoxville in 2008 and her MS in Biological Anthropology from the University of Oregon. Her research interests include skeletal biology, functional morphology, sexual polymorphism of the pelvis, and skeletal pathology and trauma analysis.

Allison Nesbitt, PhD, is an Assistant Teaching Professor in the Department of Pathology and Anatomical Sciences in the School of Medicine at the University of Missouri in Columbia, Missouri. She earned a master's degree in Anthropology with a concentration in Forensic and Biological Anthropology from Mercyhurst

University in Erie, Pennsylvania and a master's and PhD. in Anthropology from Stony Brook University in Stony Brook, New York. Her work focuses on the evolutionary and developmental variation of the human skull, anatomy education in the health professions, and improving diversity and inclusion in biological anthropology and anatomy.

Pier Paolo Petrone, MSc, is head of the Laboratory of Forensic Anthropology at the University Federico II of Naples, Italy. He carried out several archaeological excavations of pre-protohistoric and historical sites in Italy, North Africa, and Asia. His studies mainly focus on the effects and causes of death of the victims of the Vesuvius eruptions. Research on sites buried by the AD 79 and OBA Avellino Pumices events has provided useful information for the mitigation of the volcanic risk that affects three million people in metropolitan Naples. The results of these studies, published in prestigious journals (*Nature*, *PNAS*, *New England Journal of Medicine*, *PLoS ONE*), have been reported in the world press and are the subject of several scientific documentaries (Discovery Channel, BBC, History Channel, National Geographic, etc.). In 2019, his project: "Genetic Exploration of the Population of Herculaneum in AD 79" was funded by the National Geographic Society with a Research Grant.

Kassandra Pointer, BA, B.Ed, is a multidisciplinary educator and continuing-education specialist currently residing in Lethbridge, Alberta. Ms. Pointer completed her Bachelor of Arts in Biological Anthropology at the University of Alberta in 2015, having culminated her degree by partaking in a human osteological dig through the Slavia Foundation in Poland. During her Bachelor of Arts, Kassandra completed her undergraduate honor thesis on the histological analysis of cremated human bone, along with Pamela Mayne Correia. In 2019, she obtained her Bachelor of Education in Science Education from the University of Lethbridge, where her love of human anatomy melded with her adoration for teaching. She is now a substitute teacher in high school science and teaches adult courses at a continuing education center.

Elayne Pope, PhD, is a Forensic Anthropologist who researches how the human body burns, for application to fatal fire casework. She received her doctorate from the University of Arkansas in 2007 for: "The Effects of Fire on Human Remains." Dr. Pope has been a researcher and instructor for the San Luis Obispo Fire Investigation Strike Team (SLO FIST) Fatal Fire Death Investigation Course since 2008, where human cadavers are utilized to recreate fatal fire scenes (www.slofist.org). She worked as the Autopsy Supervisor and forensic anthropologist for six years at the Tidewater Office of the Chief Medical Examiner in Norfolk, Virginia. Dr. Pope is currently a forensic consultant and owner of Fatal Fire Forensics LLC.

(www.burnedbone.com) who specializes in legal / civil fatal fire case review and examinations, burn pattern analysis, skeletal trauma analysis, expert witness and testimony, training lectures and course instruction, and identification of fragmentary burnt bone (human vs. non-human / non-bone).

Julie Roberts, PhD, ChFA, is a Chartered Forensic Anthropologist (Cert FA-I) and archaeologist with over 20 years of practitioner experience in the excavation, analysis, and interpretation of burnt human remains. She received her PhD. from the University of Glasgow for her research into war crimes against children in Kosovo and Bosnia-Herzegovina in the 1990s. She is current Chair of the British Association for Forensic Anthropology, and the forensic anthropology coordinator for UK DVI, the national capability of the UK police service to respond to mass fatality incidents. She is company Scientific Advisor for Alecto Forensic Services, and a Visiting Research Fellow in the Faculty of Science at Liverpool John Moores University. Her research interests include analysis of factors which influence DNA success rates in mass fatality incidents, multidisciplinary approaches to improve identification rates in forensic and humanitarian contexts, and interpreting sequences of events in burnt and dismembered remains.

Christopher W. Schmidt, PhD, received his PhD. in Biological Anthropology from Purdue University in 1998. His research areas include the study of human teeth and the study of burnt human remains. His books include: *Long on the Tooth*, *Dental Wear in Evolutionary and Biocultural Contexts*, co-edited with Jim Watson, and two editions of *Analysis of Burned Human Remains*, co-edited with Steve Symes. His primary area of research is dental microwear texture analysis, although he has published on a wide range of topics including Neandertal diet, paleopathology, historic cemeteries, bone tools, and tissue rehydration. The journals in which he has published are, likewise, diverse and include *Paleoanthropology*, *American Journal of Physical Anthropology*, *North American Archaeologist*, *Physics Today*, *Surface Topography: Metrology and Properties*, and the *Journal of Forensic Sciences*.

Austin A. Shamlou, MSc, attended The George Washington University and graduated with a Bachelor of Science in Biological Anthropology. During her time in Washington, DC, she volunteered at the National Museum of Natural History, assisting Dr. Ubelaker on a few of his projects. In the summers of 2017 and 2018 she participated in three field schools in Austria, Romania, and Poland, emphasizing her passions for osteology and bioarchaeology. Shamlou then attended Boston University School of Medicine and received her MSc in Forensic Anthropology. Her thesis research focused on frontal sinus variations as seen on computed tomography scans. Her current research interests are around human osteology and variation, digital data and distribution, as well as diversity and inclusion within the field.

Christophe Snoeck, PhD, is a Research Professor at the Vrije Universiteit Brussel (VUB, Belgium), and the head of the Brussels Bioarchaeology Lab (BB-LAB – www.bb-lab.be). He combines his multidisciplinary expertise in bioarchaeology and isotope geochemistry to answer key archaeological questions, with a particular focus on populations that practiced cremation. Since January 2018, he has also been the Scientific Coordinator of the CRUMBEL project - Cremation, Urns and Mobility: population dynamics in BELgium (www.crumbel.org), funded by the Belgian Excellence of Science program (EoS). And since 2021, with the start of his ERC Starting Grant LUMIERE (www.erclumiere.be), he aims to develop new proxies for the study of charred and calcined bone to answer questions of mobility and landscape use at the European level.

Rebecca Stone-Gordon, MSc, holds a BA in History and Anthropology and an interdisciplinary MS in audio technology and visual media from American University, in Washington, DC. She is currently working on an MA in Public Anthropology (Biological Anthropology and Archaeology) at the same university. Her research areas include feminist theory, disability studies, the history of anatomy, archaeology, and horror film and literature. She specializes in representations of anthropology, archaeology, and mummies in Anglo-American feature films. She is also involved in interdisciplinary forensic projects at the Smithsonian Institution. She is the director of volunteer management for the Museum of Science Fiction.

Tim J.U. Thompson, PhD, is Dean of Health and Life Sciences and Professor of Applied Biological Anthropology at Teesside University. He has been practicing, researching, and teaching forensic anthropology for over 20 years, and has published over 70 peer-reviewed papers, chapters, and books. He is an expert in the effect of burning on the skeleton and previously published *The Archaeology of Cremation*. He was Editor-in-Chief of the journal *Science & Justice* and the *Journal of Forensic & Legal Medicine*, is a Fellow of five professional bodies, and holds a prestigious National Teaching Fellowship for excellence in teaching and the support for learning. In 2021 he was appointed President Elect of the Chartered Society of Forensic Sciences.

Yara Vieira Lemos, MSc, holds a BSc in Medicine and MSc in Health Sciences. She is a Certified Specialist in Legal Medicine. She is a Medical Examiner at the Civil Police of Minas Gerais, working mainly at the Laboratory of Forensic Anthropology and Applied Thanatology. She is also a roster member of JRR (Justice Rapid Response) and Assistant Professor at the Medical Sciences College of Minas Gerais. She was elected 2020–2022 President of the Brazilian Association of Forensic Anthropology (ABRAF) and is also an associated editor of the *Brazilian Journal of Forensic Anthropology and Legal Medicine*.

P. Willey, PhD, D-ABFA, is Professor Emeritus of Anthropology at Chico State University, California. He is a Diplomate of the American Board of Forensic Anthropology. In retirement, he remains actively involved in forensic anthropology, analyzing cases, participating in search and recoveries, and penning chapters. He authored *Prehistoric Warfare on the Great Plains: Skeletal Analysis of the Crow Creek Massacre Victims*, co-authored *They Died with Custer: Soldiers' Bones from the Battle of the Little Bighorn*, as well as *Mystery of the Bones: Syphilis, the Lewis and Clark Expedition, and the Arikara Indians*, and co-edited *Health of the Seventh Cavalry: A Medical History*. His final co-edited volume concerns a post-Civil War San Francisco anatomical waste deposit and it nears completion.

Amanda N. Williams, PhD, is an instructor with Truckee Meadows Community College Anthropology Department. She received her BA (2010) in Anthropology and Sociology from the University of Tennessee, Knoxville (2010), and her MA (2013) and PhD. (2020) in Biological Anthropology from the University of Montana. Dr. Williams primarily serves as an instructor, but also works in cultural resource management, where she actively engages in fieldwork, lab work, and serves as an osteological consultant for several firms and federal agencies within the northern Nevada and northern California area. Dr. Williams's research interests focus on forensic anthropology and the taphonomic processes affecting the human body after death. She is primarily interested in how these processes can be used to answer broader questions surrounding time since death estimates and used to reconstruct in situ conditions of death events. Her current research focuses on developing a broader scoring system for analyzing burnt human remains. Her primary research interests include forensic anthropology, taphonomy, and archaeology.

Lauren Zephro, PhD, is a forensic anthropologist based in central California. Lauren is currently the Forensic Services Director for the Santa Cruz County Sheriff's Office where she oversees crime scene investigation, the forensic laboratory, the property and evidence section, and the County's multidisciplinary sexual assault response team. Lauren earned her MA in Anthropology from the University of Tennessee, Knoxville, and her PhD. in Anthropology from the University of California, Santa Cruz. She is a certified latent print examiner and a Fellow of the American Academy of Sciences Anthropology Section. Her research interests and publications are primarily focused on skeletal trauma, secular change, method and theory in forensic anthropology, and burnt bone.

Preface

Thermally altered remains continue to pose a particular challenge to forensic practitioners tasked with their analysis and interpretation; consequently, it is a highly dynamic aspect of forensic science, with constant development and innovation, both in the field and in the lab.

The idea of this book originally arose from a workshop titled: "Some like it hot: A forensic analysis of burnt remains," which we presented at the American Academy of Forensic Sciences' 70th annual meeting in Seattle, 2018. Each of us having spent a significant portion of our careers working with and researching burnt remains from the angle of our respective disciplines (forensic anthropology, forensic odontology, molecular biology, and analytical chemistry), our aim was to gather forensic specialists at the forefront of their métiers in the study of burnt human remains, to provide a fresh look at the complexities involved in their recovery, analysis, and interpretation, as well as to present the most cutting edge research trends to tackle these forensic puzzles.

The overwhelming interest and feedback we received after the workshop highlighted the potential relevance of an updated textbook on the subject matter. This volume does not aim to replace, but rather build on and complement the existing excellent books covering the topic of burnt remains, such as Schmidt and Symes' 2008/2015 *The Analysis of Burned Human Remains*, Thompson's 2015 *The Archaeology of Cremation: Burned Human Remains in Funerary Studies*, Symes and Dirkmaat's 2012 *Recovery and Interpretation of Human Remains*, and Fairgrieve's 2007 *Forensic Cremation: Recovery and Analysis*.

Understanding the changes undergone by bodies when subjected to fire is of paramount importance for not only the determination of identity, but also the reconstruction of the events leading up to incineration and the determination of cause and manner of death. Therefore this book takes a novel and multidisciplinary approach to tackle the subject of burnt human remains. It is divided into four main sections. After a review of the History of the Study of Burnt Remains (Chapter 1), the first section focuses on the Search and Recovery of Burnt Human Remains from the Fire Scene (Chapters 2–4), delving into aspects such as scene analysis and interpretation for crime scene and death investigators, as well as search and recovery techniques to preserve forensic anthropologically and odontologically relevant material, context, and information. The second section looks at the Examination and Identification of Burnt Human Remains (Chapters 5–10). This includes detailing traditional and new approaches to classifying the degree of burn trauma, discussing the application of forensic medicine to determining the cause and manner of death in burnt remains, skeletal alterations though thermal exposure and the resulting challenges for biological profile estimation. It further

tackles the role of forensic odontology in the identification process of burn victims, as well as a review of novel and established approaches to trauma analysis on burnt skeletal remains. Section three looks at Analytical Approaches to the Analysis of Burnt Bone (Chapters 11–17). It covers the biochemical and structural alterations of bone subjected to fire and analytical techniques to observe and quantify them and correlating changes to temperature and exposure time, followed by a chapter on molecular changes and DNA profiling techniques from burnt bone, pointing out challenges, methods, and case examples. Further in this section, the classical approach of calorimetry to determine the degree of heat exposure is re-examined, as is the use of histology in order to distinguish human from non-human burnt bone fragments with a discussion on limitations to the technique. It elaborates how isotopic and elemental analysis on burnt bone can be used to reconstruct a person's mobility *in vivo*, as well as in some instances shed light on the burning conditions. A further chapter discusses the application of different imaging techniques, both 2D and 3D, which can be used for the analysis of heat-induced bone. The section closes with a presentation on the first reference collection of burnt remains, highlighting the availability of this skeletal assemblage for researchers, aiming to inspire more research in the field. The book finally concludes with a section on Case Studies (Chapters 18–22); following a statistical review of 44 years of forensic anthropology casework brought to the Smithsonian Institution in the Washington, DC area, four further chapters discuss the experience of their respective authors during casework in Brazil, the USA, and Afghanistan, giving not only practical, but furthermore international insights into the type of scenarios that law enforcement, medical examiners, and forensic anthropologists may find themselves confronted with regarding burned human remains. The final chapter constitutes an archaeological "cold case" – the analysis of the victims of the AD 79 eruption of Mount Vesuvius.

This book is intended to bridge the gap between research and practice. It is designed to be a "one-stop-shop" on the topic of burnt remains, and we are hoping it will become a valuable new resource for practitioners, academics, students, and the interested layperson alike. It is our aim to promote a multi- and interdisciplinary approach when facing burnt remains in case work and to inspire an increase in research in this ever-evolving field.

We would like to thank all contributing authors for agreeing to be part of this project and sharing their valuable insights and experiences. Thanks also to our editors at Wiley for their support and patience in the process of turning this project from an idea to a reality. And finally, thanks to you, our reader, for considering this book for your library. We hope it fulfills your expectations.

Sarah Ellingham
Joe Adserias-Garriga
Sara C. Zapico
Douglas H. Ubelaker

Series Preface

The forensic sciences represent diverse, dynamic fields that seek to utilize the very best techniques available to address legal issues. Fueled by advances in technology, research and methodology, as well as new case applications, the forensic sciences continue to evolve. Forensic scientists strive to improve their analyses and interpretations of evidence and to remain cognizant of the latest advancements. This series results from a collaborative effort between the American Academy of Forensic Sciences (AAFS) and Wiley to publish a select number of books that relate closely to the activities and Objectives of the AAFS. The book series reflects the goals of the AAFS to encourage quality scholarship and publication in the forensic sciences. Proposals for publication in the series are reviewed by a committee established for that purpose by the AAFS and also reviewed by Wiley.

The AAFS was founded in 1948 and represents a multidisciplinary professional organization that provides leadership to advance science and its application to the legal system. The 11 sections of the AAFS consist of Criminalistics, Digital and Multimedia Sciences, Engineering Sciences, General, Pathology/Biology, Questioned Documents, Jurisprudence, Anthropology, Toxicology, Odontology, and Psychiatry and Behavioral Science. There are over 7000 members of the AAFS, originating from all 50 States of the United States and many countries beyond. This series reflects global AAFS membership interest in new research, scholarship, and publication in the forensic sciences.

Zeno Geradts
University of Amsterdam
The Netherlands

Douglas H. Ubelaker
Senior Scientist
Smithsonian Institution
Washington, DC, USA