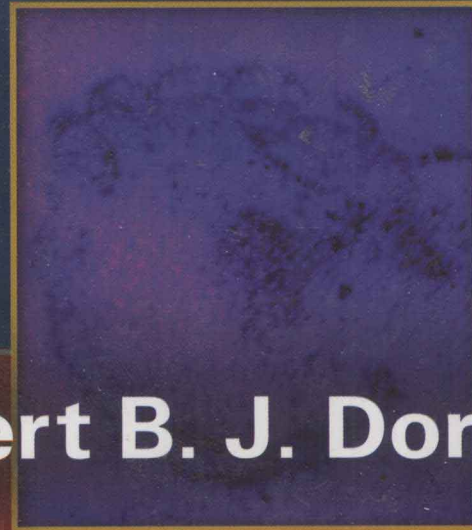
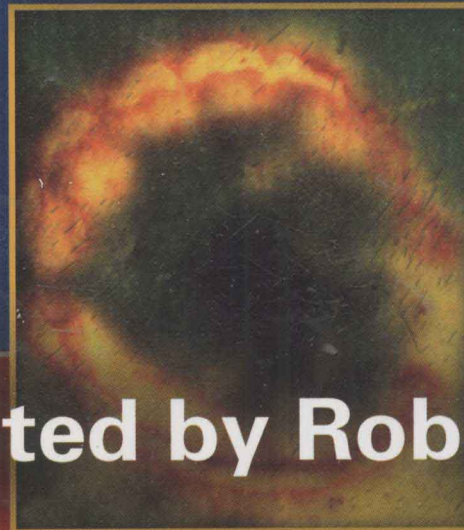
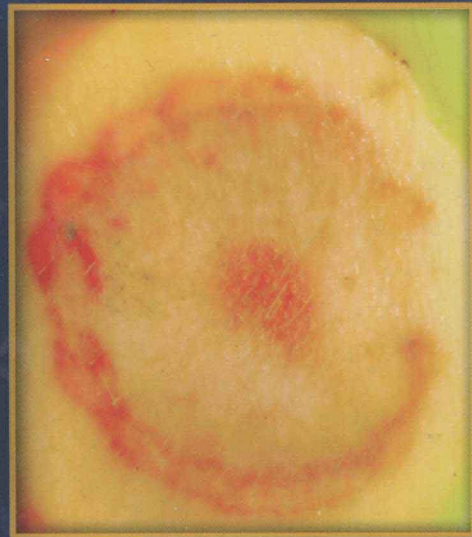


Second Edition

BITEMARK EVIDENCE

A Color Atlas and Text



Edited by Robert B. J. Dorion

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Foreword to the Second Edition

The analysis of bitemark evidence is clearly the most challenging and arguably the most intriguing aspect of forensic dentistry. And the stakes involved are high, because the bitemark evidence in a case may well be the key factor in determining whether a human being will be exonerated or sentenced to death. The Arizona case of *State v. Krone* and the Florida case of *Bundy v. State*, discussed in Chapter 1, are just two of many cases in point.

In 2003, Dr. Robert B. J. Dorion decided that there was a need to assemble the best in-depth knowledge available regarding bitemark evidence and create a high-quality text that would be a valuable and unprecedented tool for case work, research, teaching, and any other activity involving bitemarks. He developed a team of 21 exceptionally well-qualified contributors and worked industriously to assist them. The result was the 2005 publication of the first comprehensive text anywhere on the subject of bitemark evidence. As such, it is a landmark in the field of forensic science.

The outstanding reception received by the first edition validated Dr. Dorion's foresight and is a tribute to all who contributed to that monumental work. That edition also provided a solid foundation for enhancements, and the book you are now reading is a major step forward from the excellent first edition. The editor has maintained his insistence on quality and has added new

topics, new contributors, and new chapters. Some chapters, such as Chapter 1, have been extensively rewritten and expanded. Others have been updated. The book is larger, even more comprehensive, and has far more color photographs than the first edition.

Recent years have seen challenges to the legitimacy of various types of pattern analysis and this has certainly included bitemark analysis. These issues are addressed in depth in this text, starting at the end of the opening chapter. Much additional material presenting both the challenges and the responses are found in Chapters 20, 21, 28, and 33–35.

I salute Dr. Dorion and the many top-flight individuals involved in this effort for bringing together an awesome amount of information on an important subject in an organized fashion. The text *Bitemark Evidence* remains unchallenged in its field. Most importantly, I believe that both the novice and the weathered veteran in forensic dentistry who seriously utilize the contents of this book will feel richly rewarded for having done so. I wish the reader well in the adventures that lie ahead.

Gerald L. Vale, DDS, MDS, MPH, JD, D-ABFO
*Past president, American Board of Forensic Odontology;
distinguished fellow, American Academy
of Forensic Sciences*

Foreword to the First Edition

This book, *Bitemark Evidence*, is a clear and welcome reflection of the maturing of forensic odontology as a science. It is a sign that the field is evolving past its origins in a *Frye*-era “consensus of experts” and moving into an era of true scientific standards. It is also a signpost, pointing in directions still to be pursued. Those of us who have been in the field for some time can remember when we were hard pressed to find any reference textbooks whatsoever on the subject of forensic odontology, let alone bitemark evidence. This volume was conceived by its editor, Dr. Robert Dorion, to advance current knowledge and techniques in bitemark analysis in the cause of justice. In any branch of science, the questions to be asked must be tempered by the availability of the means to answer them.

Dr. Dorion has assembled a team of eminent forensic scientists from the disciplines of forensic odontology, DNA, pathology, and jurisprudence to present their views in the 13 parts of this much needed and long overdue book. The forensic community will surely appreciate the authors for the scope and depth of their knowledge of this fascinating subject. Professionals involved in the administration of justice will find this text to be an indispensable reference in any situation that confronts them with a question on the validity of bitemark evidence. The book will take the reader from the early history of bitemark investigation to the most sophisticated techniques in current use.

For years, the *Frye* rule was the standard for admission of bitemark evidence. The *Daubert* decision in

1993 radically changed the terms of admission and set the stage for objective and repeatable scientific standards. The decade since *Daubert* has been characterized by unprecedented growth in all the forensic sciences. Odontology is no exception. We have seen the emergence and development of novel methods of analysis that would have seemed like pure science fiction to the founders of this field. These techniques have had a very real and positive impact in courtrooms throughout the world. The evolution of bitemark investigation in the post-*Daubert* era is well documented in the chapters of this book. Dr. Dorion has performed an invaluable service in presenting the most up-to-date techniques of bitemark analysis in an intelligent and easily referenced manner. He has wisely chosen his contributors, whose aggregate knowledge and experience represent the very backbone of this field.

It is my privilege to have known Dr. Dorion since he was a young dental student. I have watched him grow into a leader in his field, and I hold him in the highest esteem. Likewise, I count the other contributors to this volume as valued colleagues and friends. Their work, as presented in these pages, will be an important and lasting contribution to the science of forensic odontology for years to come.

Arthur D. Goldman, DMD, FAGD, D-ABFO

*Past president, American Board of Forensic Odontology;
past president, American Academy of Forensic Sciences*

Preface

The second edition of *Bitemark Evidence*, an atlas textbook, contains over 1,500 photographs, of which more than 1,300 are in color. It covers everything from the history of bitemark evidence to diagnosis and on through courtroom testimony.

The book will interest first responders, emergency room personnel, physicians, pediatricians, dentists, nurses, crime scene investigators, police identification and photography personnel, medical examiners, coroners, pathologists, law enforcement, forensic and social service personnel, lawyers, and judges. The faculties of medicine, nursing, dentistry, and law will find this atlas textbook an invaluable reference in the respective disciplines.

The reader will appreciate the complexity, difficulties, and problems encountered by the expert in the field of bitemark evidence and its legal implications. This text is a collective work and as such reflects the knowledge, training, experience, opinions, and research of 27 authors from around the world.

The protocols for photography, collection, preservation, and analysis of bitemarks as well as the current and upcoming research are detailed and the legal implications and ramifications discussed. In the realm of death investigation, the coroner, medical examiner, or pathologist is the primary diagnostician, controller of information, and provider of access to material. The emphasis of the textbook is on diagnosis, communications, and cooperation among the different experts.

The atlas unravels the mystery of bitemarks in 13 sections. The first section is a new chapter on the historical perspective fittingly described by Senn. His treatment begins with the earliest known bitemark references from the Bible and the *Kama Sutra*, through old English law, to early cases from around the world. The era of growth and development of bitemark analysis is accentuated by significant cases from Great Britain, Germany, Russia, Norway, Scotland, Canada, Australia, Africa, and the United States. The development of forensic organizations throughout the world is outlined. Lastly, the challenges to the legitimacy of bitemark evidence are described, with particular reference to the 2009 report of the National Academy of Sciences.

Section II, on bitemark recognition, is divided into three chapters dealing with the roles of health professionals and personnel from various fields. The teamwork

approach in bitemark recognition, diagnosis, and investigation is emphasized. In Chapter 2, McDowell treats biting associated with domestic violence and child, intimate partner, and elder abuse in the living. Davis (Chapter 3) relates the role of the medical examiner, coroner, and pathologist in bitemark detection and underlines pattern variables. Delattre expresses the rationale and benefits of the teamwork approach in Chapter 4. The importance of developing a teamwork protocol is emphasized as well as the role of each team member.

In Section III, Bernstein (Chapter 5) describes the nature of bitemarks from class and individual characteristics to anatomy, variations, and pathology. In Chapter 6, he deals with reconstructive bitemark analysis: quality of the bitemark, profiling the biter and its limitations, and maintaining perspective.

Sections IV(A) and IV(B), on the collection of bitemark evidence, are divided into noninvasive and invasive analyses, respectively. The former is made up of seven chapters dealing with digital photography and practical tips, image processing and analysis for evidentiary purposes, bitemarks as biological evidence, bitemark impressions, microscopy, and the handling of perishables and nonperishables.

Golden and Wright discuss digital photography in Chapter 7, beginning with the principles of reflection, absorption, fluorescence, and diffusion. The digital armamentaria of cameras, lenses, and flash units are further analyzed. The different uses and types of photography, including infrared (IR), ultraviolet (UV), and alternate light imaging (ALI), are discussed with case presentation. The application of photographic techniques for purposes other than the recording of bitemarks rounds off the chapter.

A new chapter by Gagnon (Chapter 8) offers practical tips in forensic bitemark photography. Image processing and analysis for evidentiary purposes is aptly described by Oliver's new contribution in Chapter 9. He discusses image processing, digital work flow, and software resources.

Sweet discusses salivary swabbing and DNA analysis in Chapter 10. The discussion of salivary flow, physiology, cellular content, stability, recovery, storage, and transportation of saliva as well as case examples more than adequately covers the theme.

In Chapter 11, Dorion's discussion of bitemark impressions includes a description of materials and new inclusions on techniques for hair removal and impression taking. A new contribution by Peter Bush (Chapter 12) explores the rationale, use, materials, and methods employed for confocal laser microscopy (CLM) and the scanning electron microscope (SEM) and provides examples.

The last of the noninvasive techniques is addressed by Dorion in Chapter 13. It describes the materials and methods employed in the handling, preservation, storage, and transportation of perishables and nonperishables as well as outlining the factors affecting bitemarks in perishables.

The invasive analysis component to the collection of bitemark evidence is composed of two chapters on tissue specimens and histology. In Chapter 14, Dorion discusses skin wetness and dehydration, the ring technique for tissue excision, fixation, storage, postfixation and storage, transportation, and transillumination. Practical examples are demonstrated using the microscope and transilluminated tissue. The examples serve to illustrate the significance of transillumination.

Davis eloquently introduces histology and the "timing" of bitemarks in Chapter 15. He points out textbook discordance in estimating the timing of bruises while discussing the differences between abrasion, contusion/bruise, laceration, and postmortem bruising. Histopathology, histochemistry and biochemistry, and critique of the literature reviews help the reader understand the complexities of this evidence. Reliance on color determination for aging bitemarks is called into question.

Section V explores bitemark variables while presenting case material in four chapters. In Chapter 16, Souviron deals with animal bites in general, incorporating aquatic and carnivore bites, both fatal and nonfatal, as well as postmortem animal bites while suggesting an animal bite protocol.

In Chapter 17, Dorion deals with nonfatal and fatal carnivore bites, including mountain lion, bear, and dog cases. Section 17.3, *Forensic Nightmare: Misdiagnosis*, exposes how a simple dog bite case evolved into a homicide charge and, 4 years later, resulted in civil litigation against the police, the pathologist, and the odontologist. There is discussion of the significance of pattern distribution, wound patterning, clothing, "blood wiping," tissue avulsion, and transillumination in case evaluation. Autopsy failures and forensic lessons learned conclude the chapter.

Factors affecting bitemark dynamics introduce Chapter 18 on human bitemarks. Of the 100-odd factors involved in bitemark dynamics, Dorion specifically deals with case presentations, cross-referencing several

in other chapters. Hair, orifices, amputation/avulsion, pigmentation, healing, clothing, self-inflicted bitemarks, erectile tissue, and the presence of other trauma are among the subjects discussed.

Dorion and Souviron team up in Chapter 19 to resolve issues of patterns, lesions, and trauma-mimicking bitemarks. They discuss healing and healed lesions as well as patterned injuries on the deceased. The reader is warned of the potential for misinterpreting emergency medical treatment or autopsy trauma as bitemarks. The chapter also addresses the issue of unspecified marks and lesions.

Section VI on research is one of the major reasons for revising this edition. It incorporates four new chapters. The first, Chapter 20, is "Current Context of Bitemark Analysis and Research," written by Mary and Peter Bush to include an overview of the National Academy of Sciences report and its implications in bitemark analysis. They discuss the uniqueness of the dentition and skin as an impression material.

Chapter 21 by Dorion discusses research, emerging technologies, and recent developments. It contains over 430 color, UV, IR, and ALI photographs of "gold standard" experimental bitemarks from infliction to 9 months postmortem in some cases. It discusses, among others, the topics of the influence of the presence of hair, clothing, extracellular fluid, overlapping bitemarks, lingual markings, muscle perforation, lividity, and freezing.

Chapter 22 is another new chapter dealing with experimental bitemarks and histology by Houde, a forensic pathologist and former coroner. She describes the normal porcine skin histology, the microscopic examination of bitemarks on fresh and frozen piglet skin, and the microscopic examination of human bitemarks.

Lastly, this section contains an update to Tompkins's work on genotypic comparison of oral bacteria isolated from bitemarks and teeth in Chapter 23.

Section VII comprises the collection of evidence from the suspect. In Chapter 24, Johnson explains questions of court order versus informed consent as well as the means and methods of obtaining the suspect's dental history, intra- and extraoral photographs, and impressions.

Section VIII, on methods of bitemark comparison by Dailey, introduces the concept of test and static bites. Bite exemplars in wax, Styrofoam, animal and human skin, and the dynamic test bites on volunteers, as well as standard dental impression materials, are evaluated. Methods of direct comparison and the avoidance of technical problems regarding dental nomenclature and dental cast inversions in comparison techniques are addressed. The issues of simple versus computer-generated overlays and the respective problems of metric and digital analysis are effectively conveyed. Other comparison techniques,

three-dimensional pattern analysis, ink immersion, the dental line-up, and other methods of computer-aided visualization are discussed. Pattern recognition ability concludes Chapter 25.

In Section IX, Bernstein (Chapter 26) discusses report writing: its goals, objectives, basic qualities, preparation, content, perspective, and security. He suggests measures for maintaining objectivity and addresses the issue of the components for a standard bite-mark report. A new contribution includes the topics of disposition of evidence, investigator information, perspective, and security.

Stimson points to issues of prevention and contamination in Section X. Various subjects are addressed in Chapter 27, from personnel to autopsy protocol, instruments, and equipment, to bite-mark and dental impressions and casts.

Section XI deals with legal considerations and the courtroom. The six chapters cover science and the law, case law, courtroom aids in bite-mark evidence, and the legal liability of the expert witness. There are two new contributions on contracting with the expert witness, and wrongful convictions.

Chapter 28 introduces the reader to the legal system by explaining science and the law, justice versus truth, the adversarial system, and evidentiary restrictions. Mincer and Mincer further discuss the principles of differentiating good from junk science, the importance of objectivity, the interplay and tension between science and advocacy, and how to approach serving as an expert witness in a bite-mark case.

Barsley discusses the foundation of case law in Chapter 29, the qualification of the expert, and the concept of "degree of certainty." He delves into the battling experts, qualifying to testify, the expert's testimony in opinion, and "linkage."

A new chapter by Metcalf (Chapter 30) introduces the notion of contracting with the expert witness. It explains the notion of a valid contract, oral versus written contracts, the offer, the acceptance, and the consideration. A sample contract is included.

In Chapter 31, Kenney introduces the topic of courtroom aids in bite-mark evidence by emphasizing

the need for simplicity, clarity, and conciseness on the part of the testifying expert witness. In the early 1970s, the analysis of bite-mark evidence consisted of analyzing black-and-white photographs of dubious quality and producing hand-drawn overlays of the suspect dentition for comparison. Kenney itemizes different methods and materials that, historically, have been used in courtroom presentations by forensic dental experts in bite-mark cases.

The eye-opening Chapter 32 describes the legal liability of the expert witness with specific reference to forensic dentists. Pitluck emphasizes the reasoning behind absolute immunity and the changing concepts regarding that immunity and what to expect in the future. Chapter 33, the other new chapter in this section, written by Pretty and Bowers, discusses wrongful convictions and erroneous bite-mark opinions. It describes the anatomy of a wrongful conviction including examples.

Section XII, on contentious issues, is divided into two chapters concerning the reliability of bite-mark evidence and resolving issues in bite-mark analysis. Chapter 34 introduces concepts of reliability, validity, accuracy, sensitivity and specificity, receiver operator characteristics, and positive and negative predictive values. The effects of *Daubert* and other judicial rulings and the various research projects in bite-mark evidence and their effect on statistics are alluded to. Chapter 35, also by Pretty, discusses the human skin as a bite-mark registration material and methods of analysis—both physical comparison and molecular biological techniques. Further discussion on the levels of conclusion and uniqueness of human dentition conclude the chapter.

Lastly, Section XIII is composed of six appendices that will undoubtedly benefit the reader with their brevity, conciseness, and checklist approach.

The views and opinions expressed by one contributor in this edition may or may not coincide with or reflect the views and opinions of the other contributors. An attempt has been made, however, to reflect the contemporary scientific view of the subject matter.

Robert B. J. Dorion, editor

Acknowledgments

I would like to thank all those who have contributed directly and indirectly to this project and in particular to the 27 contributing authors, without whom this book could not have been realized.

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Lastly, I thank the various local, national, and international friends and colleagues for the encouragement expressed and the cooperation received in the writing of this edition.

Contributors

Robert B. J. Dorion (editor), BSc, DDS, FACD, D-ABFO; director of forensic dentistry, Laboratoire de Sciences Judiciaires et de Médecine Légale, Ministry of Public Security for the Province of Quebec, Montreal, Quebec, Canada; assistant professor, faculty of dentistry, McGill University; adjunct research assistant professor, Dept. of Oral Diagnostic Sciences, School of Dental Medicine, SUNY at Buffalo; past president, American Board of Forensic Odontology; past president, Canadian Society of Forensic Science; distinguished fellow, American Academy of Forensic Sciences; fellow, Canadian Society of Forensic Science; member of the board of directors of the American Academy of Forensic Sciences.

Robert E. Barsley, DDS, JD, D-ABFO; forensic dental consultant to the Orleans Parish Coroner's Office and the Jefferson Parish Coroner's Office, New Orleans, Louisiana; professor of comprehensive dentistry, and director, dental oral resources, LSUHSC School of Dentistry, New Orleans; past president, American Society of Forensic Odontology; secretary, American Academy of Forensic Sciences; fellow, American Academy of Forensic Sciences.

Mark L. Bernstein, DDS, D-ABOMP, D-ABFO; professor of oral and maxillofacial pathology, University of Louisville School of Dentistry, Louisville, Kentucky; forensic dental consultant to Chief Medical Examiner's Office, Commonwealth of Kentucky; fellow, American Academy of Forensic Sciences.

C. Michael Bowers, DDS, JD, D-ABFO; deputy medical examiner, Ventura, California; associate clinical professor, the Herman Ostrow School of Dentistry, University of Southern California, Los Angeles.

Mary A. Bush, DMD; director, the Laboratory for Forensic Odontology Research, School of Dental Medicine, University at Buffalo, State University of New York at Buffalo, New York.

Peter J. Bush, BS; director, South Campus Instrument Center; codirector, Laboratory for Forensic Odontology Research, School of Dental Medicine, University at Buffalo, State University of New York at Buffalo; adjunct professor, art conservation, Buffalo State College, Buffalo, New York.

Jon Curtis Dailey, DDS, D-ABFO; part-time private practice in prosthodontics; forensic odontology consultant, State of Massachusetts Medical Examiner's Office; adjunct faculty, Armed Forces Institute of Pathology; past president, American Society of Forensic Odontology; fellow, American Academy of Forensic Sciences.

Joseph H. Davis, MD; retired chief medical examiner, Miami-Dade County, Florida; professor of pathology emeritus, University of Miami; certified by the American Board of Pathology in pathologic anatomy and forensic pathology; past president, American Academy of Forensic Sciences; past president, National Association of Medical Examiners; distinguished fellow and Gradwohl laureate, American Academy of Forensic Sciences.

Veronique F. Delattre, BSc, DDS, FAGD, D-ABFO; director of quality assurance and risk management, and professor, University of Texas Dental Branch at Houston, Texas; forensic dental consultant, Harris County Institute of Forensic Sciences, Houston, Texas; fellow, American Academy of Forensic Sciences; fellow, Academy of General Dentistry; charter member, FBI-CJIS National Dental Image Repository Review Panel; recipient, 2008 FBI assistant director's award for exceptional public service.

Luc Gagnon, section head, Crime Scene Module Western Section, Forensic Identity Division, Criminalistics Service, Sûreté du Québec, Montreal, Quebec, Canada.

Gregory S. Golden, DDS, D-ABFO; chief odontologist/deputy coroner, County of San Bernardino, California; assistant professor, School of Dentistry, Loma Linda University, Loma Linda, California; fellow, American Academy of Forensic Sciences.

Michelle Houde, MD; retired forensic pathologist and coroner for the Province of Quebec, Canada.

L. Thomas Johnson, DDS, D-ABFO, CSCSA; associate medical examiner, Milwaukee County Medical Examiner's Office, Milwaukee, Wisconsin; professor, dental science, forensic dentistry and public health, Marquette University School of Dentistry, Milwaukee, Wisconsin; past president, American Board of Forensic Odontology; consultant, Wisconsin Department of

Justice, Crime Laboratory Bureau; fellow, American Academy of Forensic Sciences; certified senior crime scene analyst, International Association for Identification, Crime Scene Certification Board; certified law enforcement instructor, Illinois Bureau of Law Enforcement Standards and Training.

John P. Kenney, DDS, MS, D-ABFO, SCSA; deputy coroner and director of identification services, Du Page County, Illinois, Coroner's Office; associate clinical professor of surgery, Northwestern University Medical School; consultant, Joint POW-MIA Accounting Command, Hickam AFB, Hawaii; secretary and trustee, the Forensic Sciences Foundation; past president, American Board of Forensic Odontology; editorial board, *Journal of Forensic Sciences*, *Journal of Forensic Identification*; fellow, American Academy of Forensic Sciences; fellow, American Academy of Pediatric Dentistry.

John D. McDowell, DDS, MS, D-ABFO; director, oral medicine and forensic sciences, University of Colorado School of Dentistry; chairman, oral diagnosis, oral medicine and oral radiology, University of Colorado School of Dentistry; past president, American Academy of Forensic Sciences; past president, American Society of Forensic Odontology; fellow, American Academy of Forensic Sciences.

Roger D. Metcalf, DDS, JD, D-ABFO; director of the Human Identification Laboratory, Tarrant County Medical Examiner's District, Fort Worth, Texas; distinguished visiting clinical professor, Texas Wesleyan University, Fort Worth; fellow, American Academy of Forensic Sciences; fellow, American College of Legal Medicine.

Harry H. Mincer, DDS, PhD, D-ABFO; dental consultant to the medical examiner, Shelby County, Tennessee; professor and director of oral and maxillofacial diagnostic services, University of Tennessee College of Dentistry; past president American Board of Forensic Odontology; fellow, American Academy of Forensic Sciences.

Richard A. Mincer, JD; Hirst Applegate, LLP, Cheyenne, Wyoming; managing editor, *University of Memphis Law Review*; past president, Defense Lawyers Association of Wyoming.

William R. Oliver, MD, MS (computer science), MPA (justice administration); professor and director of anatomic and forensic services, Department of Pathology and Laboratory Medicine, Brody School of Medicine at

East Carolina University, Greenville, North Carolina; network administrator, Scientific Computing Network, Armed Forces Institute of Pathology; former regional medical examiner, Georgia Bureau of Investigation; former deputy medical examiner, Office of the Armed Forces Institute of Pathology; board certified in anatomic, clinical, and forensic pathology; fellow, College of American Pathologists, American Academy of Forensic Sciences, National Association of Medical Examiners; selected as one of *Federal Computer Week's* 100 most influential information technology professionals, 1997; finalist, Berry Prize in Military Medicine, 1998; executive committee, Scientific Working Group on Imaging Technology, Applied Imagery Pattern Recognition Workshop; chair, SWGIT Image Analysis Subcommittee.

Haskell M. Pitluck, JD; retired circuit court judge (Illinois); past president, American Academy of Forensic Sciences; fellow, American Academy of Forensic Sciences.

Iain A. Pretty, BDS (Hons), MSc, MPH, PhD, MFDSRCS (Ed); forensic dentist to the North West Coroner's Services; forensic consultant to Merseyside and Cheshire Police Forces; senior lecturer in dental public health, School of Dentistry, University of Manchester.

David R. Senn, DDS, D-ABFO; clinical assistant professor, dental diagnostic science, University of Texas Health Science Center at San Antonio; director, Center for Education and Research in Forensics; chief forensic odontologist, Bexar County Medical Examiner, San Antonio, Texas; fellow, American Academy of Forensic Sciences.

Richard R. Souviron, DDS, D-ABFO; chief forensic odontologist, Miami-Dade County Medical Examiner's Office, Florida; adjunct professor, pathology, University of Miami School of Medicine; past president and founding member, American Board of Forensic Odontology; fellow, American Academy of Forensic Sciences; founding member of the Odontology Section of the American Academy of Forensic Sciences.

Paul G. Stimson, DDS, MS, D-ABFO, D-ABOMP (emeritus); senior forensic consultant, Harris County Forensic Center, Office of the Medical Examiner, Houston, Texas; professor emeritus, University of Texas Dental Branch at Houston, University of Texas Health Science Center at Houston; past president, American Board of Forensic Odontology; past president and member emeritus, American Society of Forensic Odontology; fellow, American Academy of Forensic Sciences; DMORT team member.

David Sweet O.C., DMD, PhD, D-ABFO; director, Bureau of Legal Dentistry Laboratory, University of British Columbia, Vancouver, Canada; professor, faculties of dentistry and medicine, the University of British Columbia, Vancouver, Canada; consultant forensic odontologist, Office of the Chief Coroner, British Columbia Coroners' Service, Burnaby, Canada; consultant forensic odontologist, Royal Canadian Mounted Police Forensic Laboratory Services Directorate, Ottawa, Canada; fellow, American Academy of Forensic Sciences.

Geoffrey R. Tompkins, PhD; senior lecturer, Department of Oral Sciences, and director, Oral Microbiology and Dental Health Research Theme, University of Otago, Dunedin, New Zealand; past president, Georgia Chapter, American Association for Dental Research.

Franklin D. Wright, DMD, D-ABFO; forensic dental consultant, Hamilton County Coroner's Office, Cincinnati, Ohio; fellow, American Academy of Forensic Sciences.

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