

## Dental Cementum in Anthropology

Tooth enamel and dentin are the most studied hard tissues used to explore hominin evolution, life-history, diet, health, and culture. Surprisingly, cementum (the interface between the alveolar bone and the root dentin) remains the least studied dental tissue even though its unique growth, which is continuous throughout life, has been acknowledged since the 1950s. This interdisciplinary volume presents in three parts state-of-the-art studies in cementum analysis and its broad interpretative potential in anthropology. Part I describes cementum biology; Part II presents optimized multi-species and standardized protocols to estimate age and season at death precisely. Part III highlights innovative applications in zooarchaeology, paleodemography, bioarchaeology, paleoanthropology, and forensic anthropology, demonstrating how cementochronology can profoundly affect anthropological theories. With a wealth of illustrations of cementum histology and accompanying online resources, this book provides the perfect toolkit for scholars interested in studying past and current human and animal populations.

**Stephan Naji** is a bioarchaeologist specializing in paleodemography, particularly in demographic and health transitions. His current research focuses on optimizing cementochronology within the broader evolutionary context of chronobiology for histological and virtual age-at-death estimation. He also actively promotes life-history events identification and modeling in cementum through interdisciplinary collaborations.

**William Rendu** is a zooarchaeologist interested in the mobility of past human societies. He implemented cementochronology during his PhD to discuss the seasonal distribution of Neanderthal activities. He is now continuing this work with a larger chronological framework as director of the International Research Laboratory ZooSCAn in Siberia.

**Lionel Gourichon** is a zooarchaeologist. His research interest lies in the emergence of food production in Southwest Asia and the Mediterranean area, in particular on human–animal relationships and the process of domestication. He actively contributes to methodological advances in bioarchaeology to improve the study of mammal and bird remains.

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# Dental Cementum in Anthropology

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**We would like to dedicate this book to wonderful colleagues and friends who paved the way of cementschronology for us, supported our endeavors, and brightened our lives.**

**Jean-Pierre Bocquet-Appel (1949–2018) – a mentor, a pioneer, a visionary scholar, and a generous friend. He was a true anthropologist. Farewell.**

**Anne Pike-Tay (1956–2020) – an inventive, challenging, and luminous archaeozoologist and paleoanthropologist. We owe her a lot.**

**Vicky Wedel (1974–2021) – a dedicated researcher who strived to use anthropology as a platform to speak for those who no longer had a voice. You were a gentle soul, and it was a privilege knowing you; we will miss you dearly.**

\*\*\*\*\*

**To Galina A. Klevezal, whose publications are still the benchmarks of interdisciplinary studies on cementum – we thank you sincerely for your outstanding scientific rigor and dedication.**

**To Joël Blondiaux, who trained every anthropologist in France in cementschronology – thank you so much for your patience, generosity, and brilliant scientific intuitions.**

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## Contents

	<i>List of Contributors</i>	page x
	<i>Foreword by Daniel Antoine</i>	xvii
	<b>Introduction: Cementochronology in Chronobiology</b>	1
	Stephan Naji	
<b>Part I</b>	<b>The Biology of Cementum</b>	19
<b>1</b>	<b>A Brief History of Cemental Annuli Research, with Emphasis upon Anthropological Applications</b>	21
	Jane E. Buikstra	
<b>2</b>	<b>Development and Structure of Cementum</b>	46
	Brian L. Foster, Francisco H. Nociti, Jr., and Martha J. Somerman	
<b>3</b>	<b>Insights into Cementogenesis from Human Disease and Genetically Engineered Mouse Models</b>	65
	Brian L. Foster, Michael B. Chavez, Tamara N. Kolli, and Leigh Oldershaw	
<b>4</b>	<b>A Comparative Genetic Analysis of Acellular Cementum</b>	83
	Amber E. Trujillo, Alex R. DeCasien, Mareike C. Janiak, Stephan Naji, and Todd R. Disotell	
<b>5</b>	<b>Pattern of Human Cementum Deposition with a Special Emphasis on Hypercementosis</b>	94
	Emmanuel d’Incau, Bruno Maureille, and Christine Couture-Veschambre	
<b>6</b>	<b>Recent Advances on Acellular Cementum Increments Composition Using Synchrotron X-Radiation</b>	110
	Stephan Naji, Stuart R. Stock, William Rendu, Lionel Gourichon, Thomas Colard, and Zhonghou Cai	
<b>7</b>	<b>Incremental Elemental Distribution in Chimpanzee Cellular Cementum: Insights from Synchrotron X-Ray Fluorescence and Implications for Life-History Inferences</b>	138
	Adeline Le Cabec, Jan Garrevoet, Kathryn M. Spiers, and M. Christopher Dean	

viii	<b>Contents</b>	
<b>8</b>	<b>Identifying Life-History Events in Dental Cementum: A Literature Review</b> Elis Newham and Stephan Naji	155
<b>Part II</b>	<b>Protocols</b>	171
<b>9</b>	<b>Cementochronology for Archaeologists: Experiments and Testing for an Optimized Thin-Section Preparation Protocol</b> Eric Pubert, Stephan Naji, Lionel Gourichon, Frédéric Santos, and William Rendu	173
<b>10</b>	<b>Optimizing Preparation Protocols and Microscopy for Cementochronology</b> Paola Cerrito, Stephan Naji, and Timothy Bromage	189
<b>11</b>	<b>Cementochronology Protocol for Selecting a Region of Interest in Zooarchaeology</b> William Rendu, Stephan Naji, Eric Pubert, Carlos Sánchez-Hernández, Manon Vuillien, Hala Alarashi, Emmanuel Discamps, Elodie-Laure Jimenez, Solange Rigaud, Randall White, and Lionel Gourichon	201
<b>12</b>	<b>Tooth Cementum Annulations Method for Determining Age at Death Using Modern Deciduous Human Teeth: Challenges and Lessons Learned</b> Vicki L. Wedel†, Kenneth P. Hermsen, and Mathew J. Wedel	215
<b>13</b>	<b>The Analysis of Tooth Cementum for the Histological Determination of Age and Season at Death on Teeth of US Active Duty Military Members</b> Nicholas Wilson and Katrin Koel-Abt	226
<b>14</b>	<b>Preliminary Protocol to Identify Parturitions Lines in Acellular Cementum</b> Thomas Colard, Stephan Naji, Amélie Debroucker, Sofiann El Ayoubi, and Guillaume Falgayrac	234
<b>15</b>	<b>Toward the Nondestructive Imaging of Cementum Annulations Using Synchrotron X-Ray Microtomography</b> Adeline Le Cabec, Nancy K. Tang, Valentin Ruano Rubio, and Simon Hillson	249
<b>16</b>	<b>Noninvasive 3D Methods for the Study of Dental Cementum</b> Elis Newham, Kate Robson Brown, Ian J. Corfe, Pamela G. Gill, Philippa Brewer, Priscilla Bayle, and Philipp Schneider	258
<b>Part III</b>	<b>Applications</b>	273
<b>17</b>	<b>Using Cementochronology to Discuss the Organization of Past Neanderthal Societies</b> William Rendu, Eric Pubert, and Emmanuel Discamps	275
<b>18</b>	<b>Investigating Seasonal Competition between Hominins and Cave Hyaenas in the Belgian Ardennes during the Late Pleistocene: Insights from Cementum Analyses</b> Elodie-Laure Jimenez and Mietje Germonpré	288



	Contents	ix
<b>19</b>	<b>Cementochronology to the Rescue: Osteobiography of a Middle Woodland Woman with a Combined Skeletal Dysplasia</b> Aviva A. Cormier, Jane E. Buikstra, and Stephan Naji	306
<b>20</b>	<b>Estimating a Mortality Profile of Fisher-Gatherers in Brazil Using Cementochronology</b> Stephan Naji, Joël Blondiaux, Sheila Mendonça de Souza, Iris Zeng, and Jean-Pierre Bocquet-Appel†	322
<b>21</b>	<b>Cementochronology: A Solution to Reconstructing Past Populations' Mortality Profiles Using Individual Age-at-Death Estimates</b> Laëtitia Lanteri, Bruno Bizot, Bérengère Saliba-Serre, and Aurore Schmitt	338
<b>22</b>	<b>Assessing Age-Related Mortality at Petra, Jordan, Using Cementochronology and Hazard Modeling</b> Akacia Propst, Michael Price, and Megan Perry	351
<b>23</b>	<b>Shaping Age-at-Death Distributions by Applying Tooth Cementum Analysis to the Early Medieval Graveyard of Lauchheim (Germany)</b> Ursula Wittwer-Backofen and Felix Engel	364
<b>24</b>	<b>Back to the Root: The Coming of Age of Cementochronology</b> Stephan Naji and William Rendu	379
	<i>Index</i> <i>Color plates can be found between pages 172 and 173.</i>	394

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## Foreword

### Unlocking the Potential of Cementum Layering

Daniel Antoine, The British Museum, London

The world of dental histology opens up a wealth of information on human growth and development. My early insights into this world involved evaluating the periodicity of cementum layering using teeth with a known age of extraction as part of my undergraduate research. The results were mixed, in part due to the small sample size and the complexity of imaging cementum under a scanning electron microscope. Simon Hillson and I had hoped that this form of microscopy would facilitate the counting of cementum layers! To a certain extent, it did. In some teeth, counts were similar to the age of extraction (Hillson & Antoine 2003); in others, they differed from it, and some individuals had finer layers in between more defined ones. At the time of the study, the literature was relatively sparse and I was guided by a handful of key papers (e.g., Charles et al. 1986; Condon et al. 1986). By the time I was involved in another cementum project (Huffman & Antoine 2010), I had changed my focus to enamel microstructures. A chance meeting with Stephan at a poster symposium on cementum during the 2012 American Association of Physical Anthropology meetings in Knoxville (US) revealed to me how far the field had moved forward! Following a similarly successful symposium at the 2017 meetings in New Orleans, I am very pleased that Stephan, William, and Lionel followed through to produce this comprehensive, much-needed, and remarkably insightful volume. Although the periodicity and use of incremental structures in enamel and, to a lesser extent, dentine have benefited from more anthropological research (Antoine et al. 2018), it is clear that work on cementum layering, particularly in humans, has – until recently – been more sporadic. This, in part, reflects the fact that both cementum and dentine are more susceptible than enamel to diagenetic changes, affecting our ability to observe their growth structures in many archaeological and fossil teeth (Tang et al. 2016). The highly mineralized enamel offers some protection to the dentine immediately below its surface. This is not the case for the roots on which cementum is deposited.

Combining the latest research on cementum into this single book is a major achievement and represents a giant step forward. The volume is underpinned by several chapters that explore the biology of cementum and provide the crucial background for a fuller interpretation of the histological structures being observed. A range of preparation protocols, imaging methods, and applications are also clearly presented.

Questions regarding our ability to record such structures, as well as their periodicity, are discussed in some detail. However, some questions remain, offering avenues for future research (e.g., Chapter 1). The lessons learned from work on other hard tissues may offer some valuable insights. The interpretation of incremental structures in teeth not only requires a clear understanding of the biological processes that lead to their formation, but it must also account for the physics behind the imaging techniques used to analyze such complex tissues. In transmitted light microscopy, for example, structures are usually made visible by the scattering of light through a relatively thick 100  $\mu\text{m}$  “thin section.” Over such a thickness, many variables can impact what is being observed. For example, as the layers of cementum curve around the roots, they are unlikely to be perpendicular to the plane of section and some optical interference is likely. By assessing the impact of the preparation methods (e.g., different mounting resins and planes of section), by offering clear preparation protocols, and by using multiple imaging techniques on the same tooth (e.g., Chapters 10 and 14), this volume helps us understand some of the challenges involved in imaging cementum, particularly in diagenetically altered tissues. Moving forward, the narrower optical plane of laser confocal microscopy could, for example, be used to clarify some of the structures seen in transmitted light microscopy (both can be used to image the exact same area; see Antoine et al. 2009). Such multi-imaging approaches are likely to lead to a better interpretation of what is being observed, including any complex layering patterns (e.g., doubling, sublayering, and accentuated lines) and what may be impacting our ability to record such structures. Despite the time and labor often required to image dental microstructures, the development of more sophisticated imaging techniques should help overcome some of these difficulties. The insights gained are worth the effort! This much-needed volume offers an essential framework for future research that will, hopefully, act as a catalyst to a plethora of new work. Well done!

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