

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

## TIKAL

The primary theoretical question addressed in this book focuses on the lingering concern of how the ancient Maya in the northern Petén Basin were able to sustain large populations in the midst of a tropical forest environment during the Late Classic period. This book asks how agricultural intensification was achieved and how essential resources, such as water and forest products, were managed in both upland areas and seasonal wetlands, or *bajos*. All of these activities were essential components of an initially sustainable land use strategy that eventually failed to meet the demands of an escalating population. This spiraling disconnection with sound ecological principles undoubtedly contributed to the Maya collapse. The book's findings provide insights that broaden the understanding of the rise of social complexity – the expansion of the political economy, specifically – and, in general terms, the trajectory of cultural evolution of the ancient Maya civilization.

David L. Lentz is Professor of Biological Sciences and Executive Director of the Center for Field Studies at the University of Cincinnati. He has authored more than ninety publications that have appeared as journal articles, book chapters, and three books, including this volume. His research focuses on anthropogenic landscape changes of the past and paleoethnobotanical studies in Mesoamerica, Central Asia, and North America.

Nicholas P. Dunning is Professor of Geography at the University of Cincinnati. He is a geoarchaeologist and cultural ecologist specializing in the Neotropics. He has published several books and more than ninety articles and book chapters, including those in this volume.

Vernon L. Scarborough is Distinguished University Research Professor and Charles Phelps Taft Professor in the Department of Anthropology at the University of Cincinnati. His work emphasizes sustainability and global water systems through an examination of past engineered landscapes, using comparative ecological and transdisciplinary perspectives. He has published ten books – eight of them edited, including this volume – and authored more than ninety book chapters or journal articles.

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

---

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

# Tikal

## PALEOECOLOGY OF AN ANCIENT MAYA CITY

Edited by

**David L. Lentz**

University of Cincinnati

**Nicholas P. Dunning**

University of Cincinnati

**Vernon L. Scarborough**

University of Cincinnati



**CAMBRIDGE**  
UNIVERSITY PRESS

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

## CAMBRIDGE UNIVERSITY PRESS

32 Avenue of the Americas, New York, NY 10013-2473, USA

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning, and research at the highest international levels of excellence.

[www.cambridge.org](http://www.cambridge.org)

Information on this title: [www.cambridge.org/9781107027930](http://www.cambridge.org/9781107027930)

© Cambridge University Press 2015

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

First published 2015

Printed in the United States of America

*A catalog record for this publication is available from the British Library.*

*Library of Congress Cataloging in Publication data*

Tikal : paleoecology of an ancient Maya city / edited by David L. Lentz, University of Cincinnati, Nicholas P. Dunning, University of Cincinnati, Vernon L. Scarborough, University of Cincinnati.

pages cm

Includes bibliographical references and index.

ISBN 978-1-107-02793-0 (hardback)

1. Paleoecology – Guatemala – Tikal Site. 2. Wetland agriculture – Guatemala – Tikal Site. 3. Tikal Site (Guatemala) I. Lentz, David L. (David Lewis), 1951– II. Dunning, Nicholas P. (Nicholas Pierce), 1957– III. Scarborough, Vernon L. (Vernon Lee), 1950–

QE720.2.G9T55 2015

560'.450972812–dc23 2014015323

ISBN 978-1-107-02793-0 Hardback

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party Internet Web sites referred to in this publication and does not guarantee that any content on such Web sites is, or will remain, accurate or appropriate.

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

## Contents

<i>List of Figures</i>	page vii
<i>List of Tables</i>	xi
<i>Contributors</i>	xiii
<i>Editors</i>	xvii
<i>Foreword by Payson Sheets</i>	xix
<i>Acknowledgments</i>	xxiii
1 <b>Tikal Land, Water, and Forest: An Introduction</b>	1
<i>Nicholas P. Dunning, David L. Lentz, and Vernon L. Scarborough</i>	
2 <b>The Evolution of an Ancient Waterworks System at Tikal</b>	16
<i>Vernon L. Scarborough and Liwy Grazioso Sierra</i>	
3 <b>At the Core of Tikal: Terrestrial Sediment Sampling and Water Management</b>	46
<i>Brian Lane, Vernon L. Scarborough, and Nicholas P. Dunning</i>	
4 <b>Bringing the University of Pennsylvania Maps of Tikal into the Era of Electronic GIS</b>	59
<i>Christopher Carr, Eric Weaver, Nicholas P. Dunning, and Vernon L. Scarborough</i>	
5 <b>Examining Landscape Modifications for Water Management at Tikal Using Three-Dimensional Modeling with ArcGIS</b>	87
<i>Eric Weaver, Christopher Carr, Nicholas P. Dunning, Lee Florea, and Vernon L. Scarborough</i>	

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

vi  
 CONTENTS

6	<b>Life on the Edge: Tikal in a Bajo Landscape</b>	95
	<i>Nicholas P. Dunning, Robert E. Griffin, John G. Jones, Richard E. Terry, Zachary Larsen, and Christopher Carr</i>	
7	<b>Connecting Contemporary Ecology and Ethnobotany to Ancient Plant Use Practices of the Maya at Tikal</b>	124
	<i>Kim M. Thompson, Angela Hood, Dana Cavallaro, and David L. Lentz</i>	
8	<b>Agroforestry and Agricultural Practices of the Ancient Maya at Tikal</b>	152
	<i>David L. Lentz, Kevin Magee, Eric Weaver, John G. Jones, Kenneth B. Tankersley, Angela Hood, Gerald Islebe, Carmen E. Ramos Hernandez, and Nicholas P. Dunning</i>	
9	<b>Fire and Water: The Archaeological Significance of Tikal's Quaternary Sediments</b>	186
	<i>Kenneth B. Tankersley, Nicholas P. Dunning, Vernon L. Scarborough, John G. Jones, Christopher Carr, and David L. Lentz</i>	
10	<b>Fractious Farmers at Tikal</b>	212
	<i>David Webster and Timothy Murtha</i>	
11	<b>Material Culture of Tikal</b>	238
	<i>Palma J. Buttles, Carmen E. Ramos Hernandez, and Fred Valdez Jr.</i>	
12	<b>A Neighborly View: Water and Environmental History of the El Zotz Region</b>	258
	<i>Timothy Beach, Sheryl Luzzadder-Beach, Jonathan Flood, Stephen Houston, Thomas G. Garrison, Edwin Román, Steve Bozarth, and James Doyle</i>	
13	<b>Defining the Constructed Niche of Tikal: A Summary View</b>	280
	<i>David L. Lentz, Nicholas P. Dunning, and Vernon L. Scarborough</i>	
	<i>References</i>	297
	<i>Index</i>	341

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

## Figures

1.1. Tikal chronological chart	page 6
1.2. Map of the Maya Lowlands region	7
1.3. Map showing the situation of Tikal in a landscape of uplands and <i>bajos</i>	8
1.4. Map of central Tikal showing the location of Perdido Pocket Bajo and Arroyo Corriental Bajo	9
2.1. Map showing the main catchments and associated reservoirs at Tikal	17
2.2. Scaled cross-sectional schematic of the southern half of the Tikal ridge-top	20
2.3. Map of the Temple, Palace, and Hidden Reservoir chain with the ancient arroyo course and associated excavations	23
2.4. Cross-sectional composite of Palace Dam profiles	24
2.5. Artist's reconstruction of Palace Dam with posited vertically stacked sluices	24
2.6. Map of Late Preclassic construction around the Temple–Palace–Hidden Reservoir chain	28
2.7. Analogous ravine spring setting at Naranjo today	29
2.8. Map of Corriental Reservoir coring and excavation locations	31
2.9. Map of Perdido Reservoir coring and excavation locations	34
3.1. Image of the ESP device and workers operating the foot lever for extraction	51
4.1. The lower half of the Great Plaza Quadrangle map	62
4.2. The arrangement of the nine maps in the TR11 Detail Map series	68

viii		
FIGURES		
	4.3. Accuracy test points in a plaza group on the Temple IV Quadrangle map, a chultun opening; and the center of the ruins of a range structure	69
	4.4. Morris Jones demonstrating the use of the plane table and telescopic alidade, and a local worker holding a stadia rod in a ruin	70
	4.5. Map shows the Penn Project point of beginning; the "Datum Benchmark," and UCAPT point of beginning, the "PETTY CO.B.M."	73
	4.6. The horizontal position accuracy of the TR11 Detail Maps	78
	4.7. Maps of the areas used for the vertical accuracy assessment	80
	4.8. The elevation profiles along the Perdido transect	81
	4.9. Vertical accuracy assessment comparing 103 benchmark and spot elevations from the Tikal Report No. 11 detail maps to elevations from the NASA AIRSAR mission	83
	5.1. Structures that appear to be placed to block the flow of water and form aguadas	91
	5.2. Watershed for Temple, Palace, and Hidden Reservoirs	92
	6.1. Map of a portion of the East Brecha showing aguadas and excavations	97
	6.2. Soil pit in the Bajo de Santa Fe west of the Aguada de Terminos	101
	6.3. Map of the Aguada de Terminos area	102
	6.4. North profile of Op. 5C and Op. 2B	103
	6.5. Trench profile (Op. 16) in Parcela 2, El Pinal, Bajo de Santa Fe	104
	6.6. West profile of Op. 5F in the Aguada de Terminos	106
	6.7. Pollen frequency diagram for the Aguada de Terminos (Op. 5F)	108
	6.8. Pedons and carbon isotope profiles in the Bajo de Santa Fe east of Aguada de Terminos	113
	6.9. Perdido Pocket Bajo pedons and carbon isotope profiles	115
	6.10. South profile of Op. 8D in Perdido Pocket Bajo	118
	7.1. Species accumulation curves for trees and vines	134
	7.2. Accumulated frequency of upland forest species for trees	135
	7.3. Scanning electron micrographs of <i>Brosimum alicastrum</i> , <i>Manilkara zapota</i> , and <i>Protium copal</i>	139



Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

7.4. Scanning electron micrographs of wood samples recovered from a midden in El Jaguar	147
8.1. Diagram of Grupo de Jaguar at Tikal including structures 7D20-44	154
8.2. Flotation apparatus used to extract archaeological plant remains from soil	155
8.3. Kim Thompson, Demetrio Córdova, and Marielos Corado conduct botanical surveys	156
8.4. Upland biomass calculations	158
8.5. Voronoi diagram of hypothetical limits of extractive areas during the Late Classic and Late Preclassic periods	162
8.6. Pollen profile from Aguada Vaca de Monte	163
8.7. Household 1 at Cerén	174
8.8. Plant macroremains from Tikal	176
8.9. Excavation profile (north wall) from Corriental Reservoir	181
9.1. Location of Bajo la Justa, Tikal, and other sites mentioned in the text	187
9.2. Scanning electron micrograph of a bipyramidal euhedral quartz crystal	195
9.3. Scanning electron micrograph of a bipyramidal euhedral zircon crystal	195
9.4. The trace element content of Maya Lowland sediment samples compared to volcanoes in Guatemala, Mexico, and El Salvador	197
9.5. The trace element content of reservoir sediment from Tikal	199
11.1. Lithic artifacts of the UCAPT: obsidian edge altered blade, corner modified obsidian blade, carved greenstone fragment, ovoid chert scraper, chert agricultural tool	241
11.2. Miscellaneous UCAPT artifacts: incised bone awl fragment, carved chert eccentric, shell “button”/ear flare segment, shell “button”/ear flare segment, perforated shell pendant	244
11.3. Miscellaneous UCAPT artifacts: ceramic ear flare fragment, ceramic stamp, and polychrome sherd with figure	246
11.4. Complete vessel from Operation 13: unnamed red bowl with rounded base	251
11.5. Complete vessel from Operation 13: unnamed orange-polychrome cylinder	251

ix

FIGURES

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

x		
—		
FIGURES		
	11.6. Complete vessel from Operation 13: unnamed orange-polychrome tall bowl	251
	11.7. Nearly complete vessel from Operation 13: unnamed orange-polychrome tripod dish	252
	12.1. Location map of El Zotz and surroundings	259
	12.2. Zotz Aguada excavation map	263
	12.3. Zotz Aguada stratigraphy	264
	12.4. Zotz Aguada 13A-2 Photo	265
	12.5. Diagrams of pollen morphs (above) and biosilicates (below) from Zotz	271
	12.6. Cross sections of Zotz Aguada	275

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

## Tables

3.1. Volumetric estimates of Tikal reservoirs	<i>page</i> 57
4.1. The summary of horizontal and vertical accuracy assessments	79
6.1. Aguada de Terminos Op. 5C profile description	106
6.2. Selected physical and chemical characteristics of the A horizons of 16 soil pedons	114
7.1. Top ten plant families in 5.95 ha forest survey in Tikal National Park	133
7.2. Diversity indices for all trees greater than 6 cm diameter at breast height (DBH)	135
7.3. Most abundant species by stem density and dominant species by basal area	136
7.4. Sample areas at Tikal National Park and associated richness of trees and vines	138
7.5. Ten most abundant tree species and eleven families represented in the paleoethnobotanical remains	140
7.6. Jaccard Dissimilarity Matrix comparing paleoethnobotanical remains recovered at Tikal with the modern forest and each habitat at the generic level	141
7.7. Socioeconomic value of woods present at Tikal as trees in the modern forest and as paleoethnobotanical remains	148
8.1. Aboveground biomass of modern Tikal forests and estimates for forests during the Late Classic period	165
8.2. Fuel and timber needs of Tikal during the Late Classic period	167
8.3. Comparison of climatic conditions of Tikal and Cerén	173
8.4. Ancient plant remains identified at Tikal	175
9.1. Radiocarbon dates obtained from the Quaternary sediments of Tikal and vicinity	188

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

xii		
TABLES		
	9.2. X-ray diffraction analysis of reservoir, aguada, and bajo sediments from Tikal and vicinity	192
	9.3. Trace element content of Tikal reservoir sediments and comparative volcanic sources	198
	9.4. Stable carbon isotope values for insoluble soil organic matter from reservoirs	205
	10.1. Tikal landscape (slope + topographic position)	222
	11.1. Obsidian artifacts from various excavations	241
	11.2. Chert artifacts from various operations	243
	11.3. Major temporal periods and associated types in the UCAPT collection	247
	11.4. Quantity of sherds and chronological assessment per operation and subop	248

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

## Contributors

**Timothy Beach** is Centennial Professor in the Department of Geography and Environment at the University of Texas at Austin. He is an elected AAAS Fellow and has held fellowships from the Guggenheim Foundation and Dumbarton Oaks. His research focuses on soil and agricultural systems, geomorphology, water, environmental change, paleoclimate, and geoarchaeology.

**Steven Bozarth** is a researcher in the Department of Geography at the University of Kansas. His research interests include palynology, opal phytolith analysis, paleoenvironmental reconstruction, and ancient agriculture.

**Palma J. Buttles** is Manager and Senior Member of the Technical Staff at the Software Engineering Institute at Carnegie Mellon University and Research Fellow at the Texas Archaeological Research Laboratory, University of Texas at Austin. A recent paper is "People Capability Maturity: Contributing to Organizational Success," *Joburg Centre for Software Engineering Annual Report (2009)*, University of the Witwatersrand, Johannesburg, South Africa.

**Christopher Carr** is a doctoral student at the University of Cincinnati in the Department of Geography. A recent publication is entitled "Map of the Ruins of Tikal, El Petén, Guatemala and Georeferenced Versions of the Maps Therein," which appeared in *Tikal Report 11* (tDAR ID: 390922) <http://core.tdar.org/project/390922>.

**Dana Cavallaro** recently received her M.S. degree from the Department of Biological Sciences at the University of Cincinnati. Her thesis is entitled "Reconstructing the Past: Paleoethnobotanical Evidence for Ancient Maya Plant Use Practices at the Dos Pilas Site, Guatemala."

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

xiv

## CONTRIBUTORS

James Doyle is Post-Doctoral Associate in Pre-Columbian Studies at the Dumbarton Oaks Research Library and Collection. He is the author of the article “Re-Group on ‘E-Groups’: Monumentality and Early Centers in the Middle Preclassic Maya Lowlands,” which appeared in *Latin American Antiquity* in 2012.

Jonathan Flood is a doctoral candidate at the University of Texas at Austin in the Department of Geography and the Environment. His research interests include archaeology, geoarchaeology, water quality, human ecology, fluvial geomorphology, groundwater hydrology, and water chemistry.

Lee Florea is Professor at Ball State University in the Department of Geological Sciences. His research interests include hydrogeology, geomorphology, geochemistry, geophysics, carbonate geology, and biology with a focus on sinkholes, caves, and springs.

Thomas G. Garrison is Lecturer in the Department of Anthropology and Archaeology at the University of Southern California. He has been the director of the El Zotz Archaeological Project since 2012 and is currently editing *An Inconstant Landscape: The Archaeology of El Zotz, Guatemala* (Colorado) with Stephen Houston.

Liwly Grazioso Sierra is Professor of Maya Archaeology at the Universidad de San Carlos de Guatemala. A recent work by her is “Río Azul, belleza enclavada en el triffinio Guatemala-México-Belice,” which appeared in *Publicaciones Mesoamericanas*.

Robert E. Griffin is an Assistant Professor in Atmospheric Science at The University of Alabama in Huntsville. His research interests include environmental archaeology, GIS, and remote sensing across Central America.

Angela Hood is Senior Archaeologist at GAI Consultants, Inc., in Pittsburgh, Pennsylvania. She is a recent graduate of the University of Cincinnati; her M.A. thesis is entitled “Testing the Veracity of Paleoethnobotanical Macroremain Data: A Case Study from the Ceren Site, El Salvador.”

Stephen Houston serves as Dupee Family Professor of Social Sciences at Brown University. Among his recent publications are *The Life Within: Classic Maya and the Matter of Permanence* (Yale) and an edited volume, *The Shape of Script: How and Why Writing Systems Change* (SAR Press). A MacArthur Fellow, he has also held fellowships and grants from the Guggenheim Foundation, the National Endowment for the Humanities, and the National Science Foundation.

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

Gerald Islebe is Mendeleev Member in Biological Sciences from El Colegio de la Frontera Sur in Chetumal, Mexico, with interests in paleoecology, biogeography, and global change. Among his recent publications is "Holocene Vegetation and Climate History of Central Quintana Roo, Yucatán Peninsula, Mexico" in *Review of Palaeobotany and Palynology* with Alicia Carrillo-Bastos.

John G. Jones is Senior Paleoethnobotanist with Archaeological Consulting Services Ltd. in Tempe, Arizona. One of his recent papers is entitled "Pollen Evidence for Early Settlement and Agriculture in Northern Belize," which appeared in *Palynology*.

Brian Lane is a doctoral student at the University of Oregon in the Department of Anthropology. His research interests include the environment, Pacific Island studies, Oceania archaeology, evolutionary archaeology, and Maya archaeology.

Zachary Larsen recently received his M.S. degree from Brigham Young University, Provo, Utah, in the Department of Environmental Science with a focus on soil archaeology. His research focus is on the geochemical analysis of the agricultural and household activities at Uci, Yucatan, Mexico.

Sheryl Luzzadder-Beach is a Professor and Chair of the Department of Geography and Environment at the University of Texas at Austin. A recent work by her is "Arising from the Wetlands: Mechanisms and Chronology of Landscape Aggradation in the Northern Coastal Plain of Belize," with Timothy Beach, which appeared in *Annals of the Association of American Geographers*.

Kevin Magee received his Ph.D. in Geography from the University of Cincinnati in 2011. His research expertise is in object-based imagery analysis methods, abstract and vague retrieval models for image classification, and remote sensing for natural and cultural resource management.

Timothy Murtha is Professor of Landscape Architecture at Pennsylvania State University. His research interests include settlement patterns, settlement ecology, demography and landscape archaeology, GIS, integrated modeling, and spatial analysis.

Carmen E. Ramos Hernandez is an archaeologist who works for the Guatemalan Institute for Anthropology and History. Her research focuses on ancient Maya material culture.

Edwin Román is Co-director of El Zotz Archaeological Project and a doctoral student in the Teresa Lozano Long Institute of Latin

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

xvi

CONTRIBUTORS

American Studies at The University of Texas at Austin. His research interests include Maya architecture, political organization, and indigenous epistemology.

Payson Sheets is Professor in the Department of Anthropology at the University of Colorado, Boulder. His area of specialization is Mesoamerican archaeology, hazards research, lithic technology, ancient adaptations, remote sensing, and geophysical applications.

Kenneth B. Tankersley is Associate Professor of Anthropology and Geology at the University of Cincinnati. One of his recent works, "Evidence for Volcanic Ash Fall in the Maya Lowlands from a Reservoir at Tikal, Guatemala," appeared in the *Journal of Archaeological Science* in 2011.

Richard E. Terry is Professor of Plant and Wildlife Sciences at Brigham Young University. One of his recent works, "Chemical Signatures of Middens at a Late Classic Maya Residential Complex, Guatemala," coauthored with Markus Eberl and Marco Alvarez, appeared in *Geoarchaeology: An International Journal* in 2012.

Kim M. Thompson recently completed her Ph.D. in the Department of Biological Sciences at the University of Cincinnati and currently serves as a Lecturer in the Department of Biological Sciences at Ohio University. Her research focuses on the characterization of the Neotropical forests of the ancient Maya and genetic variation in the valued fruit, timber, and latex tree, *Manilkara zapota*.

Fred Valdez Jr. is a Professor of Anthropology at The University of Texas at Austin. A recent work by him is "An Alternative Order: The Dualistic Economies of the Ancient Maya," with V. Scarborough, which appeared in *Latin American Antiquity*.

Eric Weaver is a doctoral student in the Department of Geography at the University of Cincinnati. His research interests include paleoclimatology, karst studies, and Maya water management.

David Webster is a Professor in the Department of Anthropology at Pennsylvania State University. Among his recent publications is *Archaeology of Ancient Mexico and Central America: An Encyclopedia* (Routledge 2010) with Susan Toby Evans.



Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

xvii

## Editors

Nicholas P. Dunning is Professor of Geography at the University of Cincinnati. He is a geoarchaeologist and cultural ecologist specializing in the Neotropics. He has published several books and more than ninety articles and book chapters including those in this volume.

David L. Lentz is Professor of Biological Sciences at the University of Cincinnati and Executive Director of the UC Center for Field Studies. He has published more than ninety articles and three books, including this volume. Previous works include: *Imperfect Balance: Landscape Transformations in the Precolumbian Americas* (Columbia) and *Seeds of Central America and Southern Mexico* (New York Botanical Garden Press), written with Ruth Dickau. A Fellow of the Linnean Society of London and former Fulbright Scholar, he has received grants for his research on the evolution of early plant domesticates and ancient landscape studies from the National Science Foundation, the National Endowment for the Humanities, the Wenner-Gren Foundation, the National Geographic Society, the Foundation for the Advancement of Mesoamerican Studies, and other sources.

Vernon L. Scarborough is Distinguished University Research Professor and Charles Phelps Taft Professor in the Department of Anthropology at the University of Cincinnati. His work emphasizes sustainability and global water systems through an examination of past engineered landscapes using comparative ecological and transdisciplinary perspectives. In addition to editing *Water and Humanity: A Historical Overview* for UNESCO, he is a steering committee member of IHOPE-Global (Integrated History for the Future of the People of Earth – [ihopenet.org](http://ihopenet.org)) located at Uppsala

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

---

xviii

EDITORS

University and an active organizer of the subgroup IHOPE-Maya. He is a Senior Editor for *WIREs Water Journal* (Wiley-Blackwell) and a Series Editor for the series *New Directions in Sustainability and Society* (Cambridge University Press), having published ten books – eight of them edited (inclusive of this volume) – and more than ninety book chapters or journal articles of his own.

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

## Foreword

I am honored to be asked to write the Foreword to such an important volume on the ancient Maya site of Tikal, Guatemala, and how its inhabitants used and misused their environment. The authors in this book address one of the towering issues facing our society today: sustainability. Ancient and recent people living on our planet have had impressive successes in achieving sustainable adaptations for hundreds and often for thousands of years, yet others have misunderstood the consequences of maladaptations and have collapsed. The ancient Maya have provided us with numerous examples of these extremes. For instance, the Maya commoners in the village of Chan, in what is now Belize, achieved a sustainable adaptation for more than two thousand years (Robin 2012), and the lead editor of this volume, David L. Lentz, contributed research results at Chan that help explain how that success was achieved. The city that rose near Chan, Xunantunich, exemplifies the other extreme, as it only lasted for two centuries and collapsed completely. The factors leading to success or failure in achieving a sustainable adaptation are explored in this current volume.

The experience of Tikal is a mixed one, between that of Chan and Xunantunich, with sustainability achieved early in its time as a complex society and maintained for a few centuries. However, they crossed the threshold of sustainability, the tipping point, and during their last centuries created such fundamental problems that they ceased to exist by A.D. 900. Understanding the factors in sustainability successes and failures has been beyond archaeologists' abilities until recently. Fortunately, the sophistication of today's researchers conducting multidisciplinary research – including the natural

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

xx

FOREWORD

sciences, social sciences, and humanities – allows serious exploration of this topic in past societies, with direct implications for our society today and into the future.

The authors herein document how the ancient Maya in the Early Classic and into the Middle Classic (see Figure 1.1) periods maintained an adaptation that supplied sufficient food, firewood, wood for construction, and other resources, without degradation of soils or rain forest. They developed a sophisticated system of agroforestry by favoring the productive trees and avoided deforestation in their early centuries. They developed sophisticated means of managing water in a challenging environment without surface rivers or lakes. Sediment cores and excavations within reservoirs, *bajos*, and *aguadas* provided information on natural and cultivated flora. In those sediments were smectite clay concentrations demonstrating the frequent airfall depositions of volcanic ash that increased soil fertility of the tropical soils. The population was growing but did not exceed the carrying capacity of the environment until around the sixth century A.D.

Because farmers interacting with their crops and soils on a daily basis are (and were in the past) acutely aware of edaphic conditions, I can only suspect the Tikal elite were unaware of the longer-term consequences of passing that tipping point into unsustainable conditions. Scholars have much to learn about elite-commoner relationships and their changes through time. A greater disconnection between the world of the elites and that of the farmers is probable. Also, Tikal was living in, and contributing to, a more bellicose environment in the sixth century and later, and the elite may have decided that population increase beyond sustainability was advantageous in warfare in the short run. At any rate, this volume documents the factors in the Late Classic period that contributed to the decline and ultimately to the total collapse of civilization at Tikal. Drought added further stress to a system already on a downward spiral. At most, the drought accelerated the demise, but it was not a sole cause. I suspect had Tikaleños done the terracing that was so prevalent at Chan and Caracol, the Late Classic decline might have been slowed, but not stopped.

What is ironic is that humanistic achievement at Tikal reached its apex during this time of stress and failure of the adaptive infrastructure, as judged by the architecture, sculpture, and other fine arts. The

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

same disjuncture occurred at Tikal's sister city, Copán, at about the same time, with the same consequences.

This book is an essential resource for Mayanists interested in the great trajectory of one of the world's civilizations. Maya achievements were stellar in art, architecture, astronomy/astrology, epigraphy, numerology, cosmology, and many other domains. As exemplified by Chan for two millennia and by Tikal for a few centuries, sustainable adaptations were achieved in spite of challenges in their environments. Decisions were made, particularly in the sixth century, that undermined that success, and the consequences of overpopulation relative to adaptation, leading to environmental degradation, are presented in this volume. Therefore, this volume is an essential resource for scholars worldwide in a wide range of disciplines who are studying sustainability. It should be required reading of politicians as well, but I am not optimistic that they would want to consider the difficult decisions that are necessary to maintain sustainability in our present world. The mantra of "growth" being essential to the futures of societies is deeply ingrained in our societies, yet it is antithetical to sustainability. It is a rare politician who has the courage to realize and express this. Can we learn from this Tikal case, or do we continue overpopulating and degrading our environment to our own long-term detriment?

Payson Sheets

xxi

FOREWORD

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

---

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

## Acknowledgments

Funds for this research project were provided by the National Science Foundation (grant #BCS-0810118), the Wenner-Gren Foundation (grant #7799), the Alphawood Foundation of Chicago, the Foundation for the Advancement of Mesoamerican Studies, and the University of Cincinnati. Without these funds this project could never have proceeded and we are deeply grateful for their support.

Eric Ponciano of the Guatemalan Ministry of Culture and Sports; Juan Carlos Pérez Calderón, Director General of the Institute of Anthropology and History of Guatemala (IDAEH); and Mónica Urquizú, Head of the Department of Prehispanic and Colonial Monuments at IDAEH, provided invaluable insight, support, and guidance during the permitting, field research, and reporting phases of this project. Ana Lucía Arroyave served as the observant and helpful IDAEH inspector for the 2010 field season. The administrators of Tikal National Park, Armando Guillén, Elmer Tun, and Fredy Sosa, were amazingly efficient and unquestionably helpful during our two field seasons (2009 and 2010) at Tikal. Likewise, staff members at Tikal National Park, namely, Benito Burgos, Marco Tulio Castellanos, Mirta Cano, Luis García, and Beto Tesucún, were extremely kind in sharing their expertise and knowledge of the park.

Two of Guatemala's preeminent archaeologists, Drs. Barbara Arroyo and Vilma Fialko, freely shared ideas and information; without their advice and support, this project might not have come to fruition. Also, Oswaldo Gómez, another archaeologist working at Tikal, was extremely kind and shared data and advice in a spirit of true academic camaraderie.

Cambridge University Press

978-1-107-02793-0 - Tikal: Paleoecology of an Ancient Maya City

Edited by David L. Lentz, Nicholas P. Dunning and Vernon L. Scarborough

Frontmatter

[More information](#)

xxiv

## ACKNOWLEDGMENTS

Our team of professional field archaeologists, including Ana Luisa Arriola, Sheryl Carcuz, María de los Ángeles Corado, Claudine Escobar Durand, Marielos Corado, Raquel Macario, Silvia Alvarado, Walter Burgos, Mauricio Díaz, and Blanca Mijangos, supervised the excavations and prepared drawings of artifacts and excavation profiles. We are deeply grateful for their efforts and talents. Eric G. Coronel kindly conducted phosphate testing on soil samples. We thank our colleague Benjamin Thomas for collecting key GPS points during the 2009 field season. Dr. Thomas Sever, currently at the University of Alabama at Huntsville, provided expert remote sensing advice and shared IKONOS images that were invaluable to the project. The late Dr. T. Patrick Culbert analyzed our ceramic collections during the 2009 season and provided a historic and philosophical connection with the earlier Penn Project at Tikal. We were honored to have shared his final field season at Tikal ([www.cambridge.org/Tikal](http://www.cambridge.org/Tikal); See S. Fig. 1).

We were fortunate to have had the field assistance of dozens of workers from the communities of El Caoba, El Ramate, Capulinar, and Zocotzal, and we thank them for their hard work, knowledge of the forests, and joyful spirits. Demetrio Córdova, Marcos Caal, Santo Chico, Elmer Yat, and José Choc were particularly helpful ([www.cambridge.org/Tikal](http://www.cambridge.org/Tikal); See S. Fig. 2).

Identifications of herbarium specimens were assisted by Ron Liesner, Richard Abbot, Charlotte Taylor, Henk van der Werf, and John Pruski of the Missouri Botanical Garden. The suggestion to sequence DNA from our unknown herbarium specimens was by Richard Abbot. Cassandra Gallagher, Katlyn Hahn, Amanda McGuire, Bradley Meyer, Grace Morris, Blair Mynear, Nicole O'Connell, Anne Schmidt, Alex Zumberger, Sarah Shalloe, and Venicia Sloten assisted with processing, identifying, and imaging paleoethnobotanical remains. Linnea Lentz and Victoria Lentz provided highly useful assistance in the lab. Dr. Necati Kaval was of great assistance in the use of the environmental scanning electron microscope. Trent Leslie provided some key assistance in using R for data analysis.

We thank Kathleen Carr, Kenneth Hinkel, Kevin Raleigh, Jeffrey Marion, and Mary Pohl for insightful editorial assistance on earlier drafts of this volume. Finally, we are especially grateful for the editorial efforts of Lorelle Lentz, who has the uncanny ability to turn verbal chaos into well-ordered prose.