Contents

List of Figures and Tables ................................................................. page xiii
Acknowledgments ............................................................................. xv
List of Abbreviations .......................................................................... xix

Introduction: Growth, Punctuation, and Human Well-Being .................. 1

PART I  EVOLUTION AND EARTH SYSTEMS ........................................... 15

1  Geological Time: The Court Jester on the Platform of Life ................. 25
Tectonics, Asteroids, Plumes, Punctuation, Gaia: Revolutions in Earth Science 26
Evolution: From Neo-Darwinism to Complex Emergence ................. 29
A Punctuated Earth Systems Synthesis ............................................ 36
Origins: The Hadean and the Archean ............................................. 37
The Archean/Paleo-Proterozoic Crisis ............................................. 38
The Neoproterozoic Crisis and the Cambrian: A Snowball Earth? ........ 42
Phanerozoic Super-Cycles – and Biotic Extinctions and Escalations ....... 44
Mass Extinctions ............................................................................. 49

2  Human Emergence ............................................................................ 55
Into the Cenozoic Icehouse ............................................................... 56
The Court Jester in the Cenozoic: Debate and Three Kinds of Evidence ................................................. 58
Miocene Apes and the Early Hominins ............................................. 62
Orbital Cycles: From the 23K World to the 41K World ....................... 66
The 41K World and the Genus Homo ............................................. 70
The 100K World: Homo Heidelbergensis, Archaic Homo Sapiens ........ 77
Modern Humans in the 100K World .............................................. 83
The Modern Origins Debate and a Renewed Understanding of Mortality ......................................................... 97
## Contents

Gould and Eldridge’s Punctuation Meets Boserup’s Intensification: Toward a New Understanding of the Upper Paleolithic  

**PART II  DOMESTICATION, AGRICULTURE, AND THE RISE OF THE STATE**  

3  Agricultural Revolutions  
**Energy** 121  
**Changing Climates: The End of the Pleistocene** 123  
**New Climate Science, New Archaeological Science** 130  
**Human Adaptation at the Bølling-Allerød Warming: The Mesolithic** 134  
**The Younger Dryas and the Early Holocene: Cereal Domestication in the Northern Mid-Latitudes** 136  
**Early Holocene Warming and Tropical Domestications** 144  
**Into the Mid-Holocene: Final Domestications and First Dispersals** 152  

4  The Mid-Holocene, the Late Neolithic, and the Urban-State Revolution  
**The Emergence of Modern Global Climates: The Mid-Holocene Transition** 165  
**The Mid-Holocene Crisis and the Rise of the State** 166  
**Neolithic Intensification: The Secondary Products Revolution** 183  
**China and Mesopotamia in the Neolithic–Bronze Age Transition** 191  

5  Human Well-Being from the Paleolithic to the Rise of the State  
**Human Health in the Paleolithic** 213  
**The Neolithic Demographic Transition** 216  
**Civilizational Stresses in the Neolithic** 220  
**Fertility and Mortality in the Neolithic** 225  
**Fertility, Mortality, and the Origins of Complex Societies: The Case of Southwest Asia** 229  

**PART III  ANCIENT AND MEDIEVAL AGRARIAN SOCIETIES** 243  

6  Stasis and Growth in the Epoch of Agrarian Empires  
**Getting Ahead, Running in Place, Falling Behind** 261  
**Population Growth and Dark Ages** 269  
**Endogenous Degradations?** 272  
**Late Holocene Climate Reversals** 276  
**Disease and Epidemics** 279  
**Energy: Innovation, Labor, and Slavery** 281  
**Punctuations** 283
Contents

7 Optimum and Crisis in Early Civilizations, 3000–500 BC
   The Old World Bronze Age: Expansions and Crises, 3000–1000 BC 288
   The Preclassical Crisis and the Age of Iron, 1200–300 BC 288
   A Global View on Optimum and Crisis 300
   Human Health in the Bronze Age Optimum and the Iron Age/Preclassical Crisis 306

8 A Global Antiquity, 500 BC–AD 542
   The Problem of Growth in Antiquity 317
   China, Iron, and Rotary Power 318
   Global Antiquity: Numbers and Climate 322
   The Rise of Rome 328
   The Fall of Rome? 339

9 The Global Dark and Middle Ages, AD 542–1350
   Climate Reversals in the Tropics and the North 351
   The Dark Ages, AD 400–900 351
   The Medieval Climate Anomaly, AD 900–1275 358
   Population and Health in the Old World Dark and Middle Ages 360
   Growth and Crisis in the Medieval World, 1000–1350 362
   Southern Asia 363
   North America 364
   China and Mongolia 367
   Into the Little Ice Age 370
   Europe 372
   The Little Ice Age and the Black Death 380

PART IV INTO THE MODERN CONDITION 393

10 Climate, Demography, Economy, and Polity in the Late Medieval–Early Modern World, 1350–1700 413
   Population in and beyond the Third Age of Epidemics, 1300–1800 414
   The Question of Growth and Divergence 417
   The Aftermath of the Third Age of Epidemics 423
   Emerging European Empires, New World Depopulation, and the Origins of the African Slave Trade 429
   The Little Ice Age, New World Depopulation, and the Origins of the African Slave Trade 438
   The Little Ice Age and Early Modern Eurasia 444
   Early Modern England in the Age of Empire, the Little Ice Age, and the Seventeenth-Century Crisis 451
   The Seventeenth-Century English Energy Revolution 459

11 Global Transformations: Atlantic Origins, 1700–1870 467
   The End of the Little Ice Age and the Beginning of Modern Population Growth, 1700–1860s 468
# Table of Contents

## The Beginnings of the Modern Anthropocene
- The Beginnings of the Modern Anthropocene 476
- Industrial Revolutions 479
- The First Industrial Revolution 483
- Emissions and Atmosphere, 1800–1880 495

## Launching Modern Growth: 1870 to 1945
- Urbanization, a New Political Economy, and the Second Industrial Revolution 500
- Atlantic Cities and the First Wave: Environmental Crisis and Social Reform 500
- The Second Industrial Revolution 509
- The Demographic Revolution, 1800–1945 513
- 1914–1945: A World in Crisis, Growth on Hold 518
- Environmental Impacts, 1870–1945: The Second Wave 524

## Growth beyond Limits: 1945 to Present
- The Demographic Revolution, Part II: 1945 to Present 529
- The Age of High Growth and a Third Industrial Revolution? 530
- The World Economy, 1945 to Present 534
- Environmental Impacts, 1945 to Present: Confronting the Third Wave 543
- The Modern Anthropocene 553

## Coda: A Rough Journey into an Uncertain Future
- Malthus Vindicated? 559
- Deniers, Pessimists, and Pragmatists 570

## Data Bibliography: Full Citations for Data Used in Figures and Tables 581

## Index 593