

Contents

UNIT ONE INTRODUCTION TO THE DISCIPLINE 1

CHAPTER 1 THE SCIENCE OF BIOGEOGRAPHY 3

What Is Biogeography? 4

Definition 4

Relationships to other sciences and outline of the book 7

Philosophy and basic principles 9

Doing Contemporary Biogeography 12

CHAPTER 2 THE HISTORY OF BIOGEOGRAPHY 15

The Age of Exploration 16

Biogeography of the Nineteenth Century 24

Four British scientists 26

BOX 2.1 *Biogeographic Principles Advocated by Alfred Russel Wallace* 33

Other contributions of the nineteenth century 34

The First Half of the Twentieth Century 39

Biogeography since the 1950s 41



UNIT TWO THE GEOGRAPHIC AND ECOLOGICAL FOUNDATIONS OF BIOGEOGRAPHY 45

CHAPTER 3 THE GEOGRAPHIC TEMPLATE: Visualization and Analysis of Biogeography Patterns 47

Definition and Components of the Geographic Template 47

The geographic template 47

Climate 49

Soils 58

Aquatic environments 63

Time 68

Two-Dimensional Renderings of the Geographic Template 69

Early maps and cartography 69

Flattening the globe: Projections and geographic coordinate systems 70

Visualization of Biogeographic Patterns 71

History and exemplars of visualization in biogeography 71

The GIS revolution 76

Cartograms and strategic “distortions” 77

Obtaining Geo-Referenced Data 77

Humboldt’s legacy: A global system of observatories 77

Remote sensing and satellite imagery 79

Interpolation over space and time 79

Analysis of Biogeographic Patterns 80

CHAPTER 4 DISTRIBUTIONS OF SPECIES: Ecological Foundations 83

Biogeography's Fundamental Unit 83

The Distribution of Individuals 83

The Distribution of Species Populations 86

Mapping and measuring the range 86

Population growth and demography 89

Hutchinson's multidimensional niche concept 89

The geographic range as a reflection of the niche 91

The relationship between distribution and abundance 93

What Limits the Geographic Range? 95

Physical limiting factors 96

Disturbance and time 101

Interactions with other organisms 104

A Preview of Derived Patterns 114

Range dynamics 114

Areography: Size, shape, and internal structure
of the range 115

Ecogeography: Variation in phenotypes across the
range 116

Multispecies patterns: Range overlap, richness, and
exclusive distributions 116

Predicting Fundamental and Realized Ranges 118

Synthesis 119

CHAPTER 5 DISTRIBUTIONS OF COMMUNITIES 121

Historical and Biogeographic Perspectives 121

Communities and Ecosystems 123

Definitions 123

Community organization: Energetic considerations 124

Distribution of Communities in Space and Time 130

Spatial patterns 130

Temporal patterns 133

Terrestrial Biomes 136

Tropical rain forest 138

Tropical deciduous forest 140

Thorn woodland 141

Tropical savanna 142

Desert 143

Sclerophyllous woodland 144

Subtropical evergreen forest 145

Temperate deciduous forest 146

Temperate rain forest 147

Temperate grassland 148

Boreal forest 149

Tundra 149

Aquatic Communities 151

Marine communities 153

Freshwater communities 154

A Global Comparison of Biomes and Communities 156

Ecosystem Geography 159



UNIT THREE FUNDAMENTAL BIOGEOGRAPHIC PROCESSES AND EARTH HISTORY 165

CHAPTER 6 DISPERSAL AND IMMIGRATION 167

What Is Dispersal? 169

Dispersal as an ecological process 169

Dispersal as a historical biogeographic event 170

Dispersal and Range Expansion 170

Jump dispersal 171

Diffusion 172

Secular migration 181

Mechanisms of Movement 181

Active dispersal 181

Passive dispersal 184

The Nature of Barriers 188

Physiological barriers 190

Ecological and psychological barriers 192

- Biotic Exchange and Dispersal Routes** 193
 Corridors 194
 Filters 194
 Sweepstakes routes 196
 Other means of biotic exchange 199
 Dispersal curves within and among species 200
Establishing a Colony 200
 Influence of habitat selection 201
 What constitutes a propagule? 203
 Survival in a new ecosystem 204
Advances in the Study of Dispersal 205

CHAPTER 7 SPECIATION AND EXTINCTION 207

- BOX 7.1 Glossary of Some Terms Used by Systematists and Evolutionary Biologists** 208
Systematics 210
 What are species? 210
 Higher classifications 215
Speciation 217
 Mechanisms of genetic differentiation 217
 Allopatric speciation 224
 Sympatric and parapatric speciation 230
Diversification 236
 Ecological differentiation 236
 Adaptive radiation 238
Extinction 242
 Ecological processes 242
 Recent extinctions 245
 Extinctions in the fossil record 247
Macroevolution 250
 Evolution in the fossil record 250
 Species selection 252
 The role of historical contingency 253
 Micro- and macroevolution: Toward a synthesis 257

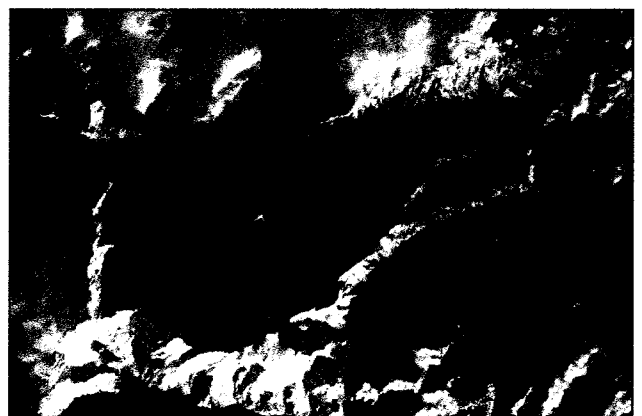
CHAPTER 8 THE CHANGING EARTH 259

- The Geological Timescale** 259
 Estimating time 261
The Theory of Continental Drift 263
 Wegener's theory 267
 Early opposition to continental drift 269
 Evidence for continental drift 271

- BOX 8.1 Stratigraphic, Paleoclimatic, and Paleontological Discoveries that Contributed to the Acceptance of the Theory of Continental Drift** 272
The Current Model 280
Earth's Tectonic History 285
Tectonic History of the Continents 286
 Tectonic development of marine basins and island chains 299
Climatic and Biogeographic Consequences of Plate Tectonics 306

CHAPTER 9 GLACIATION AND BIOGEOGRAPHIC DYNAMICS OF THE PLEISTOCENE 313

- Extent of Pleistocene Glaciation** 320
Effects on Non-Glaciated Areas 322
 Temperature 322
 Geographic shifts in climatic zones 324
 Sea level changes during the Pleistocene 326
Biogeographic Responses to Climatic Cycles of the Pleistocene 329
BOX 9.1 Biogeographic Responses to Climatic Cycles of the Pleistocene 330
 Biogeographic responses of terrestrial biotas 330
 Dynamics of plant communities in the aridlands of North and South America 340
 Aquatic systems 342
Biotic Exchange and Glacial Cycles 347
Glacial Refugia 348
Extinctions of the Pleistocene Megafauna 353



UNIT FOUR EVOLUTIONARY HISTORY OF LINEAGES AND BIOTAS 359

CHAPTER 10 THE GEOGRAPHY OF DIVERSIFICATION 361

The Fundamental Geographic Patterns 362

Endemism and Cosmopolitanism 365

The origins of endemics 368

Provincialism 370

Terrestrial regions and provinces 370

BOX 10.1 *Endemic Birds and Plants of South America and Australia* 376

Marine regions and provinces 384

Classifying islands 388

Quantifying similarity among biotas 392

BOX 10.2 *Endemic Birds and Plants of South America and Australia* 392

Disjunction 396

Patterns 396

Processes 398

Maintenance of Distinct Biotas 399

Barriers between biogeographic regions 400

Resistance to invasion 400

Avian migration and provincialism 401

Biotic Interchange 404

The Great American Biotic Interchange 406

The Lessepsian exchange: The Suez Canal 412

The Divergence and Convergence of Isolated Biotas 413

Divergence 413

Convergence 415

Overview 421

CHAPTER 11 RECONSTRUCTING THE HISTORY OF LINEAGES 423

Classifying Biodiversity and Inferring Evolutionary Relationships 424

Systematics 425

Evolutionary systematics 425

Numerical phenetics 427

Phylogenetic systematics 427

BOX 11.1 *The Principles and Rules of Hennigian Logic* 430

Molecular Systematics 430

BOX 11.2 *The Basis of Hennig's Paradigm: A Hypothetical Example of Cladogenesis and Cladogram Construction* 431

Phylogeography 436

The dual nature of phylogeography 437

Combining phylogeography and ecological niche modeling 441

The Fossil Record 441

Limitations of the fossil record 443

Biogeographic implications of fossils 445

Molecular Clocks and Estimating Times of Divergence 453

The Future of Lineage Reconstruction 454

CHAPTER 12 RECONSTRUCTING THE HISTORY OF BIOTAS 457

Origins of Modern Historical Biogeography 458

Early efforts: Determining centers of origin and directions of dispersal 459

From center of origin–dispersal to vicariance 464

Beyond Vicariance Biogeography and Simple Vicariance 471

Fundamental questions and issues in modern historical biogeography 471

BOX 12.1 *Defining and Delineating Areas of Endemism* 472

BOX 12.2 *Processes That Reduce the Generality of the General Area Cladogram* 474

Three approaches to reconstructing area and lineage histories 487

BOX 12.3 *Primary and Secondary Brooks Parsimony Analysis* 488

Phylogeography, again 490

BOX 12.4 *Statistical Phylogeography* 494

What Are We Learning about Lineage and Biotic Histories? 498

Histories in Gondwanaland 499

Histories in the Holarctic 502

Histories in, and just before, the ice ages 503

The Continuing Transformation of Historical Biogeography 505



UNIT SIX CONSERVATION AND THE FRONTIERS OF BIOGEOGRAPHY 695

CHAPTER 16 CONSERVATION BIOGEOGRAPHY AND THE DYNAMIC GEOGRAPHY OF HUMANITY 697

The Biodiversity Crisis and the Geography of Extinctions 697

Biodiversity and the Linnaean shortfall 698

The geography of prehistoric extinctions 702

The geography of recent extinctions and endangerment 703

Geographic range collapse 710

The Dynamic Geography of Extinction Forces 719

The ecology and geography of invasions 719

Dynamic landscapes and seascapes 729

Biogeography of global climate change 734

The biogeography of humanity 740

Conservation Biogeography 753

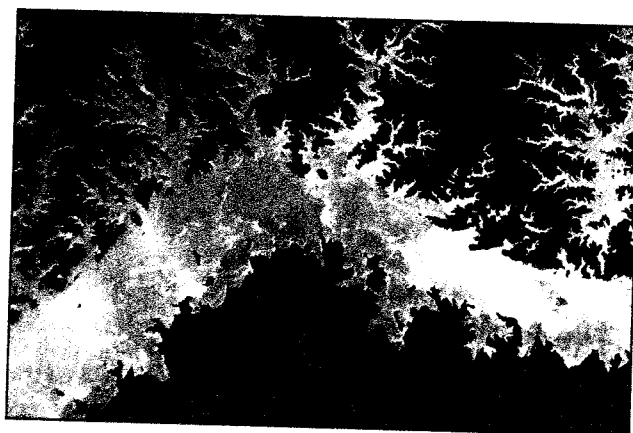
BOX 16.1 *A Case Study in Conservation Biogeography—
Biological Diversity of the Philippines* 756

CHAPTER 17 THE FRONTIERS OF BIOGEOGRAPHY 761

From the Foundations to the Frontiers of Biogeography 761

The Frontiers 762

New Dimensions of Biogeography 764



Glossary 765

Bibliography 785

Index 849