

国外生命科学优秀教材

ECOLOGY

生态学

(第五版)

(影印版)

Charles J. Krebs



科学出版社

生态学

(第五版 影印版)

Ecology: The Experimental Analysis of Distribution and Abundance

(Fifth Edition)

Charles J. Krebs



科学出版社

北京

内 容 简 介

本书是生态学领域颇享赞誉的教材, 目前已出版到第五版。在生物种群和生物群落水平上探讨了生物的分布和多样性, 并在涉及生态学的基础知识和研究方法的基础上, 讨论了生态学中许多有关生物分布和多样性还具有争论性的问题。该书的编排体例更易于理解, 较同类书具有更多的有关数量、分析和统计上的生态学信息, 重点论述了生态学实验的目的, 使学生对生态学有更深入的认识。其基础知识较全面, 知识量较大, 较适合高等院校相关专业的师生以及致力于环境保护和自然规划人员使用。

Ecology: The Experimental Analysis of Distribution and Abundance, 5e

Charles J. Krebs

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ISBN 0321068793

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图书在版编目 (CIP) 数据

生态学: 第5版/(美) 克雷布斯 (Krebs, C. J.) 著. 影印本. —北京: 科学出版社, 2003.1

国外生命科学优秀教材

ISBN 7-03-010977-5

I. 生… II. 克… III. 生态学-高等学校-教材-英文 IV. Q14

中国版本图书馆 CIP 数据核字 (2002) 第 091391 号

责任编辑: 盖 宇 庞在堂/责任校对: 庞在堂

责任印制: 刘士平/封面设计: 北新华文

科学出版社 出版

北京东黄城根北街16号

邮政编码: 100717

<http://www.sciencep.com>

新蕾印刷厂 印刷

科学出版社发行 各地新华书店经销

*

2003年1月第 五 版 开本: 850×1168 1/16

2003年1月第一次印刷 印张: 45

印数: 1-3 000 字数: 1 089 000

定价: 65.00 元

(如有印装质量问题, 我社负责调换〈环伟〉)

To the Unknown Ecologist
who works without recognition to preserve the
ecological integrity of the Earth for our grandchildren
and who measures riches not in stocks and bonds
but in biodiversity

ABOUT THE AUTHOR



WHILE GROWING UP IN ST. LOUIS, I became interested in polar exploration and read every book in the library about the arctic. I was fortunate to get a summer job working on the Pribilof Islands in the Bering Sea, and have been a northern ecologist ever since. I began my studies in wildlife management at the University of Minnesota, and moved to Canada to do graduate work at the University of British Columbia in 1957. After a Ph.D. on lemming populations in the Canadian arctic, I moved to Berkeley to do a Miller Postdoctoral Fellowship with Frank Pitelka. I finally got a proper job at Indiana University in Bloomington in 1964 and began teaching ecology to undergraduates. It was clear to me that there was a shortage of teaching material in ecology, and in particular there was no text that captured the Eltonian approach to ecology through population and community dynamics. I began writing this book in 1967

and the first edition appeared in 1972. One of the great joys of writing a textbook is meeting people all over the world who used my text during their education. Through five editions I have tried to track the progress of ecological science, and it is a sign of progress that ecologists are now recognized all over the world for their contributions to wise management of our natural heritage.

I am currently Professor of Zoology at the University of British Columbia in Vancouver. In addition to teaching ecology, I have worked extensively on the population of rodents in northern Canada, the United States, and Australia, trying to understand the mechanisms behind population fluctuations. I have written three ecology textbooks including *Ecology: The Experimental Analysis of Distribution and Abundance, Fifth Edition* and *Ecological Methodology, Second Edition* both published by Benjamin Cummings

P R E F A C E

YOU ARE LIVING IN THE AGE OF ECOLOGY, and as a citizen you ought to learn something about this subject. There has been a revolution of human thinking in the last 30 years that has centered on the relationship between humans and their environment. The broader policy problems this revolution has brought forward are the focus of the environment movement, the applied scientific problems, and the focus of environmental science. The basic science behind it all is the science of ecology. Sustainability is the mantra of all our politicians, and environmental problems are now a common subject in the daily newspapers.

Just as it is useful to know something about physics if you wish to be an engineer, it is useful to learn something about ecology if you wish to understand the problems humans face with sustaining their environment. This text is dedicated to presenting to you the outlines of the science of ecology. If you understand how the natural world works, you will be better poised to understand the Age of Ecology as it unfolds, to think with an ecological conscience.

Two dilemmas face the textbook writer. First, the writer must plot a course that will place the book serenely between the pitfalls of the past and the bandwagons of the present. We all recognize the pitfalls of the past, and any text has an obligation to point out some of these lest history repeat itself. We do not do as well at recognizing the pitfalls of the present at recognizing which of the current bandwagons in ecology are enduring and which are ephemeral. Science, like most subjects of human endeavor, is subject to bandwagons, only some of which are useful for our long-term understanding. Second, the writer must create a textbook that pleases not only the students but also their instructors. I have strived to make this book readable, and the greatest compliment any text can get is that students think it readable and interesting.

Each chapter in this book attempts to raise a question about how populations and communities

operate in nature, and to give you enough information that you can think about it intelligently. If you need more information, a list of suggested readings is a good starting point. Each chapter ends with a series of questions and problems that are devised to stimulate thought. I have not provided answers to these questions. For many of them the answer is not yet known. An overview question at the end of each chapter is a still more general question that may be the focus of a class discussion. Many overview questions are action-oriented. A key focus of much ecological thought ought to be "What are the practical consequences of this idea?"

In this edition I have added chapters on the population dynamics of disease and parasitism, and on ecosystem health and human impacts. I have tried to emphasize the historical development of ecology by adding photos of famous ecologists in each chapter. Science is a human activity and the scientists who have built ecology and are building it today are themselves interesting characters worthy of more recognition. I have extensively revised many of the chapters, particularly those on conservation biology, community organization, and primary production, and strengthened the integration of evolutionary and functional ecology. Conservation biology is a focus for practical problems that cry out for ecological understanding and is one of the strong growth points of ecological science. Many of the attempts to conserve biodiversity hinge on concepts of community organization that need careful thought and analysis. Many chapters deal with ecological attributes and their evolutionary background. Ecologists can benefit by stepping back and looking at ecological systems in a revolutionary perspective, and students of evolution can benefit from knowing how ecological systems function, for they cannot otherwise understand natural selection. I have added essays in many chapters to illustrate some of the kinds of problems and ques-

tions ecologists deal with in their attempt to understand nature.

This book is my own attempt to present modern ecology as an interesting and dynamic subject. Beneath the variety of approaches that characterize modern ecology lie a few basic problems that I have attempted to sketch. I have placed special emphasis on problems and have illustrated them by examples chosen as diversely as possible from the plant and animal kingdoms. This book is not an encyclopedia of ecology but an introduction to its problems. It is not descriptive ecology and will not tell students about the ecology of the seashore or the ecology of the alpine tundra. It approaches ecology as a series of problems, problems that confined neither to the seashore nor to the alpine tundra but are sufficiently general to be studied in either area.

To understand the problems of ecology, students must have some background in biology and mathematics. Students will find that they can understand ecology without knowing any mathematics but that mathematics is necessary for those who wish to proceed beyond the simplest level of analysis. Ecology is not a haven for people who cannot do mathematics, and in this respect it is no different from chemistry and physics. Statistics and calculus are useful but not essential for an understanding of this book. I present mathematical analyses step by step and illustrate them with graphs. Students who cannot follow the mathematics should be able to get the essence of the arguments from the graphs.

The problems of ecology are "biological" problems and will be solved not by mathematicians but by biologists. Students will find that, contrary to the impression they get from other sources, the problems of ecology have not all been solved. A start has been made in solving many ecological problems, and I cannot give the "answer" to many of the problems I discuss. Controversies are common in ecology, and an important part of ecological training is appreciating the controversies and trying to understand why people may look at the same data and yet reach opposite conclusions.

Students can learn much about the science of ecology by analyzing one of its controversies. If you think that ecologists have the answer to most of our environmental questions, you will be surprised when you look into the variety of ecological controversies. Controversy is not a sign of weak science, and to appreciate controversies you should try to find out the

scope of the controversy and what kinds of observations are needed to solve it. Many of the environmental controversies of our day, like climate change, involve a mixture of scientific facts and policy decisions. Scientific facts alone do not determine policy, but policy without a solid scientific grounding is doomed. The relevant scientific facts are never completely known for many environmental problems, and we must decide what to do in the face of uncertainty. Interim policy decisions always point out the need for more scientific analysis, and there must be a continuous feedback loop between policy and all the environmental sciences, including ecology.

Good ecology is quantitative. At the end of many of the quantitative chapters, problems are included because no one can appreciate the quantitative aspects of ecology without going through some of the calculations. Most of the calculations are simple, but I have tried to leave some of them open-ended so that interested students can carry on under their own steam.

If there is a message in this book, it is a simple one: Progress in answering ecological questions comes when experimental techniques are used. The habit of asking, "What experiment could answer this question?" is the most basic aspect of scientific method that students should learn to cultivate. When there is controversy, asking this question can cut to the heart of the matter.

Technical terms in this book are kept to a minimum; labeling with words should not be confused with understanding. The glossary of technical words, together with the indexes, should be adequate to cover technical definitions.

I thank my many friends and colleagues who have contributed to formulating and clarifying the material presented here. In particular I thank my colleagues Dennis Chitty, Judy Myers, Jamie Smith, Carl Walters, and Tony Sinclair for their assistance, and Brian Walker and the many ecologists at CSIRO Wildlife and Ecology in Canberra who answered endless queries during this version. For a detailed critique of the revision I am indebted to John C. Horn, St. Ambrose University, Davenport, IA; Alan Stam, Capital University, Columbus, OH; Merrill Sweet, Texas A&M University, College Station, TX; John Baccus, Southwest Texas State University, San Marcos, TX; Ralph J. Larson, San Francisco State University, San Francisco, CA; Mary Wicksten, Texas A&M University, College Station, TX; Stephen G. Tilley, Smith College, Northampton, MA; Robert Bailey, Central

Michigan University, Mt Pleasant, MI; Patricia L. Kennedy, Colorado State University, Ft. Collins, CO; Henry Merchant, George Washington University, Washington DC; Kathy Williams, San Diego State University, San Diego, CA; S. Sweet, Texas A&M University, College Station, TX. To all of these I am most grateful.

Thanks to Elizabeth Fogerty, Heather Dutton, and Chriscelle Merquillo at Addison Wesley who did

more than their share of editorial work to help improve this edition. Finally I want to thank the real authors of this book, the hundreds of ecologists who have toiled in the field and laboratory to extract from the study of organisms the concepts discussed here. A person's life work may be boiled down to a few sentences in a book, and we ecologists owe a debt that we cannot pay to our intellectual ancestors.

Charley Krebs

C O N T E N T S

Preface xviii

PART 1 WHAT IS ECOLOGY? 1

CHAPTER 1 INTRODUCTION TO THE SCIENCE OF ECOLOGY 2

- Definition of Ecology 2
- History of Ecology 3
- Basic Problems and Approaches to Ecology 7
- Levels of Integration 10
- Methods of Approach to Ecology 11
- Application of the Scientific Method to Ecology 11
- Essay 1.1 Science and Values in Ecology 12*
- Box 1.1 Scientific Method: Definitions of Terms 13*
- Essay 1.2 On Ecological Truth 14*
- Key Concepts 15
- Selected References 15
- Questions and Problems 15

CHAPTER 2 EVOLUTION AND ECOLOGY 17

- What Is Evolution? 17
- Adaptation 18
- Box 2.1 What Is Fitness? 19*
 - Clutch Size in Birds 22*
- Coevolution 25
- Essay 2.1 Evolution and "Arms Races" 26*
- Units of Selection 26
 - Genetic Selection 27*
 - Kin Selection 27*
 - Group Selection 27*
- Summary 27
- Key Concepts 28
- Selected References 28
- Questions and Problems 28

PART 2 THE PROBLEM OF DISTRIBUTION: POPULATIONS 31

CHAPTER 3 METHODS FOR ANALYZING DISTRIBUTIONS 32

- Transplant Experiments 32
- Essay 3.1 Liebig's Law of the Minimum* 34
- Physiological Ecology 35
- Adaptation 36
- Summary 38
- Key Concepts 39
- Selected References 39
- Questions and Problems 39

CHAPTER 4 FACTORS THAT LIMIT DISTRIBUTIONS: DISPERSAL 41

- Examples of Dispersal 41
 - Zebra Mussel (Dreissena polymorphus)* 41
 - Gypsy Moth (Lymantria dispar)* 42
 - Chestnut Blight (Cryphonectria parasitica)* 44
 - California Sea Otter (Enhydra lutris)* 45
- The Three Modes of Dispersal 46
- Essay 4.1 Ships, Ballast Water, and Marine Dispersal* 47
- Box 4.1 Definition of Terms for Introduced Nonnative Species* 50
- Colonization and Extinction 50
- Evolutionary Advantages of Dispersal 53
- Summary 55
- Key Concepts 55
- Selected References 56
- Questions and Problems 56

CHAPTER 5 FACTORS THAT LIMIT DISTRIBUTIONS: HABITAT SELECTION 57

- Behavioral Mechanisms of Habitat Selection 57
- Evolution of Habitat Preferences 65
- A Theory of Habitat Selection 67
- Summary 69
- Key Concepts 69
- Selected References 69
- Questions and Problems 70

CHAPTER 6 FACTORS THAT LIMIT DISTRIBUTIONS: INTERRELATIONS WITH OTHER SPECIES 71

- Predation 71
 - Restriction of Prey by Predators* 71
 - Restriction of Predators by Prey* 75

(continued)

(Chapter 6, continued)

Disease and Parasitism	77
Allelopathy	78
Competition	80
<i>Essay 6.1 What is Competition?</i>	82
Summary	83
Key Concepts	83
Selected References	84
Questions and Problems	84

CHAPTER 7 FACTORS THAT LIMIT DISTRIBUTIONS: TEMPERATURE, MOISTURE, AND OTHER PHYSICAL-CHEMICAL FACTORS 86

Climatology	86
Temperature and Moisture as Limiting Factors	88
<i>Interaction Between Temperature and Moisture</i>	91
<i>Adaptations to Temperature and Moisture</i>	94
Light as a Limiting Factor	97
Climate Change and Species Distributions	102
Summary	103
Key Concepts	104
Selected References	104
Questions and Problems	104

CHAPTER 8 THE RELATIONSHIP BETWEEN DISTRIBUTION AND ABUNDANCE 106

The Spatial Scale of Geographic Ranges	106
Variations in Geographic Range Size	108
Range Size and Abundance	111
Summary	113
Key Concepts	114
Selected References	114
Questions and Problems	114

PART 3 THE PROBLEM OF ABUNDANCE 115

CHAPTER 9 POPULATION PARAMETERS 116

The Population as a Unit of Study	116
<i>Box 9.1 Definitions of Population Parameters</i>	00
Unitary and Modular Organisms	117
Estimation of Population Parameters	119
<i>Box 9.2 Calculation of Expected Population Density from the Regression Data Given in Table 9.1</i>	120
<i>Measurements of Absolute Density</i>	120
<i>Indices of Relative Density</i>	125

<i>Essay 9.1 A Historical Essay in Ecology: The Cormack-Jolly-Seber</i>	
<i>Mark-Recapture Model</i>	126
<i>Natality</i>	128
<i>Mortality</i>	128
<i>Immigration and Emigration</i>	129
Limitations of the Population Approach	130
Composition of Populations	130
Summary	131
Key Concepts	131
Selected References	131
Questions and Problems	132

CHAPTER 10 DEMOGRAPHIC TECHNIQUES: VITAL STATISTICS 133

Life Tables	133
<i>Box 10.1 Calculation of Per Capita Rates</i>	135
Intrinsic Capacity for Increase in Numbers	138
<i>Essay 10.1 Demographic Projections and Predictions</i>	143
<i>Box 10.2 Calculation of the Intrinsic Capacity for Increase</i>	
<i>from Lotka's Characteristic Equation</i>	145
Reproductive Value	145
Age Distributions	146
Evolution of Demographic Traits	149
Summary	154
Key Concepts	154
Selected References	154
Questions and Problems	155

CHAPTER 11 POPULATION GROWTH 157

Mathematical Theory	157
<i>Growth in Populations with Discrete Generations</i>	157
<i>Growth in Populations with Overlapping Generations</i>	160
<i>Box 11.1 What is Little-r and Why Is It So Confusing?</i>	162
Laboratory Tests of the Logistics Theory	163
Field Data on Population Growth	164
<i>Essay 11.1 What Is a "Good" Population Growth Model?</i>	166
<i>Box 11.2 A Simple Time-Lag Model of Population Growth</i>	168
Time-Lag Models of Population Growth	169
Stochastic Models of Population Growth	169
Population Projection Matrices	173
Summary	176
Key Concepts	176
Selected References	177
Questions and Problems	177

CHAPTER 12	SPECIES INTERACTIONS: COMPETITION	179
	Classification of Species Interactions	179
	Theories on Competition for Resources	180
	<i>Mathematical Model of Lotka and Volterra</i>	180
	Tilman's Model	182
	<i>Essay 12.1 What Is a Phase Plane, and What Is an Isocline?</i>	184
	Competition in Experimental Laboratory Populations	185
	Competition in Natural Populations	190
	Evolution of Competitive Ability	199
	<i>Theory of r-Selection and K-Selection</i>	199
	<i>Grime's Theory of Plant Strategies</i>	201
	Character Displacement	201
	Diffuse Competition and Indirect Effects	202
	Summary	203
	Key Concepts	204
	Selected References	204
	Questions and Problems	205
CHAPTER 13	SPECIES INTERACTIONS: PREDATION	206
	Mathematical Models of Predation	207
	<i>Discrete Generations</i>	207
	<i>Continuous Generations</i>	209
	Laboratory Studies of Predation	212
	Field Studies of Predation	216
	<i>Essay 13.1 Laboratory Studies and Field Studies</i>	217
	Optimal Foraging Theory	225
	Evolution of Predator-Prey Systems	228
	<i>Warning Coloration</i>	229
	<i>Group Living</i>	231
	Summary	232
	Key Concepts	232
	Selected References	232
	Questions and Problems	233
CHAPTER 14	SPECIES INTERACTIONS: HERBIVORY AND MUTUALISM	235
	Defense Mechanisms in Plants	235
	<i>Tannins in Oak Trees</i>	238
	<i>Ants and Acacias</i>	239
	<i>Spines in a Marine Bryozoan</i>	241
	<i>Spines and Thorns in Terrestrial Plants</i>	242
	Herbivores on the Serengeti Plains	242
	Can Grazing Benefit Plants?	246
	<i>Essay 14.1 Herbivory, Economics, and Land Use</i>	247
	Dynamics of Herbivore Populations	248
	<i>Interactive Grazing: Ungulate Irruptions</i>	248
	<i>Noninteractive Grazing: Finch Populations</i>	251

Seed Dispersal: An Example of Mutualism	253
Complex Species Interactions	254
Summary	256
Key Concepts	256
Selected References	256
Questions and Problems	257

CHAPTER 15 SPECIES INTERACTIONS: DISEASE AND PARASITISM 258

Mathematical Models of Host-Disease Interaction	258
<i>Compartment Models with Constant Population Size</i>	259
<i>Essay 15.1 What Is the Transmission Coefficient (β), and How Can We Measure It?</i>	261
<i>Compartment Models with Variable Population Size</i>	262
<i>Box 15.1 How Can We Determine R_0? A Mathematical Excursion</i>	263
Effects of Disease on Individuals	264
<i>Effects on Reproductions</i>	264
Effects on Mortality	265
Effects of Disease on Populations	267
<i>Brucellosis in Ungulates</i>	267
<i>Rabies in Wildlife</i>	268
<i>Myxomatosis in the European Rabbit</i>	272
<i>Box 15.2 A Simple Rabies Model</i>	273
Evolution of Host-Parasite Systems	275
<i>Essay 15.2 What is the Red Queen Hypothesis?</i>	276
Summary	277
Key Concepts	278
Selected References	278
Questions and Problems	279

CHAPTER 16 POPULATION REGULATION 280

A Simple Model of Population Regulation	281
Historical Views of Population Regulation	282
<i>Essay 16.1 Definitions in Population Regulation</i>	283
A Modern Synthesis of Population Regulation	288
<i>Essay 16.2 Why Is Population Regulation So Controversial?</i>	290
Two Approaches to Studying Population Dynamics	293
<i>Key Factor Analysis</i>	293
<i>Experimental Analysis</i>	296
Plant Population Regulation	297
Source and Sink Populations	299
Evolutionary Implications of Population Regulation	300
Summary	302
Key Concepts	302
Selected References	303
Questions and Problems	303

CHAPTER 17	APPLIED PROBLEMS I: HARVESTING POPULATIONS	305
	Logistic Models	307
	Dynamic Pool Models	309
	Laboratory Studies on Harvesting Theory	316
	The Concept of Optimum Yield	318
	Case Study: The King Crab Fishery	319
	Case Study: The Northern Cod Fishery	321
	Case Study: Antarctic Whaling	324
	Risk-Averse Management Strategies	325
	<i>Essay 17.1 Principles of Effective Resource Management</i>	326
	<i>Box 17.1 What Are the Harvest Strategies for a Fishery?</i>	327
	Summary	328
	Key Concepts	328
	Selected References	328
	Questions and Problems	329
CHAPTER 18	APPLIED PROBLEMS II: PEST CONTROL	331
	Examples of Biological Control	333
	<i>Cottony-Cushion Scale</i> (<i>Icerya purchasi</i>)	333
	<i>Prickly Pear</i> (<i>Opuntia</i> spp.)	334
	<i>Floating Fern</i> (<i>Salvinia molesta</i>)	336
	Theory of Biological Control	337
	Genetic Controls of Pests	342
	Immunocontraception	344
	Integrated Control	346
	Generalizations About Biological Control	349
	Risks of Biological Control	351
	Summary	352
	Key Concepts	353
	Selected References	353
	Questions and Problems	353
CHAPTER 19	APPLIED PROBLEMS III: CONSERVATION BIOLOGY	355
	Small-Population Paradigm	355
	<i>Minimum Viable Populations</i>	356
	<i>Box 19.1 What Is Effective Population Size?</i>	359
	<i>Essay 19.1 Diagnosing a Declining Population</i>	360
	<i>The Declining-Population Paradigm</i>	360
	<i>Overkill</i>	361
	<i>Habitat Destruction and Fragmentation</i>	362
	<i>Essay 19.2 Fragmentation of Habitats and Area-Sensitive Species</i>	367
	Impacts of Introduced Species	371
	<i>Chains of Extinctions</i>	373
	Reserve Design and Reserve Selection	373
	<i>Box 19.2 Recovery of Petrels After Eradication of Feral Cats on Marion Island, Indian Ocean</i>	374
	<i>Box 19.3 An Algorithm for Choosing Reserves for a Taxonomic Group</i>	375

Examples of Conservation Problems	377
<i>Furbish's Lousewort</i>	377
<i>The Northern Spotted Owl</i>	379
Summary	381
Conclusion	382
Key Concepts	382
Selected References	382
Question and Problems	383

PART 4 DISTRIBUTION AND ABUNDANCE AT THE COMMUNITY LEVEL 385

CHAPTER 20 THE NATURE OF THE COMMUNITY 386

Dynamic Relations Between Populations	386
<i>Essay 20.1 What Is the Gaia Hypothesis?</i>	388
Community Characteristics	392
<i>Community Boundaries?</i>	392
<i>Distributional Relations of Species in Communities</i>	395
<i>Indicator Species in Communities</i>	398
<i>Box 20.1 Criteria for Indicator Species</i>	399
Summary	400
Key Concepts	401
Selected References	401
Questions and Problems	401

CHAPTER 21 COMMUNITY CHANGE 403

Primary Succession on Mount St. Helens	403
Concepts of Succession	406
A Simple Mathematical Model of Succession	409
Case Studies of Succession	412
<i>Glacial Moraine Succession in Southeastern Alaska</i>	413
<i>Lake Michigan Sand-Dune Succession</i>	416
<i>Essay 21.1 Why Is Sphagnum Moss So Common?</i>	417
<i>Abandoned Farmland in North Carolina</i>	419
The Climax State	423
Patch Dynamics	424
Summary	431
Key Concepts	431
Selected References	431
Questions and Problems	432

CHAPTER 22 COMMUNITY ORGANIZATION I: BIODIVERSITY 434

Measurement of Biodiversity	434
<i>Essay 22.1 Biodiversity: A Brief History</i>	436
Some Examples of Diversity Gradients	438

(continued)

(Chapter 22, continued)

<i>Box 22.1 A Simple Model of Latitudinal Gradients in Biodiversity</i>	443
Factors That Might Cause Diversity Gradients	443
<i>History Factory</i>	444
<i>Spatial Heterogeneity</i>	445
<i>Competition</i>	447
<i>Predation</i>	448
<i>Climate and Climatic Variability</i>	450
<i>Productivity</i>	452
<i>Disturbance</i>	452
Local and Regional Diversity	454
Summary	456
Key Concepts	456
Selected References	457
Questions and Problems	457

CHAPTER 23 COMMUNITY ORGANIZATION II: PREDATION AND COMPETITION IN EQUILIBRIAL COMMUNITIES 459

<i>Box 23.1 Measuring Community Importance</i>	461
Food Chains and Trophic Levels	463
<i>Essay 23.1 Use of Stable Isotopes to Analyze Food Chains</i>	466
Functional Roles and Guilds	469
Keystone Species	471
Dominant Species	474
<i>Essay 23.2 Fishing Down Food Webs</i>	477
Community Stability	477
Restoration Ecology	480
Summary	482
Key Concepts	483
Selected References	483
Questions and Problems	484

CHAPTER 24 COMMUNITY ORGANIZATION III: DISTURBANCE AND NONEQUILIBRIUM COMMUNITIES 485

Patches and Disturbance	485
The Role of Disturbance in Communities	486
<i>Coral Reef Communities</i>	486
<i>Essay 24.1 Why Are Corals Bleaching?</i>	489
<i>Rocky Intertidal Communities</i>	491
Theoretical Nonequilibrium Models	492
Conceptual Models of Community Organization	495
<i>Essay 24.2 Biomanipulation of Lakes</i>	499
The Special Case of Island Species	501
<i>Box 24.1 Measuring Immigration and Extinction Rates</i>	507
Multiple Stable States in Communities	508
Summary	509
Key Concepts	510
Selected References	510
Questions and Problems	511