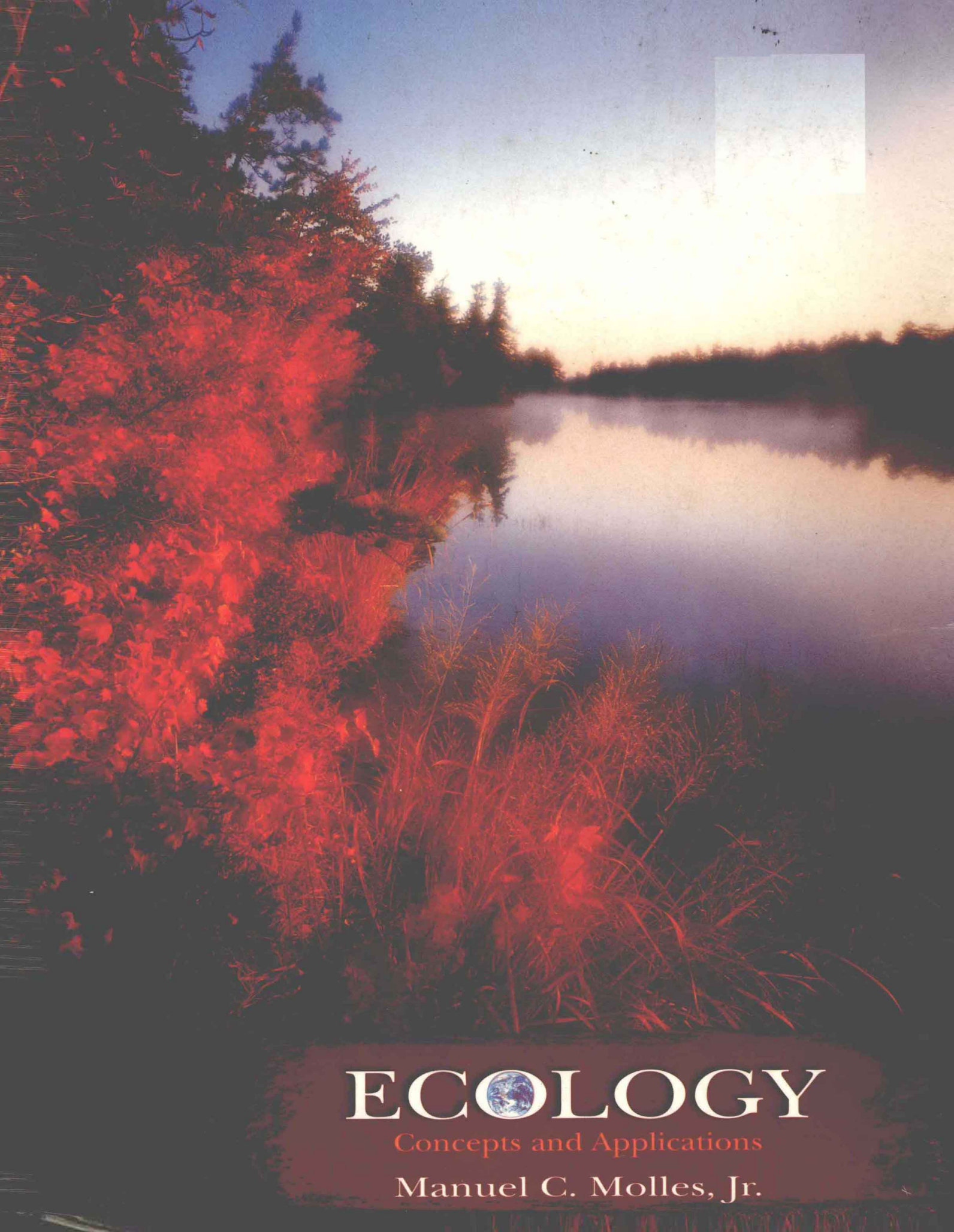

ECOLOGY

Concepts and Applications

Manuel C. Molles, Jr.

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Manuel C. Molles, Jr.
University of New Mexico

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ABOUT THE AUTHOR

Dr. Manuel Molles is Professor of Biology at the University of New Mexico, where he has been a member of the faculty and curator in the Museum of Southwestern Biology since 1975. He received his B.S. from Humboldt State University in 1971 and his Ph.D. from the Department of Ecology and Evolutionary Biology at the University of Arizona in 1976. The author has sought to broaden his geographic perspective by teaching and conducting ecological research in Latin America, the Caribbean, and Europe. He was awarded a Fulbright Research Fellowship to conduct research on river ecology in Portugal and has held visiting professor appointments in the Department of Zoology at the University of Coimbra, Portugal, in the Laboratory of Hydrology at the Polytechnic University of Madrid, Spain, and at the University of Montana's Flathead Lake Biological Station.

Originally trained as a marine ecologist and fisheries biologist, the author has worked mainly on river and riparian ecology at the University of New Mexico. His research has concerned a wide range of ecological levels, including behavioral ecology, population biology, community ecology, ecosystem ecology, biogeography of stream insects, and the influence of a large-scale climate system (El Niño) on the dynamics of southwestern river and riparian ecosystems. His current research concerns the effects of flooding and exotic vegetation on the structure and dynamics of the Rio Grande riparian ecosystem.

Throughout his career, the author has attempted to combine research, teaching, and service, involving undergraduate as well as graduate students in his ongoing projects. At the University of New Mexico, he has taught a broad range of lower division, upper division, and graduate courses, including Principles of Biology, Evolution and Ecology, Stream Ecology, Limnology and Oceanography, Marine Biology, and Community and Ecosystem Ecology. He has also taught courses in Global Change and River Ecology at the University of Coimbra, Portugal, and Groundwater and Riparian Ecology at the Flathead Lake Biological Station. Dr. Manuel Molles was named Teacher of the Year by the University of New Mexico for 1995–96.

To Bobbie, Hani, and Anders

PREFACE

About 2,500 years ago, the Greek philosopher Zeno proposed a paradox that captures the challenge faced by ecology instructors and their students. In the tale of Achilles and the Tortoise, Zeno argued that if a fast runner, such as the mythical Achilles, gave a tortoise a head start in a race, he could never overtake it. Zeno proposed that since there are an infinite number of points between him and the tortoise, Achilles never catches up. Modern mathematics has solved this paradox and we can take comfort that, even in Zeno's theoretical universe, Olympic runners can overtake tortoises. However, there is a place where Zeno's arguments appear to hold, and that is in the world of teaching dynamic scientific disciplines such as ecology.

The challenge to ecology instructors and their students is much greater than that faced by Achilles—greater because instructors and students are matched against a much swifter opponent with a longer head start. As they attempt to cover the space between the beginning and end of this subject, the rapid pace of discovery moves the limits of the discipline ahead, not at the speed of a tortoise but at that of a hare. Zeno would be very happy in this universe because here, the instructor and students can never catch up. However, with careful organization and modern tools, such as the World Wide Web, they can come close.

In an address at the 1991 meeting of the Ecological Society of America in San Antonio, Texas, eminent ecologist Paul Risser challenged ecology instructors to focus their attention on the major concepts of the field. If we subdivide a large and dynamic subject, such as ecology, too finely, we cannot cover it in one or two academic terms. Risser proposed that by focusing on major concepts, however, we may provide students with a robust framework of the discipline upon which they can build.

This book attempts to address Risser's challenge. Each chapter is organized around two to four major concepts to present the student with a manageable and memorable synthesis of the subject. I have found that while beginning ecology students can absorb a few central concepts well, they can easily get lost in a sea of details. Each concept is supported by case histories that provide evidence for the concept and introduce students to the research approaches used in the various areas of ecology. Wherever possible, the original research and the scientists who did the research are presented. Allowing the scientists who created this field to emerge from the background and lead students through the discipline breathes life into the subject and helps students retain information.

AUDIENCE

I have written this book for students taking their first undergraduate course in ecology. I have assumed that students in this one-semester course have some knowledge of basic chemistry and mathematics and that they have had a course in general biology that included introductions to physiology, biological diversity, and evolution. An evolutionary perspective forms the foundation of the entire discussion. Evolution is brought to center stage throughout the book, as it is needed to support understanding of major concepts. My choices about coverage and depth of study are based on the past 20 years of teaching ecology to undergraduate students. With these students in mind, I organized the book as follows.

ORGANIZATION

The discussion begins with a brief introduction to the nature and history of the discipline of ecology, followed by section I, which includes two chapters on natural history—life on land and life in water. My intent is to establish a common foundation of natural history upon which to base the later discussions of ecological concepts. The introduction and natural history chapters can stand on their own and should be readily accessible to most students. They may be assigned as background reading, leaving 17 chapters to cover in a one-semester course. Sections II through VI build a hierarchical perspective: section II concerns the ecology of individuals; section III focuses on population ecology; section IV presents the ecology of interactions; section V summarizes community and ecosystem ecology; and finally, section VI discusses large-scale ecology and includes chapters on landscape, geographic, and global ecology. These topics were first introduced in section I within a natural history context. In summary, the book begins with the natural history of the planet, considers portions of the whole in the middle chapters, and ends with another perspective of the entire planet in the concluding chapter.

Learning Aids

All chapters beyond chapter 1 feature the following learning system:

Introduction The introduction to each chapter presents the student with the flavor of the subject at hand and important background information. Some introductions include

historical events related to the subject; others present an example of an ecological process. All attempt to engage students and draw them into the discussion that follows.

Concepts The goal of this book is to build a foundation of ecological knowledge around key concepts. The concepts are listed after the chapter introduction to alert the student to the major topics to follow, and to provide a place where the student can go to find a list of the important points of each chapter.

- The hydrologic cycle exchanges water among reservoirs.
- The biology of aquatic environments corresponds broadly to variations in physical factors such as light, temperature, and water movements and to chemical factors such as salinity and oxygen.

Case Histories Illustrating concepts with case histories provides a narrative that reinforces the concepts, supports them with evidence, and introduces students to the methods and people that have created the discipline of ecology. My presentation approximates the case-studies approach that has worked well for my former students who have gone on to schools of law and medicine.

Applications and Tools Many undergraduate students want to know how abstract ideas and general relationships can be applied to the ecological problems facing us all. They are concerned with the practical side of ecology and want to know more about the tools of science. It is for these students that I have included a chapter section called Applications and Tools. It is clear to professional ecologists that addressing the practical side of ecology is aided by a knowledge of the abstract and theoretical sides of the field. However, many undergraduates have not yet reached this stage of development. I have found that including a few applications in my courses motivates students to learn more of the underlying principles. In addition, it seems that environmental problems are now so numerous and so pressing that they have erased a once easy distinction between general and applied ecology.

Summary The chapter summary reviews the main points of the content. The concepts around which each chapter is organized are boldfaced in the summary to reemphasize the main points of the chapter.

Review Questions The review questions are designed to help students think more deeply about each concept and to reflect on alternative views. They also provide a place to fill in any remaining gaps in the information presented and take students beyond the foundation established in the main body of the chapter.

Suggested Readings Each chapter ends with a list of suggested readings. Though all of the readings take the student beyond the coverage in the chapter, they have been chosen to serve a variety of purposes. Some are books that provide a broad overview; others are papers that trace the development of particular concepts or controversies in ecology. I have provided a brief description and rationale for each.

On the Net The World Wide Web provides one of the most powerful tools to help keep abreast of changes in ecology. I have chosen a broad range of Internet sites to provide supplementary information on the subject of each chapter. In addition, this book has its own web site at which updated information on Internet sources, suggested readings, and new discoveries are provided.

ON THE NET

Ocean Planet-Smithsonian
http://seawifs.gsfc.nasa.gov/ocean_planet.html

Monterey Bay Aquarium On.Line
http://www.mbayaq.org/

Australian Institute of Marine Science, Coral Reefs and Mangroves . . .
http://ibm590.aims.gov.au/

Coral Reef Research Institute
http://www.bio.usyd.edu.au/CRRI/crri-ind.html

Cairns OnLine Environment Guide: Mangroves
http://www.cairns.aust.com/environ/mangroves.htm

References are an important part of any scientific work. However, I have found that many undergraduates are distracted by a large number of references within the text. Undergraduates in a general ecology course are usually in a state of transition. Their scholarship has advanced beyond a general biology course but they are not yet accomplished researchers. One of the goals of a general ecology course should be to introduce these students to the primary literature without burying them in citations. With this goal in mind, I have reduced the number of citations to those necessary to support detailed discussions of particular research projects. References cited are listed at the end of the book.

Illustrations

Finally, a great deal of effort has been put into the development of illustrations, both photographs and line art. The goal has been to create more effective pedagogical tools through skillful design and use of color and to rearrange the traditional presentation of information in figures and captions. Much explanatory material has been moved from captions to illustrations to provide students with key information where they need it most.

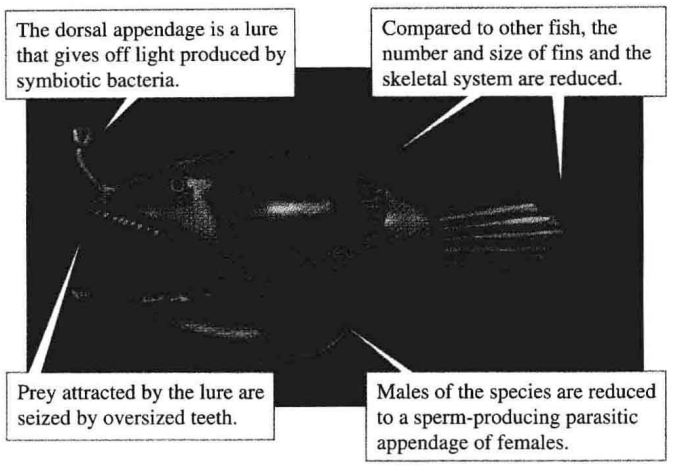

FIGURE 3.4 *Deep-sea anglerfish.*

SUPPLEMENTARY MATERIALS

Instructor's Manual and Test Item File

The Instructor's Manual and Test Item File is designed to assist instructors as they plan and prepare for classes using *Ecology: Concepts, and Applications.* Relevant films, videotapes, and computer programs are included in the manual, as well as a listing of the transparencies that supplement the text. The Test Item File offers 40 to 50 questions per chapter, including multiple-choice, fill-in-the-blank, and true/false questions.

Classroom Testing Software

This helpful, easy-to-use, computerized test-generating software is available to instructors for testing and grading. It is offered in both Windows and Macintosh formats.

Transparencies

A set of transparencies of 100 key figures from the text are available free to instructors.

Laboratory Manuals

Field and Laboratory Methods for General Ecology, 4th ed., by Brower, Zar, and Von Ende.

Laboratory Manual for General Ecology, 7th ed., by Cox.

Titles of Related Interest

Conservation Biology, 2d ed., by Cox.

Environmental Science: The Study of Interrelationships, 6th ed., by Enger and Smith.

Environmental Science: A Global Concern, 5th ed., by Cunningham and Saigo.

Environmental Problem Solving Workbook: A Case Study Approach, by Heathcote.

Annual Editions: Environment 97/98. Editor: John L. Allen.

Taking Sides: Clashing Views on Controversial Environmental Issues, 7th ed. Editor: Theodore D. Goldfarb.

Sources: Notable Selections in Environmental Studies. Editor: Theodore D. Goldfarb.

The Dushkin Student Atlas of Environmental Issues. Editor: John Allen.

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