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(Mostly) Species Diversity Patterns in the Sea

Ormond, Rupert F. G., John D. Gage, and Martin Vivian Angel, editors. 1997. **Marine biodiversity: patterns and processes.** Cambridge University Press, New York. xxii + 449 p. $74.95, ISBN: 0-521-55222-2.

Since the term biological diversity (Lovejoy, T. 1980. ''Foreword'' in Michael E. Soulé and Bruce A. Wilcox, editors. *Conservation biology—an evolutionary-ecological perspective.* Sinauer Associates, Sunderland, Massachusetts; Norse, E. A., and R. E. McManus. 1980. Ecology and living resources: biological diversity. pp. 31–80 in Council on Environmental Quality. *Environmental quality—1980: the eleventh annual report of the Council on Environmental Quality.* U.S. Government Printing Office, Washington, D.C.) and its synonym biodiversity (Wilson, E. O., editor. 1988. *Biodiversity.* National Academy Press, Washington, D.C.) emerged from the conservation literature into the broader lexicon, stopping biodiversity loss has become the focus of conservation worldwide and provided impetus for public funding of systematics, biogeography and ecology. Because biodiversity on land has received the lion's share of attention and books on marine biodiversity are few, I awaited this book eagerly.

I was disappointed to find that the book focuses mostly on descriptions of species diversity patterns and the processes that could shape them, giving insufficient attention to lower and higher levels of genetic diversity within species and ecosystem diversity. The relevance of such patterns to conservation is explicit in only a few chapters, which is unfortunate because many will buy this book for insights into a realm increasingly dominated by humans. Moreover, marine biodiversity patterns are frustratingly complex, and some herein are plagued by sparse data or have underlying mechanisms so obscure that the authors' best efforts cannot yet contribute much to the conceptual foundation for marine stewardship. Simply put, we do not yet have the data or theory that we need. Other chapters, however, are intriguing, well written, and highly relevant. The book's topics range broadly, from subpolar to tropical, nearshore to oceanic, benthic to planktonic, diatoms to fishes, Mesozoic to modern.

M. V. Angel's chapter on pelagic biodiversity is inexplicably narrow. Whereas the pelagic realm is home to phytoplankton, zooplankton, neuston, nekton, and flying organisms that feed near the surface, the chapter mentions only phytoplankton, crustaceans, and three small mesopelagic fishes, thereby omitting gelatinous zooplankton, squids, sharks, mackerels, tunas, billfishes, sea turtles, seabirds, pinnipeds, and cetaceans. This is analogous to neglecting reptiles, birds, antelopes, zebras, elephants, hyenas, and lions in a chapter on African savanna biodiversity. Pelagic biodiversity is more than what plankton nets sample.

M. A. Rex et al. provide useful ideas on deepsea species diversity patterns and processes, but show how devilishly difficult it is to demonstrate broad geographic patterns in the deep sea when the total area of the seabed sampled quantitatively is only 500 m^2 worldwide. They provide evidence of a polar–tropical species diversity gradient in the northern hemisphere, but including the especially poorly sampled southern hemisphere complicates the picture. This is reinforced by A. Clarke and J. A. Crame's lucid chapter on shallow water latitudinal gradients, which explains how the greater species diversity in Antarctic waters reflects both historic and modern environmental differences from the Arctic and provides welcome comparison with the better-known terrestrial latitudinal species diversity gradient. J. D. Gage provides a thoughtful examination of disturbance in the deep sea, a realm where some places are much more dynamic than had been thought.

Nutrient status deserves far more attention from ecologists and conservation biologists. J. D. Taylor's illuminating chapter examines community differences related to ecosystems' nutrient status. Reef corals become less diverse and ultimately less abundant in waters with more available nutrients, while bioeroders (such as *Lithophaga* date mussels) become more active and primary production shifts progressively from animals having endozoic algal mutualists to benthic seaweeds to phytoplankton. This sequence describes an increasing proportion of coral reefs. Taylor also points out that predatory gastropods in eutrophic waters on continental shores tend to be generalist feeders on suspension-feeding barnacles and bivalves, whereas predatory gastropods in oligotrophic waters are more specialized feeders on algal-grazing polychaetes, sipunculans, or gastropods. Understanding such changes in species composition and trophic structure could alert us to degradation in nearshore assemblages. My only quibble: in three tables showing higher diversity of bivalves or other taxa on continental margins and high islands versus oceanic islands, Taylor concludes that trophic status causes this pattern without ruling out island biogeographic differences in extinction and recolonization rates.

R. F. G. Ormond and C. M. Roberts offer a wide-ranging look at fish diversity gradients in coral reefs, the pinnacles of marine species diversity that comprise only 0.1% of the Earth's surface. Latitudinal gradients are far less pronounced than longitudinal ones; diversity declines sharply eastward (and less sharply westward) from the richest waters in Indonesia, Philippines, and Great Barrier Reef. The authors wend their way through the controversy over whether reef fish species composition is determined primarily by differential recruitment or by post-recruitment competition or predation. One annoying error: labels are reversed in Figure 10.7. Coral reef fishes are ideal examples of species that display metapopulation dynamics, which makes them more vulnerable than generally assumed.

The first chapter on genetic diversity challenges the canonical view that high gene flow across vast areas prevents marine populations from differentiating and adapting to local conditions. J. E. Niegel provides evidence for a startling hypothesis: that the apparent genetic homogeneity in highly fecund marine species with planktonic larvae occurs because genetically effective population sizes of marine species might be much smaller than census population sizes because few individuals contribute to the next generation. Furthermore, because recently reduced populations haven't evolved tolerance to inbreeding depression, his hypothesis has major conservation implications: ''if the geographical range of a once widespread marine species becomes restricted to a few reserves or protected habitats, a rapid loss of genetic diversity may result.'' The pillars of fishery and marine protected area management might be thinner than had been assumed. The other genetics chapter, by J. Grahame et al. on littorinid snail cryptospecies, is too specialized for a book of this scope.

Two chapters, one by R. Elmgren and C. Hill and one by G. C. Ray et al., examine ecosystem diversity, emphasizing roles of epifaunal bivalves in ecosystems of northern Europe (blue mussels, *Mytilus edulis* or *M. trossulus*) and eastern North America (American oysters, *Crassostrea virginica*), respectively. The low and decreasing species diversity in arms of the Baltic Sea, particularly loss of blue mussels, leads to drastic change in ecosystem function. Ray et al.'s table 15.5 is a fascinating and comprehensive list of key functions of oysters. They give an estimate that oyster larvae survivorship to adulthood is 14 per million fertilized eggs. Even this low survivorship seems too high (adults can release tens of millions of eggs). Chapters by M. C. M. Beveridge et al. and J. S. H. Pullen nicely summarize threats to marine biodiversity from mariculture and from other activities, respectively, the latter as a reason for adopting integrated coastal zone management.

Although this collection lacks the tight integration of the best edited volumes, has uneven quality and serious gaps, its more thought-provoking chapters and the paucity of competing books will give it a niche until more books are available. It also shows that international cooperation in marine biodiversity research still lies ahead. Most of its authors are British; others are from Norwegian, Swedish, Dutch, and U.S. institutions, but none of the eight multi-authored chapters have authors from more than one nation.

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ECOLOGICAL USE OF NATURAL CO_2 SPRINGS

Raschi, A., F. Milglietta, R. Tognetti, and Paul Richard van Gardingen, editors. 1997. **Plant responses to elevated CO_2: evidence from natural springs.** Cambridge University Press, New York. xiv + 272 p. $69.95 ISBN: 0-521-58203-2.

Successful research often involves a search for the proper material and/or settings to address critical scientific issues. The field of molecular genetics, for instance, has used *Escherichia coli* as a model system to illustrate principles of DNA and RNA transcription. In ecology, different sizes of islands off seashore have been employed to understand relationships between species migration and population/community structure, resulting in the subdiscipline of island biogeography. In order to examine long-term plant and ecosystem responses to rising atmospheric CO_2 concentration in the natural world, global change scientists have also searched for new approaches and natural settings. *Plant responses to elevated CO_2* was born out of such a search and presents research results from natural CO_2 springs. These natural springs provide a unique opportunity for global change research, particularly in relation to long-term issues.

Plant responses to elevated CO_2 have been extensively studied during the past two decades, primarily using growth chambers and greenhouses as controlled environments. More recently open-top chambers and free-air CO_2 enrichment facilities in natural ecosystems have been employed. Although past research has greatly improved our understanding of short-term responses of physiological processes to elevated CO_2, our capability to address long-term issues has been extremely limited because most of the experiments last only from several weeks to a few years. Salient long-term issues, which potentially can be addressed through the use of natural springs, include: 1) regulation of physiological acclimation through slow plant and soil processes, 2) genetic adaptation to a gradual increase in atmospheric CO_2, 3) changes in population structure and species composition of plant communities, and 4) dynamics of soil organic matter and nutrient supply.

Plant responses to elevated CO_2 devotes the majority of its 18 chapters to physiological acclimation. Two basic approaches are presented: one is to measure physiological activities of plants along CO_2 gradients, and the other is to conduct transplant experiments. In the latter case, seeds or rhizomes were collected from sites with different CO_2 exposure and then grown in controlled environments for physiological studies. While data are minimal in most of the chapters, measurements along CO_2 gradients suggest that a few consistent patterns occur in elevated CO_2. These include 1) reduction in stomatal conductance and density, 2) increase in water use efficiency, and 3) increase in plant biomass growth. The chapter by M. C. Fordham et al. presents a rigorous study using the transplant approach. The authors found that the faster growth of plants adapted to high CO_2 sites is strongly correlated with seed weights. Unfortunately, none of the chapters examines adaptation using genetic and/or evolutionary approaches.

Although several chapters describe the vegetation around CO_2-enriched springs, only F. Selvi addresses the question of whether or not elevated CO_2 would induce changes in plant community structure. Selvi's survey of herbaceous communities surrounding the gas vents of six springs in Italy showed