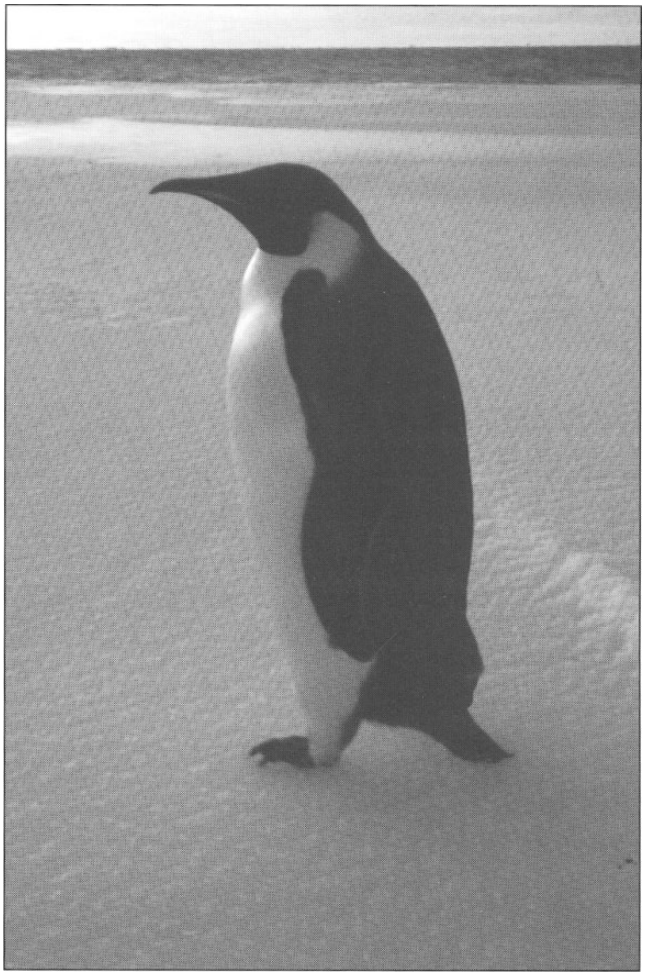
A lesson from the bottom of our planet

Antarctic Communities: Species, Structure and Survival. B. Battaglia, J. Valencia, and D. W. H. Walton, eds. Cambridge University Press, Cambridge, UK, 1997. 490 pp., illus. $150.00 (ISBN 0-521-48033-7 cloth).



This book is a compilation of 63 papers taken from the sixth biological symposium sponsored by the Scientific Committee on Antarctic Research (SCAR) held in Venice, Italy, from 30 May to 3 June 1994. SCAR symposia have been held approximately every four years since 1962. Each meeting stands as a major landmark in the development of biology in the Antarctic, summarizing current scientific preoccupations and setting goals for future international research efforts. This volume focuses on research at the community level.

To many, Antarctic science has long been viewed as being of only regional interest. Given the current state of global environmental issues, this idea is far from reality: Antarctica now contributes significantly to the investigation of global issues, resulting in major scientific advances. In particular, biological issues such as global warming and stratospheric ozone destruction have attracted top researchers from many countries to examine adaptive strategies of organisms that live in or are associated with Antarctica. Biological research in the area has also intensified due to increased fishing and tourism. Consequently, new research stations are being constructed, and research efforts by many nations are being intensified. For example, the National Science Foundation now funds two Long Term Ecological Research (LTER) sites on the continent, and the Italian government has established a new base in Terra Nova Bay.

When I first paged through this volume, I was skeptical that it would remain true to its stated community focus because of the wide range of its topics: from biodiversity to trophic flows, from ecophysiological strategies to the impacts of environmental change and to the effects of human disturbance in terrestrial, marine, and freshwater ecosystems of the Antarctic and Southern Ocean. After reading through the papers, however, I realized that my initial reaction was anything but correct. The editors have done a superb job of selecting relevant papers from the symposium and organizing them into coherent sections that address specific community properties.

The chapters, which cover all major biological habitats on the continent, are logically structured into six sections: "Biodiversity and Evolution," "Community Structure and Function," "Survival Mechanisms," "Adaptive Mechanisms," "Human Impact and Environmental Change," and "Postscript" (an overview of future research opportunities). The editors provide excellent introductions for each section that describe the importance of the topic as it relates to community ecology and summarize how the chapters address timely issues on both a regional and global basis.

The first section, "Biodiversity and Evolution," contains nine chapters covering the diversity of marine systems, lichens, mosses, fish, and prokaryotes. This section clearly shows that Antarctic biodiversity, both at the species and community levels, varies among locations and with the organisms involved. Techniques used to assess biodiversity in Antarctica combine traditional taxonomy, physiology, and molecular biology. These approaches, which together are necessary to solve many of the existing problems in taxonomy, also allow biologists to understand the functional role of biodiversity and may reveal new mechanisms of adaptation and evolution. Information on the biodiversity of Antarctic habitats is particularly important, given

the increasing anthropogenic impact now occurring on the continent.

I found chapter 8, on prokaryotic diversity, particular intriguing in its discussion of whether there are any true "Antarctic" prokaryotes. The authors—P. Franzmann, S. Dobson, P. Nichols, and T. McMeekin—use 16S rRNA genes as a molecular clock to show that the Antarctic species diverged from their nearest known non-Antarctic relatives long before Antarctica established a permanently cold environment. This conclusion, in concert with the fact that most Antarctic bacterial and cyanobacterial species do not function optimally at the temperature of the environment from which they were isolated (e.g., Tang et al. 1997), raises interesting questions about prokaryotic endemism that remain to be resolved. It would be interesting to couch current and future information about Antarctic biodiversity in the context of ecosystem reliability, where reliability refers to the probability that a system will provide a consistent level of performance over a given unit of time (Naeem and Li 1997). Within this concept, biodiversity may represent a form of biological insurance against the loss or poor performance of selected species.

The "Community Structure and Function" section, with 15 chapters, focuses almost entirely on aquatic systems, ranging from coastal waters to benthic shelf communities, tidal lagoons, and lakes. This focus presumably results from the lack of liquid water to support life in the terrestrial environment (Kennedy 1993). After reading this section, I was struck by the fact that the structure and function of pelagic and benthic marine habitats are far more complex than those of terrestrial and limnetic habitats, which contain fewer species. This disparity suggests that the relative stability of the marine environment, compared with the extreme seasonal changes in conditions experienced by terrestrial systems, has made the buffered aquatic system an easier place for communities to assemble and persist. As in chapters in other sections of the book, a number of techniques are used to assess community structure and function, ranging from photobiological traits to lipid signatures.

The nine chapters of the "Survival Mechanisms" section are particularly relevant to Antarctic research. Antarctica is the coldest and driest continent on the planet, to the extent that it as been used as an analogue in the search for life on other planetary bodies (McKay 1993). Organisms within various Antarctic habitats must be able to colonize, grow, and reproduce under freeze–thaw cycles, extreme seasonality in food supply, and desiccation. Each chapter in this section deals with the strategies that certain organisms use to persist under these environmental extremes. For example, the krill *Euphausia superba* harbors symbiotic bacteria in its gut that produce fatty acids used by the krill for routine metabolic maintenance; summer reserves of lipid are stored for later use in reproduction and molting. Consequently, the reproductive cycle of *E. superba* is independent of seasonal cycles of ice formation and food availability. This section also contains several fascinating chapters on the

production, genetics, and use of bloodborne antifreeze glycoproteins that allow fish to survive in −2 °C ocean water.

The "Adaptive Mechanisms" section (14 chapters) follows logically from the section on survival mechanisms. In the introduction to this section, the editors discuss the tautological implications of the statement "organisms survive because they are adapted." They qualify this statement by pointing out that "adaptation" is the ability of organisms to cope with environmental features and their changes; the greater the level of adaptation, the greater the potential to survive and reproduce. The chapters in this section make it clear that if there is a central theme of Antarctic biology, it concerns adaptive strategies. These chapters primarily use biochemical, physiological, and genetic techniques to examine how organisms cope with what appear to be inhospitable environments. Very different from the chapters on cellular responses to the environment is chapter 46, by J. M. Burns and J. W. Testa, which outlines the adaptive value of physiologically induced ontogenetic changes in the diving behavior of Weddell seal pups that are linked to the diel cycles and vertical migration of their prey.

I found the "Human Impact and Environmental Change" section (16 papers) to be the most intriguing section, perhaps because of the ambiguity in the results. It is clear that the world's environment is changing; the question now is: How much of that change is the result of human activities? Global change models predict further increases in global temperature, with polar regions expected to be most acutely affected. Anthropogenic depletion of Antarctic ozone is also an issue of global concern. Hence, Antarctic ecosystems and associated communities are perhaps the most sensitive indicators of environmental change on the planet. The chapters in this section use a wide variety of data sources to illustrate the historical variability of climate in both temperate and polar regions. Not surprisingly, conclusions from various sources used to estimate atmospheric warming are equivocal. For example, estimates of seawater paleotemperatures do not agree closely with those of atmospheric temperatures deduced from ice cores.

Another group of chapters in this section focuses on the effects of enhanced UV on various biological assemblages. Chapter 51, by H. Marchant, concludes that Antarctic birds and mammals are unlikely to be affected directly by enhanced UV-B, whereas terrestrial cryptogams and marine phytoplankton are likely to respond by producing protective pigments. Despite the production of protective pigments, the authors still conclude that primary productivity in the marginal ice zone is depressed by 6–12% during periods of high UV-B radiation. Interestingly, chapter 52, by O. Holm-Hansen, V. Villafañe, and W. Helbling, concludes that enhanced UV-B has not significantly affected primary production in Antarctic coastal waters, whereas UV-A has shown important inhibitory effects on photosynthesis. It is clear that conclusions of effects of enhanced UV radiation on Antarctic phytoplankton remain tentative.

The final group of chapters in this section addresses the impact of human presence on the environment. Given the fact that many of the landscapes in Antarctica have remained unchanged for millennia (Denton et al. 1993), even minimal human presence leaves its mark. This fact is exemplified by results from chapter 55, by J. Ellis-Evans, J. Laybourn-Parry, P. Bayliss, and S. Perriss, which shows that a research camp has significantly altered plankton communities in a nearby lake. Several other chapters point to the possibility of irreversible community change associated with the introduction of nonnative species to the Antarctic.

Without a doubt, scientists working on the biology of polar regions should have this book on their shelf. It will also be an invaluable reference for ecologists concerned with life in extreme environments, conservation biology, and global change biology. It is well organized and contains many examples of community interactions that can and should be applied on a global scale. The editors are to be applauded for their selection of chapters, which represent contributions from 15 countries and cover virtually all of the habitats supporting life on or associated with the Antarctic continent.

The volume clearly meets the goals of SCAR in defining the present state of science in Antarctica and producing intriguing routes for future research. For example, it is clear that a majority of research in Antarctica, both past and present, has focused on marine systems, with relatively little effort directed toward terrestrial habitats, particularly soils. The paucity of soils research may well be related to the relatively small proportion of exposed soils on the continent and surrounding islands, or perhaps to the difficulty of examining community interactions in such oligotrophic systems. Whatever the case, the ecology of Antarctic terrestrial ecosystems requires more study.

Despite the relative paucity of manuscripts on terrestrial systems, it is clear that community-level research is flourishing in Antarctica. Because high-latitude systems are extremely sensitive to global change, the data presented in this book provide a benchmark that can be used to gauge future ecological change in the Antarctic environment. Because Antarctic research is of such global importance, I believe we will continue to see inertia build in the Antarctic research programs of all nations already working there. These facts are clearly stated in the last section of the book, which summarizes the state of biological research in Antarctica (both politically and scientifically) and discusses potential future research opportunities. After reading this book, I find myself fully in agreement with the editors' final conclusion that Antarctic biology is "alive and well."

JOHN C. PRISCU
Department of Biology
Montana State University
Bozeman, MT 59717

References cited

Denton GH, Sugden DE, Marchant DR, Hall BL, Wilch TI. 1993. East Antarctic ice sheet sensitivity to Pliocene climatic change from a dry valleys perspective. Geografiska Annaler 75A: 155–204.

Kennedy AD. 1993. Water as a limiting factor in the Antarctgic terrestrial environment: A biogeographical synthesis. Arctic and Alpine Research 25: 308–315.

McKay CP. 1993. Relevance of Antarctic microbial ecosystems to exobiology. In Friedmann E, ed. Antarctic Microbiol-

ogy. New York: John Wiley & Sons.

Naeem S, Li S. 1997. Biodiversity enhances ecosystem reliability. Nature 390: 507–509.

Tang EPY, Tremblay R, Vincent WF. 1997. Cyanobacterial dominance of polar freshwater ecosystems: Are high-latitude mat-formers adapted to low temperature? Journal of Phycology 33: 171–181.

ALL ABOUT MOOSE

Ecology and Management of the North American Moose. Albert W. Franzmann and Charles C. Schwartz, eds. Smithsonian Institution Press, Washington, DC, 1998. 733 pp., illus. $59.95 (ISBN 1-56098-775-8 paper).

Few species of wildlife have held human fascination and interest quite as well as the moose. Historically, moose provided subsistence for Native Americans, and today they are an important game species prized by hunters for both meat and trophies. Considered by many people to be charismatic megafauna, moose can often be observed along roadsides or wetlands during visits to natural areas across much of North America. Game biologists have studied moose for many years in an attempt to understand their ecology and manage their populations. As a result, a considerable amount of information is available on their behavior, movements, survival, and habitat requirements. Although these studies have led to a solid understanding of the major factors affecting their populations, moose remain one of the most unique and interesting mammals known to us.

Ecology and Management of the North American Moose, edited by Albert W. Franzmann and Charles C. Schwartz, is a highly readable summary of the current state of knowledge of moose biology and management. The idea for the book originated from a discussion during the 1991 North American Moose Conference in Anchorage, Alaska, at which conference attendees overwhelmingly acknowledged the need for a comprehensive volume on this important species. The resulting publication is an ambitious endeavor involving the contributions of over 20 authors, many of whom have devoted a significant portion of their professional life to studying moose ecology. The book covers a voluminous literature base (i.e., more than 2500 citations) that includes both peer-reviewed and non–peer reviewed publications, and I know of few post-1970 references on moose that have been excluded. Appendices giving the common and scientific names of plants and animals cited, a list of contributors, and a detailed index supplement the information in the text. Most of the many diagrams and photographs are excellent and complement the text nicely.

The 19 chapters are organized into major topics reviewing aspects of moose ecology and management. The book begins with a historical and anthropological overview of the importance of moose to Native Americans and early European settlers, which also sets the stage for the next 13 chapters, on moose ecology. Two of these chapters, "Evolution and Taxonomy" and "Population Density and Trends," summarize information on the present and historical distribution and abundance of moose across the continent. The chapters