quencies of genes under selection in structured populations. Thus, the best way to break the back of the material is through participation in a reading group or seminar led by someone steeped in the conceptual foundations of the field and familiar with illustrative empirical examples. The mathematical tools needed to read this book are not beyond the basics of calculus and linear algebra, but the derived formulas presented throughout the text increasingly tax the ability of the noncognoscenti to conceptually interpret their meaning in the context of the common origins (coalescence) of genes found in different subgroups of the population.

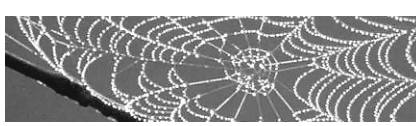
In concluding a short introductory chapter, Rousset advises the reader that "this book aims to show how a range of questions can be efficiently addressed using a limited number of concepts and technical tools, and to provide a self-contained account of the basic models of the genetic structure of populations"—an aim that is certainly fulfilled. He further advises that one can either read chapters 3 and 4, reviewing neutral theory of population structure, or jump straight from chapter 2, which covers the basics of influence of selection and drift on changes in allele frequencies from one generation to the next, to chapters 5 and beyond, where the real meat of the book resides.

Chapter 5, followed by the more technical chapter 6, signals the modernity of Rousset's approach by developing an excellent exposition of the dynamical concepts underpinning "evolutionarily stable strategy theory," an approach introduced by Maynard Smith and his collaborators in the 1970s. This modern treatment is continued in chapter 7, where the ideas of W. D. Hamilton on inclusive fitness, cooperation, and altruism are presented in the mathematical framework developed in the early chapters. Rousset takes considerable care in this chapter to clarify the essential differences between inclusive and direct fitness, as well as unify these two views of selection. Of particular note in this chapter is an insightful diagram (figure 7.2) that clarifies, in the context of Hamilton's famous identity of evolutionarily favored acts (involving costs, benefits, and relatedness of actors and recipients), when such acts should be interpreted as cooperation, altruism, spite, or selfishness.

The remaining four substantive chapters of the book deal with diploid and sex-structured populations (chapter 8), effective population size (chapter 9), and the generalization of the analysis to account for fluctuating (chapter 10) and class-structured (chapter 11) populations. A short chapter offering an overview and perspectives concludes the book.

In the final paragraph of the last chapter, Rousset raises the issue that a common problem in the field of population dynamics (from both an evolutionary and an ecological perspective) is how to make theoretical models simpler. The trap here is that, although we may find more effective ways to encapsulate our understanding of the commonalities of a broad spectrum of processes in relatively simple equations, the ideas behind those equations are neither simple nor easy to master. It takes about six years of slogging through mathematical physics to understand the real implications of the fundamental equations of physics so elegantly represented by a set of symbols that I have seen printed on a T-shirt. In the same way, Rousset has done a fine job of unifying seemingly disparate ideas in population genetics under the rubric of rather compact-looking "gene coalescence" equations. From his concluding statement, it is clear that Rousset would like to make his equations even more compact. But for most of us reading his book, our task is to master the concepts behind the elegant equations presented in Rousset's monograph, if we are to have any hope of keeping up with future developments in the field of mathematical population genetics.

WAYNE M GETZ
*Department of Environmental Science, Policy, and Management*
*University of California*
*Berkeley, CA 94720*



## AN ECOSYSTEM OF SUPERLATIVES

**Under Antarctic Ice: The Photographs of Norbert Wu.** Text by Jim Mastro, photographic notes by Norbert Wu. University of California Press, Berkeley, 2004. 176 pp., illus. $39.95 (ISBN 0520235045 cloth).

This book presents the reader with a view that few ever experience: the underwater world beneath the annual sea ice in McMurdo Sound, Antarctica. This view is presented through the lens of internationally renowned photographer Norbert Wu, who, under the auspices of the National Science Foundation (NSF), spent three years photographing the icy waters in the region. The book includes more than 100 full-color images that take the reader on a tour of the higher life forms and their sub-ice habitats in this unique ecosystem.

Wu also focuses his lens on the conditions that scientists and support staff have to face to work in one of the harshest environments on our planet. His remarkable images show the novel habitats frequented by tiny notothenioid fishes, which produce glycopeptide antifreeze molecules that inhibit the growth of ice crystals in the body; the graceful movement of penguins swimming under the ice; and minke whales trapped in ice-locked pools, to list just a few examples. Each individual image is accompanied by photographic notes by Wu that reveal his fascination with this underwater world, where visibility can reach 180 meters, and detail the obstacles that a photographer must endure to work in this environment. Wu graciously provides detailed descriptions of the equipment and printing processes that have yielded the one-of-a-kind images included in this book.

A real bonus is the narrative provided by Jim Mastro, who worked in Antarctica from 1982 to 1996, during which he served for five years as manager of the US scientific diving program for the NSF Office of Polar Programs. Mastro is a consummate science writer who has published feature articles in *International Wildlife* and is the author and photographer of *Antarctica: A Year at the Bottom of the World* (Boston: Little, Brown, 2002). Mastro's eloquent introductory text combines the history of exploration in this region with an overview of the history of Antarctica, bringing us to the icy continent we see today. With this backdrop, the reader is introduced to the physical and chemical differences that are present within McMurdo Sound, an arrangement that dovetails perfectly with Wu's photographs.

Beginning with Carsten Borchgrevink's 1899 winter expedition, and continuing through Robert F. Scott's unsuccessful attempts to reach the South Pole during his 1901 and 1910 expeditions and, later, Ernest Shackleton's 1914 voyage in the *Endurance,* the southernmost continent has lured explorers and scientists to its virgin land. The early explorers' diaries often depict Antarctica as a harsh, barren landscape devoid of life. I can attest to having had this feeling as a young scientist in the mid-1980s studying the microalgae living in sea ice in McMurdo Sound. While traveling by snowmobile to a dive site near Cape Evans, the site of Scott's 1910 base camp, I could not help but think how lifeless the place was. It was not until I squeezed into my dry suit, shimmied through a hole 1 meter in diameter, and drilled through sea ice 2 meters thick that I realized the environment under the ice offered a clement refuge from the dry, cold, and windy surface. My haunting memories of the stark surface environment were immediately left behind as I witnessed the biotic diversity and abundance offered by the colorful sub-ice world. The hazards of working in such an environment also became vividly clear as my air regulator froze shut during my ascent, forcing me to reach the surface on a final gasp of air.

The Antarctic continent itself covers more than 13 million square kilometers (roughly 1.5 times the size of the United States), and during winter, the sea ice surrounding the continent nearly doubles its extent. How did Antarctica become the icy continent we know today? A model of Earth some 250 million years ago would show the continent in the center of the vast supercontinent Pangaea. Major rifting events then occurred, fragmenting the supercontinent until Antarctica developed its present shape. The rifting opened seaways between major oceans and changed the ocean circulation around the Antarctic continent. Throughout this time, Antarctica remained in the low southern latitudes and has been in a near-polar position for about 100 million years.

Despite its near-polar position, Antarctica's climate was initially warm. Seas surrounding the continent at this time had bottom-water temperatures ranging from 12 to 16 degrees Celsius and supported a complex fauna typical of contemporary temperate oceans, while temperate vegetation flourished on land. These temperate climatic conditions ended dramatically when rifting opened crucial oceanic passages, including the Tasmanian Seaway and the Drake Passage.

This rifting combined with declining atmospheric carbon dioxide levels to trigger dramatic cooling and the onset of rapid glaciation. Continued cooling shifted eastern Antarctic into a state of permanent glaciation and allowed the growth of the more dynamic West Antarctic ice sheet. Despite several climate reversals since Antarctica became perennially glaciated, the present polar ocean surrounding the continent is Earth's most severely and consistently cold marine environment.

The marine species that are depicted so eloquently in Wu's book have been shaped by evolution driven by a long period of stable, low temperatures; they illustrate Jared Diamond's comment that "Unplanned natural experiments create ecological communities that we would have never dreamed of creating" (*Science* 294: 1848). Indeed, Darwin, if he could have peered beneath the Antarctic sea ice, would have found another powerful example of evolutionary divergence to support his theory of evolution. The rapid onset of extreme conditions in this isolated polar marine environment has clearly driven the rapid evolution of the species present, yielding a hotbed of evolutionary change in a cold portion of Earth.

Wu's photographs reveal vividly the contemporary result of evolution in a cold, insular environment. His images depict fish that, unique among vertebrates, lack red blood cells; microalgae that persist in brine channels within sea ice; fishes whose blood remains in the liquid state at subzero temperatures because of the presence of novel biological antifreeze proteins; giant jellyfish with tentacles 9 meters long; sea spiders the size of a human hand; and sponges that tower above the surface of the sediments.

Implicit in the images and accompanying text is the highly sensitive nature of sub-ice life to environmental change. Although highly adapted to the icy world, polar organisms are acutely sensitive to anthropogenic perturbation, such as the production of greenhouse gases and ozone-destroying chemicals. Human activities are already affecting polar ecosystems dramatically, and these effects are likely to increase in the future. This book provides important background to our understanding of the delicate life forms and behavioral patterns associated with Antarctic sea ice. The organisms pictured in the volume may well serve as "canaries in the coal mine" and provide warnings about the effects of climate change worldwide.

The fascination that polar ecosystems hold for scientists and nonscientists alike is not difficult to understand, given the key role of these ecosystems in many aspects of the Earth system. Though *Under Antarctic Ice: The Photographs of Norbert Wu* serves appropriately as a coffee table book, it goes well beyond this use. The informed reader should have no problem linking Jim Mastro's informative text with Wu's images to gain a scientific understanding of the complexity and sensitivity of the icy ecosystem depicted. After my initial reading of the book, I could not help but think of it as a beautifully illustrated introductory textbook on Antarctic nearshore marine life.

One final aspect that cannot be overlooked is the collection of photographic notes near the end of the volume. Any serious outdoor photographer can glean an enormous amount of information from the technical details Wu provides. Although the images alone are worth the cost of the book, there is also a plethora of information that will be of interest to the general public, to polar and nonpolar scientists, and to wildlife photographers. This book will remain a staple on my coffee table and on my scientific bookshelf for many years to come.

JOHN C. PRISCU
*Department of Land Resources and Environmental Sciences*
*Montana State University*
*Bozeman, MT 59717*

## SIMPLER, BUT STILL NOT SIMPLE

**Complex Worlds from Simpler Nervous Systems.** Frederick R. Prete, ed. MIT Press, Cambridge, MA, 2004. 436 pp., illus. $40.00 (ISBN 0262661748 paper).

Not many years ago I gave a talk to an audience, consisting largely of engineers, on what the field of neuroethology had to offer to their efforts to design "biologically inspired" computer chips. I introduced them to what is arguably the best-understood part of any nervous system on this planet, the crustacean stomatogastric ganglion (STG). I told them we had a complete wiring diagram for its 30-odd neurons, could record simultaneously from up to eight of these cells to describe their circuit interactions, knew all of the neurotransmitters and most of the neuromodulators they used, had constructed detailed biophysical models of the individual neurons, and were only now beginning to figure out how this circuit actually worked. But the jaw-dropping moment came when I told them that this level of knowledge had required an investment of something on the order of 1000 person-years, and that the behavior the STG produces is *movement of the animal's stomach.* Even the simplest neural systems have turned out to be dauntingly complex.

Against this sobering background comes *Complex Worlds from Simpler Nervous Systems.* In this volume, Frederick Prete (of Visuo Technologies) has assembled a collection of papers that look at how "simpler" organisms (grant-speak for "not a bird or mammal") construct their *Umwelt*—their self-world. We owe the word to Jakob von Uexküll, who emphasized that organisms construct their *Umwelt* through the interaction between their physical environment and their own behavior, sensory capabilities, and internal states. Prete's self-stated goal is to move away from the misconception that animals such as spiders, insects, and molluscs are simple reflex machines, and to appreciate the complex perceptual models they construct of their environments. While this is not a view that will surprise those who study the neural bases of behavior in these simpler systems, it is a case worth making. In particular, in an era of funding agencies focusing ever more tightly on a small number of model systems, it is good to be reminded of the advantages of diversity, and of curiosity-driven research.

After a typically delightful foreword by Mike Land, the book is organized into three sections: "Creating Visual Worlds: Using Abstract Representations and Algorithms" (four chapters), "Enhancing the Visual Basics: Using Color and Polarization" (five chapters), and "Out of Sight: Creating Extravisual Worlds" (two chapters). The reader will immediately note that this is very much a book about vision. This is not surprising, given Prete's research background in vision in mantises. However, it is unfortunate that there are no chapters on olfaction, particularly given the large number of active laboratories investigating problems in olfaction in nontraditional model systems, and the fact that so many animal behaviors are guided by olfaction rather than by vision.

Nonetheless, this is a highly readable and worthwhile book. Several chapters stand out both for the wonderful behaviors described and for their careful attention to detail. I was particularly impressed by Harland and Jackson's chapter on spider-hunting spiders of the genus *Portia.* These authors actually succeed in drawing the reader into the spider's *Umwelt.* Opening with descriptions of sophisticated and flexible hunting behavior that would be surprising enough coming from a primate, let alone an arthropod, they move on to a thorough description of the known sensory capabilities of these marvelous animals. They conclude with a laudable attempt at understanding how an organism integrates disparate sensory modalities into its own view of the world. This chapter alone is worth the price of the book, but I warn principal investigators that graduate students who read it will want to change their projects!

Equally impressive from the standpoint of cognitive abilities is visual pattern recognition and mazel earning in honeybees, reviewed by Zhang and Srinivasan. These authors thoroughly review the excellent work that has come out of their own laboratory, but I was a little disappointed to find, in a chapter on cognition in bees, so little mention of olfactory learning, particularly when this is an area in which researchers are beginning to understand the cellular mechanisms involved.

Perhaps the most ambitious chapter in the book is Comer and Leung's attempt to understand the integration of multimodal inputs in the escape systems of insects. In large part because of the wealth of information on escape circuitry in crickets and cockroaches, this chapter offered the most complete description of how an animal uses its *Umwelt* to direct its behavior.

The chapters on vision in bees (Chittka and Wells), butterflies (Arikawa and colleagues), and mantis shrimps (Cronin and Marshall) are all excellent critical reviews of the current state of knowledge, and would be a superb introduction for workers new to these fields, or for those looking to catch up on recent findings. I was also gratified to learn about an animal communication system I had never encountered before: auditory signaling in bladder grasshoppers (van Staaden and colleagues). Each of these chapters contains numerous suggestions for important work that needs to be done (i.e., good thesis topics).