Life in Harsh Habitats

Antarctic Microbiology. E. IMRE FRIEDMANN and ANNE B. THISTLE, Eds. Wiley-Liss, New York, 1993. x, 634 pp., illus. $165 or £136. Wiley Series in Ecological and Applied Microbiology.

To quote from the foreword to *Antarctic Microbiology*, "Why Antarctic microbiology? Why not African, Australian, or European microbiology?" Several reasons for focusing on the Antarctic environment become apparent to the reader of this volume. Perhaps foremost is the predominance of microbes, as opposed to macroflora or fauna, in Antarctic marine, freshwater, and terrestrial habitats. In both marine and terrestrial habitats, the bulk of Antarctic primary productivity can be attributed to microscopic cyanobacteria and microalgae. In Antarctic freshwater habitats, tiny rotifers can be the top carnivores in the aquatic food web. The paucity of animal species and higher land plants in Antarctic terrestrial habitats provides a sharp contrast to the abundant macroscopic biota found in temperate and tropical climes. *Antarctic Microbiology* explores the diversity, ecology, taxonomy, and biogeochemical activities of the life forms that dominate the biology of the southernmost province.

The various contributors to the book have attempted to provide an overview of Antarctic habitats and microbial communities. The volume presents recent research on open ocean marine systems, terrestrial dry valley habitats, and freshwater environments and includes coverage of phytoplankton, planktonic protozoa, bacteria, fungi, and lichens. Also discussed are the effects of prolonged Antarctic sojourns on human health and disease, as well as current regulatory efforts that aim to protect Antarctic biota from an increasing amount of human activity. Although like many multiauthored works *Antarctic Microbiology* suffers from some disjointedness and repetition, on the whole it maintains a reasonable balance between taxonomic, organismal, and ecosystems perspectives.

The bulk of biological activity in Antarctica is found in relatively productive marine waters. Karl's contribution provides a lucid introduction to microbial processes of the southern oceans as well as their regional geography and oceanography. Major environmental parameters, including constant low surface temperatures, relatively high macronutrient concentrations, and large seasonal fluctuations in solar energy input, distinguish the southern marine provinces from other oceanic regions. Microbial food webs and trophic processes in Antarctic seas may be more seasonally and spatially variable than those in temperate and tropical oceans. Karl investigates these and other topics through a series of case studies from various areas of the southern oceans. Field data and observations on spatial and temporal variability in microbial primary and secondary production are reconciled with emerging hypotheses that attempt to describe the influence of the unique marine environment of Antarctica on autochthonous microbial processes.

There are a number of unusual habitats and microbial communities peculiar to the Antarctic environment. Palmisano and Garrison provide a detailed description of the microbial assemblages inhabiting Antarctic sea ice. Vast areas of sea ice, either landfast or freely drifting pack ice, serve as a substrate for large populations of surface-associated microalgae. Colonization of the sea ice surfaces and their interior by such microalgae presumably initiates the development of diverse and complex microbial assemblages. The authors survey the taxonomy and functional attributes of ice-bound microbiota, their distribution in the ice, and their relative activities and physiological ecology. Nienow and Friedmann introduce the reader to endolithic (literally, "within rock") microbial communities, which exist in the dry valleys of the Ross Desert. Here, temperatures below freezing persist throughout the year, and the only form of precipitation is snow. The surfaces of rocks under such harsh conditions are abiotic, but in some areas intermittent solar heating of sandstones is sufficient to melt snow, which percolates into the rocks' interior. It is hidden beneath these rock surfaces, deep within the wet subsurface of sandstone, that active, photosynthetic-based microbial communities have evolved. The effects of climate and physical conditions, as well as the general biology, symbioses, and seasonality of endolithic microbial assemblages, provide valuable insight into adaptive evolution in one of the harshest environments on Earth. Other microbial habitats examined in the book include benthic marine sediments, terrestrial soils, and areas of elevated temperature adjacent to local volcanism.

The extremely cold and arid conditions of Antarctic deserts have led some researchers to compare these habitats to the environment that may have existed on Mars over 3.8 billion years ago. Thus Antarctic microbiological research, specifically that pertaining to cold, dry valleys and frozen lakes, has served as a model of sorts for exobiologists. In his contribution on the relevance of Antarctic microbial ecosystems to exobiology McKay puts forth some interesting hypotheses concerning the possibility of life on early Mars. It is difficult to predict in what directions research on Ant-

Vignettes: Academia

I look at the university as a workplace and I say what the *hell* kind of job is it, where someone with an excellent performance record . . . can be thrown out after seven years because they believe someone else will be even more excellent? And what the hell kind of workplace is it where this rhetoric of excellence, of distinction of brilliance is so ingrained that everyone assumes—at least, everyone who's signed onto the system—that we really are working in a meritocracy, with the *most* brilliant on top and so on down the ladder.

—*Lillian S. Robinson*, in *Working-Class Women in the Academy: Laborers in the Knowledge Factory* (University of Massachusetts Press)

Fundamentally, the American university thinks of itself as a knowledge factory. It was created to rationalize and systematize, in effect to industrialize, the pursuit of knowledge. . . .

As in many other heroic callings, in science and scholarship quite ordinary mortals could now perform work previously thought reserved to those of rare talent. Once one understands this, a great deal about the life of the contemporary university begins to make sense, though one is still slightly surprised to find that the average academic department has no more people of genuine intellectual zest and broad enthusiasm than one is apt to find at a convention of stockmen, charter fishing boat operators, city managers, or restaurateurs.

—*Charles W. Anderson*, in *Prescribing the Life of the Mind: An Essay on the Purpose of the University, the Aims of Liberal Education, the Competence of Citizens, and the Cultivation of Practical Reason* (University of Wisconsin Press)

arctic microbiology will go in the future. It is evident from this volume, however, that the application of new technologies to Antarctic microbiological research will yield even more novel and unanticipated discoveries.

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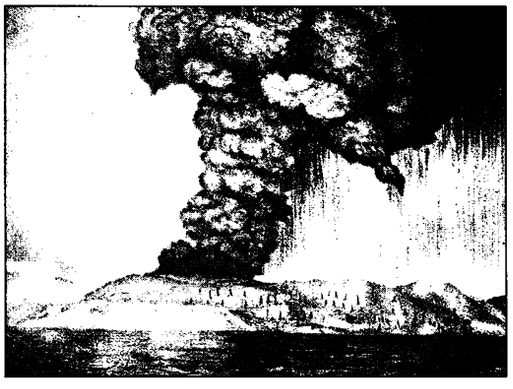
Recipes for Disaster

Volcanoes. A Planetary Perspective. PETER FRANCIS. Clarendon (Oxford University Press), New York, 1993. x, 443 pp., illus. $85 or £50; paper, $42.95 or £25.

Geology 101 instructors always look forward to their lectures on volcanoes. Even the most bored business or communications major becomes attentive when presented with films of molten lava or accounts of fatal eruptions. Similarly, authors of volcano books often have a relatively easy sell, as the normally jaded public snatches up almost any volume with glowing magma or towering ash columns on its cover. Peter Francis's 1976 book *Volcanoes* was one of the first such books targeted specifically to a popular audience. It went on to achieve considerable success, in part because of its accessible style, low price, and lack of competitors.



"Drawing from the Royal Society's report of the eruption on Krakatau [Indonesia], based on a photograph taken by a member of the last party to visit the island, on 27 May 1883. Stumps of trees are shown on the slopes. No photographs exist of the catastrophic phase of the eruption." [From *Volcanoes: A Planetary Perspective*]

Since then, volcanology has made tremendous advances. Exceptionally well documented eruptions at Mount St. Helens, Mauna Loa, Kilauea, and Etna have revealed much about the physical causes of volcanic activity. Equally fruitful has been a growing tendency for volcanologists to collaborate with physicists, engineers, and mathematicians. The Voyager and Magellan space missions returned images of bizarre volcanic features on the outer-planet satellites and Venus, greatly expanding our ideas of what constitutes "normal" eruptive behavior. Ambitious undersea exploration has mapped large stretches of the mid-ocean ridge system, site of the most extensive volcanism on Earth.

As a co-worker of many of the principal architects of these discoveries, Francis has been in a good position to provide an update of the situation. However, the popular niche his earlier book had filled is now occupied by several worthy successors. As a result, he set a more ambitious goal for *Volcanoes: A Planetary Perspective*—to give a general audience a pleasurable yet detailed review of what makes volcanoes tick. The final product leads the reader on a private field trip around the globe (and solar system), safely exploring volcanoes both notorious and obscure, active and dormant, explosive and effusive, subaerial and submarine. In the end we have a greater appreciation for the myriad ways in which volcanoes threaten society, and also for the challenges faced by researchers who have to recommend strategies to mitigate the effects of future eruptions.

Like many scientists, volcanologists infer general principles from case studies. They then use these principles to help diagnose exceedingly complex pathologies. Most volcanic models are based on a surprisingly small set of observations, so the need for practitioners to be familiar with as many known eruptions as possible is acute. For instance, the deadly class of explosions resulting in such well-known depressions as Long Valley in California and Yellowstone in Wyoming have never been witnessed. In the last dozen years, those two sites, plus highly populated calderas in Rabaul (Papua New Guinea) and Naples, have inflated with either new magma or exsolved gases, causing the ground to rise by as much as 2 meters and earthquake activity to increase dramatically. In all these cases catastrophe was averted as the craters subsided, but owing to our lack of direct experience with this type of eruption we can have little confidence that the danger has truly passed. Francis has worked on dozens of large calderas in the Andes, and his chapter on this topic clearly conveys their gigantic scale and potential for disaster.

Fifteen years ago, a similar state of ignorance existed for another perilous volcanic process—wholesale slumping of mountains to generate debris avalanches. However, in 1980 the violent collapse of Mount St. Helens graphically demonstrated both the dynamics of such events and the deposits they leave behind. Francis has devoted much of his recent career to studying these volcanic landslides. His chapter on "magic carpets and muck" details the controversies surrounding how these features travel unusually great distances (sometimes uphill), their fundamental role in creating the familiar shapes of many volcanoes, and their potential for generating catastrophic tsunamis, which may represent "the ultimate volcanic hazard."

Francis has written a highly personal discourse, focusing on those volcanoes and topics that most captivate him. As a result, even the nonspecialist reader will be left with the idea that volcanoes are not just somber subjects of news stories but also sources of intellectual challenge that call for multidisciplinary solutions. The book's subtitle is somewhat inaccurate. Most of the chapters have little reference to volcanoes on other planets, and the final chapter, "Extraterrestrial volcanism," although thorough, is one of the less innovative. A more appropriate subtitle might have been "A physical perspective," for it is Francis's subtle appreciation of how volcanoes work that really sets this book apart. His discussions of difficult topics ranging from lava rheology to explosive decompression to atmospheric circulation are refreshingly comprehensible. Nonetheless, readers lacking the equivalent of an introductory course in geology may stumble over much unfamiliar vocabulary.

The parts of the book that nongeologists may find most intriguing concern the difficulties posed by restive volcanoes that refuse to exhibit "normal" behavior. Pinatubo's giant outburst in 1991 stands as one of volcanology's triumphs: Tens of thousands of lives and billions of dollars worth of equipment were saved when evacuation recommendations were heeded. Similar suggestions about Nevado del Ruiz volcano made to Colombian officials in 1985 were ignored, leading directly to the deaths of 25,000 people. In these two cases the hazards could be delineated because patterns of seismic and gaseous precursors conformed to existing models. But what does one do when premonitory signals appear in populated areas for months or years without culmination? Such a quandary currently faces Italian volcanologists monitoring the resort island of Vulcano, where even a mild eruption during the summer tourist season would likely lead to over 10,000 deaths. Gas emissions suggesting the ascent of magma have increased rapidly in the last five years, but without a more dramatic manifestation, the local population has been unwilling to leave and political leaders have found little justification for ordering them to do so. In the end, finding ways to communicate with the public about such ambiguous signals is the greatest challenge facing volcanologists. *Volcanoes: A*