

The Biology of Polar Regions

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might be unwise to design a robot that could eventually undo even its initial “immutable” values and take on a new *summum bonum*, but this is not an engineering impossibility (Suber 2001). Perhaps the only way to make an accountable robot that could deserve punishment for its misdeeds and rewards for its heroics would be to give it the dangerous capacity to renounce the values we installed in it at birth.

McFarland has done his homework well; he offers a patient, sympathetic, and largely accurate discussion of philosophers’ best relevant work, plunging into the darkest thickets of controversy over supervenience, eliminativism, symbol grounding, higher-order thought theories, and the like. Some of his readings will jar the authors he discusses, who will think that they have been misunderstood to hold positions that had never occurred to them, but they will never find him sniping in standard philosophical fashion; if he misreads them, it is because his effort to find a constructive reading was too charitable by half. Philosophers are not always trying to do as much as scientists imagine.

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LIFE AT THE ENDS OF THE EARTH

The Biology of Polar Regions. 2nd ed. D. N. Thomas, G. E. Fogg, P. Convey, C. H. Fritsen, J.-M. Gili, R. Gradinger, J. Laybourn-Parry, K. Reid, and D. W. H. Walton. Oxford University Press, 2008. 416 pp., illus. \$60.00 (ISBN 9780199298136 paper).

As a scientist who has spent 25 years conducting research in polar regions, I was immediately drawn to *The Biology of Polar Regions* for several reasons: (a) The poles, particularly Antarctica, represent one of the last frontiers of exploration on our planet; (b) polar environments are highly sensitive barometers of climate change and can affect the entire Earth system as they respond to changing climate; and (c) this work continues the vision and style of the late G. E. Fogg, who was not only an eminent scientist but also a visionary able to view Earth in a completely holistic way. The first version of the book, published in 1998, was written by Fogg alone; for this second edition, it took eight authoritative authors—with expertise spanning topics such as marine biology, biological oceanography, sea ice, soils, limnology, climate change, and Antarctic conservation and policy—to update Fogg’s original version. Kudos to the present authors for maintaining Fogg’s original chapters 1 and 2 and the concluding chapter largely unchanged, paying tribute to his inquisitive pursuit of the nature of science and masterful synthesis of information across many disciplines.

Fogg’s first two chapters describe the basic physical and biological constraints on life in polar regions. The subsequent nine chapters are updated substantially to reflect the many new discoveries made over the past decade. I found the chapters on sea ice, marine benthos, and human impacts (particularly the review of polar politics) to be exceptional. Any student of the polar sciences must read

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these chapters. Difficult and often controversial topics such as photophysiology (chapter 2) and turbulence (chapter 3) provide the reader with a nice review of the processes before delving into their roles in polar environments. Each chapter typically ends with summary or conclusion sections, which could work well, but, unfortunately, several of these sections are not well developed. For example, the “wider perspectives” section of chapter 4 (“Glacial Habitats in Polar Regions”) hardly goes beyond the surface on the role of polar environments as analogs for life on other icy worlds. Only two references in this section were published after 2005, which does little justice to what we have learned about the icy systems of Mars, Europa, and Enceladus over the past five years. I think that many aspects of this chapter, and the book in general, are directly relevant to astrobiology and worthy of better coverage.

This edition of The Biology of Polar Regions packs a plethora of information. The authors’ detailed comparisons of Arctic and Antarctic habitats generate a breadth of coverage that few books on polar environments offer.

I was also left wondering to what degree the data presented in many of the chapters have changed over the past five years as the result of climate change. This is particularly relevant to the descriptions of species within Arctic terrestrial and marine systems, which are clearly in a state of transition. For example, are the depth profiles, species lists, and food-chain depictions in chapter 5 (“Inland Waters in Polar Regions”) and chapter 6 (“Open Oceans in Polar Regions”) representative of the present situation? Current literature indicates that these relationships have changed or are in the process of changing rapidly. Although the authors do devote chapter 10 to describing the influence of climate change on many levels of polar ecosystems, and even include a section on

mechanisms of colonization and biological invasion in view of a changing climate, readers who direct their attention to only selected chapters would benefit from the inclusion of the specific state of the environment, given the rapid changes in climate in polar regions.

The tables and graphs, and the combination of black-and-white and color images, in this version of *The Biology of Polar Regions* offer a reprieve from the limited black-and-white illustrations in Fogg's original volume. This artwork makes the entire book more accessible and informative.

I did find a number of disturbing typographical and spelling errors (e.g., on p. 14, "12m thick pack ice" should presumably be "1.2m thick pack ice," and the lack of superscripts in table 7.1 is inexcusable). These mistakes detract from the plethora of information contained in the book and may mislead the unwary reader. I also take issue with several statements in the book. The first is in the preface: "Compared with communities of temperate and tropical regions, those in polar habitats are of recent origin and, as a result, relatively simple with few species." This concept is very deceptive. The prokaryotic assemblages in coastal seas, lakes, and subglacial environments are often every bit as diverse as those in temperate and tropical marine and freshwater environments. Moreover, many of these organisms are in the domain Archaea, and arguably not of recent origin. Finally, polar communities are anything but simple, particularly at the microbial level. The complexities imposed on them by bimodal light cycles, continuous low temperatures, and often repeated freeze-thaw cycles lead to intricacy that we may not understand for decades. I also found the following statement in chapter 8 ("Marine Benthos in Polar Regions") to be dubious: "The littoral zone consequently supports no active life in winter." Surely bacteria survive in this environment! This assertion was especially disturbing coming after the emphatic statements in the preface about the ubiquity of the microbial world, especially bacteria and archaea.

The last chapter holds two particularly strong components of this volume: "Further Reading and Web Resources" and the extensive reference list itself. About 20 percent of the almost 600 citations in the reference list were published after 2005, which is commendable, given the historical nature of many of the chapters. The Web sites provide links to most of the major polar research programs as well as to sites on polar conservation and policy. This excellent compilation of references alone makes this book an invaluable source of information.

Moreover, this edition of *The Biology of Polar Regions* packs a plethora of information. The authors' detailed comparisons of Arctic and Antarctic habitats generate a breadth of coverage that few books on polar environments offer. Despite the book's minor idiosyncrasies, it was enjoyable to read, and it's a superb starting point for those in search of information on virtually all topics in polar biology. Like other volumes in Oxford's *Biology of Habitats* series, *The Biology of Polar Regions* should be on the shelf of students studying biological or environmental science, those beginning independent research, and professional biologists embarking on research in a new habitat. Astrobiologists who use life at Earth's poles as an analog for the habitability of other icy worlds also will find this book to be a useful tool.

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Photograph: Steve Hillebrand, USFWS.

MOLECULES, MUD, MOON ROCKS, AND MICROBES

Echoes of Life: What Fossil Molecules Reveal about Earth History. Susan M. Gaines, Geoffrey Eglinton, and Jürgen Rullkötter. Oxford University Press, 2008. 376 pp., illus. \$35.00 (ISBN 9780195176193 cloth).

In her first book, *Carbon Dreams* (2001), Susan Gaines combined fact and fiction to depict the life and struggles of a female geochemist as her career developed. The book portrayed the scientific world in both positive and negative ways by highlighting the passion that scientists have for their research, the difficulties and frustrations of finding funding, and the politics of scientific discovery. In her second book, *Echoes of Life*, with coauthors Geoffrey Eglinton and Jürgen Rullkötter, Gaines once again explores the trials and tribulations of scientific discovery, but this time the story is nonfiction, and the real-world context is the inception and growth of biomarker research and geochemistry.

The science of biomarkers evolved while oil exploration was in high gear, the oceans depths were being scoured, and interplanetary dust and moon rocks were a vast mystery. Throughout *Echoes of Life*, the science and the politics of research, as well as the collaborations and rivalries of researchers, are carefully portrayed. For example, the chapter "From the Moon to Mars" recounts how researchers receiving bits of the moon from NASA's Project Apollo—and there were many of them—had to swear to secrecy about their results until 5 January 1970 (the first day of a NASA-convened Lunar Science Conference). The book also discusses the interest of oil companies and government agencies, in the United States and abroad, in funding biomarker research. Given recent negative social, economic, and political attitudes toward fossil fuels and oil companies, readers will be fascinated by the

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