Life in Ancient Ice

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Book Reviews

PERSPECTIVES POUR UNE GÉOBIOLOGIE DES MONTAGNES. By Paul Ozenda. Lausanne, Switzerland: Presses Polytechniques et Universitaires Romandes, 2002. 195 pp. €37.40. ISBN 2880744938.

This is a curious little book, and is rather unclassifiable in today's diversified fields of environmental sciences. The book is worthwhile for the useful compiled historical information and ideas that it presents, but is also highly frustrating in form and substance, even for a French reader. Indeed, the primary drawback for many non-French readers will be that the text is primarily in French. Only short, albeit informative, abstracts in English are found at the beginning of each chapter.

The author, Professor Paul Ozenda, now retired, had a distinguished and productive career as a geobotanist, for lack of a better word, spanning over half of the twentieth century. He was a pioneer and leader in the disciplines of plant and vegetation ecology in Europe during that period. It is remarkable that, at an age when some North American ecologists might be content to play golf, Professor Ozenda still exhibits knowledge of and passion for his profession. Indeed, the book is a largely personal reflection on the vast field of mountain biogeography and ecology, in the widest sense of these two terms.

The contributions of this book that may be of interest to today's practitioners fall into three broad categories. First, the book describes the historical development of a particular approach to the study of mountains, their environment, biology, and ecology, which was highly successful and widespread during the past century. It is extremely advantageous to recognize how past advances in this area have led to contemporary approaches to scientific issues. Second, it contains useful information (interpretations, data, maps, citations) that a younger generation of scientists not taught in the fields covered may find difficult to access elsewhere, since many aspects of these materials are no longer part of modern curricula. Third, it contains ideas and concepts that are of use during the present period of large-scale production of maps, monitoring schemes, and interdisciplinary approaches to ecological issues. In essence, the book makes us aware that there is nothing really new in our self-described innovative approaches to ecology and that, successful or not, our predecessors also considered that only integration and synthesis would yield full knowledge and understanding of mountain ecosystems at multiple spatial and temporal scales.

Unfortunately, the book suffers from serious weaknesses. Many portions of the text contain arcane jargon that few modern students of the field will feel enthusiastic about and that, in this reviewer's opinion, has lost its interest and relevance. This is regrettable because the concepts hidden behind the jargon can be interesting and relevant. Furthermore, the author compounds this problem by lengthy discussions of issues that, again in this reviewer's opinion, can be perceived as sterile refinements of obsolete systems of ideas. This is even more unfortunate, because buried under rather unexciting discussions in what seems to be a foreign language (no pun intended), some significant problems are explored: the distributions of species in response to large geologic phenomena, climatic variability over large areas and multiple temporal scales, and the potential responses of mountain ecosystems to climatic and land use changes, among other topics.

The book is well organized to achieve objectives that are clearly formulated in the "Avant-propos" or preamble (pp. V–VII). The ten chapters are articulated in three parts. The first part (chapters 1–3) defines the object of the book, i.e., the mountain systems, their spatial scales, their geographic distributions, and climatic complexity. It also includes a short discussion of the alpine-subalpine ecotone. The second part (chapters 4–6) tackles different dimensions of biodiversity in mountains with a special focus on species richness and within-community diversity. The third part (chapters 7–10) attempts a synthesis through integration to explain the vegetation and its floristic composition in mountain systems all over the world. The author presents a conceptual model of vegetation distributions for the European Alps and endeavors to expand it to the rest of the world. This attempt exemplifies both the contributions and weaknesses noted earlier. On one hand, a tremendous amount of useful information is presented. On the other hand, the lengthy discussion of obscure systems of classification borders on the tedious and the frivolous. The book would have benefited from de-emphasizing the typology of mountain systems and expanding the section on the dynamics of vegetation patterns.

In summary, this is a really difficult book to review fairly. As the reflection of a European scientist who has contributed to his field of study, it has noteworthy dimensions, especially for students of the Alps. It can be used today to provide background information on integrated mountain ecology. However, it is of limited use for generating new ideas. The choice of citations limits its value as a reference book. For example, this reviewer does not understand the rationale for excluding major North American references on the topic (e.g., Daubenmire, Billings, Peet) while other less relevant references are included. This is also true for the omission of important European references. Still, this book provides some remarkable insights into past work that has influenced the field during the mid-twentieth century.

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ANTARCTIC MARINE PROTISTS. Edited by Fiona J. Scott and Harvey J. Marchant. Canberra: Australian Biological Resources Study, 2005. 563 pp. AUS $95.00. ISBN 0-642-56835-9.

The stated aim of this book is to "... provide an illustrated description for each formally described species of Antarctic marine protist." Over 500 species are described and illustrated with over 1300 light and electron micrographs and drawings. Each description includes detailed morphology, distribution, and references. The practice of illustrating every species sets this book apart from other guides like *The Illustrated Guide to the Protozoa, second edition* (edited by John J Lee, Gordon F. Leedale, and Phyllis Bradbury; Society of Protozoologists, 2000). The pictures are large enough to be useful in identification work. The book was originally conceived as an in-house handbook for the editors' studies on phytoplankton, but fortunately they were encouraged to broaden that concept. The editors must be incredibly knowledgeable and hard-working; they are authors or co-authors of 13 of 15 chapters in the book.

Of the book's nearly 600 pages, one-third is required for diatoms and another fifth for ciliates. The book has a helpful glossary and a wonderful bibliography with over a thousand entries, worth the price by itself.

The title is misleading. The book is not about marine protists; it is about *pelagic* protists, those that are captured by filtering seawater.

1523-0430/06 $7.00

Benthic protists are not represented in this book even though many benthic organisms become pelagic during part of their life cycle or because of physical disruption. In this regard, it seems odd to have a book about marine protists that includes only one foraminiferan, especially since they are so important in the ecology of Antarctic coasts.

But why "protist" anyway? The term is used today to refer non-specifically to single-celled eukaryotes, but it no longer has a place in the evolutionary tree of life—the organisms we call "protists" belong to all eight families of eukaryotes in the current family tree. And the editors include *Synechoccus*, a cyanobacterium, which is a prokaryote and not a protist in any classification. So why not at least include all marine protists?

In many ways, I am the intended consumer of this book. For the past year I have been identifying organisms found in Antarctic near-shore waters as part of a larger study of the benthos using a cabled observatory. This has not been easy because I am not a specialist and there is no single source of information for identifying Antarctic organisms. I have had to work from general texts, papers on specific organisms, and web sites that have identifying pictures. I really need a field guide to Antarctic marine organisms, but this book is not that.

Allow me to illustrate my problem. At our study site, there suddenly appeared some strange, dark green, spiky, hemispherical organisms, 200 μm in diameter. I searched to figure out what they might be, but could not find descriptions or pictures of these organisms. They are not to be found in this book either, because they turn out to be sponges, and sponges are clearly not protists. Nonetheless, they are small organisms found in Antarctic waters, and though mostly benthic, at least some of their life is obviously pelagic and in any case I had to identify them.

The next problem is the normal practice of illustrating species by family. There are no Peterson-Guide-like illustrations to guide a non-expert to the right family. More problematic is uneven acknowledgment of the limits of the known. Again, let me give an example. The Haptophyta are divided into two chapters (with different authors): the Prymnesiales and the Coccolithophorales. When I received the book I turned first to the latter hoping both to identify the coccolithophores found at our site and to see beautiful pictures. In particular, I wanted to identify the spectacular coccolithophores of genus *Umbelloshphaera* that have trumpet-shaped scales. The book has only one SEM micrograph of an umbelloshphaeran, from the EMIDAS web site, and it is different than the ones at our research site. The authors state of coccolithophores, "Until recently, many species remained undiscovered owing to their small size and delicate structure." Indeed, many remain. On the other hand, in the other chapter, the description of *Phaeocystis antarctica* (sometimes the most abundant pelagic phytoplankton species) includes helpful discussion about unknowns about its life cycle and morphology. These authors acknowledge the unknown: "... a number of *Chrysochromulina*-like scales are included here to alert readers to possible new taxa."

Finally, I have concerns about the production of the book. This is a reference tool that will be thumbed through. I worry about the binding; my copy is already showing wear. And though it does not affect the book's usefulness for identification purposes, the printing of many micrographs could have been better. The contrast is weak, and the black background is gray. What should be spectacular pictures of beautiful organisms come off looking dull. Nonetheless, I caution buyers against letting their copy fall into the hands of the theocrats of "Intelligent Design." The diatoms and dinoflagellates look very machined.

It seems churlish to criticize such a useful book. I am in awe of the authors' accomplishments; on my own I have been able to identify only a few dozen organisms. For investigators trying to identify pelagic Antarctic protists, it is indispensable. But, like so much of Antarctic science, after considerable effort, this book is still only a glimpse into the unknown.

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LIFE IN ANCIENT ICE. Edited by John D. Castello and Scott O. Rogers. Princeton, New Jersey: Princeton University Press, 2005. 336 pp. $69.50. ISBN 0691074755.

This book might well have been titled *Life in Ancient Ice!* because it reports the unexpected finding that all the ice realms, polar, glacial, and permafrost, are part of the biosphere. Since more than 80% of the earth's surface (including oceans) is permanently cold (<5°C), this represents an important expansion of our understanding of life on earth.

The book results from a symposium in 2001 organized by the editors and sponsored by the National Science Foundation. The 20 chapters in the book are, presumably, edited versions of papers presented at that symposium. Each chapter reports the methods and findings of an investigation into the presence and viability of viruses, prokaryotes, or eukaryotes (diatoms, yeast, fungi) from a particular icy environment. Protocols are described in sufficient detail to allow evaluation and emulation. The chapter on human viruses presents no empirical data (but does include the interesting idea that it may be possible to isolate the virus that caused the 1918 Spanish Flu from frozen victims of the pandemic). Six of the chapters are by Russian investigators, and these chapters have valuable references to work published in Russian journals. One chapter is a report of an attempt to design a new tool for *in situ* identification of living organisms using auto-fluorescence signals. The first and last chapters are by the editors, and they do a superb job of laying out the significance of these investigations and raising important procedural questions. Like all organizers, they lay large claims for the importance of this work, but they are also scrupulously honest about the need for replicative experiments before accepting initial results: "This is an immediate need that must be met by those of us working in this field of science. This is an important priority because unless it is accomplished we risk disbelief by the general scientific community" (p. 290). In the last chapter, the editors make recommendations on how to address that need.

This book might also have been titled *Life in Ancient Ice?* because considerable skepticism is to be expected about the extraordinary claims presented: Cyanobacterial doubling time of nine years (Lake Bonney, Antarctic Dry Valleys)? Viable bacteria, not in a frozen resting state, from three million-year-old permafrost (Kolyma tundra, Siberia)? Human viral pathogens released from ancient ice by global warming?

Foremost, there are procedural questions about the various decontamination protocols utilized. Each author presents data about the efficacy of their protocols, but that data needs scrutiny. And contamination is only one barrier to replication, as the excellent chapter on studies of the Lake Vostok ice core points out: "... the apparent inability to precisely replicate the findings of other laboratories ..." has "... many possible reasons, none of which is mutually exclusive" (p. 257). Then there are basic questions in biology that need addressing. As the editors point out, the question of microbial metabolism in ice *in situ* must be resolved: "Are some microorganisms immured in ice for millennia able to maintain viability, and if so what are the mechanisms involved?" (p. 298). And so far, "No one has yet carried out a thorough study of the depth dependence of types of microbes, or of the fractions

that are metabolizing, dormant, or dead" (p. 268). How stable is DNA over millennia?

There is also unfamiliar physics to ponder, including evidence for microscopic layers of liquid water around ice inclusions, and little-understood biological phenomena to consider, including symbiotic effects in biological aggregations. And then there is the meaning of the word "Life" in the title. As usually applied, the term refers to organisms carrying out normal life processes in a selected ecological niche. But several chapters make clear that birds or wind deposited the organisms found in the ice. Rather than "living" in ice, they are preserved there—which has different implications.

Finally, there are questions of scientific validity. What are we to make of a study on yeasts in ancient permafrost that isolates viable organisms from only two of seven samples, one 3 million years old (p. 120)? How can that be compared statistically to the finding that "... viable fungi have been recovered from all (glacial) ice subcores examined to date, including ice from both Antarctica and Greenland" (p. 162)? One chapter states in its introduction: "We hypothesize that the worldwide distribution of the yeasts may be influenced by ablation of glacial ice" (p. 181). But the finding of yeast in ice reported in this chapter does not of itself establish this hypothesis. In the immediately preceding sentence in the introduction these investigators point out: "These organisms are ubiquitous on leaf surfaces, they commonly occur in soils; fresh, estuarine, and marine waters; indoor and outdoor air; and clouds and fog." So why would not the worldwide distribution be driven in the opposite direction, into the ice?

Taking a clue from the jacket cover photograph of a scientist climbing an ice cliff, perhaps this book could have been titled *Life **on** Ancient Ice*, in this case "Life" referring to the scientists who are attempting to unlock a new paradigm. It is this aspect of the book that is most fascinating to me, and most problematic. My academic position is in a teaching college where I challenge first-year biology majors to define "life." This book would be a useful tool in complicating my students' assignment. But, because this book is a compilation of research papers, it would be difficult reading for an undergraduate. In fact, because the investigations use the full range of modern technology, including molecular, optical, and chemical methods, the book is difficult reading for anyone. And although the editors apparently made a sincere effort to produce a useful book, the diversity of tools utilized in these investigations means figures require extensive study, and minor editorial lapses make understanding difficult. A diagram (Fig. 7.1) of methane and nitrite content in a cross section of Late Cenozoic permafrost has the x-axis labeled "H(m)," which I think means "Horizon in meters," but I cannot be sure. Fig. 4.1 is a "plot of the inverse of the square root of the generation time versus temperature" for Antarctic sea ice bacteria compared to "the predicted value for the entire biokinetic temperature range and determined from fitting the Ratkowsky (square root) growth rate model to the experimental data." I puzzled over this diagram a long time; presumably investigators in the field know why this information is presented in this manner. (Curiously, in my copy, one line of the caption of this figure is printed in a smaller font than the rest of the book.)

Clearly, the book was not produced for a general audience. However, both a general audience and a professional audience would undoubtedly have enjoyed at least a summary of the questions and answers that must have followed each presentation at the symposium. And I suspect that discussions between formal sessions produced even more interesting ideas and speculations. None of this is reported. But these are minor quibbles that are elicited only because the topic is so fascinating and the book so important. Two compelling reasons why progress in this field matters are: (1) these studies are required to guide the search for extraterrestrial life because conditions on Mars and Europa are icy, and (2) "... *in situ* biological alteration of gases and ions may skew paleoclimatic interpretations of ice core records" (p. 236).

This book documents how far the study of life in ice has advanced in the decade since Abyzov's chapter on microorganisms in the Antarctic ice in the 1993 book *Antarctic Microbiology* (edited by E. Imre Friedmann, Wiley-Liss, 1993). As the new field of study of life in extreme conditions continues to expand, this book will be a constant reference. Someday it will be seen to have been seminal.

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GLACIERS. SECOND EDITION. By Michael Hambrey and Jürg Alean. Cambridge, U.K., and New York: Cambridge University Press, 2004. 394 pp. $60.00. ISBN 0521828082.

The second edition, like its predecessor, describes glaciers from a broad perspective. The authors discuss not only glaciers past and present, but their effects on the landscape and their relation to man's activities. The book is written for the non-specialist, but both specialist and non-specialist will be impressed by the astonishing collection of photographs on almost every page, and their wide geographic coverage. The specialist will also enjoy the review of the broader field into which his specialty fits, and in the process may be stimulated to think about fundamental issues. For example, we are told that retreating glaciers tend to have low-angle snouts, which is true. But how well do we really understand the underlying physics?

The book is an expanded and updated version of the first edition, and has mostly new photographs. The first half contains what might be considered a descriptive and unusually well-illustrated version of the conventional material covered by a course in glaciology, telling us "how glaciers work." It is followed by chapters dedicated to Antarctica (not Greenland) and volcanoes. Then come chapters dealing with such topics as glaciers and landscape development, wildlife, benefits and hazards, glacial changes on time scales of a few years to a few million years, and climate and sea level change. The book concludes with a provocative discussion of the future of glaciers, the role of mankind in shaping that future, and the implications for living conditions on earth.

The reader will be pleased to find writing that is clear and entertaining. In a book with wide coverage but finite length, the authors have had to make decisions about allocation of space. Whether the choices are optimum is a matter of opinion, but I felt that the balance was excellent. Of course, one can always think of improvements in such a comprehensive work. For example, there is discussion about how the size and shape of a glacier affects the time scale for response to climate (a popular topic in specialists' circles), but no parallel discussion about the amplitude of the response. By demonstrating how a small change in the equilibrium line altitude (ELA) of a low-slope glacier can remove most of the accumulation area, it would be easy to show how the geometric factors which determine the time scale tend also to determine the amplitude. A long flat glacier may have a longer "time scale" for response to climate than a short steep one, but the ultimate response, at least to a permanent change, will be much larger.

Also, but through no fault of its own, the book follows some bad habits common among specialists. For example, given the rapidity with which glaciers change, we should get into the habit of dating all glacier photos when we publish them; in the case of this book, potential research value would be added to an excellent photo collection. We should not say "meltwater" when we mean "water" in general. We should make a more careful distinction between glacier "advance" and "motion." Finally, it could be argued that we should not say "sliding"

when we mean "basal motion," which includes deformation of subglacial sediments. Admittedly the non-specialist (or even the specialist) reader will be unaware of most of these distinctions, perhaps rightly so.

In an endnote, the authors tell us that although they have tried to explain how glaciers work, "... first and foremost [they] have tried to convey the beauty and fascination of glaciers." In my opinion they have succeeded at both. They have produced a significant and enjoyable book that merits the wide audience at which it is aimed.

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