# The Biology of Alpine Habitats

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book he is curiously restrained. One chapter, however, titled "Getting Up to Speed," is subtitled "Leaping, Launching and Lurching." This lovely chapter is about biological projectiles: spores, seeds, fleas, and even kangaroos. Here Vogel relates acceleration to the size of the projectile: Mulberry pollen is shot out with an acceleration of nearly one million times that of gravity (g), whereas a kangaroo achieves only 6.7 g of acceleration. He then goes on to discuss the limitations of muscle as a source of mechanical work and power, and the widespread use of elastic materials to store muscle energy in jumping insects, showing that these are far less regularly used by mammals. The real winners in the ballistics record book are plants and fungi, which eject seeds or spores by wonderful osmotic engines in reproduction-bound self-destructive devices, but these single-shot mechanisms are too diverse to detail here.

One area of interest to Vogel's mentor Schmidt Nielsen was the thermal relations of organisms in their environments. On this topic, not surprisingly, Vogel starts with a comparatively conventional look at the ways by which heat is transferred—some very familiar to biologists (and in everyday life), such as radiation and convection—but he moves on to surprising areas such as infrared radiation from seaweeds into the sky. He explores how animals can adjust their rates of heat transfer by balancing internal forced convection using the blood system with natural convection or conduction at the body surface. (A nice example is the seaweed-munching Galápagos iguana, which balances solar heating while on land with conductive and convective cooling while foraging underwater.)

On the topics of water and water-based biological fluids, such as sap or blood, the reader finds studies of the effects of ice crystals on cells and on biological antifreezes, as well as the effects of temperature and solutes such as salt on the amount of gas that dissolves in water. There is a delightful account of how water can be condensed from seemingly arid desert sand and how a similar process might be exploited by a desert-living tunnel spider. And then there is a discussion of cryptobiosis: Life without water as a trick for survival in one sort of extreme environment. I could go on, picking out more plums from a rich pie, but I shall leave the rest for the reader to find.

*Glimpses of Creatures in Their Physical Worlds* does not profess to have a "target"; rather, Vogel looks at a particular area of physics or mechanics and wonders (or is it wanders?) on paper whither it will lead. The wandering often goes in unexpected directions, such as the observation that it is rare to find gliding seeds that weigh less than one gram, or the trajectories of fungal spores, or that there are both mechanical and fluid-dynamic constraints on the height of trees.

Vogel also has a liking for dimensionless numbers. Some of these are familiar: the Reynolds number and its use in describing the relative importance of viscous and inertial effects in fluid dynamics; and the Froude number describing the relationhip between size, velocity, and the acceleration due to gravity in the walk-to-gallop transitions in quadrupeds. Others, such as the Péclet number, describing the relationship between velocity and distance on the rate of diffusion in a system, or the Grashof number, describing the intensity of free convection, are less familiar. I did sometimes find myself wondering about the importance of a particular number and seeking an everyday explanation of its relevance. And yet curious omissions exist, such as the Strouhal number, which describes the relationship between size, velocity, and the frequency of vortex shedding in, for example, fish swimming, but this is an area into which Vogel does not enter in this book.

The bibliography is commendable for three reasons: First, it covers 24 pages and lists some 500 references; second, it extends from the early 19th century (amusingly including the overture to Rossini's opera *William Tell*) up to 2008; and third—and I wish more authors did this—it provides the pages on which the reference is cited in the text. There is also a list of the symbols used in the text—vital both as a space saver and as a ready cross-reference.

Overall, I found *Glimpses of Creatures in Their Physical Worlds* to be rather less accessible than some of Vogel's earlier, and more popular, books. I think this is because of the welter of equations that require serious concentration and are sometimes unsupported by examples. As ever, Vogel is inspiring and his insights are remarkable—but this time it's harder work.

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## LIFE AT ALTITUDE

**The Biology of Alpine Habitats.** Laszlo Nagy and Georg Grabherr. Oxford University Press. 2009. 376 pp. $125.00 hardback, $55.00 paperback.

This book, *The Biology of Alpine Habitats*, is the 14th in the series *The Biology of Habitats* (excluding four second editions), published by Oxford University Press with the goal of "providing an integrated overview of the design, physiology, and ecology of the biota, set in the context of the physical environment." The series is aimed mainly at senior undergraduates and graduates taking courses in ecology or environmental science, as well as interested professionals. The authors, Laszlo Nagy and Georg Grabherr, both of the Department of Conservation Biology of the University of Vienna,

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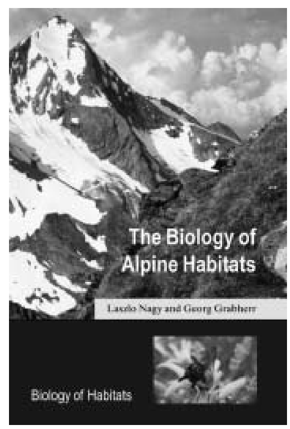
are experts in vegetation science with much research experience in alpine environments.

The book highlights the uniqueness of alpine habitats with an example from South America: Along a longitudinal gradient of 30 kilometers there is a 0.2 degrees Celsius (°C) variation in air temperature, but along an elevational gradient of approximately 5000 meters there is a 29°C variation in air temperature. The book undertakes a comprehensive integration and synthesis of a variety of topics to provide an overview that recognizes the physical environment as the main template driving the biology in these areas. The authors' approach benefits from an in-depth focus on the functioning of alpine ecosystems and not just on community assemblage and adaptations. This attention to function is important for understanding the major variables driving these systems. The book is divided into 10 main chapters plus a chapter of concluding remarks.

The authors give excellent coverage of the variables (in particular landforms, hydrology, and soils) that create alpine habitats. There is a particularly good section on soil formation and soil types in relation to their worldwide spatial and temporal distribution, including the importance of cryoturbation in soil formation. Chapter 6 attempts to elucidate common themes and features of alpine ecosystems worldwide, highlighting the specializations of the communities and assemblages found in such ecosystems.

Chapter 8 examines the historical and contemporary biogeography, adaptations, and evolution of alpine organisms to explain the extent of their ranges and their relationship to climatic zones. It is evident that there is a relatively high abundance of endemic species in most alpine faunas—for example, there are 400 in the European Alps, and the Himalayas have the highest overall percentage at 50 percent. The authors express caution about applying island biogeography theory to alpine habitats, noting that the typical relationship between species diversity and area frequently does not hold there. This point is illustrated by the contemporarious alpine fauna of Scotland, where species richness has remained roughly constant since the last major ice age despite a significant reduction in land surface area. This maintenance of diversity is a result of the ability of alpine faunas to colonize and survive by evolving




and adapting (some alpine plants can live for hundreds, even thousands, of years). The book's coverage of the adaptations and survival of alpine organisms is comprehensive and well integrated into the text.

The book also covers temporal and spatial dynamics in depth. The authors pay particular attention to primary succession in terrestrial vegetation on land exposed by retreating glaciers. There is a comprehensive section on the role of biotic interactions, including competition and facilitation, in comparison with the abiotic environment. The classic primary successional studies in Glacier Bay, Alaska, a nonalpine environment, are mentioned, although the authors might have helped readers more if they had compared this site with a typical alpine environment. The roles and impacts of herbivores on boreal alpine vegetation are considered in some detail in the discussion of different terrestrial habitats.

One of the most interesting sections of the book provides an overview of global changes in climate and in nitrogen deposition. It is clear that alpine environments are more sensitive to climate change than are many other areas. An examination of climate history clearly illustrates previous warming periods that drove to extinction species adapted specifically to living at altitude. As a consequence, only 22 of the 800 taxa recorded above tree line in the Pyrenees are not found below tree line. More taxa will be lost if warming occurs as expected. Alpine areas in Europe, apart from the Alps and the southern Scandes, would be virtually eliminated under the warming scenarios now expected. I only wish this discussion were longer.

The last section covers land use and conservation. Again, a fuller treatment would have been preferable, as these are key issues for alpine habitats. Nevertheless, there are comprehensive summary tables on alpine conservation problems and ecosystem values. In the concluding remarks the authors present a hypothetical ecosystem framework for alpine zone mountains that links their biodiversity and habitat diversity patterns principally to water availability.

Excellent summary tables throughout the book help to synthesize the material, and many of these have references to sources for further reading (although references are missing for a few key tables). Figures, most adapted or taken from other works, are also potentially helpful, but unfortunately many are difficult to read, particularly because of the shading. Some of the photographs seem to have been taken in color and then converted to black and white, which might explain their unfortunate lack of visual impact. An attractive feature is highlighted subject boxes that serve to focus the reader's interest on specific topics (e.g., phylogeography, cryptogams in succession on glacier forelands, proxy measurements for climate). There is an extensive list of more than 800 references, but fewer than 35 of these date from later than 2006.

The book would have been more appropriately titled "The Biology of Alpine Terrestrial Habitats." As a freshwater ecologist I was disappointed that coverage of freshwater habitats, including glacier-fed streams and alpine lakes, was virtually absent, apart from a brief description of "life in troubled waters" (about glacial rivers, though it sounds like a Simon and Garfunkel song) and a brief mention of the effects of ultraviolet-B radiation on crustaceans in alpine lakes. The authors state that "the biology of alpine freshwaters is discussed in detail in specialist texts," but they provide no references, and thus lose the opportunity to fully examine the linkages between terrestrial and freshwater ecosystems in alpine habitats. This is unfortunate, because streams have important influences on soil moisture as well as on carbon and nitrogen fluxes.

That said, the book definitely fulfills its goal with regard to terrestrial alpine habitats. Its strength lies in how it synthesizes the major driving variables, which include elevation gradients, energy and climate, landforms, and hydrology and soils, while also examining the responses of community types and assemblages, including their biogeography, adaptation, and evolution. The paperback will appeal to students interested in or taking courses involving alpine habitats as well as to professionals looking for an introduction to this environment.

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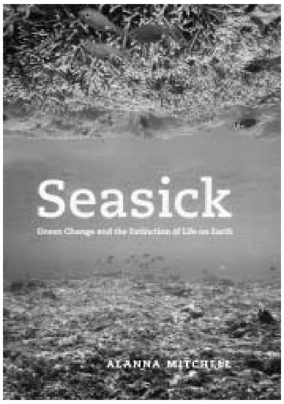
### TOO LITTLE, TOO LATE?

**Seasick: Ocean Change and the Extinction of Life on Earth.** Alanna Mitchell. University of Chicago Press, 2009. 176 pp., illus. $25.00 (ISBN 9780226532585 cloth).

*Seasick: Ocean Change and the Extinction of Life on Earth* is intended to alert or, better said, alarm the public about a host of grave assaults on the world's oceans. It joins other recent books whose titles also tread unsubtly. A sampler: *The End of the Line: How Overfishing Is Changing the World and What We Eat; The Empty Ocean; The Unnatural History of the Sea; Ocean Bankruptcy: World Fisheries on the Brink of Disaster.*




Scientists who write or become sources for such books feel an accelerating sense of urgency that overmasters what climatologist James Hansen has called the habit of "scientific reticence." A few, such as Hansen or the redoubtable Scripps marine biologist Jeremy Jackson, pursue public advocacy. As conditions worsen, these scientists' numbers may swell, despite a long list of professional disincentives.

Many others feel enough confidence to at least hazard some candor about the significance of their results, one on one, when speaking to the right journalist. *Seasick* benefits from several such encounters. In symposia or other professional settings, as author Alanna Mitchell writes at one point, "There's a question no one wants to deal with: is all of this research too little, too late?" She asks it—frequently—and focuses sharply.

- Ecosystem modeler Jerry Blackford's data augur that by 2050, for example, ocean acidity will be higher than it has been for 20 million years. Mitchell sums up: "The oceans' lifeforms will be disconnected from their own evolutionary heritage."
- Twenty percent of the world's coral reefs have been destroyed and 50 percent are "in trouble." Eighty percent of Caribbean corals are dead. For one international project out to collect genetic samples—Noah-like, lest they disappear—corals are the "most urgently endangered group of species known of in the world."
- There are now about 400 hypoxic "dead zones" in the oceans; this figure has doubled each decade since 1960, and a report by the United Nations Environment Programme says their number is "poised to escalate rapidly," threatening the whole global fishery in this century.
- Then there's global warming…

It may seem remarkable that oil spills did not make the list, given what's occurred in the Gulf since *Seasick* was published, but that is not a serious omission on the author's part. It is, rather, a reminder that the threats are probably too many to be treated in one book, and that some seemingly stable, back-burner ocean stressors can suddenly veer toward catastrophe.

That the oceans are threatened will not be news for conservation biologists. Nor can *Seasick* serve as a source of research data. Mitchell is a mainstream journalist, until recently a science reporter for the *Toronto Globe and Mail*, and the book is written for a general audience. So the question becomes: Does her book have value for scientists?

I think yes, for a couple of reasons. For some, who may be holed up within their research niches, it offers a well-integrated interdisciplinarity, if at a general level. Mitchell uses a wealth of published research, her extensive interviews, and personal observations to lay out the dire synergies of global warming, ocean acidification, overfishing, and dead zones.

Another positive feature of the book may seem off-putting at first: This is a personal odyssey, deeply engaged.

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