BOOK REVIEWS

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VAN DOVER, C. L. 2000. **The ecology of deep-sea hydrothermal vents.** Princeton University Press. xx + 412 p. US$39.50. ISBN 0-691-04929-7.

Deep-sea hydrothermal vents, first discovered in 1977, occur in association with underwater volcanism on midocean ridges and in back-arc basins. Hydrothermal fluids discharging from these vents support microbial chemolithoautotrophy and dependent faunal communities. Vent fluids are formed by reaction of seawater with hot rock, and researchers quickly realized that vent ecosystems are ultimately powered by geothermal heat. More than 100 vent fields have been documented along the 50,000-km global midocean ridge system, and 500 new animal species, over 80% of which are endemic to vents, have so far been described. Unusual, highly evolved symbioses between invertebrates and chemolithoautotrophic bacteria are common at vents, and their biomass rivals that of the most productive ecosystems on earth. The predominance of chemoautotrophic and hyperthermophilic microbes in hydrothermal vent waters has stimulated new theories of the origin of life on earth and prompted astrobiologists to seriously consider geothermal energy as a viable power source for biosynthesis and maintenance of carbon-based life forms on other worlds. For these reasons, the discovery of chemosynthetic-based ecosystems at hydrothermal vents is arguably one of the most important findings in biological science in the latter half of the 20th century.

Van Dover's well-researched and comprehensive book describes the ecology of this complex and energetic environment, where amidst many other strange and complex phenomena, mantle heat is transformed into genetic code. Broad in scope, it is written for advanced undergraduates, graduate students, and professional researchers. It includes background material from many disciplines, devoting entire chapters to the geology of hydrothermal vents; the properties of hydrothermal fluids; and the biology, evolution, and biogeography of vent organisms. This design reflects the unusual multidisciplinary approach that has developed in hydrothermal vent research and has led to the shaping of a generation of young scientists who move with ease across disciplinary boundaries. The chapter on evolution and biogeography provides interesting examples of interdisciplinary work at hydrothermal vents, where molecular biologists are drawing on the history of seafloor spreading and ridge crest architecture to understand gene flow between vent fields and biogeographical regions.

The writing style is a strong point of the book. Ideas are presented in a concise and authoritative yet very personable and flowing narrative. Historic anecdotes introduce ideas, and data and figures are made more interesting by explanations of how and why measurements were made. Most chapters begin with lengthy summaries of previous research followed by a brief synopsis and occasional stabs at synthesis. This format has the advantage of bringing the unfamiliar reader up to date with the results of past and recent studies, but those seeking a more comprehensive theoretical treatment are left somewhat wanting. The brief syntheses offered are sometimes thoughtful and identify interesting problems for future research, whereas other potentially interesting points, such as the influence of tides and volcanic eruptions on reproductive and recruitment synchrony, are raised but discussed only in a rather cursory and sometimes confusing manner.

The book begins with an overview of the ecology of the surrounding deep sea, setting the stage for following chapters that describe the vent environment, its unique organisms, and what is known of their extraordinary adaptations to an extreme and ephemeral habitat. The latter part of the book would have been greatly improved by the inclusion of a chapter on vent ecosystem function, perhaps using a generic model to critically examine linkages between tectonic, hydrothermal, and biological processes. Instead, it ends with asides: chapters on cognate communities and theories on the origin of life at hydrothermal vents. To be fair, any attempt at synthesis in vent ecology would have to contend with a rather disparate literature and, like it or not, discovery and description have taken precedence over comprehensive, integrated study of vent ecosystems. Indeed, even the hypothesized dependence of vent food webs on chemolithoautotrophic productivity remains to be quantitatively established.

Despite these gaps in our understanding, we are approaching a point where we can begin using these unique ecosystems to test elements of ecological theory, the entire body of which has been developed elsewhere. That is, ecological concepts can be put on trial in a setting where different basic rules govern life and ecosystem processes, as a result of the coupling of vent ecosystems to geothermal rather than solar energy and to geological rather than seasonal or climatic cycles. For example, Van Dover describes how seafloor volcanic eruptions have provided wonderful opportunities for the study of ecosystem adaptations to disturbance. Since 1991, serendipity and remote monitoring have permitted the launching of several time series studies that began with the immediate aftermath of seafloor eruptions on the East Pacific Rise and the Juan de Fuca Ridge. Established vents and vent communities are buried by lava flows, and within days, new vents begin issuing hydrothermal fluids through fractures in the fresh rock. The rapidity with which new vents are colonized has left even vent biologists searching for superlatives and for concepts and models in ecological theory that fit the accumulating data on de novo ecosystem assembly and disturbance–diversity relationships. Van Dover also describes studies of community-level adaptations to shifting environmental gradients and abrupt disturbances on the surfaces of large sulfide edifices. Emerging from this work is a concept of a spatially and temporally varying mosaic community where ''while there may be no ordered succession . . . there are assembly rules.'' There are parallels here with plant communities under conditions of chronic disturbance, but no immediately obvious fit to models developed for other benthic ecosystems.

Comprehensive ecosystem-level studies at vents will require large, coordinated, multidisciplinary research efforts just to follow the trail of material and energy fluxes from the upwelling mantle into the biosphere. Recent initiatives by organizations in several countries, including the U.S. National Science Foundation's RIDGE program, call for a series of long-term, integrated studies at a small number of representative locations at ridge crest and back-arc spreading centers. Such integrated studies should lead to substantial progress in our understanding of vent ecosystem function and linkages to the complex array of processes that support life at seafloor vents and within the upper oceanic crust. They will also reveal how vent ecosystems measure up against photosynthetic ecosystems.

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