Antarctic Sea Ice: Biological Processes, Interactions and Variability, Antarctic Research Services.(Review)

by Raymond C. Smith

Biological Processes, Interactions and Variability, Antarctic Research Series, Vol. 73. Michael Lizotte and Kevin Arrigo, eds. American Geophysical Union, Washington, DC, 1998. 198 pp., illus. $45.00 (ISBN 0-87590-901-9 cloth).

Sea ice is a complex and variable matrix of physics and biology, providing diverse ecological habitats that are a major component of one of the largest and most dynamic ecosystems on Earth. The formation, persistence, and decay of sea ice plays a crucial role in creating distinct physical and chemical habitat conditions and microclimates; thus, it is fundamental in structuring the Antarctic marine ecosystem. By virtue of this complexity, sea ice significantly broadens the spectrum of ecological niches within the Antarctic marine environment. The atmosphere and ocean continuously modify the distribution, thickness, and structure of snow and sea ice cover and, consequently, the biological assemblages associated with snow and sea ice. Poorly understood physical and biological feedback processes also link the sea ice cover's capacity to influence the atmosphere and ocean. Many climate models predict that hypothesized sea ice-related feedback mechanisms will lead to enhanced warming at higher latitudes as a possible impact of increased atmospheric C[O.sub.2], thus making these regions important areas in which to study ecological responses to climate variability. It is within this context that this collection of papers on Antarctic sea ice (Volume 73 of the Antarctic Research Series) was published with the purpose of "presenting new information about this ecosystem."

The Antarctic Research Series (whose first volume was published in 1963 by the American Geophysical Union) now comprises more than 70 volumes. Over half of these volumes have themes related to the biology of Antarctic regions, and 23 volumes specifically address "Biology of the Antarctic Seas." The Antarctic Research Series presents "authoritative original results of scientific work in the high latitudes of the southern hemisphere," and it is aimed at an interdisciplinary and international audience. Surprisingly, for a series devoted to the Antarctic, Volume 73 is the first to be devoted to sea ice biology. Although it is an uneven compilation of 12 relatively unconnected chapters, the book will be valuable for workers in the field and an important resource for graduate students. It is timely, it covers a wide array of topics related to sea ice biology, it includes up-to-date references, and it presents some exciting new material.

I found two highly interdisciplinary chapters that presented results from ecosystem models to be the best evidence of the value and timeliness of this volume. In the first chapter, Chris Fritsen and coworkers use a numerical model of "ice growth, ice hydrostatics, radiative transfer processes, nutrient exchange processes, and microalgal growth" to investigate the dynamics of surface and bottom-ice microalgal communities.

As a component of this mechanistic model, these authors developed a flood-freeze algorithm that permits ice-algae dynamics to be studied systematically with respect to variations in snow cover. One element of sea ice habitat complexity, especially in the Southern Ocean, is the position of microalgae within the vertical structure of snow-covered sea ice. The relative loading (i.e., weight) of snow on sea ice determines whether or not the snow-sea ice interface is above or below sea level. The position of this interface then determines the potential for sea water to flood the ice surface and consequently provide for the creation of a nutrient-rich microhabitat. In turn, this in-ice habitat influences the subsequent physical processes of ice growth and decay. An important characteristic of this model is that it deals explicitly with how the sea ice ecosystem itself is structured on a temporal basis; consequently, it permits processes affecting both ice geophysics and ice micro-biota, and their interactions, to be studied as a function of local weather patterns and oceanic forcing. This model is an important new diagnostic tool for the investigation of the time-varying sea ice ecosystem.

The second model, presented by Kevin Arrigo and coworkers, is distinctly different. Arrigo et al. estimate sea ice biomass and productivity within the Antarctic pack ice for five sectors of the Southern Ocean as well as for the entire Southern Ocean by using a one-dimensional sea ice ecosystem model that incorporates representative environmental inputs. In addition to estimating biomass and productivity, the model provides a quantitative mechanism for assessing the sensitivity of sea ice production to various model parameters, including the spectral photo-adaptation parameter and the algal loss rate. This model is valuable in that it demonstrates the quantitative assessment of sea ice primary productivity and permits an increased understanding of the important parameters for this estimation. It is an important step forward in evaluating the contribution of sea ice to overall

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primary productivity of the Antarctic.

Several chapters in this volume present new information on algal biomass in sea ice. Gerhard Dieckmann and coworkers provide a straightforward compilation of currently available data on sea ice standing stock that will be a valuable source of information for future modelers. Michael Lizotte and coworkers give an overview of how pigment signatures found in sea ice during various stages of growth and decay, when contrasted with those in the underlying water column, can provide valuable information on community structure and development. This work, like the Fritsen et al. model, gives evidence of how the sea ice ecosystem is temporally structured and indicates how its seasonal evolution may be inferred from pigment signatures.

Antarctic Sea Ice: Biological Processes, Interactions and Variability also presents a range of other topics, including chapters on nitrogen metabolism, production of dimethyl-sulfoniopropionate, the response of ice algae to UV, the use of sediment and sea ice diatoms as paleo-environmental indicators, and zooplankton grazing. Despite the lack of integration among chapters - the volume's main limitation - it succeeds in revealing what it calls "the widening scope of current sea ice research in Antarctica."

Taking In the Sites

The following Web sites, developed by science museums in North America, will appeal to "virtual museum-goers" of all ages.

The Franklin Institute Science Museum, located in Philadelphia, Pennsylvania, has developed a Web site (sln.fi.edu) that promotes innovations in education. One component is "Wired@School," a program involving nine teachers who have developed activities for increased Internet use in the K-8 classroom. Among the projects is a step-by-step lesson on how to help students use computer animation programs. The museum's online exhibits include a look at the Wright brothers and their scientific journey to flight; a portrayal of Ben Franklin and his discoveries relating to lightning and electricity; and activities, resources, and information based on "Eureka! A Techno-Mystery," a children's play currently showing at the museum proper. The museum's online magazine, inQuiry Almanack, is also full of information on topics ranging from spiders to flowers. Finally, for Internet beginners, the museum presents an online "World Wide Web Workbook" to assist in learning terminology and Web-navigating skills.

A fascinating and often humorous look at science can be found at the Ontario Science Centre's Web site, www.osc.on.ca. The "Interactive Zone" requires Macromedia's free Shockwave Player to participate in most of the activities. Visitors can experiment with color by manipulating colored circles on the screen, and they can engage in several "stupid computer tricks" (which are actually educational and fun).

Located in San Francisco, California, the Exploratorium is a museum of "science, art and human perception," and its Web site (www.exploratorium.edu) reflects this comprehensiveness. Interactive lessons on the science of baseball, hockey, and cycling will interest both sports buffs and couch potatoes. For instance, visitors can improve their virtual batting skills by changing the strength of their swing or the type of pitch. Other interesting online exhibits focus on frogs and the human memory. Also available for perusal is Exploratorium Magazine Online, a good source of science information. Finally, the museum's digital library allows users to listen to and sometimes watch past Webcasts on topics as diverse as the science of chocolate and a solar eclipse.

Another site of interest is:

The Cyberspace Museum of Natural History and Exploration Technology: www.cyberspacemuseum.com

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