

shores of Britain. They boasted about their steam engines, screw propellers, water desalination devices, and foods preserved in airtight cans. They saw themselves as vanguards of a highly sophisticated society in which towns were already linked by rail networks, and were being connected by a system of telegraph communication. There was even talk of laying a submarine cable across the Atlantic! Fitzjames and Lieutenant James Fairholme mused about the fascinating possibility that it might one day be possible to send a message rapidly all round the world by wire. Would there ever come a time, they wondered, when a ship in Arctic seas could somehow communicate with civilized places?

To summarize the book would give away too much and deprive readers of the pleasure of making their own discoveries. It is enough to say that Fitzjames describes the disintegration of the expedition before he writes his last words (and reveals a long-kept secret) on 26 August 1849.

The book's dust cover features a watercolour by Samuel Gurney Cresswell, one of the many naval officers who went looking for Franklin a few years later. Illustrations in the text are from an obscure book on exploration published 30 years later, showing the Arctic as publishers like to show it — dark, threatening, and dangerous, with quaint native inhabitants and fierce animals. I think it would have been more effective to carry the Fitzjames fiction a step further and illustrate his letters with the sketches he might have made of subjects relating specifically to the expedition — the ships, the officers, their clothing and equipment. These could be based on contemporary pictures in newspapers and periodicals (for example *Illustrated London News* published a sketch of the very cabin occupied by Fitzjames). A map inside the covers is entitled 'Fitzjames' Arctic 1845–1849,' but this is a little misleading. Based on modern maps, it shows the delineation of coasts as we know it now (and of course as it really was at the time), but it does not portray the Arctic as Fitzjames and his colleagues knew it. *Their* Arctic was a region of mystery in which the true distribution of land and sea was still unknown, and it is disappointing that Fitzjames did not paste into one of his letters a map of the period to show what Europeans knew about the Canadian Arctic and what they did not. Considering that the expedition was observing and charting some coastlines for the first time (the northern part of Cornwallis Island, for instance), he might have been tempted to draw sketch maps in his letters to show these regions, and I feel sure he would have drawn a sketch map of Beechey Island to show the storehouses and other buildings they built, the place where they buried their dead, and the position of the wintering ships in the bay.

John Wilson, a resident of British Columbia, has previously written highly praised books of historical fiction for children. This book, aimed at an adult audience, maintains his high standards, and will be a fascinating read for anyone interested in Arctic history. (W. Gillies Ross, Department of Geography, Bishop's University, Lennoxville, Quebec J1M 1Z7, Canada.)

THE FRESHWATER BUDGET OF THE ARCTIC OCEAN. E.L. Lewis (Editor). 2000. Dordrecht: Kluwer Academic Publishers. xxii + 623 p, illustrated, hard cover. ISBN 0-7923-6439-2. £132.00; US\$208.00; NLG 425.

'You can't always tell a book by its cover' is a common axiom of literature, in all its various guises. This axiom certainly holds true for the 623-page tome entitled *The freshwater budget of the Arctic Ocean*. The philosophy, depth, and breadth of this marvelous book is rather poetically encapsulated in the preamble by the multi-talented Mark Serreze:

*The water that runs to the Arctic sea,
Ought to be balancing P minus E.
While all of us know this has to be true,
Why then, we ask, are our budgets askew?*

The other verses that Serreze has penned are equally appealing as an eloquent expression of the complexities and associated challenges faced with the task of summing up the current knowledge of the freshwater budget of the Arctic Ocean. From my perspective the task these scientists set for themselves is nothing short of extraordinary. The book successfully captures the current state of knowledge, and the various areas requiring investigation, in each of the primary components of the Arctic system that affect, or are affected by, the freshwater flux within the Arctic Ocean.

The book takes what is commonly considered to be an 'Arctic systems' perspective. We all know that the Earth-atmosphere system in the polar regions consists of a series of complex interactions amongst the atmosphere, hydrosphere, lithosphere, and biosphere. The authors of this text take on the task of examining the role of the freshwater flux within the first three of these spheres. Given the magnitude of this task, I can hardly be critical of them for restricting their work to the physical system by ignoring the biosphere.

The book begins with the science drivers associated with freshwater fluxes in the Arctic system. The primary pathways for the influx of freshwater are defined as precipitation (solid and liquid), terrestrial hydroclimatology, evaporation, and oceanic advection (including sea ice). The timing, magnitudes, and processes associated with these pathways are investigated from the perspective of the ocean-sea-ice-atmosphere system and in particular the role that the atmosphere and hydrosphere play in defining the processes that control ocean circulation.

The book provides valuable measurements of state variables for various components of the system; indicates the current understanding of several of the most important processes controlling this system; critically examines issues relating to areas of controversy within this broad disciplinary field; provides several chapters that review and illustrate aspects of the current scientific toolbox (modeling, reanalysis data, remote sensing, station data, etc); and provides the necessary background and thematic linkages amongst the 24 chapters in the text.

The first two chapters of the text provide a broad overview of the hydrosphere and the atmosphere, focusing

on global-scale aspects pertaining to the freshwater budget of the Arctic Ocean. Both of these chapters are designed to be introductory in nature and are presented at an introductory to mid-level undergraduate university level. Chapters 1 and 2 focus on large time and space scales (global, decadal), thereby setting the stage for the more local examination of the atmosphere and hydrosphere in chapters 3 to 7. Chapters 3, 4, and 5 continue with the overview material, yet provide increasing amounts of detail pertaining to atmospheric, hydrospheric, and oceanic aspects of the freshwater budget. These chapters really provide the details of the primary science drivers within each of the sub-disciplines and also provide a valuable review of the current state of understanding of many of the most important processes. The practitioner of a particular sub-component of this discipline will find useful information in many of these chapters in areas that may not be that familiar to them.

In chapter 6 the authors provide an overview of one of the primary scientific tools used in studies of freshwater fluxes — that of general circulation modeling. As a major tool in studying climate sensitivity to both external and internal forcings, these tools are becoming increasingly important for examining mechanisms of climate variability and change.

The following chapters of the book are loosely structured into the atmospheric, hydrospheric, and oceanic sub-components of the introductory chapters. Each of the chapters within these subsections provides specific treatments of various geographical, temporal, and process-oriented relationships required to understand the freshwater budget of the Arctic Ocean. Many of the chapters also take a particular emphasis on either a process, geographical, or temporal focus.

Chapters 7 to 10 examine various aspects of the atmospheric water balance and the characteristics of precipitation (P) and evaporation (E). The net P-E drives much of the atmospheric system and is the principal coupling mechanism of interest between the surface (either land, ocean, or sea ice) with the atmosphere. Many of the chapters examine aspects of the role of freshwater input to the system from the atmosphere and lithosphere within reference to the role of P-E within the ocean system. The authors examine the role of these freshwater inputs/outputs from the perspective of atmospheric feedbacks and processes that couple the atmosphere, land, ocean, and cryospheric surfaces. Chapters 11 to 17 look at aspects of the freshwater discharge from the major river systems flowing into the Arctic basin and the role this pathway has on thermohaline circulation, and sea-ice production and export. The hydroclimatology of various geographical areas are examined (Siberian rivers, Mackenzie basin), as are aspects of the interface between estuarine environments and the shallow and deep shelves of the Arctic basin. The hydroclimatology studies include basin-scale hydrological processes with the associated coupling to atmospheric processes. Chapters 18 to 24 examine oceanic-

related issues, including aspects of sea ice (frozen ocean). A variety of individual studies are presented focusing on particular techniques (satellite remote sensing, tracer studies, modeling) and studies with a particular geographic focus (North American Arctic, Bering Sea, Fram Strait, Nordic seas).

This text is an essential part of the reference library of any serious Arctic researcher (including environmental scientists, oceanographers, climatologists, and biologists). The authors have succeeded in creating a document with tremendous breadth, yet have achieved this with a considerable amount of depth. The text will serve as an excellent reference source for the practising scientist and will also be suitable as a graduate level text in Arctic system science. I can also see the text having relevance to undergraduate teaching, as many of the chapters provide a contemporary view of research into freshwater fluxes within the Arctic Ocean.

I, for one, am very happy to have this book as part of my library. (David G. Barber, Department of Geography, University of Manitoba, Winnipeg, MB, Canada.)

MUSKOXEN AND THEIR HUNTERS: A HISTORY. Peter C. Lent. 1999. Norman, Oklahoma: Oklahoma University Press (Animal Natural History Series 5). xi + 324 p, illustrated, hard cover. ISBN 0-8061-3170-5. \$US57.50.

The muskox (*Ovibos moschatus*) is in many ways the quintessential Arctic land mammal. Its long, coarse, dark-brown outer coat covers a thick layer of remarkably fine wool — known by its Inuktitut name of *qiviut* — which is rated as the best natural fibre in terms of its insulating qualities. This means that muskoxen are almost impervious to low temperatures. Capable of surviving on a wide range of fodder types (often of quite low nutritional value), they usually do not travel far over the course of a year, thus conserving energy. Prehistorically the species was circumpolar in its distribution and extended very far south around the margins of the Pleistocene ice sheets, as well as occupying extensive glacier-free areas farther north, such as Beringia or Banks Island. Here the muskox was the contemporary of the mammoth, woolly rhinoceros, and the sabre-toothed tiger. It is one of the few survivors of this Pleistocene steppe-tundra fauna.

All in all, the muskox is a species that tends to rouse the curiosity of the general public, and while there have been works on its physiology and behaviour and its escape from near-extinction (in northern Canada at least), as well as numerous specialized articles in zoological journals, until now there has been no single work on almost every aspect of the species. Lent, a zoologist who has worked closely with muskoxen for decades (particularly on Nunivak Island), has now filled this lacuna in exemplary fashion.

Lent begins with a discussion of the Pleistocene antecedents of the muskox and its relationship with such extinct species as the low-horned muskox (*Praeovibos* and *Boötherium bombifrons*) and the 'helmeted' or 'bonnet-horned' muskox (*Symbos cavifrons*). This discussion of