

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

the Pleistocene situation continues with an examination of the preferred habitat of these different species and of the distribution of *Ovibos moschatus* both south of the Pleistocene ice sheets and on the more northerly unglaciated areas, a distribution that dictated postglacial movements, with immigration into the progressively deglaciated areas from various directions.

A detailed discussion of the interaction between prehistoric hunters and muskoxen follows. Central to this discussion is Count Eigel Knuth's demonstration that paleo-Eskimos, known as the Independence I culture, had relied heavily on hunting muskoxen and, indeed, had followed the muskox as they migrated east from Beringia to the eastern Canadian Arctic islands and round the north coast of Greenland to East Greenland. Coming closer to the present, Lent next examines the interaction between Inuit and Indians (especially Chipewyan) and muskoxen during the early historical period, arguing that with few exceptions they represented a critical, or at most a casual, resource, but rarely a staple resource.

Europeans penetrated into the range of the muskox at a relatively late date. The first regular encounters (and hence muskox hunts) came with the Royal Navy's ongoing search for the Northwest Passage, and especially with the search for the missing Franklin expedition after 1848. Lent discusses the impact of these encounters on muskox stocks — a relatively minor impact overall, although Captain Henry Kellett's expedition, wintering at Dealy Island, killed some 115 animals on Melville Island during the winter of 1852–53. A much heavier drain on the stocks (almost entirely from the Canadian mainland tundra) was the commercial trade in hides that began around 1860 and continued until about 1915, by which time the species was practically commercially extinct on the mainland. Indian and Inuit hunters pursued the muskoxen relentlessly, trading their hides to the Hudson's Bay Company, to a few independent traders, and to the whalers in Hudson Bay and the Beaufort Sea. In a remarkably early and far-seeing piece of conservation legislation, the Canadian government afforded total protection to the muskox in 1917; initially aboriginal people were permitted to hunt muskoxen if threatened by starvation, but in 1924 the species was given total protection. As Lent has pointed out, recovery was initially quite slow and it was not until around 1960 that numbers began to increase dramatically and the species began to recolonize its historical range. Almost certainly the recovery had been impeded until then by illegal hunting by Inuit; at that point, however, concentration of the human population into a relatively few coastal settlements greatly reduced the range of hunts, and afforded the muskoxen greater protection.

Thereafter, as Lent reports, recovery has been dramatic, even explosive in some areas. The most striking example comes from Banks Island where few, if any, muskoxen existed around 1915–17, although they had been numerous earlier. The first animals reappeared in the 1950s. Present estimates of the Banks Island population

are in excess of 64,000, out of a total world population of around 170,000. As a species the muskox is definitely no longer endangered.

In recognition of this fact, in 1967 the Department of Renewable Resources, Government of the Northwest Territories, established quotas for a limited muskox hunt, allocated to 16 Inuit communities, ranging from four for Arctic Bay to a quota that now stands at 4000 for Sachs Harbour on Banks Island. In the latter case a mobile, government-approved abattoir handles hundreds of muskoxen per year, the meat being sold commercially in southern Canada.

Lent also discusses in detail a further interesting aspect of muskox demography and distribution, namely its introduction (or in some cases reintroduction) to areas where it had never occurred in historic time, or where it has been extinct for some time. These relocations include the transfer of animals from East Greenland to Nunivak Island off the west coast of Alaska in 1935 and 1936, and from there subsequently to Nelson Island, Seward Peninsula, and the North Slope of Alaska. In Canada, animals from Ellesmere Island were relocated to Fort Chimo, initially as a domestication experiment, but were subsequently released and have now colonized much of Ungava. Another two such relocations saw muskoxen from Banks and Nunivak islands going to two locations in the Soviet Union: Poluostrov Taymyr on the mainland, and Ostrov Vrangelya to the north of Chukotka. In both cases the population has grown dramatically and dispersed widely. Also in the 1970s animals from East Greenland were relocated in the Søndre Strømfjord (Kangerlussuaq) area of West Greenland, where they have similarly adapted very successfully, multiplying rapidly and expanding their range. As a result of these and other relocations, muskoxen are now more widely distributed (and probably more numerous) than at any time since the end of the Pleistocene.

Lent ends his study with a history and analysis of attempts at domestication. Starting with John Teal's pioneer experiment at domestication in Vermont in 1954, Lent traces the history of domestication through Teal's operation at Fairbanks (starting in 1964–65), the movement of the animals to Unalakleet in 1975–76, and their ultimate movement back east to Palmer in the Matanuska Valley, where the herd is still located. The purpose of the operation is the harvest of *qiviut*, which is combed from the animals during the natural moulting period; the raw *qiviut* is then flown to a spinning mill in Rhode Island, and the yarn flown back to Alaska and distributed to native knitters in a large number of villages in Alaska. Their output (scarves, etc) is retailed through a shop at the muskox farm at Palmer and through a store in Anchorage. From this discussion, Lent proceeds naturally to the topic of the biology of muskoxen in captivity and to the fact that the Palmer herd appears to be becoming increasingly prone to disease and especially to high calf mortality rates.

This brief overview touches only on the highlights of the vast amount of information concerning muskoxen

contained in this volume. It might justifiably be subtitled 'An encyclopedia' rather than 'A history.' There are very few obvious errors: 'Beechey Strait' (page 80) should presumably read 'Barrow Strait,' and on the same page 'Alexandria Fiord' should be 'Alexandra Fiord.' Canadian readers will be disturbed and puzzled to see the Canadian Governor General, Earl Grey (the original presenter of the Grey Cup for Canadian Football) rendered as 'Lord Gray.' Even more puzzling is Lent's consistent rendering of RCMP (Royal Canadian Mounted Police) as simply CMP.

These, however, are very minor flaws. More serious is the fact that the entire book is a little dated. While the bibliography is generally quite exhaustive, numbering over 650 entries, only 18 of these references are dated later than 1995, since which date much has been published on muskoxen. Indeed the book has all the signs of a manuscript for which the author was searching for a publisher for several years. If this were the case, reluctance to update the material once a publisher had been found is understandable, but unfortunate. But apart from this weakness, Lent has produced a superlative study of one of the most fascinating of the Arctic mammals, one that is unlikely to be superseded for a very long time. (William Barr, Arctic Institute of North America, University of Calgary, 2500 University Drive NW, Calgary, Alberta T2N 1N4, Canada.)

SUNRISE OVER PANGNIRTUNG: THE STORY OF OTTO SCHAEFER, MD. Gerald W. Hankins. 2000. Calgary: The Arctic Institute of North America (Komatik Series 6). xiii + 250 p, illustrated, soft cover. ISBN 0-919034-97-7. US\$19.95.

This book is a celebration of the life of Otto Schaefer, whose career as a physician in the Canadian Arctic, where he spent 32 years in all, will be well known to many readers. Schaefer was born in 1919 in Betzdorf, a small German town in the Rhineland. As a child he had felt inspired to visit the north by reading Franz Boas' two volumes that arose from the latter's participation in the work of the International Polar Year. Schaefer studied medicine during World War II and graduated from Heidelberg in 1944. He arrived in Canada in 1951 and, after passing the relevant examinations to secure certification to practise and having married, he received an appointment in Aklavik, where he arrived on 29 January 1953.

The author gives a fascinating account of Schaefer's work in the different isolated communities to which he was posted. Pangnirtung, on Baffin Island, was the favourite of these for Schaefer's family, and hence the title of the book. The 'sunrise' part of the title comes from his work bringing 'the dawn of a new day for health care in the North.'

The author does not overlook those parts of Schaefer's career during which he was based at large hospitals in southern Canada, but in which he often worked with northern peoples evacuated there for specialist treatment. Schaefer was not only a dedicated physician but an astute observer of the peoples among whom he worked. His

admirable habit of writing down clinical and other relevant observations at the time in notebooks assisted him in rapidly acquiring a comprehensive overall perspective of the medical situation in each area in which he worked. This, in turn, meant that he was excellently placed to draw important deductions about, for example, the benefits to be derived by babies from consuming their mothers' milk, rather than artificial substitutes, and of the pernicious effects of alcohol. These insights enabled him to influence medical and other opinion not only by examples of practice but also by preparing articles published in the medical literature. The book makes it clear that Schaefer did not avoid controversy in such matters, but he seems very often to have been proved right.

The book also includes much fascinating material on the way of life not only of the local peoples but also of Europeans working in the Arctic. The author makes it apparent that Schaefer was well disposed towards missionaries, which is refreshing to read in these 'politically correct' times, and provides much information concerning the interactions between the different groups of peoples. The chapters are, on the whole, very short and have such titles as 'Witness for the prosecution,' which largely concerns the murder of the wife of a Royal Canadian Mounted Police special constable, in the investigation of which Schaefer was engaged; 'Patients and characters'; and 'On board the C.D. Howe.' This was a vessel that undertook an annual voyage to isolated settlements carrying supplies, and that had a travelling medical facility. Further chapters include 'White-knuckle moments,' largely about Schaefer's wife Editha (Didi), who seems to have been a real paragon in the difficult circumstances in which the family frequently found itself living; and 'The executioners,' concerning an interesting criminal case that posed questions about the interaction of Inuit behaviour and western justice. Much stress is placed on the Circumpolar Medical Conferences, of which Schaefer was general chairman of the third, held in Yellowknife. As Schaefer grew older and with his advancing reputation as an international authority in Arctic medicine, he received numerous honours, including the Order of Canada in 1976, and these are duly recorded. The author concludes his work with a chapter entitled 'If Otto Schaefer hadn't gone to the Arctic,' which may be summed up by the comment of a friend that 'his academic research and studies were done specifically to benefit them (the Inuit).'

There is an appendix listing Schaefer's papers, a bibliography, and an index. The book is copiously illustrated by excellent photographs, many of which were by Schaefer himself. These are amongst the most interesting aspects of the book, as they set the prose into its proper context.

The book is written in a pleasant, light, somewhat journalistic, style that may not be to the taste of all readers. Very many chapters start *in medias res*, with such sentences as 'It happened one day in April, when Otto was away with his dog team...' or 'It was 1:30 AM on April 12, 1964, when Otto Schaefer finally put down his pen and