

eth century. The packaging and marketing of exploration seemed to require the perpetuation of the fallacies of scale, a continuing reliance on western 'expertise' and refusal to accept the lessons Rae learnt from his indigenous companions. In this, as in so many other matters, the English establishment remained stubbornly impervious to good sense. Admiration for heroic failure and the inability to recognise quiet success have remained one of the most disfiguring aspects of British culture. (John M. MacKenzie, Department of History, Lancaster University, Lancaster LA1 4YW.)

**ANTARCTIC MICROBIOLOGY.** E. Imre Friedmann (Editor). 1993. New York: Wiley-Liss. x + 634 p, illustrated, hard cover. ISBN 0-471-50776-8. £136.00.

This is a comprehensive and stimulating volume covering a wide range of Antarctic habitats, communities, and organisms. It is written by scientists with proven field experience and provides an excellent starting point for entering the field of Antarctic biology with experience of other areas. However, an introductory chapter to explain the significance of Antarctic microbiology could have synthesized the separate contributions with a holistic approach specially relevant to current interest in environmental change.

The chapters are grouped under three general headings: marine environments; terrestrial and freshwater environments; and other topics, which include human diseases, exobiology, and protection issues.

The first marine paper, by D.M. Karl, on microbial processes in the Southern Ocean ably introduces Antarctic marine ecosystems. Karl discusses determination of biomass but surprisingly does not include image analysis as used by workers such as Sieracki. He concentrates on activity, trophic models, and physiological responses to driving forces, and discusses bacterioplankton-phytoplankton correlations. Tables of substrate uptake, turnover rates, and mass fluxes, and of bacterioplankton abundance, productivity, and growth rates from diverse areas of the Southern Ocean give a comprehensive overview. However, the topical effect of UV-B radiation on marine microbial processes is barely mentioned. Case studies unique to polar regions include the multi-disciplinary AMERIEZ Program (Antarctic Marine Ecosystem at the Ice-Edge Zone) of the USA in the Weddell-Scotia sea. Other studies cover the Drake Passage, Prydz Bay, and waters under the Ross Ice Shelf 450 km from the open sea. Karl rounds off with a stimulating summary of current technology and new issues such as microbial loops.

An authoritative account of phytoplankton of the Southern Ocean, by S.Z. El-Sayed and G.A. Fryxell, includes superb photographs. The authors revise marine food webs to emphasize the significance of choanoflagellates and picoplankton, whose taxonomy is conspicuously undescribed. Populations under ice shelves, in the open ocean, and in nearshore waters are compared, highlighting

vertical zonation and seasonal fluctuation, especially at the ice edge. The influence of UV-B is noted but recent relevant work by Karentz and others is omitted. The authors analyse factors governing distribution and productivity, including the controversy over Fe-limitation and the unpredictability of correlations between phytoplankton abundance and grazing by heterogeneous krill populations.

D.L. Garrison and M.M. Gowing accentuate taxonomic problems with protozooplankton by admitting the impossibility of presenting a species list! Tables summarize the relatively few but significant cruises that have addressed protozooplankton and describe abundance and biomass of pelagic populations. The authors discuss the variability of bacteria-grazing by flagellates at ice-covered and open-water stations. They review how recent findings have invalidated the short diatom-krill food web by describing the flagellate-dominated microbial (regenerating) system with superimposed blooms of larger phytoplankton.

A chapter on sea-ice microbes, by A.C. Palmisano and D.L. Garrison, concisely describes sea-ice habitats before giving a well-illustrated taxonomic account of the microbiota. A thorough description of the structure and ecophysiology of the microbial assemblages highlights the significance of their lipid composition and response of pigmentation to photosynthetically-active radiation. Gaps in our knowledge of their primary production and its significance for the community are discussed.

The expertise of D.C. White and others results in an enlightening account of phospholipid ester-linked fatty acids (PLFA) and sterols used for determining the biomass of the nearshore benthic microflora and its ecophysiology and taxonomy. They also stress the value of PLFA analysis for detecting extraneous contamination. However, it is unfortunate that benthic microbiological work at Signy Island (inaccurately described as sub-Antarctic) has been omitted.

The chapter by J.T. Staley and R.P. Herwig synthesizes a broad remit on particulate organic degradation, ranging from marine particulate matter and penguin rookeries to moss communities. Decomposer activity in the maritime Antarctic is contrasted with continental Antarctica and the sub-Antarctic. Particulate substrates include recalcitrant molecules such as chitin (in exoskeletons of invertebrates such as krill and in terrestrial fungal hyphae), keratin (fur and feathers), cellulose (cryptograms and grasses), and more labile uric acid (penguin guano). Attention is given to the consumption of krill by predators and the importance of their gut microbiota.

Cyanobacteria receive minimal attention in any of the marine chapters. Does this mean that they are insignificant in the Southern Ocean despite references to picoplankton, or that nobody has looked for them? The marine chapters are lacking in references to European Antarctic microbiological research, and the comprehensive international BIOMASS programme (Biological Investigations of Marine Antarctic Systems and Stocks) is mentioned only briefly. Nevertheless, this group of chapters contains a

wealth of information on the microbes of Antarctic marine ecosystems.

In a large volume of disparate chapters, a detailed index is necessary to follow themes between accounts. This index is occasionally limited for this purpose. It suggests that cyanobacteria are not found in Antarctic seas, despite their listing amongst general marine picoplankton in chapter 3 and benthos in chapter 5. However, a separate complete taxonomic and geographic index to the book has been prepared by A.B. Thistle, listing more than 1500 items (compared with approximately 500 items in the original) with several thousand references to the text. It is available free of charge from Polar Desert Research Center, Department of Biological Science, Florida State University, Tallahassee, Florida 32306-2043, USA (phone: 904-644-5438).

Although the terrestrial and freshwater environments section lacks an introductory paper, the first chapter of the terrestrial group is very welcome, as it is the only comprehensive account in English by S.S. Abyzov of the isolation of viable microbes from the deep ice cores drilled at Vostok station, central Antarctica. It assesses contamination risks and confirms the detection of viable bacteria up to 200,000 years old. The account summarizes the occurrence of bacteria, yeasts, and fungi at various depths and the significance of differential longevity and spore-formation. The detection of mesophiles and normally soil-inhabiting actinomycetes is suggested as evidence of long-range transport from more northerly regions. SEM photographs illustrate cytoplasmic denaturation with increasing age whilst retaining adequate ultrastructure to sustain viability. Comparisons with Gilichinsky's Siberian permafrost cores containing viable bacteria millions of years old would have been valuable. This chapter is an important contribution from the Russian literature.

H.S. Vishniac's account of soil microbiology presents essential taxonomy in a stimulating style underpinned by the issue of indigeneity. Information on microbial diversity from disparate sources is integrated skilfully. Bacteria, yeasts, fungi, and protozoa are discussed thoroughly, although cyanobacteria and microalgae are barely mentioned, despite their significant role in primary colonization of moist Antarctic soils. The author's specialism in ecophysiology is evident in her discussion of environmental factors, especially in interpreting water availability. She contrasts the xerophytic indigenous yeasts in the Ross desert with those thriving in saturated moss carpets at Signy Island. After a review of nutritional factors, the account finishes with an overview of microbial community structures and a provocative discussion of Antarctic deserts as an environment 'too harsh for life?' (page 326).

The chapter on terrestrial lithic (rock) communities, by J.A. Nienow and E.I. Friedmann, is a definitive review of Antarctic lithophytic ecology. It covers the interaction between microbes and substratum as influenced by the 'nanoclimate' of the microhabitat and short growing sea-

son. Referenced tables and figures summarize the microclimate, edaphic factors, structure, and taxonomy of distinctive communities, which are well-illustrated with light- and SEM-photographs. Although endolithic communities are emphasized, chasmolithic (crack-dwelling), hypolithic (under stones), and epilithic (surficial) communities are also described. Analysis of ecophysiological processes includes the influence of temperature, moisture, light, and substratum structure, and conversely, the microbial weathering of rocks. Deleterious effects of excessive visible light radiation are described, but not the effects of UV-B under the ozone hole. The remarkable longevity of endolithic communities (up to 10,000 years) is discussed in relation to the exobiology of Mars, which is reviewed later.

The microflora of hot soil sounds incongruous for a volume on Antarctic microbiology. However, the volcanoes of Ross Island, northern Victoria Land, and Deception Island provide an unusual opportunity to study microbial dispersal, colonization, and biogeography as described by P.A. Broady. The author gives a well-illustrated, first-hand account of the localised but significant habitats of fumaroles, which support species not found elsewhere in the Antarctic. Algae at high altitude on continental volcanoes occupy a niche equivalent to that of mosses near maritime Antarctic fumaroles. The insularity of these volcanoes is shown by species differences between Mt Erebus and Mt Melbourne, both in the McMurdo Sound region.

A chapter by L. Kappen lays refreshing emphasis on the ecophysiological role of lichens in Antarctica rather than traditional taxonomy and distribution. Good illustrations show the relevance of morphological and ultrastructural diversity. The account stresses interactions with the habitat, such as biological weathering. The author's expertise authenticates sections on adaptation of lichens to moisture availability, their mechanical resistance to disruption, wind, snow and ice, and their response to the delicate balance between temperature, relative humidity, and snow-lie. The account of effects of high light intensity could have been enhanced by consideration of resistance to escalating UV-B radiation, to which Antarctic lichens are vulnerable in spring. Productivity is contrasted between Arctic and Antarctic and within southern seasons.

G.M. Simmons Jr and others declare their intention to focus on microbial activity in water bodies south of the Antarctic Circle. As this volume does not have a parallel contribution for the maritime Antarctic, the overview of microbial limnology is therefore unbalanced. The decision to exclude Signy Island (again erroneously referred to as sub-Antarctic) omits the unique long-term data set accumulated for a diversity of lakes ranging from proglacial to eutrophic under recent invasion by fur seals. It excludes findings on sediment micropalaeontology, methanogenesis, lake turnover, and microbial loops that are activated annually by cyclic ice cover. The chapter also omits valuable

work done by other nations, such as Estonia, in the Schirmacher Oasis. Having said that, the review of continental lakes is thorough. It deals with water bodies that have a perennially frozen cover or are frozen solid, or are so saline that they never freeze. Meltwater-fed Dry Valley lakes are compared with atypical lakes of marine origin in the Vestfold Hills. Diverse aspects of the lakes' environment include ice cover, sediment deposition, and light regimes, but skim lightly over the remarkable temperature inversion that characterizes Lake Vanda and the eminently high osmotic stresses of Don Juan Pond. Plankton are discussed in relation to productivity and chemical processes at various depths. The excellent section on the dominant benthic microbial mats (modern stromatolites) is very well-illustrated. It draws attention to their formation being due in part to the conspicuous absence of disruptive metazoans. This chapter captures the uniqueness of Dry Valley limnology.

A contribution by W.F. Vincent and others concisely encapsulates the distribution, diversity, and characteristics of microbiota in flowing waters throughout the Antarctic. Attention is drawn to the 'ubiquitous presence of abundant cyanobacteria in the large majority of Antarctic streams' (page 544). Transient water flow considers sediment load and nutrients. Habitats include rock faces, ice, and saturated mineral soils, dealing with the colonization of soils by cyanobacteria, algae, and diatoms omitted from the earlier chapter. Assessment of photosynthesis and respiration by the microflora is synthesized into conceptual models of growth and loss processes. The influence of nutrients and temperature are discussed along with survival characteristics such as freezing resistance and protection against high-light intensity and UV-B. The illustrations are outstanding.

The chapter by H.G. Muchmore and others is different from the rest, as it concerns the microbiology of the warm homeostatic environment within the human being. Nevertheless, it relates closely to environmental issues. Viability in viruses for growth in cell lines in research hospitals is sustained by growing the cells in field stations. A thorough account is given of long-term studies of staphylococcal and streptococcal distribution within Antarctic communities. Parallels drawn between communities in Antarctic stations and future Mars missions lead appropriately into the next chapter on exobiology by C.P. Mackay.

The McMurdo Dry Valleys region was used in the early 1970s to test life detection systems for the NASA Viking Mars lander vehicle. A photograph from a Mars orbiter shows meandering dry river beds, and the author ably presents the physical evidence for liquid water in former habitats and potential current habitats such as river-bed permafrost. He also discusses the importance of ice cover on former Martian lakes in sustaining favourable physical and chemical conditions long enough for life to originate and evolve. He reviews the possibility of endolithic growth on Mars equivalent to Antarctic systems, and the likelihood of finding chemical and morpho-

logical fossils of endoliths. While referring to lake- and stream-beds as possible sources of residual life, it is surprising that he, too, does not cite the work of Gilichinsky on ancient permafrost microbes, which adds impetus for further microbiological Mars missions and their evaluation in Antarctica.

To maintain the validity of their research, scientists must protect their working environment. It is therefore appropriate that this book ends with a review by S. Draggan of Antarctic sites either protected specifically for microbiological reasons, or of incidental microbiological value. Protection policies and the status of Specially Protected Areas (SPAs) and Sites of Special Scientific Interest (SSSIs) are explained.

The preservation of these unique Antarctic sites rounds off a very comprehensive review volume. It is a shame that it is so highly priced as I recommend it highly as a reference work for all who wish to research into the microbiology of this uniquely challenging region. (D.D. Wynn-Williams, British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET.)

**DEAD SILENCE: THE GREATEST MYSTERY IN ARCTIC DISCOVERY.** John Geiger and Owen Beattie. 1993. London: Bloomsbury Publishing. 219p, illustrated, hard cover. ISBN 0-7475-1185-3. £16.99.

On 6 June 1719 two vessels of the Hudson's Bay Company sailed from London, bound for Hudson Bay to search for the Northwest Passage, the first such expedition since those of Captain Thomas James and Captain Luke Foxe 88 years previously. The ships were the frigate *Albany*, 80 tons, built in 1716, which had already made two voyages to the Bay, under the command of Captain George Berley, and a small sloop, *Discovery*, specially built for the expedition, under the command of Captain David Vaughan, who had served as a sloop-master in the Bay. Total complement of the two vessels was about 40 men. The ships were well stocked with flour, bread, butter, bacon, stock fish, beef, and pork, as well as with materials for building winter quarters, including 3500 bricks, lime, and lumber.

In overall command of the expedition was James Knight, aged around 70. Knight had first joined the Company as a carpenter and shipwright in 1676. In the intervening years he had risen to the position of 'Governor in the Bay,' and among his varied achievements had recaptured *Albany* from the French in 1693, accepted the surrender of Fort Bourbon (York Factory) from Nicolas Jérémie after the Treaty of Utrecht in 1714, and, in 1717, established the Company's post at the mouth of the Churchill River, which later became Fort Prince of Wales.

During his years in the Bay, Knight had repeatedly heard stories from the Chipewyan of a location to the northwest where native copper was readily obtainable, and, even more alluringly, stories of Indians that 'bring a Yellow Mettle.' Knight had therefore formulated a plan that became an obsession, to search for these minerals in conjunction with a search for the Northwest Passage to the