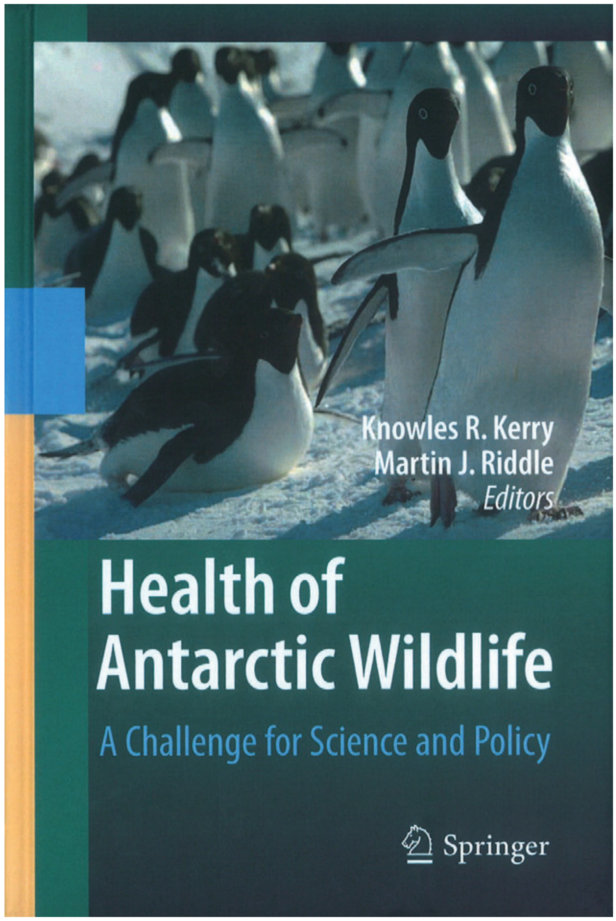
BOOK REVIEW

Review of *Health of Antarctic wildlife: a challenge for science and policy*, edited by Knowles R. Kerry & Martin J. Riddle (2009). Dordrecht: Springer. 470 pp. ISBN 978-3-540-93922-1.

Climate change and disease, among other factors, play an important role in the regulation and evolution of animal populations through the differential survival of individuals (Holmes 1996; Harvell et al. 2002). The study and monitoring of disease is important because diseases are likely to be spread more rapidly now than in the recent past because of increased globalization and rapid human-induced climate change (Daszak et al. 2000; Ward & Lafferty 2004). Antarctic wildlife offers a unique opportunity to study disease spread in terms of globalization and climate change because: (1) Antarctic animals are increasingly exposed to humans and other disease vectors, such as introduced species; and (2) there is strong evidence of climatic changes in and around Antarctica (Mayewski et al. 2009), which together may affect the composition and virulence of pathogens or increase the overlap between Antarctic and other seabirds and their parasites (e.g., Kovats et al. 2001).

In their new book, *Health of Antarctic wildlife: a challenge for science and policy*, two pioneer researchers of the effects of humans on Antarctic wildlife, Knowles Kerry and Martin Riddle, bring together what is known about disease prevalence and the management of disease outbreaks in the Antarctic. This book and its many contributors—28 in all—provide an up-to-date overview of the health of Antarctic birds and seals. For any practising biologist, ecologist or veterinarian interested in Antarctic biology this book is immensely valuable, not only because it brings together information from a wide range of fields and expertise, but also and perhaps most critically it describes exactly how suspicious die-offs should be treated to minimize the potential spread of disease, and to reduce the risk to the human researchers most likely to discover such events.



Antarctica is unlikely to share many of the diseases found in the neighbouring southern continents on account of the temporal (many millions of years) and geographical/spatial isolation of the continent by the Southern Ocean, which forms a functional barrier across which few animals, among them, birds and seals, can cross. Most animals in Antarctica and on the surrounding sub-Antarctic islands have evolved in relative isolation, which has limited their contact with disease and inhibits the introduction of vectors or intermediate hosts, such as ectoparasites. Consequently, Antarctic animals are likely to have reduced immune capabilities for fending off introduced disease. Indeed, there have been only two reported cases of mass mortalities of Antarctic wildlife: one of crabeater seals (*Labodon carcinophagus*) and one of Adélie penguins (*Pygoscelis adeliae*) (Laws & Taylor 1957; Gardner et al. 1997); two smaller, more insidious, mortality events occurred in the sub-Antarctic involving the Amsterdam albatross (*Diomedia amsterdamensis*) and Hooker's sea lions (*Phocarctos hookeri*) (Weimerskirch 2004; Wilkinson et al. 2006). However, the wildlife in Antarctica is no longer as isolated as in the past because of the ease of transport to Antarctica and the increasing number of people visiting

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the southern polar regions, including scientists, fishers and tourists, a topic covered comprehensively in *Health of Antarctic wildlife*. Not only are more people visiting the Antarctic, but rapid and widespread travel within Antarctica is now commonplace. This behaviour increases the risk of disease spread, endemic and introduced alike. Whereas disease spread is not a novel concern (Murray 1964), the issue of disease introduction has, until the publication of *Health of Antarctic wildlife*, received relatively little scientific attention in Antarctica. One possible reason for this is that little is known of diseases in Antarctic animal populations, in particular the introduction of disease, and probably more importantly the manifestation of as yet undiscovered or mutating diseases (for an example of a recently discovered novel virus, see Linn et al. 2001). Another explanation may have to do with the rarity with which diseased individuals are observed. This may change if disease outbreaks occur more frequently or if they are more readily observed because of increased scientific observation in Antarctica.

Animal behaviour, including human behaviour, is an important component in the spread and maintenance of disease (McCallum et al. 2001). As such, it is important that it forms the basis of any assessments investigating or managing disease. Sadly, in *Health of Antarctic wildlife*, animal behaviour other than human behaviour receives little focused attention, as do life-history studies in general (see below). Of particular concern for the spread of disease is the human propensity to alter ecosystems through their behaviour, e.g., habitat modification and the introduction of invasive species, thereby altering the behaviour of animals. This brings into contact species that otherwise would have very low chances of interacting, increasing the probability of disease spread. Moreover, the fact that many Antarctic taxa such as seals, penguins and Antarctic petrels form dense aggregations highlights how animal behaviour can promote the easy intracolony spread of disease. Because most colonies tend to be separated by large distances, the potential for intercolony infection is probably low, but this is currently difficult to quantify because of the paucity of species-specific behavioural information. Little is known of individual animal movements between breeding colonies and/or the extent of mixing between populations. Diseases can be spread between colonies via other means, such as predators and scavengers. The south polar skua (*Catharacta maccormicki*) is such a predator/scavenger. Skuas are mobile predators that feed/scavenge on all Antarctic taxa, and travel freely between the Northern and Southern hemispheres (Devillers 1977), and may therefore be significant contributors to intercolony disease spread. The clear need to integrate animal behaviour, e.g., migratory and dispersal behaviour, and animal biology and ecology in general, receives little coverage in *Health of Antarctic wildlife*, in contrast to the study of human behaviour.

Human activity in Antarctica can promote disease spread and outbreaks by a number of direct and indirect mechanisms, and this is covered thoroughly in *Health of Antarctic wildlife*. People may act as vectors for infectious agents, either by bringing non-indigenous pathogens into the region or by translocating indigenous pathogens. Although humans are not the only mechanism for disease incursion to Antarctica, they are an important mechanism for disease or pathogen introduction because of their mobility and diets. Of particular concern are imported poultry products, including eggs, egg powder and frozen or freeze-dried meat, which may be sources of viruses and bacteria that are pathogenic to humans, seals and seabirds. Poultry has been linked to the transmission of Newcastle disease in Antarctic seabirds, and because antibodies to Newcastle disease have been found in many birds (e.g., Gardner et al. 1997, and references therein), it follows that viral (and other) diseases, such as avian influenza, can be easily transmitted to Antarctic birds through foodstuffs regularly consumed by humans in Antarctica. Vehicles, equipment and clothing used in Antarctica can also carry pathogens if they are used for recreation, training or work in other locations before being used in Antarctica.

Human activity may also result in stress to wildlife, a major contributing factor to the outbreak of disease (Lafferty & Holt 2003). Humans may cause animals stress by polluting the Antarctic environment (e.g., discharging sewage into the ocean from research stations or ships at sea) or by creating food shortages, as when fisheries compete for the same food stocks. Researchers and tourists disturb animals in other ways. Stress to animals may also be induced by climate change and habitat destruction, and fragmentation that results from human activities. It is often thought that because Antarctic species are well adapted to survive under extreme environmental conditions that they are immune to environmental stress—this is clearly not the case.

Prevention in most cases is probably the most effective way of dealing with diseases in Antarctica, simply because it is not easy to observe clinical ante-mortem symptoms in the field. To prevent pathogenic disease from being introduced into Antarctica, strict quarantine measures need to be implemented, and it is encouraging to note that there are now strict pre-departure checks in place to restrict the accidental introduction of pathogens. The problem here is one of compliance, especially on illegal vessels (generally fishing vessels) entering Antarctic waters. Such illegal vessels, many of which originate in Asia, where diseases like avian influenza are prevalent

(Webby & Webster 2001), are of particular concern and high risk. This risk is exemplified by the presence of avian influenza antibodies in Antarctic seabirds (Morgan & Westbury 1988; Austin & Webster 1993), indicating that these birds have at some stage been exposed to the virus. Of concern are the high mutation rates of viruses: it is feasible that a benign form may under certain circumstances (e.g., climate change) morph rapidly into a virulent form that bypasses the immune response, resulting in serious pathological consequences and pandemic disease. *Health of Antarctic wildlife* makes an important research and practical contribution by highlighting the quarantine measures that Australia in particular is taking to limit the probability of disease introduction into Antarctica. Such proactive quarantine measures are likely to be the most effective way of limiting potential disease outbreaks.

Much remains to be learned about disease in Antarctic wildlife if the risk of disease introduction is to be managed effectively. Little information is currently available on which to base reliable risk assessment. Sound research and long-term monitoring programmes will reduce the risk of large-scale infections and reduce the vulnerability of wildlife in Antarctica to disease outbreak. *Health of Antarctic wildlife* provides an invaluable first step to achieving this by summarizing what is known to date and delineating practical measures to manage outbreaks. The book also outlines the key research requirements that will contribute to the better understanding and management of disease in Antarctica, including:

- Baseline information on disease agents so that native and exotic disease agents can be distinguished and regional and seasonal variation of disease can be understood.
- Baseline information on population size, health status, mortality, migratory behaviour and population dynamics.
- The distribution and abundance of potential pathogens.
- The processes that promote disease outbreak, e.g., climate change and stress.
- The survival of pathogens on foodstuffs, vehicles and clothing.
- The effectiveness of Antarctic sewage treatment to remove pathogens.
- The likelihood of transfer of pathogens.
- Monitoring affected populations, and recovering corpses to confirm disease occurrence.

Diseases play an important role in evolutionary and ecological processes, so collecting this kind of information, along with developing practical methods for the on-site investigation of disease incidents, will undoubtedly contribute to the ultimate aim of sound conservation of a unique part of our planet.

Although *Health of Antarctic wildlife* covers much ground thoroughly, I was left wondering where the papers on population ecology and demography were. Animal life history can have a profound effect on the spread or maintenance of disease in populations. Information regarding animal movement and habitat use, how animals interact with one another and other animals, how population density affects animal interaction and movement, and how changes in population size affect animal behaviour are all vital pieces of information to map and assess the spread of disease. Ultimately life-history and vital-rate information are crucial components needed for designing and implementing management strategies, such as the management of badgers in the UK to curtail bovine tuberculosis (Woodroffe et al. 2009). Indeed, an increasingly important component of managing disease is to use models to simulate and predict potential rates of spread. Such models rely heavily on basic life-history information as inputs to quantify the rates at which animals will re-invade areas from which animals were removed: either killed by disease or culled to control disease. Given the importance of integrating life-history information and disease behaviour to inform effective disease management and control, it was a little disappointing that this did not receive more attention in the book. A section describing and perhaps even presenting some easy-to-use tools that assess the effectiveness of removing animals for disease control (Jenkins et al. 2008), or a section on how life history and environmental variability interact to drive disease spread, would have been most informative. Many of these tools have only been developed very recently (e.g., McMahon et al. 2010), and serve as motivation for a future Antarctic wildlife health symposium.

It has been 10 years since the symposium upon which this book is based was held, and it is timely, perhaps even overdue, that a follow-up symposium be held. Given the importance of a broad ecological context, such a symposium might build on the excellent groundwork of this first meeting by taking a broader view of health in the Antarctic by contextualizing the role of disease and health in managing the Antarctic ecosystem as a whole: taking a "one-health approach" (Daszak et al. 2007). This collaborative approach to understanding the processes of disease emergence links veterinary medicine, public health and ecological approaches in a single framework underpinned by evolutionary theory. This would not only greatly advance the field of study, it would also provide a framework from which to develop coordinated projects with the single goal of ensuring a functional ecosystem, by defining the role of disease in driving population change. The dynamics of disease emergence are complex and an integrated process such as the one-health approach is the best way forward for developing a sound understanding of the mechanics of disease emergence and its effective management or containment.

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 Polar Research 29 2010 463–466