

BOOK REVIEW

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Reindeer and Caribou: Health and Disease.

First Edition. Edited by Morten Tryland and Susan J. Kutz. CRC Press Taylor and Francis Group, Boca Raton, Florida, USA. 2019. 534 pp. ISBN 9781482250688. US\$205.00 (hardback), US\$184.50 (eBook).

Margaret A. Highland

Reindeer and Caribou: Health and Disease is a first edition textbook that beautifully brings together a comprehensive array of information on *Rangifer tarandus*. Summarizing a wealth of information in an easy-to-read format, this text is sure to be the go-to reference for this species. Considering the range of information, which is a compilation of multiple authors with expertise in the subject areas covered, the text is well organized and filled with hundreds of beautifully captured and displayed illustrations. The 294 color and 15 black-and-white illustrations include images, diagrams, and tables that effectively support and summarize data and concepts. Information within each of the 16 chapters is well referenced with hundreds of citations provided appropriately after each subsection, making this textbook a thorough review of the literature.

Chapter 1, "Introduction," sensibly starts with an introduction to the history, ecology, sociologic and economic importance, biology (reproductive emphasis), and taxonomy of caribou and reindeer and provides definition for these two vernacular names given to the single species *R. tarandus*. Chapter 2, "Rangifer Health: A Holistic Perspective," goes on to set the stage for the remainder of the book,

providing a holistic perspective on health and disease. The authors provide an excellent reminder to the reader that understanding and managing this balance require a broad view, one that looks beyond infectious and/or noninfectious agents alone. Although this concept is often depicted as a Venn diagram representing the epidemiologic triad of disease, which in basic form includes the host, agent, and environment, the authors provide a more extensive perspective and an illustration of extrinsic and intrinsic factors, or determinants, that influence *R. tarandus* health. Although the provided diagram centers on *R. tarandus*, the concept can certainly be extrapolated to the health of other animals, and humans alike. The bulk of this chapter provides an overview of the impact of environmental determinants (extrinsic factors) on intrinsic factors, particularly on stress and immunity, and provides a reasonably detailed account of the physiologic impact of stress on animal health.

Chapter 3, "Rangifer Diet and Nutritional Needs," is subdivided into six sections that logically move from requirements (i.e., seasonal habitats, the function of the ruminant gastrointestinal tract in nutrient acquisition, nutritional physiology at differing reproductive stages and seasons) to deficiencies, starvation, and how to assess body condition. The sixth subsection rounds out this chapter by discussing the effects of nutrition on population dynamics, reproduction, and management. Discussion and references are presented for considering whether *Rangifer* populations are limited by predation and harvest or by ongoing habitat changes (e.g., human fragmentation/development or cli-

mate) that threatens abundance of available forage of required quality. Although Chapter 3 focuses on free-ranging *Rangifer*, Chapter 4 is divided into 2 subsections that cover nutritional requirements and disease related to captive feeding. The first subsection covers feeding strategies, from adult nutritional recommendations and requirements to an in-brief section on bottle-feeding young. The second section describes diseases that have been identified in association with feeding captive reindeer and providing supplementary feedstuff and nutrients to free-ranging reindeer.

Chapters 5–9 describe diseases of *Rangifer*, beginning with noninfectious and traumatic diseases in Chapter 5 followed by infectious diseases in Chapters 6–9, which are categorically separated into the four main infectious disease agents, organized from largest to smallest: parasites, bacteria, viruses, and prions. Noninfectious diseases are divided into subsections on malformations, trauma, poisoning, miscellaneous, and neoplasia. A few highlights from this chapter include 1) a table of malformations that provides the medical terms and a brief layperson description for each malformation that has been identified in *Rangifer*; and 2) brief, yet useful, descriptions of predatory injuries for aiding in identifying the culprit in cases of traumatic predatory injuries and kills. The parasite chapter begins by defining what a parasite is and provides an excellent reference table that describes each parasite by affected host organ system and clinical impact, before going on to provide more detail for each type of parasite (i.e., helminth, protozoa, arthropods) in subsequent subsections. The bacterial chapter is divided into subsections by disease entity (e.g., Pasteurellosis) and seems to provide a thorough list of bacteria and supporting references for agents reported to cause, or be associated with, disease in *Rangifer*. Although *Mycoplasma ovipneumoniae* is mentioned briefly to describe a study that reported seronegative results from a wild reindeer herd in Norway, since publication of this textbook, *M. ovipneumoniae* has been reported in the respiratory tract of healthy caribou and in association with fatal polymicrobial pneumo-

nia in a yearling caribou in Alaska (Highland et al. 2018; Rovani et al. 2019).

Chapter 10, “The Impact of Infectious Agents on *Rangifer* Populations,” brings conclusion to the preceding infectious disease chapters by outlining ways to understand and quantify the impact of infectious agents at the population level. This includes, from the perspective of someone with minimal knowledge on the topic, an easy-to-understand, yet fairly detailed overview of the use of mathematical modeling in wildlife disease and management. As with other chapters, the reader is provided with well-organized and useful tables that define terms and outlines concepts described in further detail within the chapter. Albeit interesting in concept, there is a brief subsection on the impact of parasites, food, and weather interactions specifically on Soay sheep (i.e., a breed of domestic sheep) that seems out of place for this textbook, as the connection to *Rangifer* is not stated or obviously implied.

Chapter 11, “Meat Quality and Meat Hygiene,” describes the use of reindeer in wild and farmed husbandry operations as an agricultural source of commercial meat for human consumption. Fennoscandia (i.e., Sweden, Norway, Finland) and Alaska are the main regions of focus for the information provided within this chapter. Provided early on is an interesting section on the concerns and monitoring of anthropogenic radioactive compound accumulation in reindeer and thus in meat, particularly in Fennoscandia. Although nuclear testing and the Chernobyl accident happened decades ago and contamination has since declined, the lasting effects persist. The authors prudently describe the necessity for, and results of, the continued monitoring on live animals and meat. Holding with the theme of this text overall, this chapter seems inclusive in content, providing information on 1) the impact of preslaughter handling and stress, feeding and body condition, and carcass handling on meat quality; 2) chemical composition and sensory (e.g., taste, texture) quality; and 3) regulations (meat inspection and grading) on commercial production. Ideally, this chapter would have perhaps been better placed either preceding the chapters on disease or following the

subsequent chapters (Chapters 12–15) that provide information on topics relevant to health and medical care, management/husbandry, and handling.

Chapter 12, “Assessment and Treatment of Reindeer Diseases,” provides 4 subsections on evaluating animal health and environmental adequacy, diseases described by specific body regions or organ systems (e.g., head, hooves, respiratory, digestive) and nutritional deficiencies, and generalities on medicating reindeer and monitoring health, including a general overview on how to perform a field necropsy. Although there is a lack of detail on drugs and dosing in retrospect, this seems appropriate, as specific medical management and treatment strategies for wildlife are described in other textbooks, such as *Fowler’s Zoo and Wild Animal Medicine*, now in its ninth volume (Miller et al. 2019).

Chapter 13, “Haematology and Blood Biochemistry Reference Values for *Rangifer*,” provides multiple reference tables. The authors describe the effects that handling and chemical immobilization may cause on these values as well as differences between subspecies of *Rangifer* and young and adult. Four reference tables are provided to describe different biochemical values in several subspecies under chemical or physical restraint conditions.

Chapter 14, “Caribou and Reindeer in Parks and Zoos,” is a relatively short chapter that covers topics similar to those in other chapters (e.g., husbandry requirements, nutrition, infectious and noninfectious diseases, preventive medicine, restraint, physical examination, diagnostics and surgery). Although there may be benefit to those specifically looking for information on *Rangifer* kept in zoologic facilities to have this information within one chapter, it seems this topic could have been distributed reasonably within other appropriate chapters.

Chapter 15, “Restraint and Immobilization,” covers physical capture and chemical immobilization techniques used for handling wild and (semi-)domesticated *Rangifer*, monitoring vital signs, and measuring assessable physiologic responses to handling stress. This chapter provides a nice scope of information on various physical capture techniques (e.g., helicopter net-gunning, drive-nets, netting from snowmo-

biles, water capture, corrals) and information on the use of immobilizing drugs on caribou and several subspecies of reindeer. Although the authors preface this subsection on immobilizing drugs by referring the reader to more in-depth reference texts on veterinary anesthesiology, this chapter provides a nice overview of restraint chemicals and a table of recommended drug doses and administration protocols for reindeer and caribou. As with all chapters, it seems no information is included without thorough referencing of the published literature.

Chapter 16, “Climate Change: Potential Impacts on Pasture Resources, Health and Diseases of Reindeer and Caribou,” provides a prudent finish to this engrossing book. The title thoroughly describes the content of this section without further review.

This is a valuable contribution to this specific field. The authors have painstakingly composed this piece on the species *R. tarandus*. The few related issues seemingly not described in adequate detail are most certainly covered via an exhaustive list of references to support the major concepts that are presented at a minimum. I fully appreciated the opportunity to read and review an eBook form of the text and recommend it to others with a professional interest in this species.

LITERATURE CITED

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