TUNDRA-TAIGA BIOLOGY: HUMAN, PLANT, AND ANIMAL SURVIVAL IN THE ARCTIC. Robert M.M. Crawford. 2013. Oxford: Oxford University Press. 270 p, softcover, illustrated. ISBN 978-0-19-955940-4. £75.00.

This textbook of tundra-taiga biology by R.M.M. Crawford, Professor Emeritus at the University of St Andrews, Scotland is an extremely welcome up-to-date review about human, plant and animal survival in the Arctic. It provides a circumpolar perspective on adaptation of terrestrial animals and plants inhabiting the cold climate regions of the tundra and adjacent boreal forest (taiga). The questions related to evolutionary capacity of both plants and animals to adapt not only to short growing seasons, low temperatures and unpredictable/unstable conditions in general, but also those questions related to their responses to global warming and (other) anthropogenic disturbances are the focal themes of the book. The book is based on carefully selected case studies conducted by field observations and/or laboratory experimentation, with examples of an enormous range of adaptations evolved in Arctic biota. The variation of the adaptations in form, function, and behaviour discussed are 'a reflection of the heterogeneous nature of the Arctic environment and the extraordinary facility for the evolution of a diverse range of adaptations, with each one suited to a particular niche or life style' (page 145).

The structure of this text book is clear and it consists of ten chapters, each of them divided into sub-chapters and followed by brief conclusions. In chapter 1, after defining the Arctic and presenting the main characteristics of polar climates, the author discusses polar climatic history including Cainozoic temperature changes and Pleistocene climate changes. The Arctic regions have endured a turbulent climatic history, especially throughout the Pleistocene, that is the first of two periods of the Quaternary geological epoch which lasted from about 2.588.000 – 11.600 years ago, spanning the world's recent period of repeated glaciations. The author concludes that further research into the relationships between global upwelling of ocean currents and the atmospheric CO_2 content is needed to gain a better understanding of the history of the Pleistocene epoch.

Chapter 2 discusses the Holocene in high latitudes, that is the geological epoch that began at the end of the Pleistocene around 12.000 – 11.600 or 11.200 BP and continues to the present. A question of whether or not Arctic and high alpine organisms survived the Last Glacial Maximum in favourable localities is discussed in the light of most recent studies. Past distributions of flora and fauna linked for example to glacial *refugia* are presented, highlighting the evidence from recent studies using for instance radionuclide dating, pollen analysis and different molecular genetic tools. Chapter 3 'Human arrival in the Arctic' opens up with a description of prehistoric Arctic peoples and human arrival in North America. Indigenous peoples of Arctic Eurasia and Arctic America are presented shortly and examples of their livelihood adaptations, for example hunting, fishing, gathering and herding cultures, to the unpredictable environmental fluctuations are noted.

Chapter 4 focuses on tundra diversity. A major classification of tundra types with comparison of differences in North American and Eurasian classification schemes for Arctic vegetation and with a circumpolar vegetation map is presented. This is followed by a description of diversity of tundra soil formations and tundra diversity of animals. Chapter 5 presents boreal forest and bog diversity with issues discussing for example the tundra-taiga interface, krummholz and the role of fire in the boreal forest, followed by northern mires (with a table about confusing wetland terminology) and the main mire types. Boreal forest grazers including reindeer/caribou, elk/moose and beavers, as well as insects and carnivores with examples of brown bears and wolves are considered.

Chapters 6, 7 and 8 document numerous and detailed up-to-date examples about diverse survival strategies of mammals, birds, insects and plants in cold habitats. When conditions for survival are at their limit, even a very small drop in temperature or a delay in the onset of spring can be a rigorous selective force and may have far-reaching ecological consequences on the viability of populations. Survival at sub-zero temperatures, as with most environmental stresses, bears two possible alternatives: tolerance or avoidance. Both are discussed. Energy conservation is achieved through variety of morphological and physiological adaptations, or seasonal migration depending on the ecological life strategy of the species, sub-species or local populations. In chapter 8 'Demography and reproduction' the author draws the reader's attention to the outstanding feature of the Arctic biota to repair decimated populations facing frequently catastrophic reductions, by sexual reproduction or also asexually as in the case with plants.

The author has managed to create a skilful balance between different topics of the chapters. I was particularly delighted to see the large amount of text devoted to climatic history and evolution in the Arctic as it gives long-term historical perspective for the topics discussed. Polar regions have always experienced frequent climatic fluctuations both in the short and long term, which have been manifested as a regime of environmental uncertainty. The author notes that as the thermal regime oscillates, so does the selection pressure on different species and subspecies operate, sometimes favouring one form sometimes another. An example of Arctic bears which have had a long and varied evolutionary history in the Arctic is given. Bears as a species will not disappear, because the polar bear is still capable of hybridizing with both the Siberian brown bear and the Grisly bear. Instead, even a wider range of bear species may evolve capable of utilizing the changing and possibly more productive high-altitude ecosystems.

The discussion on the human role in the Arctic in the past and present builds bridges towards a more holistic approach of this tundra-taiga biology book. Disturbance, pollution, conservation, and the future (chapter 10) discusses issues related to conservation, albeit rather shortly, and focuses on the case histories of polar bear, muskoxen and wild reindeer, and to pollution including heavy metals, oil, persistent organic pollutants (POPs) and radioactivity. As noted in the case studies on the effects of radioactivity on Arctic soils the author notes that despite many well-documented examples of nutrient retention in unproductive habitats it was an astonishment to the scientific community that radioactive substances were retained for so long in Arctic and sub-Arctic soils. Before the scientific studies were conducted, it had been earlier anticipated that rainwater, leaching, and snowmelt would

remove the radioactive ions from shallow unproductive boreal and tundra soils. But, as the author shows, this was not the case.

The relative proportion of the text and figures in this book is ideal and it is beautifully illustrated with high-quality coloured photographs, diagrams and maps, which are helpful in defining the locations of the particular case studies. All these easily attract reader's attention and greatly increase the readability of the book. The book, and particularly its non-scientist readers, would have benefited from a more thorough glossary at the end, however. Few of the terms are briefly defined in the tables within the text and those requiring more extensive definition are explained in a glossary. In my opinion, this book is a very high-quality text book and an informative picture book. Therefore I can highly recommend it not only for undergraduate and graduate students as well as professional lecturers, ecologists and conservation authorities, but also for all those who are interested in Arctic biology. This book is a very valuable and greatly enjoyable read in Arctic and tundra biology (Minna T. Turunen, Arctic Centre, University of Lapland, PO Box 122, 96101 Rovaniemi, Finland (minna.turunen@ulapland.fi)).

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