Preface

Do you remember the fascination with the incredible diversity of life forms you had when you pulled a sweep-net through the nearshore plants of a small pond? Or the feeling you had the first time you caught a fish in your childhood pond or lake? And how the frog eggs you collected and kept in the small tank one day had hatched into tadpoles? And how these small, black 'lawnmowers' were feeding on the algal mat and then one day they had metamorphosed into small frogs? Or, remember the joy playing along the shore or in the shallow waters of a lake during endless summers; a joy mixed with disgust of the muddy bottom sediments and the creepy feeling of water plants winding up your legs, or the scary belief that below the surface awaits an armada of leeches and other yet unknown creatures prepared for attack? Indeed, our feelings for lakes and ponds are individual and contradictory, and thus, our relations with freshwater systems are coloured by a mixture of joy, mysticism and even fright, but also by the knowledge that we to a large extent actually consist of water and that we therefore are a part of the endless merry-go-round of water through rain, landscapes, lakes, and organisms—the *hydrological cycle*. If you have ever touched upon such feelings, you have already taken a first step into understanding the intriguing world of freshwater systems! Man has always been fascinated by, but also dependent on, freshwater plants and animals and freshwater organisms provide an important food source and freshwater in itself is of course an essential resource for human life. Thus, it is of crucial importance to study and understand the dynamics of freshwater systems and, consequently, a specific branch of science has been devoted to this, namely, *limnology* (derived from the Greek word for 'lake', *limnos*).

Traditional limnology has used a holistic, ecosystem approach to the study of freshwater systems, focusing on physicochemical processes at the lake level (lake metabolism, nutrient cycles, lake classification). However, there has been a conflict among scientists whether abiotic *or* biotic processes are most important in shaping lake ecosystems. For a long time it was considered that abiotic factors, such as temperature and nutrients, were the major determinants of structure and function of lakes and ponds. Much less emphasis had been put on the importance of interactions between organisms, such as competition, predation, and complex interactions in food chains. But for quite a number of years now there has been an increasing interest in applying modern evolutionary and ecological theory to freshwater systems. This has

resulted in a large number of studies on physiological, morphological, and behavioural adaptations among organisms to abiotic and biotic factors and how interactions between biotic processes and abiotic constraints determine the dynamics of freshwater systems.

Throughout the world there is a tremendous variation in the size and permanence of waterbodies. They range in size from small puddles to the huge Great Lakes of North America and Lake Baikal in Russia. Some lakes are millions of years old, whereas at the other extreme ephemeral waterbodies are water-filled only during part of the year or perhaps even only during especially wet years. We also find standing waterbodies in all climatic zones, from Arctic regions where lakes are ice-covered during most of the year, to the tropical regions that experience high temperatures year-round. Of course, this large variation in spatial and temporal scale, as well as in climatic conditions creates a tremendous difference in the environmental conditions experienced by the organisms that inhabit these systems. Thus, organisms from different systems are expected to show a substantial diversity of adaptations to cope with their environment and to be specialized to a specific set of abiotic and biotic conditions. However, although organisms from different freshwater systems differ greatly, they have surprisingly many features of their ecology in common.

In this book we will focus on these general patterns in adaptations and processes found in freshwater systems. The emphasis is on lakes and ponds from temperate systems in Europe and North America, although we also have included examples from Antarctic, Arctic, and, further, in this third edition we have tried to add more information on dynamics of lakes in subtropical and tropical regions. This is, of course, due to our own personal bias, but also partly a result of the fact that most studies have been performed in northern temperate regions even if we now see an ever the more increasing number of brilliant studies also from other regions of the world. With respect to organisms, we use examples from animals, plants, and microbes wherever they are suitable to express or explain a certain process or principle. We have consciously given more emphasis to both larger (fish) and smaller organisms (ciliates, heterotrophic flagellates, bacteria and virus) than is the tradition in limnology textbooks. This expansion of the size spectrum of organisms is because research has high-lighted their importance for the structure and dynamics of freshwater systems.

In addition to focusing on general patterns and adaptations, we want to introduce the most important features of both aquatic ecology and traditional limnology. This has been a major challenge as we only had a limited number of pages to work with. We soon discovered that including all the themes that we originally planned was impossible. Instead, we have chosen to identify the niche between traditional limnology and modern evolutionary ecology. Therefore, the book covers far from all aspects of traditional limnology. The focus is instead on adaptations among organisms to cope with abiotic factors and the importance of biotic processes and interactions in food webs. Thus, we have presented our

own, highly subjective, distillation and blend of what we think is interesting and important to know for an aquatic ecologist at the beginning of his or her career. We have written the book mainly for the use of undergraduate students taking aquatic ecology/limnology courses but also for more advanced students who want to obtain an insight into the field of aquatic ecology. However, it is also our hope that it will be of interest to field naturalists and for those who enjoy strolling around lakes and ponds. The first edition of *The Biology of Lakes and Ponds* appeared in 1998 and we then revised it for the second edition that was published in 2005. The book has now sold more than 12 000 copies and is established as a textbook at many undergraduate courses in aquatic ecology and limnology in universities all over the world, which we are very proud of. The second edition has also been translated to Japanese, Chinese and Farsi. When asked by Oxford University Press to start working on a third edition we were initially a bit reluctant to take on the mission of upgrading the book, but our commissioning editor, Ian Sherman, convinced us in his, as always, gentle way.

Already when working with the second edition we received a lot of constructive comments and suggestions for changes from friends and colleagues and this has continued over the years. In the second revision we mainly expanded the chapters 'The Abiotic Frame' and 'Biodiversity and Environmental threats' in order to strengthen the discussion of the effects of physical and chemical factors on the biology of lakes and ponds and, further, the effects of environmental threats on the biodiversity of organisms. We also upgraded the text in general with new research findings and concepts. However, the scientific frontiers continue to move rapidly forward and our main mission and aim for this third edition has been to add new findings and to update examples with new research, insights and references. When starting the comprehensive reading and scanning of new literature prior to writing this edition, we realised that the area of environmental research had grown extensively during the last decade and as we wanted Lakes and Ponds to mirror expanding scientific fields, the last chapter (Chapter 6) on 'Biodiversity and environmental threats' is now substantially larger than before. Although this is unfortunate for our planet, we believe it important for readers of the new edition to know as much as possible about new environmental threats, such as climate warming, pharmaceuticals, nanoparticles and invasive species, in order to counteract threats and safeguard the aquatic environments for future generations. In addition, several other fields are expanded in different chapters in this new edition, including the importance of non-consumptive effects and subsidies in food chains, evolutionary aspects, such as rapid evolution and the growing area of eco-evolutionary interactions, and the importance of omnivory in subtropical and tropical lakes. Although this book is an introductory text to aquatic ecology and limnology, we have provided additional opportunities for more in-depth study by referring to more specialized books in *Further reading*. Moreover, at the end of each chapter, we have suggested some practical aspects, including experiments, field

studies, and questions for discussion. These features, together with the many illustrations and the *Glossary*, make the book suitable not only in traditional teaching, but also for independent study and, especially, in situations with only supervising teacher support, such as in problem-based learning (PBL). Finally, as we have got many requests over the years of using the figures of the book in teaching, we have now created a library for all figures included in the book to be freely used by teachers and students. The link to this site is: www.oup.co.uk/companion/bronmark&hansson. So, just start browsing the book, use it and enjoy! We hope that you as a reader will be satisfied with the new edition, including the easy access to figures and that this final (we promise) edition of *The Biology of Lakes and Ponds* will continue to be useful and enjoyable both for researchers and students.

We have written this book in close co-operation with each other and have had almost daily discussions over important as well as more cosmetic decisions during the writing process. We are therefore equally responsible for the final product and the order of authorship is alphabetic. However, writing a book is not something one does in isolation. We have had a lot of help from our friends and colleagues. Görel Marklund made all the beautiful line drawings; Marie Svensson and Steffi Doewes helped us with the layout and Colin Little, Mikael Svensson, Staffan Ulfstrand, Lars Leonardsson, Gertrud Cronberg, Lars Tranvik, Wilhelm Granéli, Tom Frost, Larry Greenberg, Ralf Carlsson and Stefan Weisner provided constructive comments on early manuscripts of the first edition. Several classes of Limnology at the Department of Ecology, Lund University and Environmental engineering at Lund Institute of Technology, have given helpful and encouraging comments. We also thank our fantastic editor Ian Sherman at Oxford University Press, who patiently and enthusiastically has encouraged us throughout the years. The Swedish Research Council (VR) provided funds for the illustrations. Special thanks to Nelson Hairston Jr. and Sr. for allowing us to use '*Étude*'.

Finally, now in the autumn of our careers, it is somewhat strange to realise that as we write this it is almost to the day (27th January 1994) twenty-three (23!) years since we were first approached by Cathy Kennedy at Oxford University Press asking us if we were interested in writing a book on lakes and ponds in the then new Biology of Habitats series. We were of course very flattered and enthusiastically took on the challenge. The book, in its many forms, has been with us since, as a dear companion in our everyday lives as teachers and researchers. However, a book is not everything, even if it happens to deal with the most interesting topic of science, the biology of lakes and ponds. We do have a *real* life as well and we have to thank our expanding families for their support all these years and for sharing the joys and pleasures, as well as the sometimes harder times, of our everyday lives.

Lund and Askustorp, 1 February 2017
C.B.
L-A.H.