

Preface

This book is a revision of G.E. (Tony) Fogg's *Biology of Polar Habitats* published in 1998. The fact that a major revision is needed in such a short period of time, and that an additional eight authors are needed to update the material, is a reflection of just how fast progress is being made in our exploration of polar regions and in our understanding of how life survives in these extremes. There are still surprisingly many true outposts on our planet that are not influenced by humans: unclimbed mountains, unexplored cave systems, extensive regions of desert and isolated islands. We can only presume that there is a wealth of undiscovered biology in these remote places and as-yet-unimagined and unique adaptations within the biology found there. It is true that few new mammals and birds are being discovered, but among the other groups of plants and animals, *organisms new to science* are recorded routinely as we push forward our access to these remote places.

Most staggering are the discoveries being made in the microbial world, where it has only been in the past decade or so that we have developed the tools capable of giving us an insight into the myriad of organisms just a few micrometres (μm) in size (1 μm is one thousandth of a millimetre). Within this microbial world, especially the bacteria and archaea, there are organisms capable of growth in extremes of temperature (lower limit -20°C , upper limit 113°C), acidic and alkaline pHs, high pressure, low water content, high ionizing radiation, and high salt concentrations. Collectively these organisms are referred to as *extremophiles*, and they often require the extreme condition for growth and reproduction to take place. The last few decades have seen a forging ahead of extremophile research as technological advances enable us to sample the organisms without compromise and, once isolated, to investigate their biology under simulated realistic environmental conditions.

But after centuries of exploration it is still the frozen wastelands of the polar regions that most readily captivate the attention of a wide public audience. For many the introduction is beguiling tales of adventure, but especially in the last 50 years a diverse group of scientists and non-specialists alike have been intrigued by the discoveries of a fascinating biology thriving in what were perceived for so long to be wastelands devoid of any life.

Despite all the advances many of the sentiments expressed by Tony Fogg in his Preface to the first edition of the book are worth repeating here.

A great attraction in studying polar habitats is that, although it may involve sophisticated biochemical or electronic techniques, it still takes one into wild, physically challenging, and hauntingly beautiful places. Fortunately for those who want to indulge themselves in this way there are sound scientific reasons to support their applications for the necessary funding. Apart from the interest in finding out how living organisms manage to exist under the apparently adverse conditions, polar habitats provide particularly favourable opportunities for investigating basic ecological relationships. Compared with the communities of temperate and tropical regions, those in polar habitats are of recent origin and, as a result, relatively simple with few species. This makes it somewhat easier to identify the critical factors operating in the environment to determine the presence and abundance of individual species, interrelations between species, cycling of nutrients, and energy flow. A further feature adding to the interest is that although the Arctic and Antarctic are both cold, with nights and days which last for months, they have inverse patterns of distribution of land and sea. This makes for differences in climate and ocean circulation which have had profound effects on the invasion of plants and animals from temperate zones so that the respective ecologies of the two regions are different. Not unrelated to this, there are radical differences in political regimes which have resulted in the support and organization of science in the Arctic and Antarctic being remarkably dissimilar.

Knowledge of polar habitats is valuable from the practical as well as the academic point of view. The polar regions, taken as including the sub-Arctic and sub-Antarctic as well as the high Arctic and Antarctic, occupy a great part of the earth's surface and with increasing pressure from human populations it is advisable to know what resources and potentialities these relatively unused lands and seas might provide. Proper management of polar fisheries, mineral exploitation, oil drilling, and human settlement all depend on an understanding of the ways in which habitats work. Tourism, also, burgeoning in both regions, needs an input of this understanding if visitors are to get the best out of the experience with the least damage to the environment. Beyond this, polar ecology has world-wide significance. It is increasingly evident that polar ecosystems intermesh into global processes and that they play key roles in the regulation of the environment which is vital for the well-being of all mankind.

We are grateful to a host of colleagues and collaborators for sharing material with us for publication here, including many acknowledged by Tony in *The Biology of Polar Habitats*. We are thankful to the funding agencies, colleagues, logistic support, and opportunities that we have all enjoyed while conducting work in the Arctic and Antarctic. It is these rich experiences that have resulted in our being able to contribute to a book such as this. In all of our various visits to the frozen climes we have been gifted unique glimpses into a world dominated by extremes. Our chosen field sites are still largely unspoilt by mankind, and despite some recent media reports they will surely remain so, simply because they are so vast and inaccessible. For anybody, scientist or tourist, who has the opportunity

to visit any part of the polar regions, even the margins, there is a sense of privilege of experiencing the harsh, desolate, awesome beauty that has driven the spirit of exploration and adventure ever since the frozen oceans and lands were first described.

The authors of this book have all participated in scientific expeditions, most of them multi-national ventures that take many years of planning. A highlight of our work is the close friendships and companionship that such research fosters. None of our work is possible without the strength that comes from working within a team, be it 50 people on a remote ice camp or a research vessel filled with 50 scientists and 50 crew. As individual researchers we are driven to expand our own knowledge and experience, and we certainly know much about our individual research specializations. However, working within a team forged by a common desire for discovery and to see scientific understanding furthered by our modest exploits is one of richest rewards a career as a scientist can provide.

Increasingly our work in polar regions has become more routine with permanent bases, ice-breaking research ships, and the latest satellite communications. Although still working at extreme temperatures, modern clothing and technology make even remote field campaigns quite safe and relatively comfortable. But the lure of polar research is just as great as ever before. In no small part this is driven by the tremendous changes that we are recording in the polar regions attributed to global climate change. At the time of writing the Intergovernmental Panel on Climate Change (www.ipcc.ch) is about to launch its fourth assessment report *Climate Change 2007*. There can be no doubt that in regions such as the Arctic and at least in parts of the Antarctic such as the Peninsula region in the past 50 years or so dramatic changes in the frozen landscapes have been induced by rising temperatures. It is recognized that the effects of a changing global climate will be most prominent in the polar regions, and for this reason there has to be a concentration of scientific endeavour if we are to understand the biology of the regions and interpret how the changing climate may influence the biology of these frozen realms.

This revision is produced during another major highlight in polar research, The International Polar Year 2007 to 2008 (IPY; www.ipy.org), which follows on from similar campaigns in 1882, 1932 and 1957. During the period March 2007 to March 2009 there will be an internationally co-ordinated effort to further our understanding of the Arctic and Antarctic and their respective roles in the Earth system (see special editions of the journals *Nature* published on 8 March 2007 and *Science* published on 16 March 2007). Scientists from 60 nations are joining the IPY in over 200 major projects, and it is very likely that the fourth IPY will generate a considerable wealth of knowledge that will surely necessitate this edition being revised substantially within the next decade.

This book was first conceived by Tony Fogg, a keen and influential communicator of the history of Antarctic exploration and scientific endeavour in the polar regions. Chapters 1 and 2, although updated, are largely unchanged from his first edition, since they describe the basic physical and biological constraints restricting survival polar regions. The subsequent chapters are updated substantially to reflect advances made over the last decade. However, it is a great testament to Tony that the concluding chapter is also largely unchanged: he was a perceptive scientist who was able to see the much bigger picture. As in the first edition, it is impossible to give references for everything covered in the text, but the selected citations together with the further reading list will enable the reader to locate all of the sources used.

While updating the information we have tried to maintain the same spirit of enthusiasm for the subject that was a hallmark of Tony's writing. This is not an easy task for a disparate group of authors, but we trust we have done enough to arouse curiosity and stimulate further research for a new generation of visitors to the frozen waters and lands of the Arctic and Antarctic.

David N. Thomas,
July 2007



Scientist working on Arctic pack ice in the Fram Strait in February at temperatures below -30°C (photograph David N. Thomas).