16. EPILOGUE: PALEOLIMNOLOGICAL RESEARCH FROM ARCTIC AND ANTARCTIC REGIONS

REINHARD PIENITZ (reinhard.pienitz@cen.ulaval.ca)
Paleolimnology-Paleoecology Laboratory
Centre d'études nordiques
Département de Géographie
Université Laval
Québec, Québec
G1K 7P4, Canada

MARIANNE S.V. DOUGLAS (msvd@geology.utoronto.ca)
Paleoecological Assessment Laboratory
Department of Geology
University of Toronto
Toronto, Ontario
M5S 3B1, Canada

and

JOHN P. SMOL (smolj@biology.queensu.ca)
Paleoecological Environmental Assessment and Research Laboratory
Department of Biology
Queen's University
Kingston, Ontario
K7L 3N6, Canada

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Our understanding of long-term environmental change in arctic and antarctic lakes has advanced markedly over the last two decades. This research has been driven primarily by the growing realization that circumpolar regions are critical research areas for the study of global climatic and environmental change. Logistical improvements (e.g., increased availability of aircraft, research bases, enhanced communication technology, etc.) have also made polar research safer and more feasible. Nonetheless, high costs often preclude many research initiatives, and declines in government funding programs have resulted in the closure of some key monitoring stations that are essential for understanding many of the basic environmental, limnological, and hydrological

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processes operating in high latitude regions. As outlined in the preceding chapters, we have many challenges ahead of us, but we also have many exciting opportunities.

Paleolimnologists occupy a highly respected research niche in the global change community, as sediments archive important records of environmental and climatic change. Lakes and ponds are abundant in many parts of the Arctic and Antarctica, and our ability to interpret paleoenvironmental information is increasing rapidly. These data are being incorporated, often seamlessly, into large, multi-disciplinary research initiatives. Lake sediments are providing, at a great diversity of spatial and temporal scales, important information that often cannot be gathered from other sources, and in other cases paleolimnological data complement interpretations from other natural archives, such as ice cores and marine sediments.

Polar lake sediments have been used to address many important questions, but especially those dealing with the study of climatic change. However, there is a growing realization that other scientifically and socially relevant problems require long-term perspectives (e.g., local pollution sources, long-range transport of atmospheric contaminants, penetration of ultraviolet radiation, fluctuations in economically and ecologically important animal populations). The list of possible applications is growing steadily.

Although considerable progress has been achieved in a relatively short time, the contributors to this book also identify a number of challenges. Arctic and antarctic regions cover vast areas, spanning many different types of landscapes and ecosystems. With some notable exceptions (e.g., Toolik Lake area, Alaska), we currently only have a rudimentary understanding of limnological processes for most polar regions. For example, it is widely acknowledged that climatic influences are complex and include a variety of direct and indirect effects on the physical, chemical, and biological characteristics and dynamics of lakes. As paleolimnological interpretations cannot be separated from current-day limnological processes, a better understanding of the structure and functioning of high latitude lake systems remains an important research goal.

A common perception that continues to persist is that circumpolar lakes and ponds are relatively homogenous systems, and that their characteristics can easily be generalized. With the possible exception of concluding that these systems are characterized by relatively low temperatures and have long periods of ice cover, our view is that high latitudes contain lakes and ponds that equal the limnological diversity found in other lake regions. This complexity, however, is not a deterrent to paleolimnologists, but an important advantage. As the various lake and pond systems will respond differently to climate forcing, as well as other environmental changes, carefully chosen study sites and methodological approaches can address many important research questions and problems.

The contributors to this volume have identified additional research needs. For example, much work remains on describing the taxonomy and ecological characteristics of bioindicators from polar regions. Many ecological studies thus far have relied on surface sediment calibration sets and then employed multivariate statistical techniques to interpret these complex data sets, building on the previous successes that these approaches have enjoyed in other geographic areas. However, in many high latitude lake sets, the measured limnological variables often provide only relatively weak environmental gradients, and there is little or no present-day ecological or physiological

data to bolster interpretations. Moreover, benthic taxa often dominate assemblages, thus posing additional problems with, for example, relating pelagic water chemistry measurements to periphytic algae. Calibration sets are clearly important, and should be pursued. But our view is that paleolimnologists should, at times, re-focus their efforts on understanding and interpreting overall community changes, preferably from different taxonomic groups and trophic levels, coupled with physical, sedimentological, and geochemical proxy data, to obtain a more holistic understanding of how overall lake processes and biotic communities may have changed in the past.

Another major issue that was echoed by most contributors is the problem of developing sufficiently accurate geochronological control for high latitude sediment cores. For example, ^{210}Pb inventories are usually much lower than those recorded in temperate and tropical lake systems. In addition, the paucity of terrestrial plant remains in many high polar regions, coupled with the slow degradation of terrestrial litter in polar landscapes, imposes additional limitations with standard AMS radiocarbon dating techniques. As noted by Wolfe et al. (this volume), other approaches are available and emerging and this is an active area of research. Moreover, the growing number of studies describing varved lake sediment profiles from polar lakes may alleviate some of these concerns, at least in some regions.

As shown by the contributions to this volume, there are many similarities between arctic and antarctic regions, but also some striking differences. With few exceptions, most researchers work in either the northern or southern hemisphere. As such, there is much to learn from our colleagues working at the opposite poles, yet surprisingly there is relatively little dialogue between these two groups. Hopefully this book will stimulate a more active exchange of information and expertise between these two research communities.

The publication of this book may be especially timely, as preparations for the celebration of the International Polar Year 2007-2008 are currently underway. This event marks the 125th anniversary of the First International Polar Year (1882-1883), and the 75th anniversary of the Second Polar Year (1932-1933). The previous International Polar Years catalysed many research initiatives, resulting in significant new insights. Paleolimnology was still in its infancy during the previous polar years. This is no longer the case. Never before has there been a greater need for understanding long-term changes in high latitude lake ecosystems. We are confident that paleolimnologists have the skills, approaches, and drive to meet these new challenges. No one ever claimed that this work was going to be easy or simple; we do know that this work will be important and rewarding.