Diatoms are microscopic algae, which are found in virtually every habitat where water is present. This volume is an up-to-date summary of the expanding field of their uses in environmental and earth sciences. Their abundance and wide distribution, and their well-preserved glass-like walls, make them ideal tools for a wide range of applications both as fossils and living organisms. Examples of their wide range of applications include use as environmental indicators, for oil exploration, and for forensic examination. The major emphasis is on their use in analyzing ecological problems such as climate change, acidification, and eutrophication. The contributors to the volume are leading researchers in their fields, and are brought together for the first time to give a timely synopsis of a dynamic and important area. This book should be read by environmental scientists, phycologists, limnologists, ecologists and paleoecologists, oceanographers, archeologists, and forensic scientists.

EUGENE F. STOERMER is a past-President of the Phycological Society of America and the International Association for Diatom Research. He has worked at the University of Michigan since 1965 where he is Professor in the School of Natural Resources & Environment, studying various aspects of diatom biology and ecology.

JOHN P. SMOL co-heads the Paleoecological Environmental Assessment and Research Laboratory (PEARL) at Queen’s University, Ontario, where he is Professor in the Department of Biology. He is editor-in-chief of the Journal of Paleolimnology.
"We stand on the shoulders of giants."

This book is dedicated to Dr John D. Dodd, Dr Ruth Patrick, and Dr Charles W. Reimer, whose varied contributions so greatly expanded and improved diatom studies in North America.
Contents

Preface [page xi]

Part I Introduction
  1 Applications and uses of diatoms: prologue [3]
     EUGENE F. STOERMER AND JOHN P. SMOL

Part II Diatoms as indicators of environmental change in flowing waters and lakes
  2 Assessing environmental conditions in rivers and streams with diatoms [11]
     R. JAN STEVENSON AND YANGDONG PAN
  3 Diatoms as indicators of hydrologic and climatic change in saline lakes [41]
     SHERILYN C. FRITZ, BRIAN F. CUMMING, FRANÇOISE GASSE, AND KATHLEEN R. LAIRD
  4 Diatoms as mediators of biogeochemical silica depletion in the Laurentian Great Lakes [73]
     CLAIREE L. SCHELSKE
  5 Diatoms as indicators of surface water acidity [85]
     RICHARD W. BATTARBEE, DONALD F. CHARLES, SUSHIL S. DIXIT, AND INGEMAR RENBERG
  6 Diatoms as indicators of lake eutrophication [128]
     ROLAND I. HALL AND JOHN P. SMOL
  7 Continental diatoms as indicators of long-term environmental change [169]
     J. PLATT BRADBURY
  8 Diatoms as indicators of water level change in freshwater lakes [183]
     JULIE A. WOLIN AND HAMISH C. DUTHIE

Part III Diatoms as indicators in extreme environments
  9 Diatoms as indicators of environmental change near arctic and alpine treeline [205]
     ANDRÉ F. LOTTER, REINHARD PIENITZ, AND ROLAND SCHMIDT
10. Freshwater diatoms as indicators of environmental change in the High Arctic [227]
   MARIANNE S. V. DOUGLAS AND JOHN P. SMOL
11. Diatoms as indicators of environmental change in antarctic freshwaters [245]
   SARAH A. SPAULDING AND DIANE M. MCKNIGHT
12. Diatoms of aerial habitats [264]
    JEFFREY R. JOHANSEN

Part IV Diatoms as indicators in marine and estuarine environments
13. Diatoms as indicators of coastal paleoenvironments and relative sea-level change [277]
    LUC DENYS AND HEIN DE WOLF
14. Diatoms and environmental change in brackish waters [298]
    PAULI SNOEIJS
15. Applied diatom studies in estuaries and shallow coastal environments [334]
    MICHAEL J. SULLIVAN
16. Estuarine paleoenvironmental reconstructions using diatoms [352]
    SHERRI R. COOPER
17. Diatoms and marine paleoceanography [374]
    CONSTANCE SANCETTA

Part V Other applications
18. Diatoms and archeology [389]
    STEVEN JUGGINS AND NIGEL CAMERON
19. Diatoms in oil and gas exploration [402]
    WILLIAM N. KREBS
20. Forensic science and diatoms [413]
    ANTHONY J. PEABODY
21. Toxic and harmful marine diatoms [419]
    GRETA A. FRYEELL AND MARIA C. VILLAC
22. Diatoms as markers of atmospheric transport [429]
    MARGARET A. HARPER
23. Diatomite [436]
    DAVID M. HARWOOD

Part VI Conclusions
24. Epilogue: a view to the future [447]
    EUGENE F. STOERMER AND JOHN P. SMOL
Glossary, and acronyms [451]
Index [466]
Contributors

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

EUGENE F. STOERMER
Center for Great Lakes and Aquatic Sciences, University of Michigan, Ann Arbor, MI 48109-2099, USA
stoermer@umich.edu

RICHARD W. BATTLARTEE
Environmental Change Research Centre, University College London, 26 Bedford Way, London WC1H 0AP, UK
rbattargb@geography.ucl.ac.uk

NIGEL CAMERON
Environmental Change Research Centre, University College London, 26 Bedford Way, London WC1H 0AP, UK

J. PLATT BRADBURY
US Geological Survey, MS 919 Box 23046, Federal Center, Denver, CO 80225, USA
jbradbur@usgs.gov

DONALD F. CHARLES
Patrick Center for Environmental Research, The Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103-1195, USA

SHERRI R. COOPER
Duke Wetlands Center, SOE, Box 90333, Duke University, Durham, NC 27708-0333, USA
slcooper@acpub.duke.edu

BRIAN F. CUMMING
Paleoecological Environmental Assessment and Research Laboratory (PEARL), Department of Biology, Queen’s University, Kingston, Ontario K7L 3N6, Canada

LUC DENYS
De Lescluezestraat 68, B-2600 Berchem (Antwerpen), Belgium
LUDE@rsca.ua.ac.be

HEIN DE WOLF

SUSHIL S. DIXIT
Paleoecological Environmental and Assessment Laboratory, Department of Biology, Kingston, Ontario K7L 3N6, Canada

MARianne S. V. DOUGLAS
Department of Geology, University of Toronto, 22 Russell Street, Toronto, Ontario M5S 3B1, Canada
msvd@opal.geology.utoronto.ca
Contributors

HAMISH C. DUTHIE
Department of Biology, University of Waterloo, Ontario N2L 3G1, Canada

SHERILYN C. FRITZ
Department of Geosciences, University of Nebraska, Lincoln, NE 68588, USA

GRETA A. FRYXELL
Department of Botany, University of Texas, Austin, TX 78712-7640, USA
gfryxell@bongo.cc.utexas.edu

FRANÇOISE GASSE
Cégep, Université Aix-Marseille III – CNRSFU 017, Pôle d’activité commerciale de l’Arbois, 88 80, 13345 Aix-En-Provence Cedex 4, France

ROLAND I. HALL
Climate Impacts Research Centre & Department of Environmental Health, Umeå University, Abisko Scientific Research Station, Box 62, S-981 07 Abisko, Sweden
Roland.Hall@ans.kiruna.se

MARGARET A. HARPER
Department of Geology, Research School of Earth Sciences, Victoria University of Wellington, PO Box 600, Wellington, New Zealand
Margaret.Harper@vuw.ac.nz

DAVID M. HARWOOD
Department of Geology, University of Nebraska, Lincoln, NE 68588-0340, USA
dhharwood@unlinfo.unl.edu

JEFFREY R. JOHANSEN
Department of Biology, John Carroll University, University Heights, OH 44118, USA
johansen@jcvaxa.jcu.edu

STEVEN JUGGINS
Department of Geography, University of Newcastle, Newcastle upon Tyne NE1 7RU, UK
stephen.juggins@newcastle.ac.uk

WILLIAM N. KREBS
AMOCO Production Co., 501 Westlake Park Blvd., Houston, TX 77079, USA
bill.n.krebs@amoco.com

KATHLEEN R. LAIRD
Paleoecological Environmental Assessment and Research Lab (PEARL), Department of Biology, Queen’s University, Kingston, Ontario K7L 3N6, Canada

ANDRÉ F. LOTTER
EAWAG, CH-8664 Dübendorf, Switzerland
lotter@eawag.ch

DIANE M. MCKNIGHT
Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO 80303, USA

YANGDON PAN
Environmental Sciences and Resources, Portland State University, Portland, OR 97207, USA

ANTHONY J. PEABODY
Metropolitan Forensic Science Laboratory, 109 Lambeth Road, London SE1 7LP, UK

REINHARD PIENITZ
Centre d’Études Nordiques & Département de Géographie, Université Laval, Québec G1K 7P4, Canada

INGEMAR RENBERG
Department of Environmental Health, Umeå University, S-901 87 Umeå, Sweden

CONSTANCE A. SANCETTA
National Science Foundation, 4201 Wilson Blvd., Arlington, VA 22230, USA
csancett@nsf.gov
Preface

Diatoms are being used increasingly in a wide range of applications, and the number of diatomists and their publications continues to increase rapidly. Although a number of books have dealt with various aspects of diatom biology, ecology, and taxonomy, to our knowledge, no volume exists that summarizes the many applications and uses of diatoms.

Our overall goal was to collate a series of review chapters, which would cover most of the key applications and uses of diatoms to the environmental and earth sciences. Due to space limitations, we could not include all types of applications, but we hope to have covered the main ones. Moreover, many of the chapters could easily have been double in size, and in fact several chapters could have been expanded to the size of books. Nonetheless, we hope the material has been reviewed in sufficient breadth and detail to make this a valuable reference book for a wide spectrum of scientists, managers, and other users. In addition, we hope that researchers who occasionally use diatoms in their work, or at least read about how diatoms are being used by their colleagues (e.g., archeologists, forensic scientists, climatologists, etc.), will also find the book useful.

The volume is broadly divided into six parts. Following our brief Prologue, Part II contains seven chapters that review how diatoms can be used as indicators of environmental change in flowing waters and lakes. Part III summarizes work completed on diatoms from extreme environments, such as the High Arctic, the Antarctic, and aerial habitats. These ecosystems are often considered to be especially sensitive bellwethers of environmental change. Part IV contains five chapters dealing with diatoms in marine and estuarine environments, whilst Part V summarizes some of the other applications and uses of diatoms (e.g., archeology, oil exploration and correlation, forensic studies, toxic effects, atmospheric transport, diatomites). We conclude with a short epilogue (Part VI), followed by a glossary (including acronyms) and an index.

Many individuals have helped with the preparation of this volume. We are especially grateful to Barnaby Willits (Cambridge University Press), who shepherded this project from its inception. As always, the reviewers provided excellent suggestions for improving the chapters. We are also grateful to our colleagues at the University of Michigan and at Queen’s University, and elsewhere, who helped in many ways to bring this volume to its completion. And, of course, we thank the authors.
These are exciting times for diatom-based research. We hope that the following chapters effectively summarize how these powerful approaches can be used by a diverse group of users.

EUGENE F. STOERMER
Ann Arbor, Michigan, USA

JOHN P. SMOL
Kingston, Ontario, Canada