Paleolimnology as a Tool for the Study and Management of Lakes and Reservoirs

Para mais informações contacte:

dbicudo@terra.com.br

December 3-5, 2012

São Paulo, Brazil

JOHN P. SMOL
Professor
Canada Research Chair in Environmental Change

John P. Smol biography: http://post.queensu.ca/~smolj/dper/dperjps.html

Paleoecological Environmental Assessment and Research Lab (PEARL)
Dept. Biology
Biosciences Complex, Room 4307a
Queen's University
e-mail: SMOLJ@QueensU.Ca

PEARL web site: http://post.queensu.ca/~pearl/

"Study the past to divine the future"

Confucius, *circa* 500 BC

INTRODUCTION:

There is a growing realization that long-term data are vital for understanding many ecological and environmental problems. Unfortunately, such data are rarely available, and so indirect proxy methods must be used. One of the leading approaches for inferring long-term environmental trends is paleolimnology and related paleoenvironmental fields.

Paleolimnology is a multi-disciplinary science that uses physical, chemical, and biological information preserved in sedimentary profiles to reconstruct past environmental conditions in aquatic systems. Paleolimnological reconstructions of environmental change are being increasingly used in projects around the world. For example, paleolimnology played a key role in the resolution of debates about recent international environmental problems, such as lake acidification, eutrophication, and is now an important contributor of information about climate change processes.

Although many may consider "paleolimnology" to simply refer to lake histories, for the purposes of this course we will use a much broader view, and look at long-term environmental change using many types of proxy data. For example, we will consider the information archived in lake and pond sediments, river deposits, peats, ice cores, tree rings (dendrochronology), and so forth. We will also consider topics such as historical records (e.g., written records).

The main aim of this course is to provide you with an introduction to the basic techniques used by paleolimnologists and related scientists interested in long-term environmental change, as well as a review of some key studies that are especially relevant to today's environmental problems.

TEXTBOOK:

Smol, J.P. 2008. Pollution of Lakes and Rivers: A Paleoenvironmental Perspective – 2nd Edition. Blackwell Publishing, Oxford. 383 pp.

Textbook website: http://post.queensu.ca/~pearl/textbook.htm

TENTATIV E SCHEDULE AND SUGGESTED READINGS:

Part 1. Introduction to the course and the science of paleolimnology and related techniques. The scope of paleoenvironmental change will be discussed, as well as the collection of sediment cores, and geochronological techniques. An overview of the primary sources of proxy data available will be reviewed, followed by a brief introduction to calibration sets and inference approaches used by paleolimnologists.

Suggested Readings:
Chapter 1. There is no substitute for water
Chapter 2. How long is long?
Chapter 3. Sediments: An ecosystem's memory
Chapter 4. Retrieving the sedimentary archive and establishing the geochronological clock: Collecting and dating sediment cores
Chapter 5. Reading the records stored in sediments: The present is a key to the past
Chapter 6. The paleolimnologist's Rosetta Stone: Calibrating indicators to environmental variables using surface sediment training sets

Part 2. Introduction to acidification and how paleolimnology was used to study this important international issue. Although acidic precipitation was not a major problem in most parts of South America, it was an international problem that led to the development and application of many new limnological and paleolimnological approaches, including most of the coring and inference techniques we now use for studies of recent environmental change. It was also one of the first problems where modellers were closely involved with paleolimnology. The issue of pH changes related to mining activities will also be discussed, as will be the use of paleolimnology to study ecosystem recovery.

Reading: Chapter 7: Acidification: finding the "smoking gun"

The issue of atmospheric transport of acidic precipitation leads naturally to other areas of aerially transport of pollutants. The lecture series will continue with presentations on the use of paleoenvironmental techniques to study metal pollution, persistent organic pollutants, and mercury transport.

Suggested Readings:
Chapter 8. Metals, technological development, and the environment.
Chapter 9. Persistent organic pollutants: industrially synthesized chemicals "hopping" across the planet.
Chapter 10. Mercury – "the metal that slipped away".

Part 3. The course now shifts to more local, watershed related issues. The largest water quality issue on the planet is still the over-fertilization of lakes, or eutrophication. We will spend looking at this complex environmental problem and then discussing ways that paleolimnological techniques have been used to study this issue.

The problems associated with the closely related problem of erosion will also be included.

Suggested Readings:
Chapter 11; Eutrophication: the environmental consequences of over-fertilization.
Chapter 12 Erosion: tracking the accelerated movement of material from land to water.

Part 4. We now tackle the complex problem of long-term and human-induced climatic change, which is a major focus of paleoenvironmental research.

The use of ice cores, from both high latitude and high altitude regions (e.g. Peru) will also be presented.The morning will conclude with an introduction to the basic paleolimnological techniques used to track climatic change, as well as other approaches, such as tree ring analyses, pack rat middens, and corals in the sea.

Some of the concepts described earlier will be used in a presentation entitled: "From controversy to consensus: making the case for recent climatic change in the polar regions using lake sediments", to show how comparative approaches used in paleolimnology can be sued to address these complex issues.

Suggested Reading:
Chapter 14. Greenhouse gas emissions and a changing atmosphere: tracking the effects of climatic change on water resources.

Part 5: Thus far, we have examined many of the major environmental problems in isolation. The concept of multiple stressors will be introduced with topics related to species invasions, the combined effects of ozone depletion and climatic change, and some water quality problems that are related to the multiple effects of climate change, logging, eutrophication and/or acidification. The new problem of calcium declines in some lakes, so-called "aquatic osteoporosis", will also be discussed. The increases in "taste and odour causing algae" will also be highlighted, showing how paleolimnology can be used to help decipher which environmental stressors are most important in influencing the magnitude and frequency of these problems.

In addition, we will also discuss some new applications of paleolimnology, including the use of proxy data in lake sediments to track past populations of anadromous fish, such as salmon, to track the size and effects on lake ecosystems of past seabird populations, as well as the use of paleolimnology to work with archaeologists studying past cultures.

Suggested Readings:
Chapter 13; Species invasions, biomanipulations, and extirpations.
Chapter 15; Ozone depletion, acid rain, and climate warming: the problems of multiple stressors.
Chapter 16: New problems, new challenges.
Chapter 17: Paleolimnology: a window on the past, a key to our future.

The course will conclude with a brief summary and a look to the future.