Neotoma Paleoecology Database: Recent Updates

By Jack Williams, on behalf of the Neotoma Paleoecology Database Consortium
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The mission of the Neotoma Paleoecology Database is to serve the Quaternary community and support global-change research by providing an open, high-quality, sustainable, community-curated repository for multiple kinds of paleoecological data. Since the last Quaternary Times report (May, 2017), Neotoma has continued to grow, in multiple ways: data volume, supported data types and constituent databases, data services, supported science and publications, and, most importantly, in its community of data contributors, data stewards, and leaders.

Data Volume

As of November 3, 2019, Neotoma now holds over 6.9 million individual observations, from 37,732 datasets, distributed among 18,212 sites. The global scope of Neotoma is increasing, particularly with the current data mobilization campaigns for the European Pollen Database and Latin American Pollen Database, both constituent databases in Neotoma. A new campaign has just been launched for the African Pollen Database, with funding from the Belmont Forum (lead PI: Nick McKay) and a workshop in Oct 2019 hosted by the Research Institute for Development (IRD).

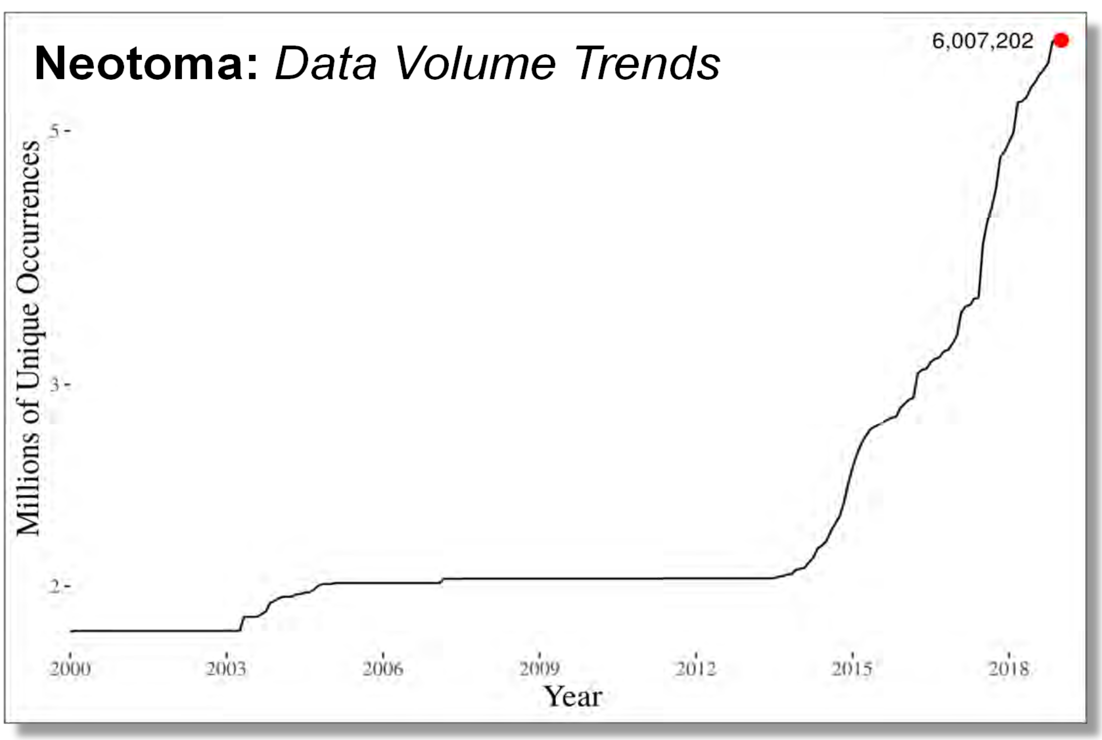

Figure: S.Goring

Supported Data Types and Constituent Databases

Neotoma now has sizeable holdings in diatoms (1,149 stratigraphic datasets, 1,305 surface samples), insects (210 stratigraphic datasets, 13 surface samples), ostracodes (12 stratigraphic records, 5,057 surface samples), pollen (4,567 stratigraphic datasets, 3,166 surface samples), testate amoebae (85 stratigraphic datasets, 2,393 surface samples), vertebrates (5,028 stratigraphic datasets), and water chemistry (7,655 datasets). Neotoma also stores over 5,700 geochronological datasets, most linked to age-depth models. Other supported data types include biomarkers, chironomids, cladocerans, loss-on-ignition, macroinvertebrates, phytoliths, plant macrofossils, stable isotopes, XRF, and XRD. Each data type is associated with one or more Constituent Databases, each with one or more expert Data Stewards.

Supported Science and Publications

Neotoma is designed to support broad-scale, multi-site, and multi-proxy research. Current research collaborations include ACCEDE, CLIMATE12K, ECORE3, HOPE, LANDCOVER6K, and SKOPE. In these partnerships, researchers building large data syntheses benefit from the large curated data resources. In return, macro-scale researchers can improve Neotoma, by mobilizing and uploading new records, catching and fixing errors, adding new age models, and building new software or analytical workflows that directly link to Neotoma data. Examples of these two-way interactions include the HOPE project, which is helping facilitate uploads of data into the EPD and LAPD, and Wang et al. (2019), which has just built over 550 new Bacon age models for North American pollen records. Several papers describe Neotoma itself: 1) Williams et al. (2018) offers an overview of Neotoma, its design philosophies, and key concepts; 2) Grimm et al. (2018) reviews the concepts of constituent databases and data stewards; and 3) Goring et al. (2018) reviews the educational resources associated with Neotoma. And, the PAGES Fall 2018 issue on Building and Harnessing Open Paleodata (https://doi.org/10.22498/pages.26.2) provides a survey of community curated and open data resources across the paleosciences.

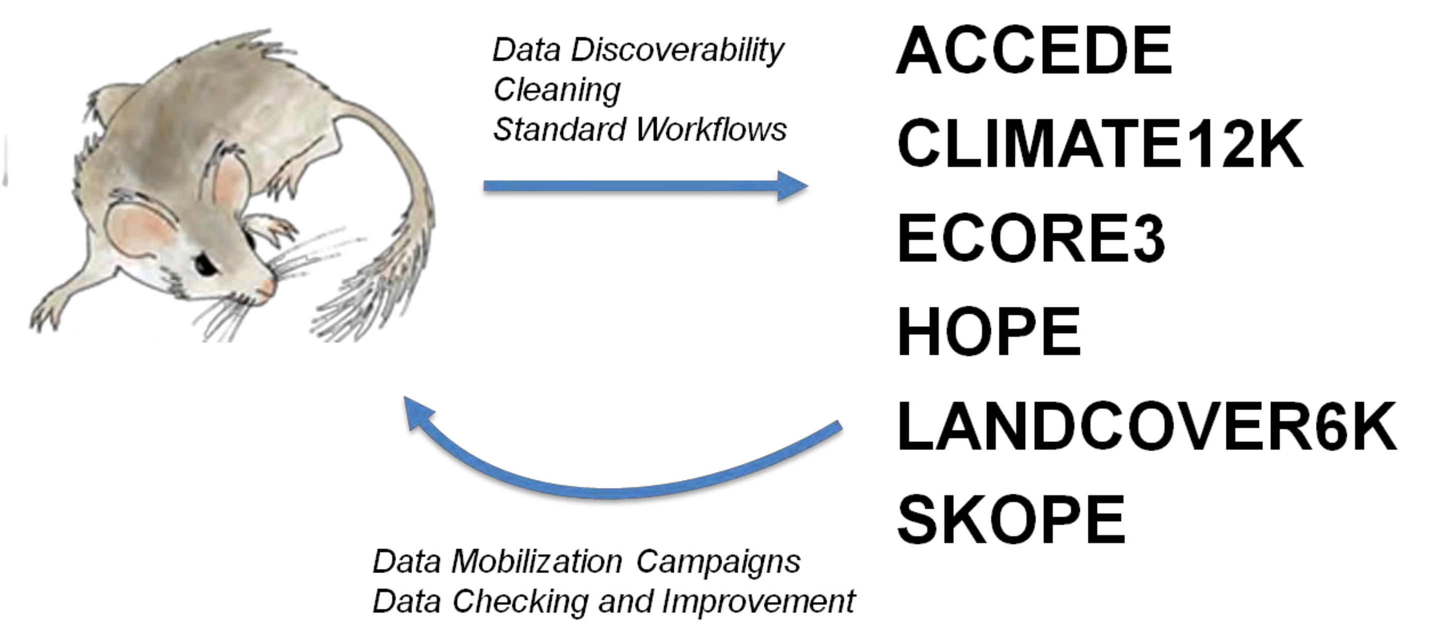

Figure: S.Goring

Data Services

1) DOIs. All Neotoma datasets are now assigned unique identifiers (DOIs), each associated with a landing page (Example 1: pollen dataset at Ballygisheen Bog: http://data-dev.neotomadb.org/14194; Example 2: vertebrate dataset at La Grande: http://data-dev.neotomadb.org/5900). These DOIs and landing pages support requirements for FAIR data publication by AGU and other journals (Wilkinson et al., 2016), and they can be readily found and searched by Google Datasets and other search engines. The automatic generation of DOIs is still in the beta stage and for now we generate DOIs in batches on an as-needed basis. We expect full automation by early 2020. 2) Flyover Country. Flyover Country (https://flyovercountry.io/) is a phone app designed for travelers interested in learning about the geological world around them. Travelers can enter their start and end locations, and then Flyover Country will provide them information about the geological forrmations that they see and fossil localities drawn from Neotoma and the Paleobiology Database.

Community

Neotoma supports and is supported by a large and growing community of data stewards, data contributors, and leaders. Particular shout-outs to Bob Booth (Testate Amoebae, Lehigh), Mona Dombosh (FAUNMAP, Penn State), Don Charles (Diatoms, Drexel), Suzette Flantua (LAPD, Bergen), Thomas Giesecke (EPD, Goettingen), Alison Smith (Ostracodes, Kent State), Alison Stegner (FAUNMAP, Stanford), and many more. And, most of all, Eric Grimm, for his tireless work and leadership as lead steward and Tilia engineer. The Leadership Council for 2019 is: Alan Ashworth, Jessica Blois (Assoc Chair), Phil Buckland, Thomas Giesecke, Simon Goring, Eric Grimm, Claudio Latorre, Suzie Pilaar-Birch, Alison Smith, Hiraku Takahara, and Jack Williams (Chair). And thanks to Simon Goring (Wisconsin), Mike Stryker (Penn State), and Steve Crawford (Penn State) for keeping the lights on and new features rolling out.

If you're interested in learning more, see www.neotomadb.org and its resources page https://www.neotomadb.org/about/category/resources. If you'd like to become a member, you can sign up here: https://tinyurl.com/NeotomaMember. If you'd like to contribute data or become a steward, you can reach out to Jack Williams (jwwilliams1@wisc.edu), Jessica Blois (jblois@ucmerced.edu), Eric Grimm (eric.c.grimm@outlook.com), anyone on the Leadership Council, or the all-purpose Neotoma email: neotoma-contact@googlegroups.com. Neotoma has been supported by NSF's Geoinformatics and EarthCube programs, and the Belmont Forum. Let us know if and how we can help you, your data, and your science.

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Neotoma Paleoecology Database

NeotomaDB

Mission: Support global-change research by providing an open, community-curated repository for multiple kinds of paleoecological data

Key Characteristics

- Open Data
- Curated by Community -> High-Value Data
- Standardized Variable Names & Taxonomy
- Flexible data models for sites, proxies, cores, etc.
- Time: Age Controls and Age Models

Fossil Pollen, Vertebrates, Diatoms, Ostracodes, Testate Amoebae, Stable Isotopes, Plant Macrofossils, Packrat Middens, …

Williams et al. (2018) Quaternary Research

Research Reports

Tracking natural climate modes of variability through the use of high-resolution climate records from the top of the Earth

By Francois Lapointe
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There exist many climate modes of variability on Earth based on to instrumental data over the past ~160 years. Few of them contain a long-frequency component, one of the best examples is the Atlantic Multidecadal Oscillation (AMO). The AMO has been ascribed as a 40-80 year cycle and involves large-scale variations in sea-surface temperature (SST) in the North Atlantic region. During its positive phase, SSTs are warmer than usual from the Equator to ~ 70°N and colder conditions are observed during the negative phase. Among the climate impacts of the AMO, droughts have been reported in the Sahel (Folland et al., 1986; Giannini et al., 2003; Lu and Delworth 2005; Ting et al., 2011) and the USA (McCabe et al., 2004; Ting et al., 2011), precipitation in South America (Seager et al., 2010) and hurricane frequency in the Atlantic (Goldenberg et al., 2001; Sutton and Hodson, 2007). Yet, not much is known about the AMO influences on Arctic regions as meteorological data there generally don't extend prior to the 1950s. Therefore, it is difficult to capture any AMO-signal either in arctic meteorological dataset or instrumental data from lower latitudes that are ~160 years of length (barely capturing two AMO cycles). Future climate projections need to know whether the AMO is a persistent feature of the Earth's climate, and what are the mechanisms driving it. The only way to uncover this is with the use of past high-resolution climate records.

Part of my research is dedicated to the use of annually laminated (varved) sediments from the Arctic (Figure 1). These sedimentary records typically go ~3000 years back in time, but we hope to get at least ~6000 years at Linne Lake, on Svalbard (Figure 1). Among the goals of working with these fascinating archives is to decipher abrupt climate changes in the past (e.g., changing precipitation regime) but also to extract periodicities in these long-term time series. To do so, fine-scale analysis on thin-sections has to be done for annual data extraction. For example, it is impossible to obtain grain-size distribution (GSD) using classical techniques (e.g., laser diffraction) because the sampling interval (>0.5 cm) is larger than the actual annual varve (generally <0.2 cm in the Arctic). Thus, we use a Scanning Electron Microscope (SEM) to quantify each of the varves in thin sections. These high-resolution images allow to clearly detect thin varves (<0.2 cm) that are hard to distinguish on optical images from thin sections, thus this technique helps substantially with varve chronologies. These SEM images also allow to acquire annual GSD, which gives important information on sedimentary processes. Other proxies in the research involve geochemical variations using µ-xrf data and high-resolution density with the Ct-Scan. Taken altogether, these proxies help to disentangle the different signals (snow melt, rainfall, temperature) found in the varves. In Svalbard, recent periods of intense rainfall, associated with warm SSTs and absence of sea-ice cover, now occurs in all seasons with the greatest increases seen in fall and winter.

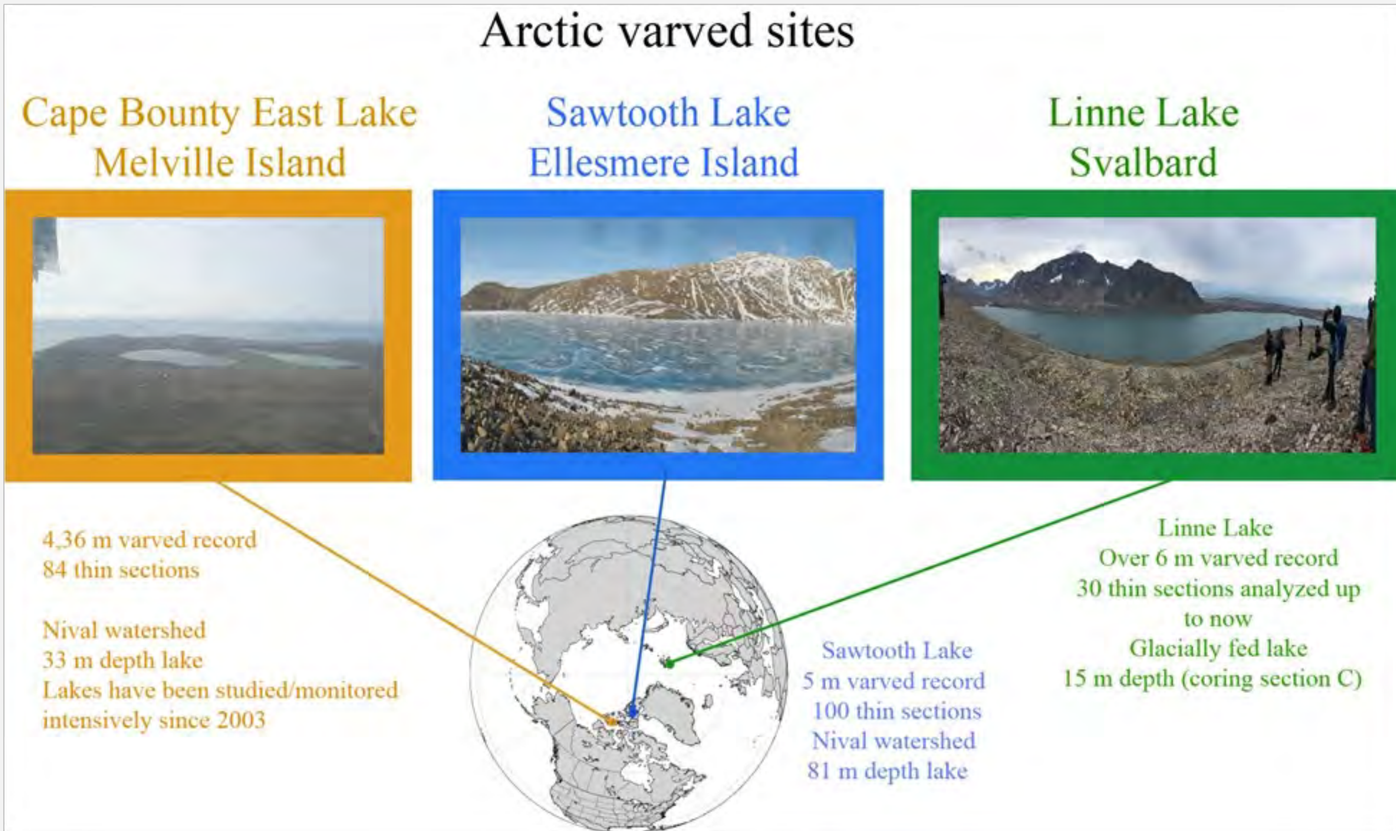

Figure 1. *Location of Arctic lakes in the Canadian Arctic (orange and blue) and on Svalbard (green) that contain annually laminated (varved) sediments with specific details.*

Using the geochemical signature of these rainfall events, we will be able to identify if similar conditions have occurred in the past or if Svalbard has recently experienced a drastic hydrological shift.

An example of how these archives can be precious to uncover the influence of known climate oscillation is shown at Cape Bounty East Lake (Figure 2). The varved record shows periodicities that match closely those found in the instrumental Pacific Decadal Oscillation (PDO) (Lapointe et al., 2017). Results suggest that the negative phase of the PDO is linked with increased precipitations and decreased sea-ice cover in the Western Canadian Arctic as revealed by instrumental and proxies correlations (Figure 2). These observations would probably not have been found without the use of these finely laminated lacustrine sediments.

Our current work at South Sawtooth Lake highlights so far a great influence of the AMO on Ellesmere Island. Colder (warmer) conditions on Ellesmere Island are found during the negative (positive) phases of the AMO ($r = 0.55$ $p < 0.001$). The negative phase is also associated with snow cover that persists later in summer resulting in increased snowmelt intensity that is reflected in the Sawtooth varved record through enhanced Titanium variations.

At Linne Lake, on Svalbard, a remarkable correlation ca be found between instrumental AMO and the longest available temperature dataset (Nordli et al., 2014) in region >70°N (Figure 3a, b). The varve thickness data (and the coarse grain-size) is significantly correlated to the temperature variability (Figure 3c) and the AMO. Thus, this varved record is potentially a great candidate for tracking the AMO in the past.

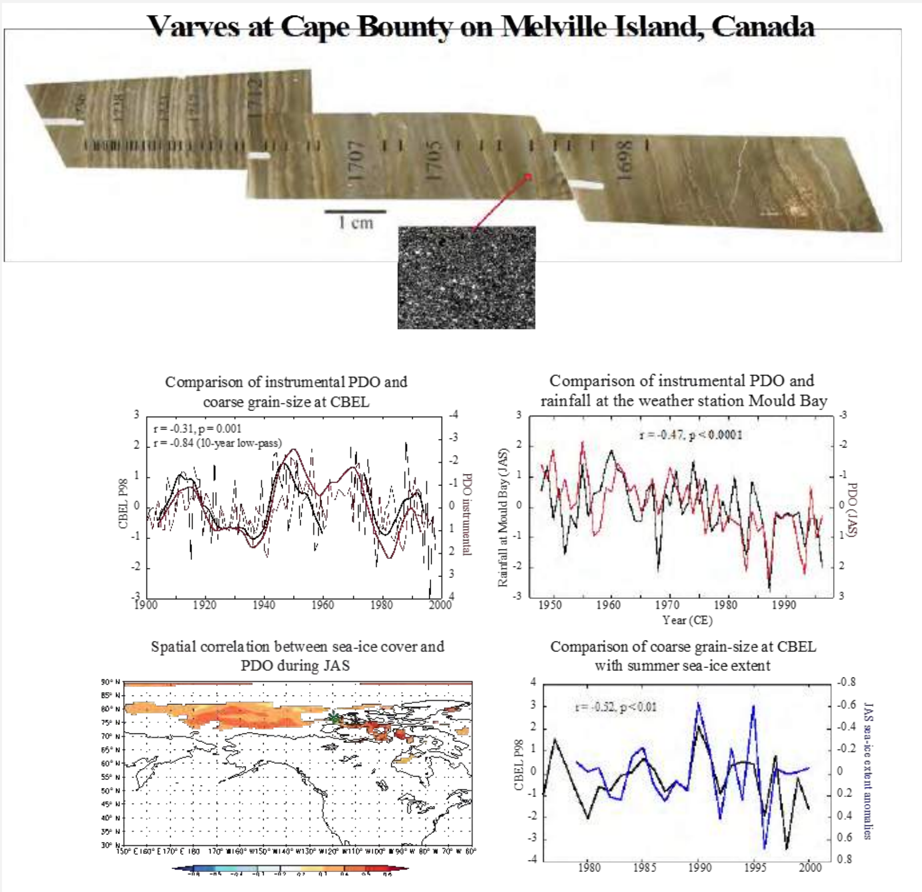

Figure 2. *Above: three overlapping thin -sections showing varves from the late 17th to early 18th century. Image acquired at the scanning electron microscope (SEM) in backscattered mode showing coarse silt. Over 7000 images at the SEM were collected to recover the past ~2850 years. Below: correlations showing that the Pacific Decadal Oscillation (PDO) influences significantly the Western Canadian Arctic. The correlation map denotes the varved record at Cape Bounty (black asterisk) and the nearby weather station Mould Bay (green asterisk). Figures from Lapointe et al. (2017).*

Finally, the climate of these regions appears to be dominated by the AMO (except Cape Bounty). They thus hold great potential to describe very high temporal variability (annual to seasonal) of this climate oscillation over the past several millennia. We are heading to Svalbard on April 2019 to collect the longest varved record from the area, and hopefully extract an annual (to sub-annual) signal of the AMO for the past ~6000 years.

Acknowledgements

The project at Svalbard is funded by the National Science Foundation through a grant to Raymond Bradley (University of Massachusetts) and Michael Retelle (Bates College). FL wishes to thank the Polar Continental Shelf Program, Canada Natural Resources, for their great help for field preparations and logistic inputs at Cape Bounty (Melville Island) and Sawtooth Lake (Ellesmere Island). We are grateful to NSERC discovery and northern supplement grants (grant number RGPIN-2014-05810 and RGPNS-2014-305427 to Pierre Francus).

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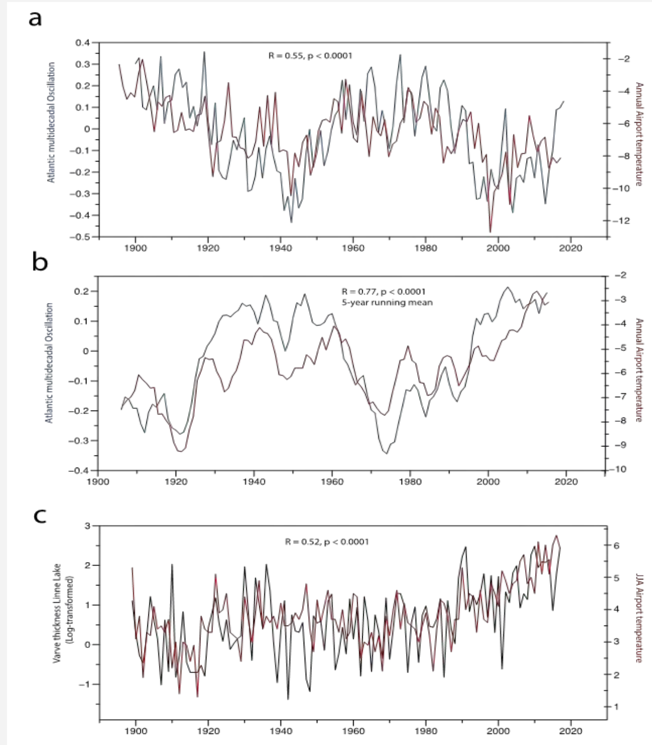

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PACEMAP: Predicting Arctic Change through Ecosystem MoleculAr Proxies

- With new techniques and old mud we reconstruct past Arctic warmth to anticipate the future -

By Giff Miller
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The Arctic is warming faster than any other region of the planet, and the effects are already apparent. Landscapes that have been continuously ice-covered since the start of the last glacial cycle and now being revealed as cold-based ice recedes under warming summers. Working in the Eastern Canadian Arctic for 50 years Gifford Miller has seen those changes. And traveling to the same small Inuit communities, grey-haired friends, who as children were amazed by his film camera, are now watching movies on smart phones, and hunters are trading their snowmobiles for canoes earlier each spring.

Climate models suggest that over the next century the Arctic will experience twice the warming seen at lower latitudes. What will that mean for the Inuit living there? Already new birds are appearing in summer; how will the vegetation change? When was the last time the Arctic experienced conditions similar to the projected climate in 2100 CE?

Those are some of the questions that Miller and colleagues are trying to answer with PACEMAP, an interdisciplinary project involving scientists from the University of Colorado Boulder, the University at Buffalo, the University of Alaska Fairbanks, and Curtin University in Australia. PACEMAP brings together ecologists, geologists, and paleoclimatologists, with organic geochemists and geneticists, to utilize the past to predict the future. Capitalizing on lake sediment deposited in past warm times on Baffin Island, including the Early Holocene, the Last Interglacial (MIS 5e), and the penultimate interglacial (MIS 7; Figure 1), our field teams will recover pristine continuous sedimentary records that span earlier warm intervals. Although lacustrine archives from these time periods have been lost from most northern lands, where repeated glaciations usually erase sediment from earlier warm intervals, Baffin Island is one of a handful of locations where pre-last glaciation sediment survived underneath non-erosive, cold-based glacial ice. The PACEMAP project seeks to analyze these unique records using new analytical techniques to provide quantitative evidence of past ecosystems and more tightly constrain summer temperatures during past warm times to predict ecosystem status in 2100 CE.

The team is using molecular approaches to reconstruct changes in climate, hydrology, and vegetation through past warm times. Greg deWet (Post doc) and Jon Raberg (PhD student), working with Julio Sepúlveda at Colorado are using bacterial membrane lipids, called branched glycerol dialkyl tetraethers (brGDGTs), to reconstruct climate back through

Figure 1. *Lake sediment coring on Baffin Island (photo: Zach Montes, Orijin Media).*

time. The distribution of these compounds in modern environments has been empirically shown to relate to environmental temperature, and one of the goals of the project is to create a site-specific calibration for Baffin Island. Elizabeth Thomas and Devon Gorbey (PhD student, Buffalo) are evaluating changes in precipitation source and moisture balance from the hydrogen isotopic composition of leaf waxes (d2Hwax) in terrestrial and aquatic plant sources. And Sarah Crump (Postdoc, Colorado) working with Mike Bunce at Curtin University in Australia are using ancient sedimentary DNA extracted from interglacial sediment to provide a more authentic reconstruction of local vegetation communities, where long-distance pollen dispersal compromises pollen records. This approach, relatively untested on such long timescales, also involves modern validation work, where Martha Raynolds and Shawnee Kasanke, ecologists working with Skip Walker at the University of Alaska Fairbanks map the modern vegetation around the study sites to compare with DNA extracted from surface sediments at our coring sites.

PACEMAP is about to enter its third field season, with researchers heading to Baffin Island in May to recover sediment cores using lake ice as a coring platform, followed by a more expansive summer team that will collect modern environmental samples, recover and redeploy sediment traps and temperature loggers, and map vegetation. Data and results from the project will be made publicly available as they are published.

We thank our Inuit guides for their knowledge, support, and hard work in the field, in particular Joshua Akavak, Mina Kunilusie, and Gordie Audlakiak. We also thank the Nunavut Research Institute and Arctic College in Iqaluit for logistical support, and the Inuit of Baffin Island for permission to travel and work on their land. The PACEMAP project is funded by the Office of Polar Programs at NSF to Gifford Miller and Julio Sepúlveda (Colorado), Skip Walker (Alaska) and Elizabeth Thomas (Buffalo).

Obituaries

Albert M. Swain (1940-2019)

By Konrad Gajewski, University of Ottawa, gajewski@uottawa.ca

Last summer, we heard the news that Dr. Al Swain passed away at the age of 78. He lived his life in Wisconsin and Minnesota, and began his education in a one-room schoolhouse not far from Madison. After university, he taught high school, and while taking a summer workshop for teachers at U Minnesota, met Ed Cushing, and went to do his PhD. While there, he had the dream summer job, as field assistant to Miron Heinselman in his classic study of fire history of the Boundary Waters Canoe Area. This involved a couple of summers canoeing and camping though the region, stopping to core trees and determine the age of the fires along the route. After the PhD, he got a research position at University of Wisconsin-Madison Center for Climatic Research, where he headed one component of the original COHMAP project, concerned with the climate of the past 2000 years. He spent about a decade there, finding and collecting frozen cores from varved sediments on a transect from Maine to Minnesota, as well as a couple from Washington State (the latter never published). He seemed to have a knack for finding these lakes, but finding varved sequences actually involved spending winters poring over maps and lake inventory lists to identify candidate sites, and long field seasons coring dozens of lakes to find an occasional one with varves. Decades later, these cores are still the major source of high-resolution paleoenvironmental information of the past 2ka for the region. After that funding wore out, he entered the public service. His dream was to get a job as a resident scientist at a place such as the Stockden Island Park in Lake Superior, where he had done some work on a contract. It seems this dream never panned out, but he remained active in a range of activities for over 30 years including volunteering as Park Naturalist at Blue Mounds Park.

Although he published few papers during his scientific career, this work was pioneering and these classic studies are still being cited 10-20 times per year, more than 40 years after they were published! And this doesn't include the many times his cores and surface samples are used in synthesis studies but not cited (an unfortunate but common practice). The Lake of the Clouds study from his PhD thesis, which has been cited over 400 times (Swain, 1973), established the use of charcoal analysis as a fire indicator and demonstrated, contrary to the general opinion at the time, that high-resolution pollen studies from varved sediments could provide useful information about vegetation dynamics. His classic study of Hells Kitchen Lake (Swain, 1978), which showed post-fire succession in a sediment core, has been cited at least 200 times. He was the first to show that eastern and midwestern forests had different fire return intervals although it is not clear if this was ever published or only presented in conferences. In addition to training several people in palynology, tree-ring and paleoenvironmental methodology, and working with others in several projects, he and his associates also contributed hundreds of unpublished surface samples to the North American Modern Pollen Database which are incorporated into NEOTOMA, and these have been the basis of dozens of studies.

Al Swain publications (partial list)

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Marjorie Green Winkler (1934-2019)

By Patricia Sanford and Konrad Gajewski

Marjorie Winkler passed away last summer at the age of 84. A brilliant student in high school, she did her undergraduate degree at Cornell, then worked for years in various biology labs. Always a political progressive, she would tell stories of what it was like at University during the McCarthy days, where she would encounter colleagues who “didn’t exist”, yet were still working doing their research. Moving around following her husband’s career and having 4 children, as was the norm in those days, she was occupied in various jobs during her 20s and 30s. In her early 40s, when the family moved to Madison, she began volunteering at City School as a natural history teacher and at the University of Wisconsin Arboretum.

After much nagging from her husband Stefan, she enrolled in graduate school and began working on peat bogs with Calvin DeWitt at the UW-Institute for Environmental Studies. In addition she began working in the paleo-lab at University of Wisconsin Center for Climatic Research.

At UW, her work was marked by its creativity, interdisciplinarity and the enthusiasm with which she approached everything. It was also based on her deep knowledge of basic biology and chemistry and long experience in various laboratories. Lakes and bogs were a particular love of hers; she knew all the wetlands in southern Wisconsin and probably cored most of them at some point. An example of Marge's creativity and lateral thinking: at one point, her husband Stefan, a radiologist at the Veteran's Hospital had one of the early 3-D scanners. She proposed to bring the varved sediments from a frozen core to be scanned, to determine if we could see the varves in better detail. How to transport and keep the frozen core intact was a problem; which she solved by placing it in a plastic container to which was added some jello; green as I recall. Late one Friday night, when the machine was free, we took it over to the hospital; apparently this kind of activity happened often, to the consternation of the Department Head. It didn't produce anything as the resolution was insufficient at the time, but still, we couldn't keep up with the constant stream of ideas coming from her.

Marge had a fruitful relationship with the National Park Service, launching paleoecological studies of Cape Cod National Seashore and Everglades National Park and working with Kenneth Cole, Margaret Davis, and others on a series of research efforts at Voyageur's and Isle Royale National Parks and Apostle Islands and Pictured Rocks National Lakeshores. These resulted in several publications and numerous Reports to the Park Service.

The 1990's were a particularly fruitful time for Marge. She produced paleoecological studies of a number of lakes on Lac du Flambeau (Lake Superior Chippewa Indian Nation) tribal lands to provide prehistoric background for acidification and mercury studies as related to the fisheries of these lakes and for heavy metal contamination of lakes bounded by commercial cranberry operations' pesticide use. Together with Pao K. Wang she pulled together a monumental compendium of all that was then known about the Late Quaternary vegetation and climate of China for the COHMAP project subsequently published in the 1993 volume *Global Climates since the Last Glacial Maximum*. One of her long-term goals, to core the sediments of Walden Pond (made famous by Henry David Thoreau's book *Walden,* 1854), was at least partially accomplished by obtaining a short core of its sediments for pollen and charcoal analysis of the most recent 600 years. This research was highlighted in a science article by William K. Stevens, "History of Walden Emerges from its Mud" in the New York Times, October 8, 1991.

Throughout her years at the Center for Climatic Research Marge mentored many students and guided masters and doctoral thesis research. She was also involved in early efforts at involving underserved minority high school students in STEM research. As a service to the larger professional paleoecology-paleoclimatology community she reviewed numerous pre-publication manuscripts and many National Science Foundation grant applications. Throughout her life and career she remained a kind and humble person always concerned about friends, colleagues, and people everywhere.

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