Project information

Project title

Clams as climate and ecosystem recorders during the Holocene

Year

2011/2012

Project leader

Michael Carroll, ApN

Participants

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Participants, Fram Center:

- NPI (Haakon Hop)
- UiT, Inst. Geology (Katrine Husim)
- UNIS (Jørgen Berge)
- Bangor University (UK)
- Bates College (USA)
- Iowa State University (USA)

Flagship

Fjord and coast, Theme: Structure, function and change in Arctic and boreal fjord ecosystems

Funding Source

Fram Centre, internal

Summary of Results

Sub-goal:

1. Develop long-term chronologies with annual resolution for modern samples and at key climatic transitions in the past millennium and through the Holocene.

Living samples of the long-lived bivalve (*Arctica islandica*; (Norsk - kuskjell; English - ocean quahog) were collected alive from a coastal site in northwest Finnmark. In addition, recently dead shells were collected from the beach faces from the same locations, as well as sub fossil specimens from inland raised beaches. We dated some of these sub fossils to mid-Holocene (≈5000 BP) with 14C dating techniques. A subsample (n=5) of the live-collected individuals were processed in the laboratory (imbedded in epoxy, cross-sectioned) and then the annual growth bands counted. This provides both the age of each individual and interannual differences in growth. The oldest individual examined thus far was 120 years old. Raw growth rates were detrended (correcting for ontogenetic changes with age), and the growth increments from individual samples were statistically cross-matched, resulting in a master growth chronology. This chronology extends from 1950-2008.

The standardized growth pattern (SGI) was compared with climatic indices, and a strong relationship was identified between growth and the North Atlantic Oscillation (NAO) and the Arctic Oscillation (AO) indices, indicating a strong, large-scale climatic regulation of growth.

Stable isotopic ratios of oxygen (18O/16O) were examined at a subannual scale over 12 annual increments, and compared with sea surface temperature over the same time (IMR time series) in order to determine seasonality in growth. This analysis indicates that growth commences in March, peaks in May, and largely ceases during October. This has important implications for geochemical andecological relationships.

4. Combine modern and fossil results with other proxy records (i.e. lake sediment varves and marine microfauna) to establish a multi-proxy approach to understanding past environmental change.

Not addressed in 2011.

Presented data are from M. Mette (graduate student, Iowa State University), and A. Wanamaker (supervisor).

Published Results/Planned Publications

- Carroll, M.L., W.G. Ambrose Jr., B.S. Levin, G.A. Henkes, H. Hop, S. Ryan, W. Locke, P.E. Renaud. 2011. Pan-Svalbard growth rate variability and environmental regulation in the Arctic bivalve Serripes groenlandicus. 15th Norwegian-Russian Symposium, 6-9 September 2011, Longyearben, Svalbard, Norway. (Oral Presentation).
- Mette, M., A.D. Wanamaker, W.G. Ambrose, M. Retelle, M. Carroll, B. Locke. 2012. Shell growth strongly coupled with positive Arctic Oscillation and North Atlantic Oscillation phases: insights from a sclerochronological and geochemical study from northern Norway (Ingöy). Abstract, Ocean Sciences Meeting. Feb. 2010, Salt Lake City, USA

Communicated Results

Participation and communication of data (by H. Andrade, APN) at the Sclerochronology Field Week Workshop (August 2011).

Interdisciplinary Cooperation

The project is disciplinary in nature, combining marine ecologists, biogeochemists, and paleoceanographers.

It is also quite international in scope, with much of the relevant instrumentation and analytical expertise existing outside Norway. In this project, the the analytical work is taking place at Bates College (laboratory preparation, image analysis), and Iowa State University (growth increment analysis, isotopic analysis, statistical cross matching).

Budget in accordance to results

The funding from the Fram Center provided a necessary boost for the early-midstages of this project. It allowed us to process samples of bivalves collected from coastal regions in northern Finnmark in 2009. This resulted in the development of the first bivalve chronologies from Arctica islandica in Norway, the first shell stable isotopic and mineralogical time series from this species in Norway, and allowed identification of the intra-annual (seasonal) patterns of this species. The project funding also increased internal competence in the statistical cross-matching techniques in chronology building, as well as new field collections of high-Arctic specimens (Serripes groenlandicus, Mya truncata) from North of Svalbard in April.

Additional funding is required to complete all the tasks in the original project outline. Proposals are currently under review at NFR (Norklima program), and the U.S. National Science Foundation.

If Yes

Mineralogical patterns in bivalve shells are a result of a suite of environmental factors at the time the shell material is laid down. These factors can be related to natural environmental phenomena (changing temperature, salinity, or availability of organic material). But chemical ratios in the shell may also indicate exposure to anthropogenic constituents (e.g. Barium, Lead). Changes in the concentrations in such constituents may allow reconstruction of the time history of such industrial-based discharges. This has not yet been realized in the present project, but could be a commercialization of the present technology.

Conclusions

Understanding the causes and consequences of present environmental changes currently taking place require an understanding of natural scales of variability in natural systems. Analysis of shell growth rings over long time scales provides a relevant ecosystem monitor, not only of growth (biological effect), but also environmental changes over long time scales (temperature, salinity, seasonality, food availability). But these proxies must be properly calibrated. The present project is doing just that, but analyzing one of the longest lived animals known, identifying its growth patterns, and the relationships of its shell chemistry to variability in local conditions. In this way, we can not only reconstruct past environments, but also begin to understand the possible effects of future climatic changes in the boreal-arctic boundary.