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Development and Analysis of Millennial-Scale Tree Ring Records from Glacier Bay National Park and Preserve, Alaska (Glacier Bay)
Greg Wiles (The College of Wooster)
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The Biogeochemistry and Environmental History of Bioluminescent Bays, Vieques, Puerto Rico
Tim Ku (Wesleyan University) Suzanne O'Connell (Wesleyan University), Anna Martini (Amherst College)
Students: Erin Algeo, Jennifer Bourdeau, Justin Clark, Margaret Selzer, Ulyanna Sorokopoud, Sarah Tracy

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Keck Geology Consortium: Projects 2007-2008
Short Contributions – Puerto Rico

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PALEOENVIRONMENTAL CHANGES IN THE BIOLUMINESCENT BAYS OF VIEQUES, PUERTO RICO: EVIDENCE FROM OSTRACODS

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INTRODUCTION

The primary objective of this study is to determine the increases or decreases in saline levels over time in Puerto Mosquito and Puerto Ferro, two south-facing bays on the island of Vieques, P.R. This was done by measuring changes in species composition and pore shape in ostracods. Ostracods are micro-crustaceans that are sensitive to salinity, temperature, pH levels and food supply (Schornikov, 2000). Hence they have been used successfully as paleo-saline indicators in previous paleoenvironmental interpretations. They are considered to be reliable proxies because they have been used to predict the salinity in other fluctuating salinity environments.

For example, Frenzel and Boomer (2005) grouped the ostracod species in marginal marine brackish waters by their type of environment. *Cyprideis torosa* are found in holeuryhaline waters, while *Cyprideis neglecta* are a halophile freshwater species. Frenzel and Boomer (2005) grouped species to represent marine brackish water as well. In this study, 4 samples from 1 core in Puerto Mosquito and 17 samples from 3 cores in Puerto Ferro were counted. The proportions of species were compared at different core depths and were found to indicate the dominant water type during that interval.

The species *Cyprideis torosa* have also been used in other studies to determine the salinity because of their sieve-type pores (Rosenfeld & Vesper, 1977). The pores are generally circular, but within Cyprideis they can vary from round to oblong to irregular. Rosenfeld and Vesper (1977) determined that saline levels decreased as the percentage of round pores increased. Therefore, round pore dominance indicates fresher water. A sieve-type pore analysis was performed on four samples from one shallow core of Puerto Mosquito.

METHODS

Sample Collection and Preparation

Four cores were extracted from both Puerto Mosquito and Puerto Ferro using a push core or a vibracore. Core lengths range from 63 to 369 cm. Cores were visually logged for sediment grain size, color, and recognizable shelly material to determine sedimentary facies. Cores from Puerto Mosquito consist of clay, fine sand and coarse sand, with variable amounts of whole shells and shell fragments, and rare root fragments. Cores from Puerto Ferro consist of coarse sand, shelly material and halimeda sand scattered throughout the core. The core color in both bays varies from dark gray, to greenish gray, to olive gray or olive black.

Selected intervals from 3 cores were wet sieved at 63 um and oven dried at 90 ^{o}C overnight. The dried sediment was sieved at a larger fraction of 3000 um in order to remove the large rocks and biological material. The remaining 63 to 3000 um sediment was passed through a Splitor until it was close to one cubic centimeter in size. A microcentrifuge tube, cut at 1ml, was used as a scoop so all sample sizes were uniform. The sediment was poured from the Splitor into the microcentrifuge tube until it was a full, loose fit. No weight was recorded during this process. All ostracods were subsequently picked, identified and counted from the 1cc sample from the three Puerto Ferro cores.

The core within Puerto Mosquito had two distinct markers: a shelly layer and a clay layer. The cores within Puerto Ferro had one marker: the transition from carbonate sand to halimeda sand. The Puerto Mosquito core was dated by the Keck project coordinators using 210Pb dating.

Species Assemblage Analysis

The assemblages within intervals from two cores in Puerto Ferro were compared to determine if the assemblages varied over time. If there was no change, then the saline level did not vary enough to affect the ostracod population. If there was a change, then it could be determined whether the saline level increased or decreased from the present day known levels by looking to see which species proportions changed favorably and which water type they preferred. As a result, the changes in salinity can be recorded as increasing or decreasing throughout the three estimated dates.

Sieve-Pore Analysis

C. torosa were photographed uncoated with a Scanning Electron Microscope, (SEM) at low pressure with a backscatter detector. Between three and six ostracods were measured from four intervals. Only a section of their sieve-pores were measured using Image J software. The section measured was from the center of the ostracod valve because that was the flattest area (Fig. 1). Pores taken from the edges could have had distorted measurements because the valve rounds at the edges. Thus, the edges were avoided. Deciding how many to count depended on the amount of sieve-type pores present. The section size was determined by maximizing the amount of sieve-type pores and ensuring the magnification was high enough to see details.

Cyprideis were not found in Puerto Ferro and were found within Puerto Mosquito. Shallow core PM12A was selected for sieve-pore analysis because it had been dated previously with 210Pb by the project coordinators. Ostracods from four intervals with average depths of: 1, 3, 19, and 23 centimeters were measured. The mean depth of 1cm was dated to be 2003 and the deepest interval, mean depth 23 centimeters, was dated to be 1941. The length and width of the sieve-type pores were measured using Image J software. The ostracod sieve-pore analysis performed in this study followed the methods defined by Rosenfeld and Vesper (1977). Firstly, length was divided by width to determine circularity. Sieve-type pores with L/W equaling greater than 1.5 were considered oblong and pores with L/W equaling less than 1.5 were considered round. Irregular pores were triangular, y- or heart shaped.

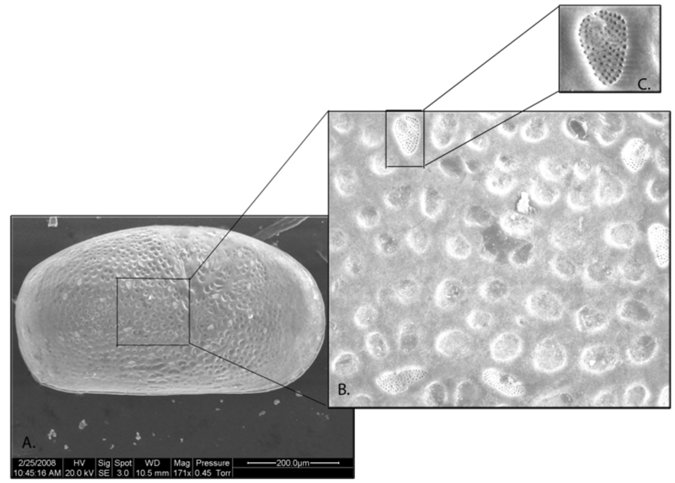

Figure 1: A) SEM photograph of Cyprideis taken at low voltage without coating. B) Section of ostracod upon which the sieve-pores were analyzed. C) SEM photograph of a sieve-type pore. Its length and width were measure to determine circularity.

RESULTS

Puerto Mosquito

Figure 2 shows the sieve-type pore analysis of PM12A in Puerto Mosquito. At 1 cm depth there was a dominance of round pores; twenty percent of pores were oblong and none were irregular (Tab. 1). However, each interval afterwards found a dominance of oblong pores, steadily increasing overtime from fifty-five percent in 1999 to eighty-three percent in 1941.

The mean round pore length had a similar trend. At the mean depth of 1 cm, the mean round pore length was smaller than it was for the remaining intervals. The size of the pore has been shown to increase with salinity (Frenzel and Boomer, 2005).

In this study, from years 1941 to 1999, the round pore size steadily decreased perhaps indicating an decrease in salinity.

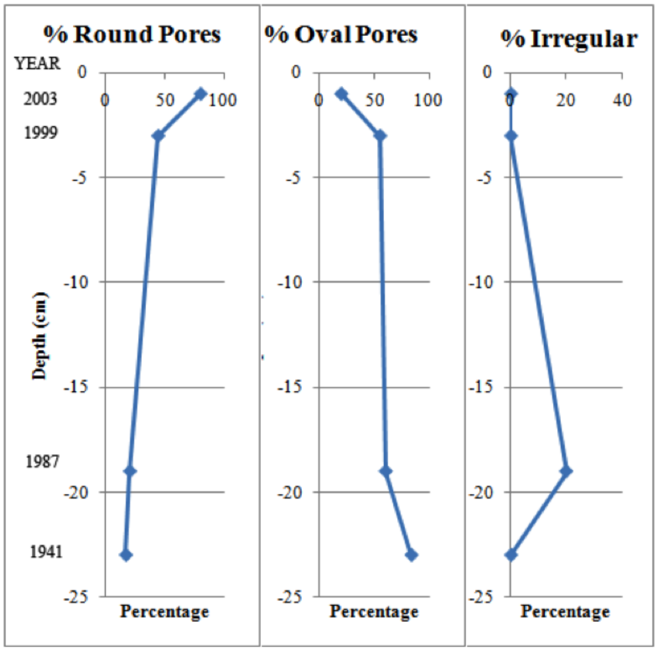

Figure 2: The percentage of round, oval and irregular pores found in PM12A. A high percentage of round pores indicate less saline waters and a low percentage of round pores indicate more saline waters.

Core	Mean Depth (cm)	Ostracods/cc	# of Species	# Loxo-concha	# Orionina	# Bairdia	# Cytherella	# Proponto-cypris
PF7	1	93	5	27	14	9	38	5
	7	27	5	8	4	7	5	3
	13	15	5	3	2	6	3	1
	19	12	5	2	2	5	3	0
	23	21	5	4	7	4	6	0
	29	22	5	4	6	6	5	1
	47	26	5	2	8	5	4	7
	69	13	5	5	3	3	2	0
PF12	27.5	37	5	17	5	5	7	3
	42.5	13	3	4	0	7	2	0
	62.5	17	4	5	0	4	6	2
	72.5	21	5	10	1	2	7	1
PFD2	8.5	30	5	5	8	3	10	4
	18.5	19	4	0	3	6	7	3
	33.5	34	5	9	6	7	10	2
	48.5	75	5	29	15	4	22	5
	63.5	64	5	24	17	1	15	7

Table 2: Genus Identification for Cores PF7, PF12 and PFD2. This table shows the raw data: how many ostracods were in every cubic centimeter interval and the numbers of each genus.

Puerto Ferro

There were five ostracod genera found within Puerto Ferro: *Loxoconcha*, *Orionina*, *Cytherella*, *Propontocypris*, and *Bairdia* (Tab. 2). The proportions of the five species remained relatively constant throughout the core (Fig. 3). 1932 is a latest known date of PF12, found at the mean depth of 27.5 centimeters. The presence of these five species corresponds with the findings of the 2007 ostracod Keck project (Robertson, 2007). It confirms that Puerto Ferro is an open marine environment and has been so since at least 1932. The data of the cores extend past the date of 1932 but how far past is unconfirmed. However, the ostracod data suggests that Puerto Ferro has been an open marine environment for some time.

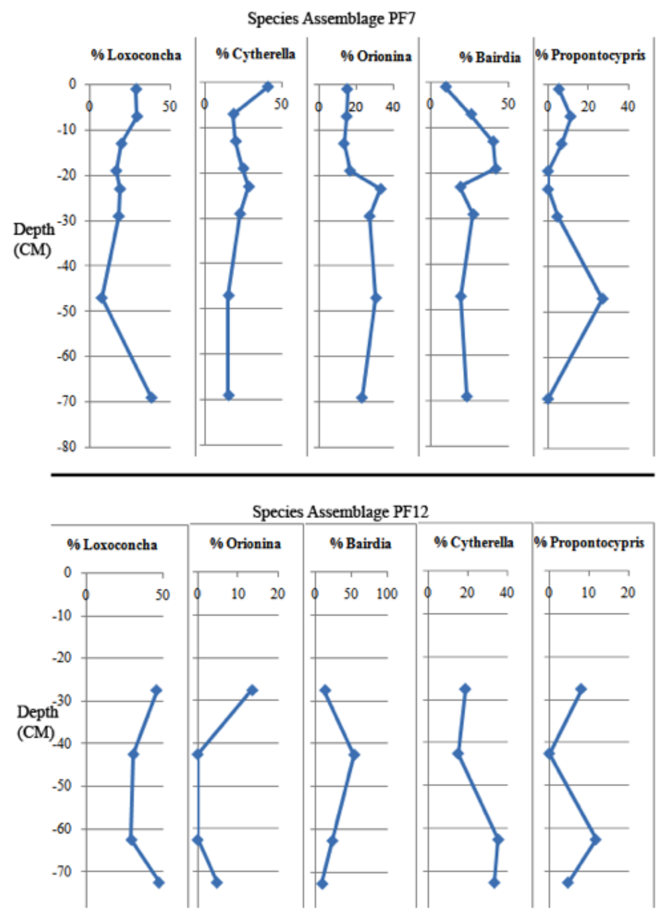

Figure 3: Species assemblages of two of the shallow cores from Puerto Ferro. It is a visual representation of the percentages of an ostracod species found at a specific depth. A statistical analysis could then tell whether the change was significant or not. A high significance could indicate a change in the water type.

DISCUSSION AND CONCLUSION

The sieve-type pore analysis of Puerto Mosquito indicates there is a difference between the salinity of the bay in the present and salinity of the bay in the past. For this study, there must be caution in using the sieve-type pore analysis. The species may be mistakenly identified because *C. torosa* is easily confused with other *Cyprideis* species such as *C. salebrosa* or *C. similis*. Furthermore, the sample size may not be large enough to yield significant quantitative data.

From the species assemblage analysis, it is confirmed that Puerto Mosquito and Puerto Ferro have little species overlap, suggesting that these two bays, while lying adjacent to one another, developed differently. This may be because of the differences in the structures of the bays. Puerto Ferro was found to be an open marine environment throughout the core record. It has the largest channel to the ocean, the biggest volume, and the maximum depth, doubling that of Puerto Mosquito. Puerto Mosquito is dominated by *Cyprideis*, a known brackish water indicator.

CONCLUSIONS/FUTURE WORK

The goal of the study was to identify changes in paleosalinity in Puerto Mosquito and Puerto Ferro. The findings indicate that the water type of Puerto Ferro have not changed while the water type of Puerto Mosquito may have been less saline in the past. Changes in the water type can indicate changes in the hydrodynamics of the bays. Puerto Ferro appears to have an unchanging water type and consequently one can only conclude that the hydrodynamics have not changed in a way that would affect the saline levels of the bay. On the other hand, evidence suggests Puerto Mosquito may have changed water type. A higher salt concentration in the present could be the bay's response to larger freshwater inputs or a decrease in bay depth.
With ostracod analyses, the investigator often has to choose between a highly detailed study that can only look at one part of a water environment and a study that is less detailed but analyzes a larger portion of the water body. This study looked at the larger body. Future studies could perform a higher detailed analysis by choosing only one core and investigating every 2 centimeter interval from top to bottom. This would provide very specific data about one part of the bay which could then be tied together with this study to make more specific estimations about the bay environment.

It would also be very interesting to consider whether or not the population of dinoflagellates within the two bays correlates to the variances of ostracod populations. If there is a strong correlation, it could be hypothesized that the environmental changes that affect the ostracod population, like salinity and temperature, are also affecting the bioluminescent dinoflagellate population.

REFERENCES

Frenzel, P. & Boomer, I., 2005. The Use of Ostracods from Marginal Marine, Brackish Waters as Bioindicators of Modern and Quaternary Environmental Change. Palaeogeography, Palaeoclimatology, Palaeoecology, 225, p. 68-92.

Rasband, W.S., ImageJ, U. S. National Institutes of Health, Bethesda, Maryland, USA, http://rsb.info.nih.gov/ij/, 1997-2007

Robertson, L.R., 2007. Paleosalinity and Accumulation Rates of Sediments in Bays of Vieques, PR: 20th Keck Symposium Volume Proceedings: College of Wooster, p. 187-191.

Rosenfeld, A. & Vesper, B., 1977. The Variability of Sieve-Type Pores in Cyprideis torosa (Jones 1850), Recent and Fossil, as an Indicator for Salinity and Paleosalinity. In Loffler, H and Danielpol, D., Eds., Aspects of Ecology and Zoogeography of Recent Fossil Ostracoda: Junk, The Hague, p. 55-66.

Schornikov, E., 2000. Ostracoda as Indicators of Conditions and Dynamics of Water Ecosystems. In Martin, R., Eds Environmental Micropaleotology: New York: Plenum Publishers, p. 181-187.

Tainer, E. 2007. A GIS Analysis of Three Bioluminescent Bays, Vieques, Puerto Rico. 20th Annual Keck Symposium: College of Wooster, p. 192-199.