

# OSTRACODES AS PROXIES FOR PALEOSALINITY IN BAYS OF VIEQUES, PUERTO RICO

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## INTRODUCTION

The 2006 Keck Geology Consortium project in Puerto Rico involves the study of environmental factors and conditions of three bays on the southern coast of the island of Vieques. One of the bays, Puerto Mosquito, is renowned for its bioluminescence caused by the dinoflagellate *Pyrodinium bahamense* var. *bahamense* (Keck Project Announcement 2006). The other two bays are Bahia Tapon and Puerto Ferro. My primary focus is to investigate both the modern and ancient salinity of the bays by studying ostracodes in the sediments of each bay. Determining if bay salinity has changed in the past can explain several things. Shifts in salinity may be evidence of a change in paleoenvironment. Changes in salinity can also indicate that the hydrodynamics of the system have changed.

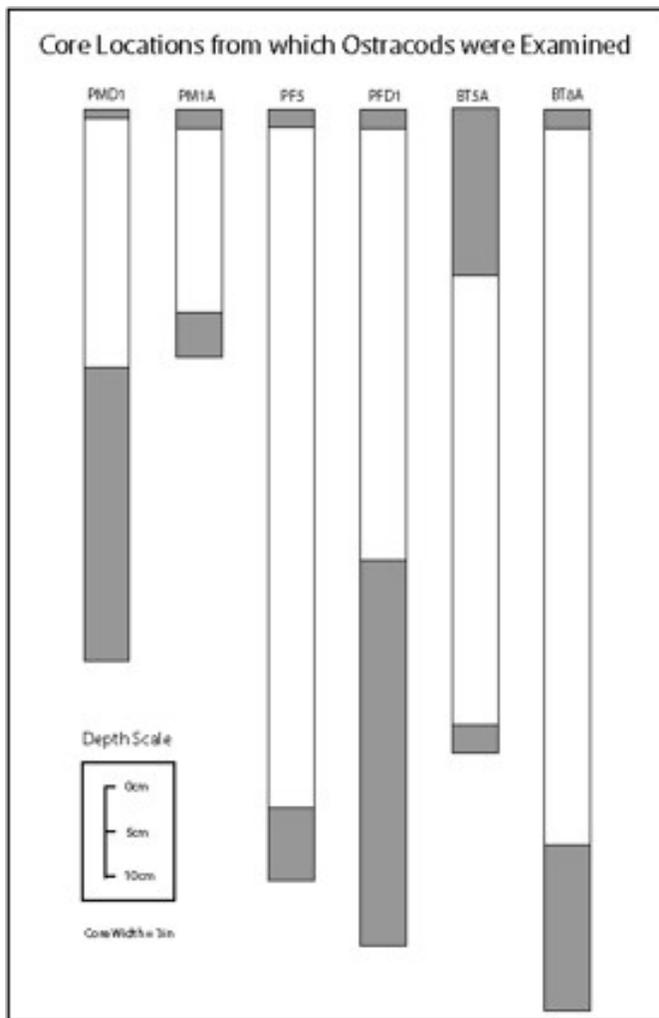
Ostracodes have been used in paleolimnology, paleoceanography, and sea level change, because of their sensitivity to changes in salinity, temperature, substrate, food supply, pH levels, and dissolved oxygen content. Individual species have different ranges of salinity tolerances; some are restricted to low-salinity conditions (stenohaline) and others may be capable of tolerating varying salinity conditions (euryhaline) (Medley et al. 2006). All ostracodes have pores that perforate the carapace, out of which hair-like sensors called sensilla protrude that enable them to sense their immediate environment (Ostracod Research

Group 1989). The ostracodes of interest in this study are *Cyprideis*, which has sieve-type pores. Pores usually have a circular outline, but vary from round to irregular. Rosenfield and Vesper (1977) determined an inverse relationship between the abundance of round pores and the salinity of the environment using *Cyprideis*.

In total, thirteen cores were extracted from all of the bays. Two cores were chosen from each of the bays to examine for ostracode assemblages. One core was chosen from a central location and one from a location near the edge, where conditions may be slightly different (depth, flow velocity, etc.). Core tops and bottoms were examined to try and compare each bay's present and past salinities, but were not of comparable depths (Fig. 1).

## METHODS

To prepare the samples for ostracode analysis, sediments from each bay were separated according to their depth and sediment lithology, and were sieved and dried. Intervals were chosen based on visible changes in sediment size, composition and color. A small sample (about half a small whirl-pak) from each interval was sieved using a 2mm, 150 $\mu$ m and 63 $\mu$ m sieve and DI water. The sediments were then dried in an oven at less than 100° F, weighed, and brushed into vials. Before picking ostracodes, the 150 $\mu$ m sample was sieved at 125 $\mu$ m to lessen the bulk of larger samples.

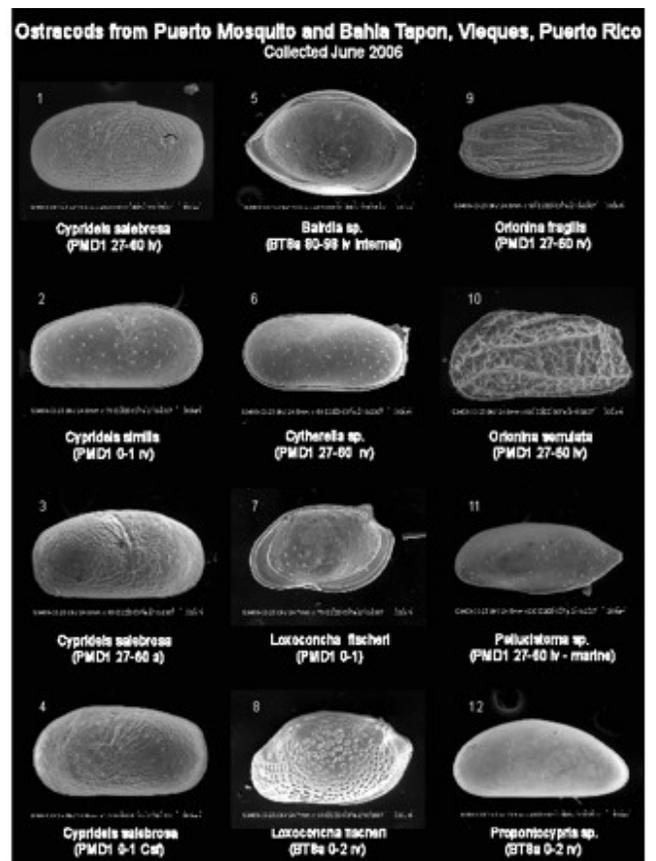


**FIGURE 1.** The lengths of each of the cores examined for ostracode assemblages. The gray areas are the top-most and bottom-most extent of the core, as sectioned according to lithology in the field in Vieques in June 2006. The reasoning for the areas chosen was to compare the most recent sediments with the oldest sediments, but the depths of the cores are clearly not comparable, as each core does not extend to the same depth.

Twenty to thirty ostracodes were then picked out of 150-125µm sample sections from the top and bottom interval of two cores from each bay; totaling 6 cores and 12 assemblages. These depths were chosen to compare the oldest and most recent sediments to characterize the maximum change in salinity (Fig. 1). The ostracodes were identified under a microscope by Dr. Neil Tibert of Mary Washington

University. Although several species were photographed for documentation purposes, the only SEM photos (Fig. 2) vital to this project are the four *Cyprideis* ostracodes, which originated in the top and bottom of one Puerto Mosquito core (PMD1).

*Cyprideis* was chosen for analysis because previous work has been done to correlate the pore circularity and areas of ostracodes from a bay in the Dominican Republic (Medley et al. 2006). This correlation was used to document changes in bay salinity. While *Cyprideis* has a fairly wide range of salinity tolerances, its optimal environment is primarily one in which it is without competition, and with high salinity. Because *Cyprideis* can survive large shifts in water conditions, it is a prime candidate for analyzing pore hole variation in shifting conditions.



**FIGURE 2.** This slide of ostracodes was photographed by Neil Tibert at the University of Mary Washington in February 2007. All were taken from Puerto Mosquito (PMD1) and Bahia Tapon (BT8A). Scale is

included under each ostracode. *Cyprideis* in numbers 1-4 were photographed to analyze the shape of their pore holes in relation to pore size.

Ostracodes were photographed from several cores using a variable pressure scanning electron microscope (Hitachi S-3400N), with low magnification images of the anterior, median, and posterior regions of the external carapace (Fig. 2). Of the four *Cyprideis* photographed (Fig. 2, numbers 1-4), pore size and shape were analyzed using image analysis software (Image J 1.30v; National Institutes of Health) to measure the circularity and area of sieve pores. I traced the edges of each sieve pore, creating a polygon and documenting the circularity, perimeter, and area of each polygon.

## RESULTS

Assemblages from the top of all Puerto Ferro and Bahia Tapon cores were identical to the assemblages found at the bottom of each respective core. The only changes in species

PMD1 and at the top of PM1A. The ostracode assemblages characterize three distinct environments. These are based on tolerances of oxygen and salinity levels in the water column, and represent a hypersaline lagoon, a partially mixed lagoon, and an open marine environment. Open marine environments generally have high species diversity, primarily due to high competition and the wide variety of nutrients from the water column. More restricted environments have less species diversity, due to the controls on the environment, such as salinity, temperature, nutrients, etc. Certain species also have distinct salinity tolerances, which can easily place a range of salinity on an environment if that species is present.

Overall changes in salinity were graphed using the Image J software, in which pore holes of *Cyprideis* were outlined to analyze both the pore circularity and area, documented in the dataset in Appendix 1. Circularity values were plotted (0=irregular, 1=circular) against the area of the pore, then a best fit linear trend was generated to establish the general slope for each carapace analyzed (Fig. 3).

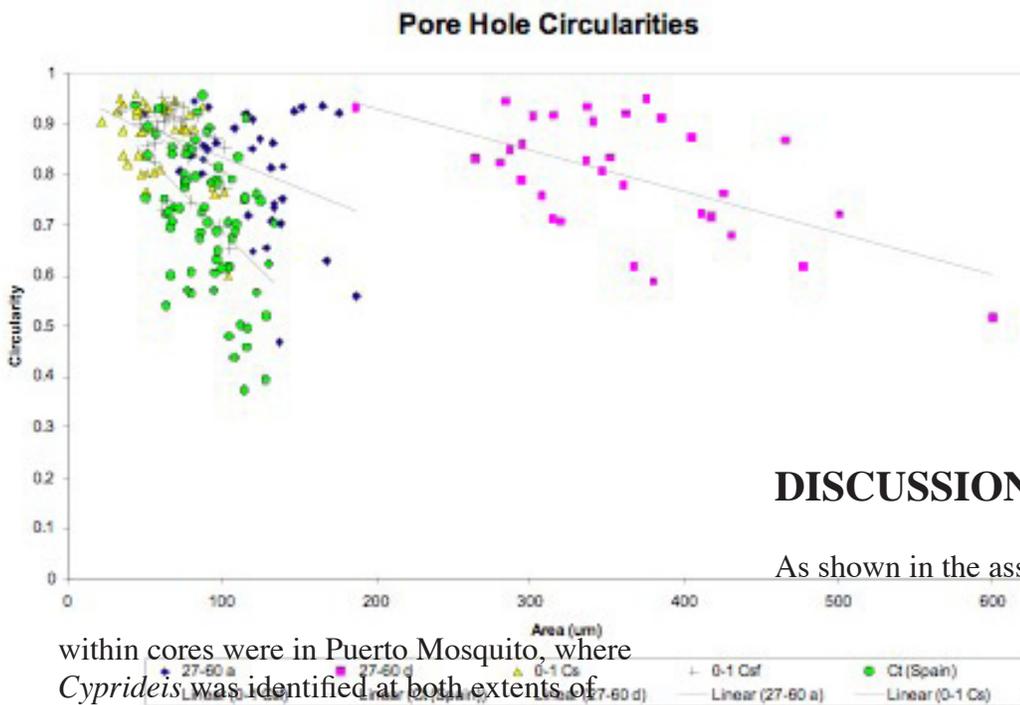


FIGURE 3. Comparison of the four *Cyprideis* that were photographed and analyzed using the Image J software. The standard pore hole shape for comparison is “Ct”, a small population from Spain (green dots). 0=irregular and 1=round. 2 ostracodes were from the bottom and 2 from the top of the Puerto Mosquito core PMD1. The two largest ostracodes (blue diamonds and pink squares) were taken from the bottom of the core (27-60). Their circularity decreases with area, but not as much as the ostracodes plotted from the base of the core. Their slope of circularity vs. area is much steeper, which is more similar to the hypersaline conditions of the population in Spain, which has the highest slope.

## DISCUSSION

As shown in the assemblage table (Fig. 1),

within cores were in Puerto Mosquito, where *Cyprideis* was identified at both extents of

4), both Puerto Ferro and Bahia Tapon are environmentally consistent over time. PFD1, PF5, and BT8A are consistently open marine, BT5A has remained a partially mixed lagoon. However, both of the cores from Puerto Mosquito change dramatically. PMD1 was once open marine and PM1A was a partially mixed lagoon. Both of these cores presently show assemblages characteristic of a hypersaline lagoon.

The changing salinity observed in Puerto Mosquito may suggest that the high population of dinoflagellates may be a relatively recent phenomena. It is possible that the more open marine environments of the other two bays keeps the populations lower.

This is an ongoing project.

	PMD1	PM1A	PFD1	PF5	BT5A	BT8A
<b>T</b>	<b>A</b>	<b>A</b>	<b>C</b>	<b>C</b>	<b>B</b>	<b>C</b>
<b>O</b>	<i>Cyprideis</i>	<i>Cyprideis</i>	<i>Orionina fragilis</i>	<i>Orionina fragilis</i>	<i>Orionina fragilis</i>	<i>Loxoconcha fischeri</i>
<b>P</b>	Sparse <i>Loxoconcha</i>	Sparse <i>Loxoconcha</i>	<i>Loxoconcha fischeri</i> <i>Orionina serrulata</i>	<i>Loxoconcha fischeri</i> <i>Orionina serrulata</i> <i>Bairdia</i> <i>Cytherella</i>	<i>Loxoconcha fischeri</i>	<i>Orionina serrulata</i> <i>Bairdia</i>
<b>B</b>	<b>C</b>	<b>B</b>	<b>C</b>	<b>C</b>	<b>B</b>	<b>C</b>
<b>O</b>	<i>Loxoconcha fischeri</i>	<i>Loxoconcha fischeri</i>	<i>Loxoconcha fischeri</i>	<i>Loxoconcha fischeri</i>	<i>Orionina fragilis</i>	<i>Bairdia</i>
<b>O</b>	<i>Perissocytheridea</i>	<i>Orionina fragilis</i>	<i>Orionina fragilis</i>	<i>Orionina fragilis</i>	<i>Loxoconcha fischeri</i>	<i>Loxoconcha fischeri</i>
<b>T</b>	<i>Cyprideis</i>		<i>Orionina serrulata</i>	<i>Orionina serrulata</i>		<i>Orionina serrulata</i>
<b>T</b>	<i>Trachyleberidae</i>			<i>Cytherella</i>		
<b>O</b>	<i>Cytherella</i>			<i>Bairdia</i>		
<b>M</b>				<i>Propontocypris</i>		

**Environment:**  
 A=Hypersaline Lagoon  
 B=Partially Mixed Lagoon  
 C=Open Marine

**FIGURE 4. Ostracode assemblages found in the top and bottom sections of each core. Three environments were determined by assemblages and certain species' tolerances, including hypersaline lagoon, partially mixed lagoon, and open marine. The environments that had the same assemblages in both the top and bottom of the core remained the same. The only ones that changed were the two in Puerto Mosquito. *Cyprideis* was only found in Puerto Mosquito. (PM=Puerto Mosquito, PF=Puerto Ferro, BT=Bahia Tapon)**

A regression line was made for each data set which include pore-hole circularity and area of four ostracodes from the top and bottom of PMD1 and a living ostracode from Spain, which inhabits waters of optimal condition at a salinity of 60 ppt, where the pores are generally circular (Fig. 3). The plot of circularity versus area shows negatively sloping trend lines that indicate decreased circularity with increasing pore size. This relationship is indicative of salinity conditions at the time of deposition.

**REFERENCES**

Keck Project Announcement 2006. <[http://keck.wooster.edu/2006\\_Project\\_Announce/PuertoRico2006.pdf](http://keck.wooster.edu/2006_Project_Announce/PuertoRico2006.pdf)>.

Medley, P., Tibert, N.E., Patterson, W., Curran, H.A., Colin, J.-P., Mezquita, F., and L. Greer 2006. Paleohydrology of Middle Holocene Lagoonal & Lacustrine Deposits in the Enriquillo Valley, Dominican

Republic: Pore Morphometrics and  
Isotope Geochemistry of Ostracoda.  
Thesis at University of Mary Washington.

Ostracod Research Group. Introduction to  
Ostracoda. based on Athersuch, J., Horne,  
D.J. & Whittaker, J.E., 1989. Marine  
and brackish water ostracods. <[http://  
w3.gre.ac.uk/schools/nri/earth/ostracod/  
introduction.htm](http://w3.gre.ac.uk/schools/nri/earth/ostracod/introduction.htm)>.

Rosenfeld, A. and 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 and Fossil Ostracoda*: The Hague,  
55-66.