Pollutants and Foraminiferal Assemblages in Laguna Torrecilla (San Juan Bay Estuary System): An Environmental Micropaleontological Approach on Medical Geology

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Introduction

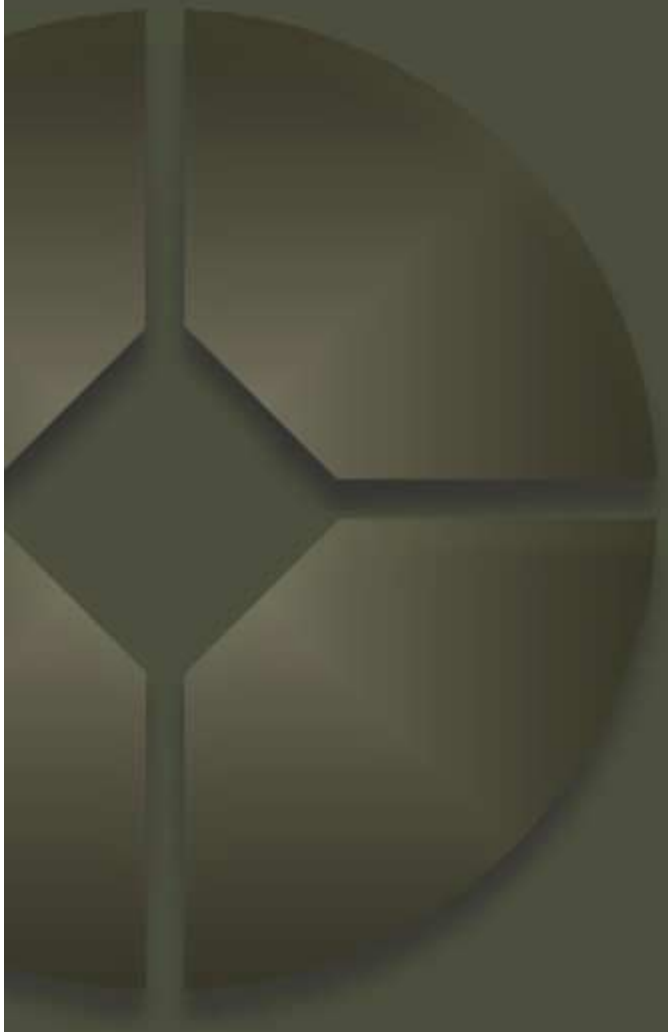
- Estuaries receive 80%-90% of all waste released to marine environments, therefore are particularly vulnerable to **heavy metal pollution.**

- Effects of pollutants:

water quality
diseases (flora/fauna)
ABNORMALITIES → INDIVIDUALS
reduced survival rates

ABUNDANCE
DIVERSITY } COMMUNITIES
DISTRIBUTION
outbreaks of human diseases

cont...



diversity: conditions amenable for opportunistic species; dominance by few taxa (resistant and/or tolerant)

abundance: species totally eliminated; decreased survivorship

abnormalities: habitat difficulties

cont...

Coastal Waters Pollutant Proxies

- water
- sediments
- plankton crustaceans (i.e. copepods)
- fishes
- ostracods
- **BENTHIC FORAMINIFERA**

What are Foraminifera?!?!?!

- Foraminifera are single cell - shelled protists.

- Test (shell) are made of Aragonite, low Mg-Calcite and/or high Mg-Calcite.

*Live in marine and/or brackish environments.

*Depths 0-3km deep.

*Planktic and Benthic habits.

Benthic Foraminifera: a pollutant proxy and/or bio-indicator

- have specific niches and therefore react quickly to adverse changes and are characterized by a wide and diverse distribution.

- are often the last organism seen to disappear completely from polluted sites making them good bio-indicators.

- distribution varies spatially and temporally in relation to external (abiotic) and internal (biotic) factors. Changes in these environmental factors can lead to changes in species composition, hence, assemblages

INEXPENSIVE biomarkers

OVER 50 YEARS IN THE MAKING…

1950 → **2000**

Zalesny (1959)

Watkins (1961)

Seiglie (1964, 1968) (PR)

Seiglie (1971, 1975) (PR)

Banerji (1992)

Alve (1995)

Samir et al. (2001)

Carnahan (2005)

"Symbiotic" relationship between forams and pollutants

*Heavy metals are absorbed preferentially by the foraminifera regardless of their concentration (Cu > Zn > Cr > Pb).

*It was found that:

a) twisted, compressed and abnormal test growths were related to higher concentrations of **heavy metals**;

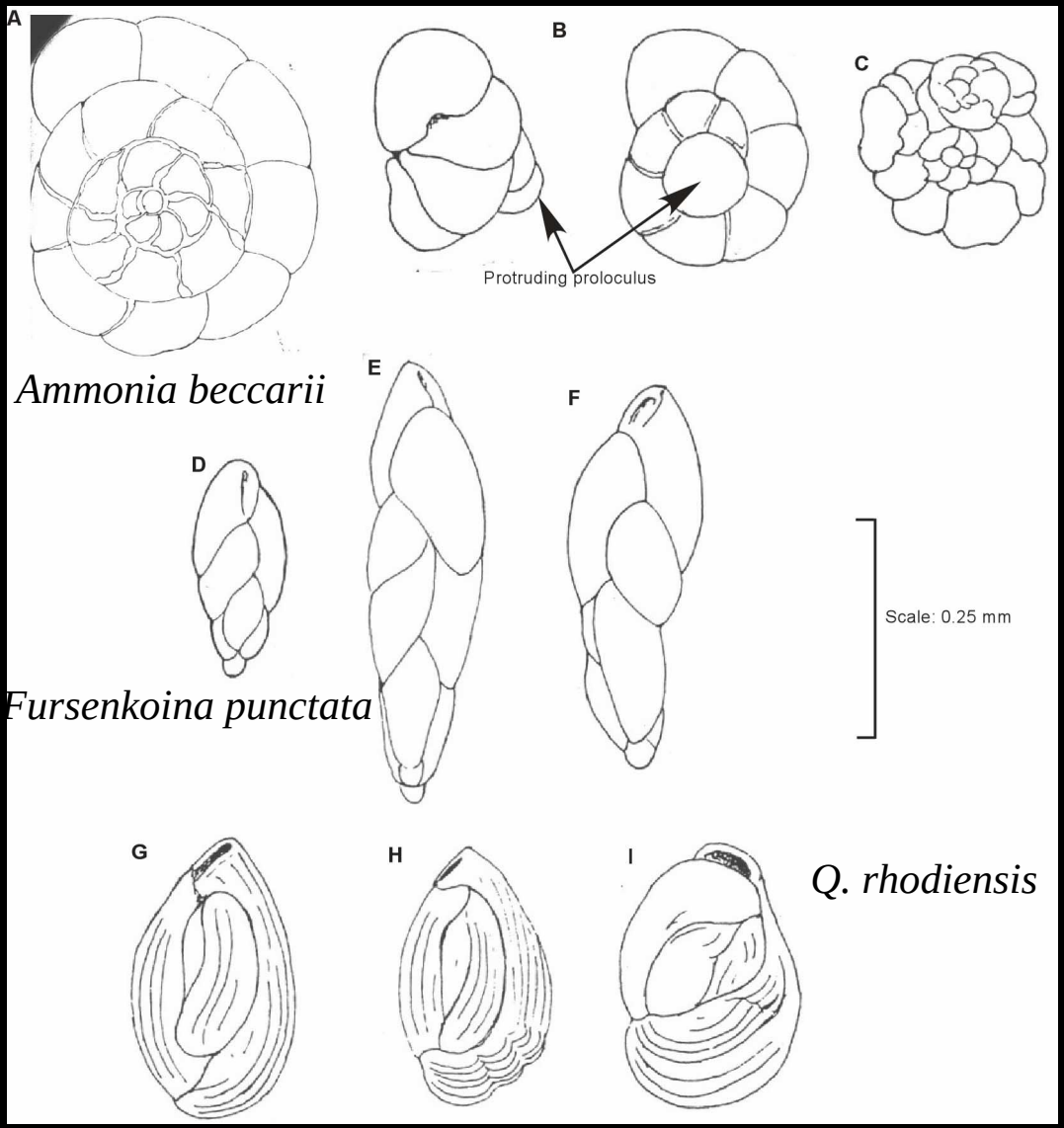
b) spiroconvex forms were related to Cr enrichment or to areas of **high organic matter** content;

c) reduced chamber size were related to **domestic sewage or low heavy metal concentrations**.

(Samir & El-Din, 2001)

“Symbiotic” relationship between forams and pollutants

(Seiglie, 1975)

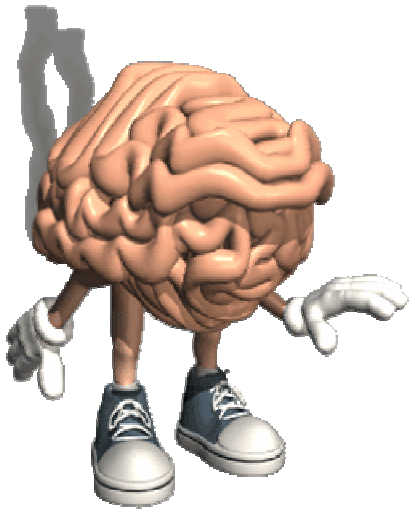


SO WHAT?!?!?!?!?!

Major Environmental Problems in San Juan Estuary

heavy metals
high levels of As, Cd, Cr, Hg, Ni, Th and Zn
violations of PR water quality standards for Cu, Pb, Hg, Se and Zn
contaminated sediments
high levels of oxygen-depleting nutrient loads
low dissolved oxygen levels
repeated fish deaths
pathogens (coliforms)
non-permitted dredging activities
urban developments (excess sedimentation)
herbicides/pesticides
loss of sea grass beds
sedimentation

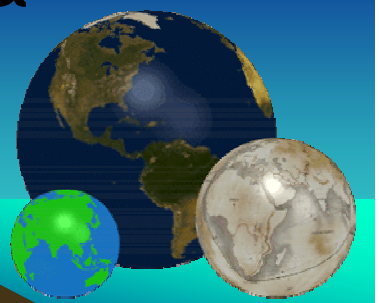
SO WHAT?!?!?!?!?!



Short Term Purposes

To re-establish the use of foraminifera as bio-indicators or proxies of heavy metal pollution in Puerto Rico.

To provide a baseline assessment and characterization of the present environmental conditions at Laguna Torrecilla using benthic forams.



Objectives

Are there key identifiable assemblages at Laguna Torrecilla and, if so, what are their distributions?

Do heavy metals and trace element concentrations, within the foraminifera tests and sediments, yield a direct relationship to test deformation?

What are the bottom water conditions of the estuary from a temporal perspective?

Is their a direct relationship between the FORAM Index and environmental conditions in estuarine environments in Laguna Torrecilla?

Why Laguna Torrecilla?

Sanitary/fluvial discharge and illegal dumps.

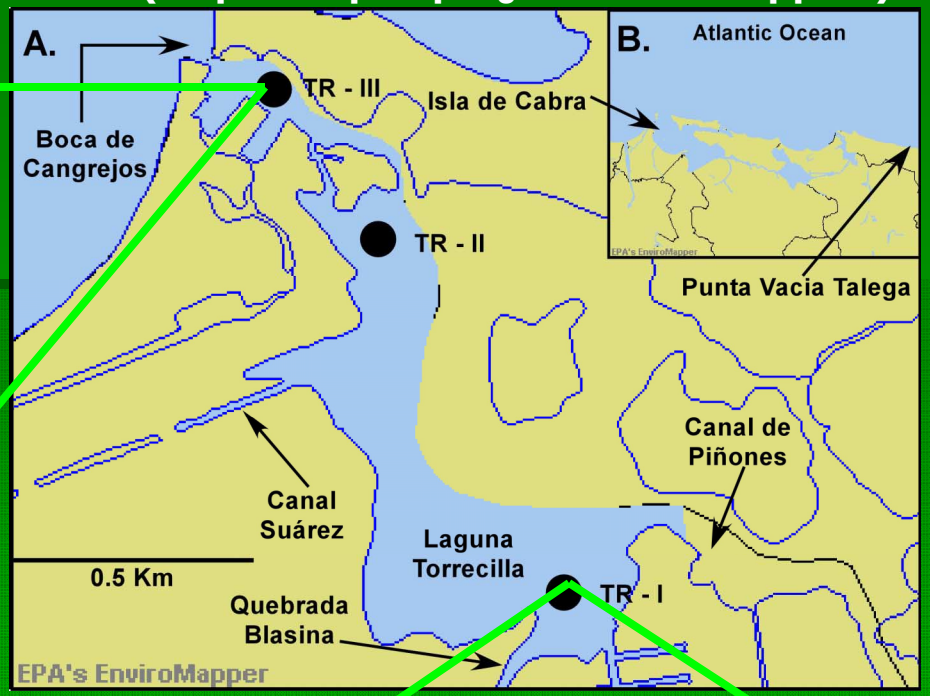
Raw sewage discharge.

Backwash from PR-Aqueduct and sewer System.

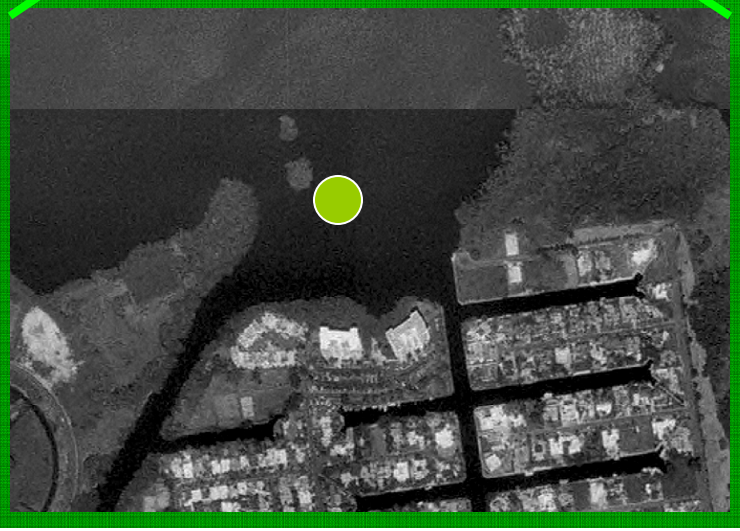
Backwash Sergio Cuevas Water treatment Plant.

Webb et al., 1998 **found:** As (17 µg/g), Hg (0.05 µg/g) and Pb (20 µg/g) metals.

(http://maps.epa.gov/enviromapper/)



Canal Suarez
Qbda. Blasina
Canal de Piñones
Boca de Cangrejo



Sampling Collection

Field Sampling (July/2005):

Instrument: Universal Core Head-Hand Auger with Slide Hammer.
Cores: 3.
Thickness: 27 cm to 32 cm.
Storage: Polycarbonate barrel (6.5 cm in dia.) at 2°C.
Samples: every 2 cm (66 cm^3).

General methodology

Grain Size Analysis

* fine sand size (>2mm) to clay size (<0.063 mm)

Foram Analysis

* >63 µm size -- 150-200 count -- genus level

Organic Matte Content (L-O-I)

* muffle furnace (450°C/6hrs)

General methodology

Geochemical Analysis

* **Metals/Trace Elements (sediments):** samples will be sent to Atclabs in Tucson- Arizona. ICP-OES: Ag, Cd, Cu, Mn, Mo, Ni, Pb, Zn, Al, As, Ba, Be, Bi, Ca, Co, Cr, Fe, K, Mg, Na, P, Sb, Sc, Sn, Sr, Ti, V, W, Y, Zr, S, and Hg .

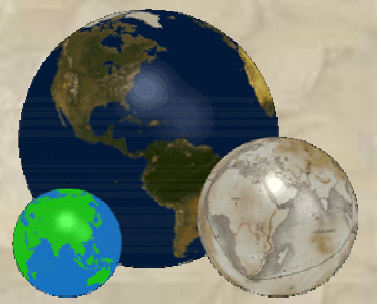
* **Dating (sediments):** 210Pb and 137Cs (Reverse coaxial Ge-detector).

* **Foraminifera:** Energy Dispersive Spectrometer (EDS) linked to a Scanning Electron Microscope (SEM).

Long Term Purposes

1. To get $$$$$$$$.

2. To culture forams in control conditions and add different [ ] of metals species in order to completely understand the nature of test deformities linked to metals.



QUESTIONS ?!?!?