

Foraminiferal Assemblages in Laguna Torrecilla (San Juan Bay Estuary System in Puerto Rico):

An Environmental Micropaleontology Approach

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ABSTRACT

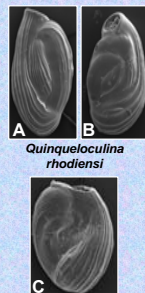
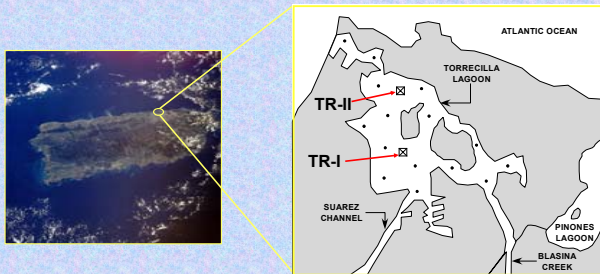
Foraminiferal assemblages (*Ammonia beccarii* cf. *typica*, *A. beccarii* cf. *tepida*, *Quinqueloculina* spp.) from 30 cm cores taken at Laguna Torrecilla, a polluted estuary, contain a relatively high occurrence of deformed tests (up to 13%). Some deformities (e.g., double tests, aberrant tests) are mostly found within the miliolids (*Quinqueloculina* spp.) while the rotaliids (*Ammonia* spp.) show fewer deformities (e.g., extended protoconch, stunted tests). Preliminary results for heavy metal analysis (ACTLABS Laboratories-Canada) from bulk sediment samples show concentrations below toxicity levels except for copper. Copper concentrations (50-138 ppm) fall between the ERL (Effect Range Low) and ERM (Effect Range Median) values representing possible to occasional detrimental effects to the aquatic environment. Organic matter content (loss-on-ignition) ranging from 10-23%, coupled with pyritized tests and framboidal pyrite, indicates low oxygen conditions. *Ammonia beccarii* cf. *typica* and *A. beccarii* cf. *tepida* showed no significant variation in size with sample depth. However, forma *tepida* was not found in the intervals with highest organic concentrations. The abundance of *A. beccarii*, which is a species highly resistant to environmental stresses, appears to be related to hypoxia events. *Ammonia-Elphidium* index values, a previously established indicator of hypoxia, are 80-100, reflecting the lack of *Elphidium* spp. Apparently reduced oxygen conditions at Laguna Torrecilla exceeded the tolerance levels of *Elphidium* spp. In addition, diversity indices show that there has been temporal variability in terms of abundance and distribution of foraminifera. Foraminiferal assemblages coupled with diversity indices and organic matter content indicates that Torrecilla Lagoon has undergone several episodes of hypoxia. Such conditions could explain the relatively high percentage of test deformities, although elevated copper concentrations may be a compounding factor.

INTRODUCTION

- Estuaries receive 80%-90% of all waste released to the environments, therefore they are particularly vulnerable to **heavy metal pollution**.
- Effects of pollutants:
 - water quality
 - diseases (flora/fauna)
 - reduced survival rates
 - human disease outbreaks
- Environmental studies have aimed to characterize and quantify anthropogenic sources of pollution entering the San Juan Bay Estuary System and less on its sub-systems (i.e., Torrecilla Lagoon).
- Elevated concentrations of As, Cd, Hg, Ni, Th, and Zn, high oxygen-depleting nutrient loads, low dissolved oxygen levels, pathogens, and loss of seagrass beds have been classified as major environmental threats to the estuary.
- Limited work during the late mid 1970's on northern Puerto Rico's coastlines investigated the impacts of eutrophication (from sewage disposal and leakage) on benthic foraminiferal assemblages. Results showed that *Ammonia beccarii* is the most common species in coastal lagoons, in Puerto Rico, under natural and polluted conditions.



FIELD AREA

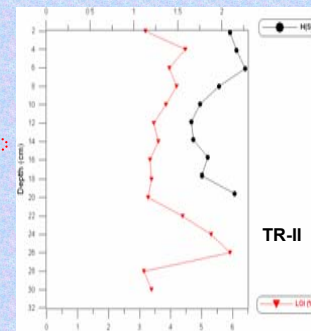
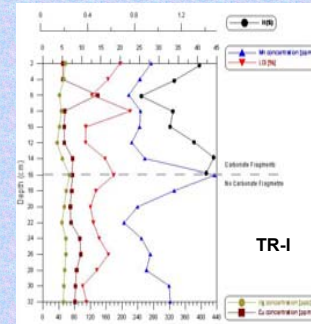
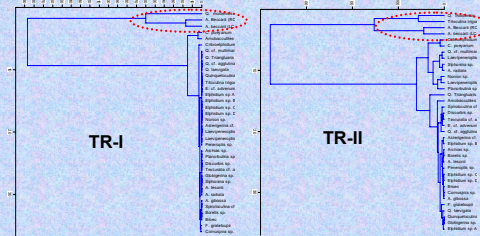


A. Normal test
B. Deformed test
C. Deformed test

RESULTS

CORE TR-I INDEICES						
SAMPLE #	Taxa S	Individuals	Shannon	Equitability	A-E	% DEFORMITY
1	6	170	1.411	0.6832	90	6%
2	6	174	1.316	0.6215	92	10%
3	6	146	1.227	0.5687	100	6%
4	6	60	1.024	0.4642	89	5%
5	5	152	1.126	0.6168	96	7%
6	4	23	0.8569	0.5889	86	4%
7	5	95	1.086	0.5927	95	13%
8	4	7	1.352	0.9661	80	14%

CORE TR-II INDEICES						
SAMPLE #	Taxa S	Individuals	Shannon	Equitability	A-E	% DEFORMITY
1	22	323	2.145	0.3883	87	10%
2	17	277	1.775	0.3471	91	15%
3	17	280	1.84	0.3703	88	6%
4	11	283	1.677	0.4862	93	19%
5	16	259	1.653	0.3266	95	10%
6	16	306	1.753	0.3608	92	8%
7	16	271	1.971	0.4487	85	10%
8	20	263	2.267	0.4827	84	3%
9	18	368	2.17	0.4864	95	9%
10	18	246	2.097	0.4522	84	6%



DISCUSSION

- Apparently the conditions at site TR-I exceed *Elphidium* spp. tolerance levels (high A-E values) and this is evidenced by deformed tests (reduced last chamber) in taxa present.
- The apparent high abundance of *Ammonia* spp. is likely related to hypoxia as indicated by the abundance of organic matter (LOI data).
- Diversity [H(S)] trends downcore in TR-I shows similarities with LOI and Cu-Hg-Mn concentrations. Fine-grain sediments (silt+clay) and metal concentration are directly related.
- Increase in diversity and approximate 4-fold less organic matter (LOI data) at site TR-II could explain more tolerable conditions.

CONCLUSIONS

- Foraminiferal assemblages, coupled with diversity indices indicates hypoxic episodes.
- These episodes show colonization excursions by *Q. rhodiensis* which then was partially displaced by *Ammonia* spp.
- Q. rhodiensis* is the one species showing the greatest variability in test deformities. These deformities could be related to organic matter input (eutrophication) and heavy metal pollution (> Cu concentrations).
- Differences between cores TR-I and TR-II in relative organic matter content, as well as assemblage composition and species diversity, can likely be explained by the proximity of site TR-II to more marine conditions.