

What Do Reef-Dwelling Foraminifers Reveal About Stressors of Coral Reefs?

Pamela Hallock
Presented by Natasha Mendez-Ferrer
College of Marine Science, University of South Florida,
St. Petersburg, Florida, USA

PART I. BLEACHING

HISTORY OF RESEARCH

- Symbiont loss was first observed in laboratory cultures in early 1980s
- Occurred in response to photic stress
 - Hallock et al. (1986)
- First observed in field populations at Lee Stocking Island in 1988
- Coral post-bleaching survey
- First observed in Florida Keys populations in late June 1991 (not present in May 1991)
- Observed in Florida Keys populations 1991 through present
- Observed in all tropical oceans since 1991 (opportunistic sampling)
- Increased prevalence at higher subtropical latitudes

MAJOR FINDINGS

- Bleaching in *Amphistegina* occurs in response to photic stress
 - Primarily wavelengths <490 nm
- Intensity of photic stress fluctuates
 - Seasonally – peaks near summer solstice
 - Intraannually
- Acute photic stress impacts reproduction and reduces recruitment
- Chronic photic stress increases susceptibility to predation and microbial infestation
- Bleaching in reef-dwelling foraminifers appears to be related to the effects of stratospheric ozone depletion.
 - Including accelerated CDOM breakdown

PARADOX

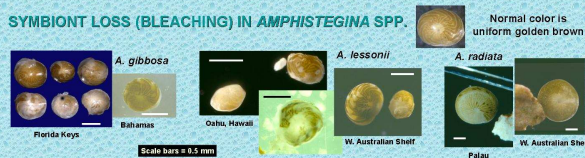
Amphistegina still thrive in the clearest offshore waters of the Florida Reef Tract, where stony coral cover has declined most!

- Paradox solution:
 - Amphistegina* populations can recover from a mortality event in a few years
 - They remain most abundant in best habitat
- Coral reefs require years to decades to recover from mortality events
 - Photo-oxidative stress is reduced in inshore waters
 - Coral reefs are currently "squeezed" between
 - Inshore potentially harmful terrestrial runoff
 - Offshore higher photo-oxidative stress

IMPLICATIONS

- Urgent need to preserve mangroves and coastal hammocks
 - Protect land from the sea
 - Protect reefs from terrestrial runoff
 - Protect reefs by producing photo-protective CDOM

SYMBIONT LOSS (BLEACHING) IN AMPHISTEGINA SPP.



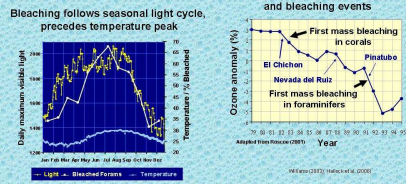
DISTRIBUTION OF AMPHISTEGINA SPP. (•) BLEACHING OBSERVATIONS (○) (YR)



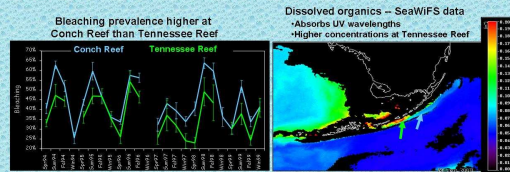
CYTOLOGY



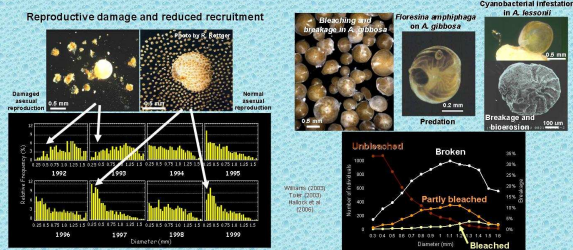
BLEACHING AND SOLAR RADIATION



BLEACHING AND WATER TRANSPARENCY



ASSOCIATED SIGNS OF STRESS



PART II. FORAMINIFERS AS BIOINDICATORS

QUESTION

Might resource managers utilize indicators of biological condition of reef environments that can relate data acquired through remote-sensing, water-quality and benthic-community monitoring to stress responses in reef organisms?

RATIONALE FOR FORAMINIFERS AS BIOINDICATORS

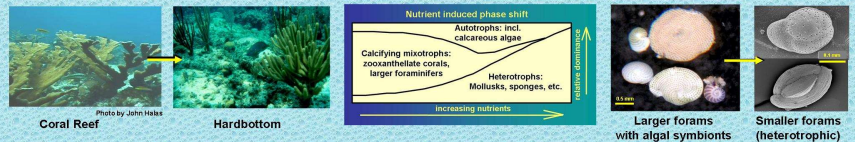
- Foraminifers are widely used as environmental and paleoenvironmental indicators.
- Reef-building corals and larger foraminifers have similar environmental requirements.
- A common, easily identifiable genus, *Amphistegina*, responds to stress similarly to corals.
- Short life spans facilitate differentiating between long-term decline and episodic stress events.
- Foraminifers are relatively small and abundant, and can be collected quickly and inexpensively.
- Foraminifers are not protected species and their collection has minimal impact on reef resources.

FoRAM (Foraminifers in Reef Assessment and Monitoring)

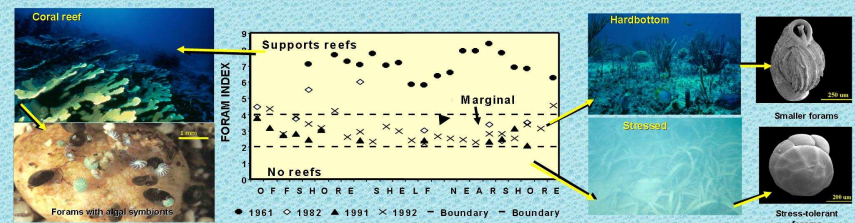
- FoRAM Index: Uses foraminiferal assemblages as indicators of suitability of sites for continued reef growth or recovery.
 - Application for resource assessment; monitoring frequency 3-5 years.
- Amphistegina* Index: Uses population parameters including abundance on reef rubble, as well as prevalence of bleaching, breakage and predation
 - Indicators of specific stresses in reef environments.
 - Application for resource and risk assessment; recommended frequency: twice per year: late spring and late summer.
- Bioassays: Experimental use of *Amphistegina* to assess stress responses;
 - Risk assessment tool as needed – protocols in development

BASIC CONCEPT

Foraminiferal assemblages respond to the same environmental stresses that induce reef community change (phase shift)



FoRAM ASSEMBLAGE INDEX



AMPHISTEGINA INDEX

- Amphistegina* spp.
 - Occur on coral reefs worldwide
 - Abundance reflects suitability of environment for calcifying organisms with algal symbionts
 - Bleaching indicates photic stress induced by high energy solar radiation (<490 nm)
 - Tolerate somewhat wider temperature range than most reef-building

Methods

- Collect pieces of reef rubble (~50-100 cm² bottom area)
- Scrub rubble with small brush, saving sediment
- Place in covered dish in seawater overnight
- Examine at ~20x magnification
- Estimate number of *Amphistegina*
- Determine % of population with some bleaching
- Seasonal sampling can distinguish chronic photic stress

RESOURCES: <http://www.marine.usf.edu/reeflab/>