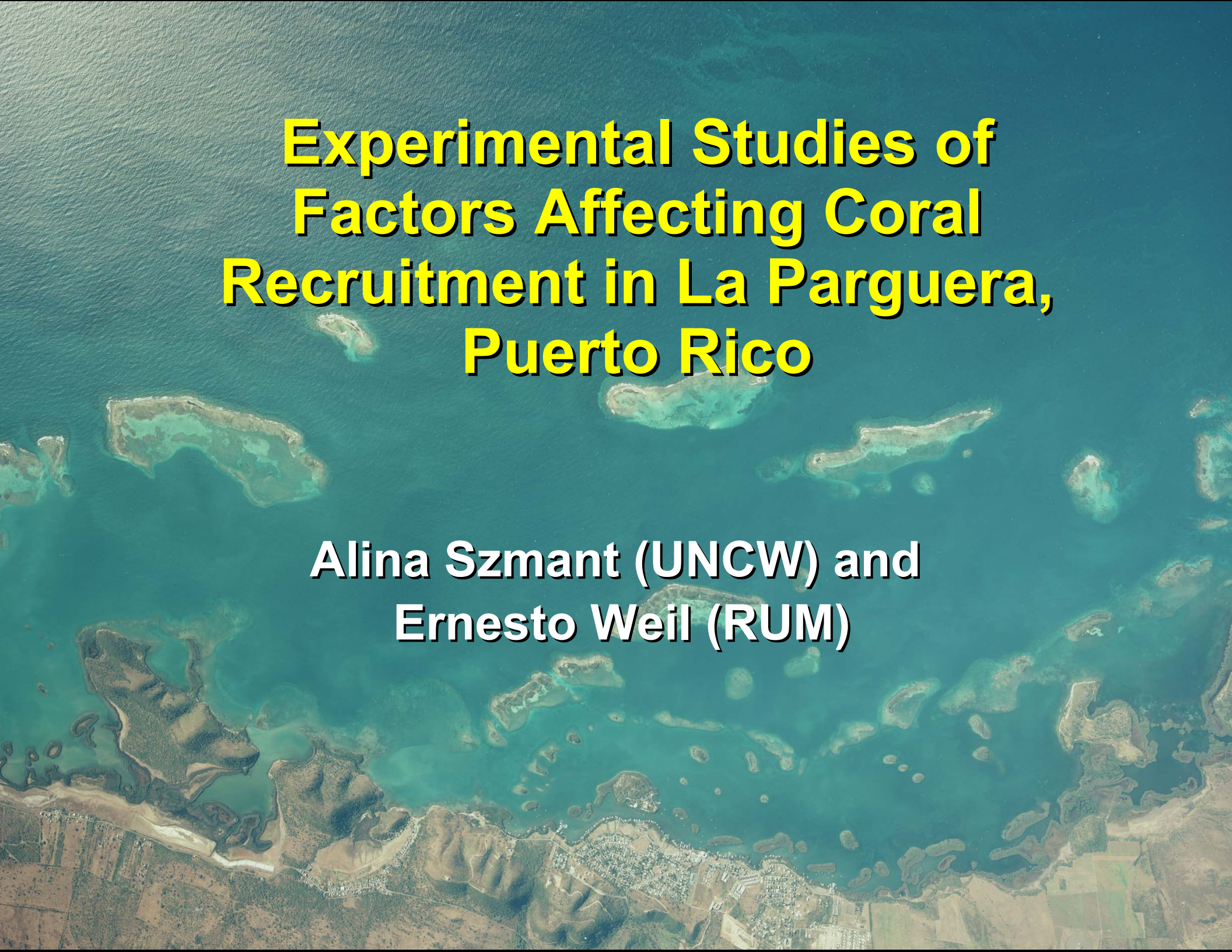
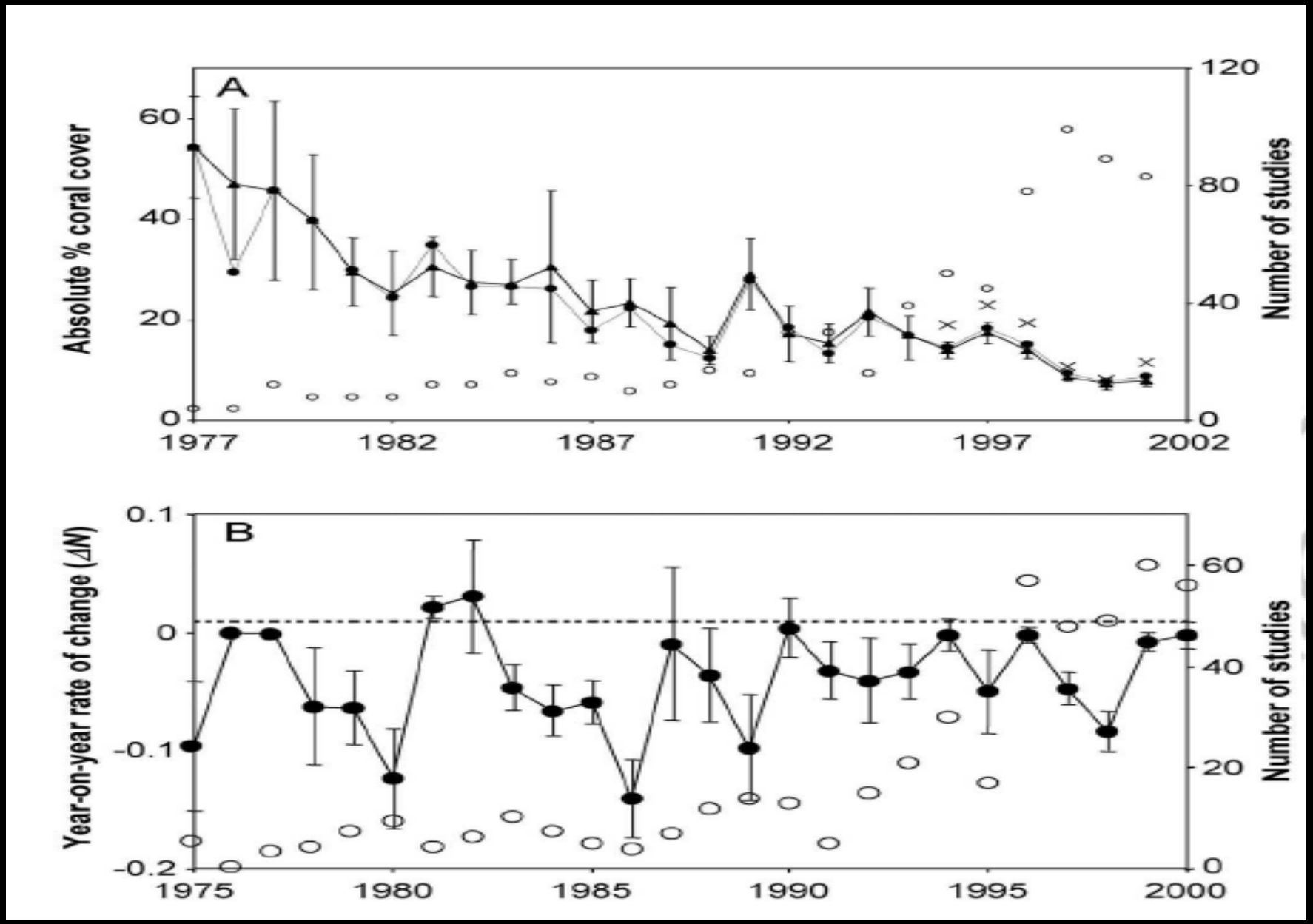


Experimental Studies of Factors Affecting Coral Recruitment in La Parguera, Puerto Rico

Alina Szmant (UNCW) and
Ernesto Weil (RUM)

The Problem:

Regional Decline in Caribbean coral cover based on published surveys



(Gardner et al 2003: Science)

Situation and Need:

- Reef building corals are not recruiting well to Caribbean reefs; over time, this contributes to decline in coral cover
- Anthropogenic activities could be affecting recruitment success
- We know little about the processes affecting coral recruitment, especially the early stages
- Research is needed to better understand conditions that are promoting or impeding coral recruitment
- We need to start at the beginning: *settlement and post-settlement survivorship*

Assuming that the supply of coral larvae is sufficient:

What factors could be affecting coral settlement?

1) Substrate quality of receiving reef
2) "Nursery quality" of receiving reef

What factors can affect substrate quality?

- grazer community composition
- weather, tides, storms
- *water quality conditions*

- Substrate characteristics affected are:
  - CCA cover and species composition?
  - microbial community?
  - macroalgal cover
  - *sediment cover & type*

Corals must compete against many plants and animals that also want to occupy the reef substrate, and coral larvae are very small at time of settlement

Therefore, environmental factors that affect substrate composition, such as water quality and grazing community structure may be important determinants of coral settlement and recruitment

Research Objectives Summer 2005:

PRIMARY: Settle coral larvae of as many species as possible onto settlement plates pre-conditioned at 3 sites along a water quality gradient; map spat and follow survivorship

- Inshore: Pelotas
- Mid-shelf: Turrumote
- Offshore: Buoy shelf edge

Research Objectives Summer 2005:

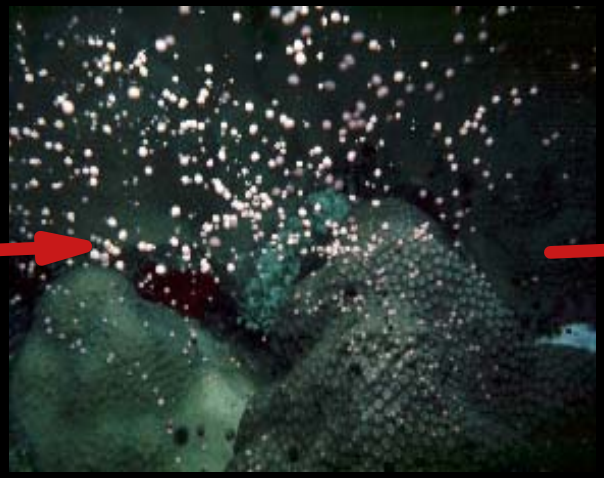
PRIMARY: Settle coral larvae of as many species as possible onto settlement plates pre-conditioned at 3 sites along a water quality gradient; map spat and follow survivorship

- Inshore: Pelotas
- Mid-shelf: Turrumote
- Offshore: Buoy shelf edge

SECONDARY:

- Continue research on settlement cues and preferences
- Begin work on effects of feeding on survivorship
- Continue research on larval behavior
- Capacity building in this research topic

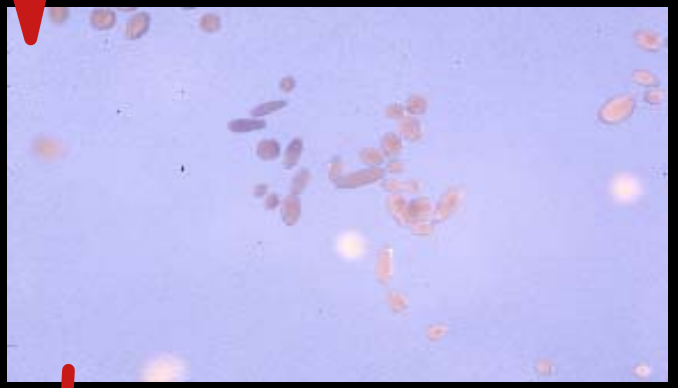
Study Sites: 3 sites, inshore to offshore



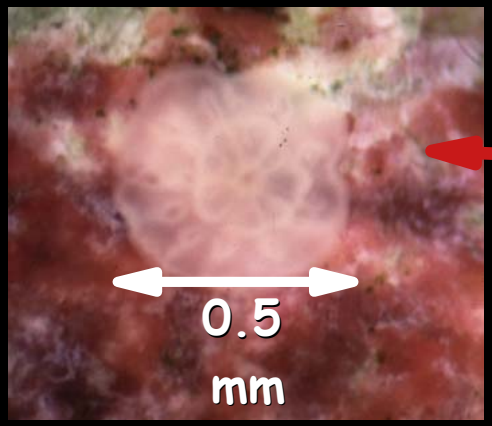
gamete bundles

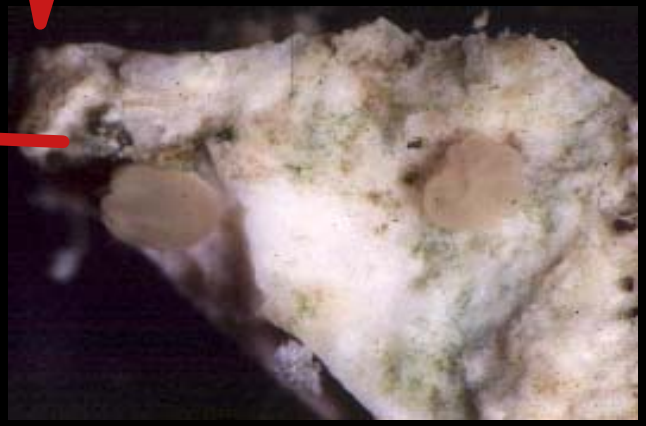
Life cycle of a broadcasting reef coral

100's of years



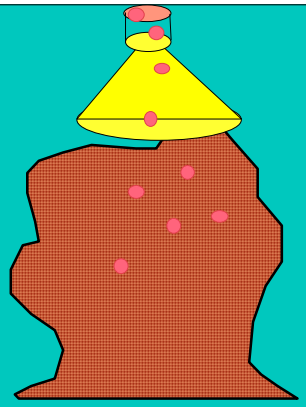
planula larvae



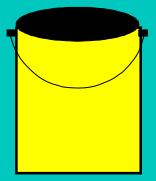


SUMMARY OF RESEARCH APPROACH

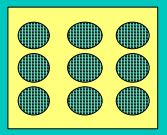
(a) Collect spawned gamete bundles



(b) Fertilize in bucket (on boat)

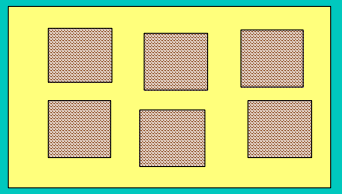


(c) Laboratory culture until larvae are competent (4-8 days)

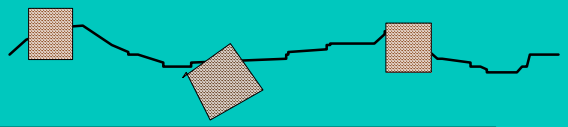


(d) Laboratory experiments; Settlement assays

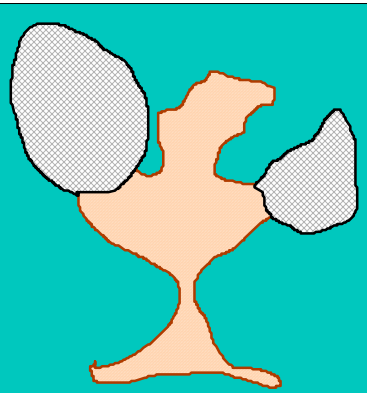
OR



(e) Settle onto pre-conditioned limestone plates; map settlement patterns



(f) Retrieve and relocate original spat; determine survivorship



(g) Direct re-seeding of dead substrate

Settlement Behavior, Patterns and Cues

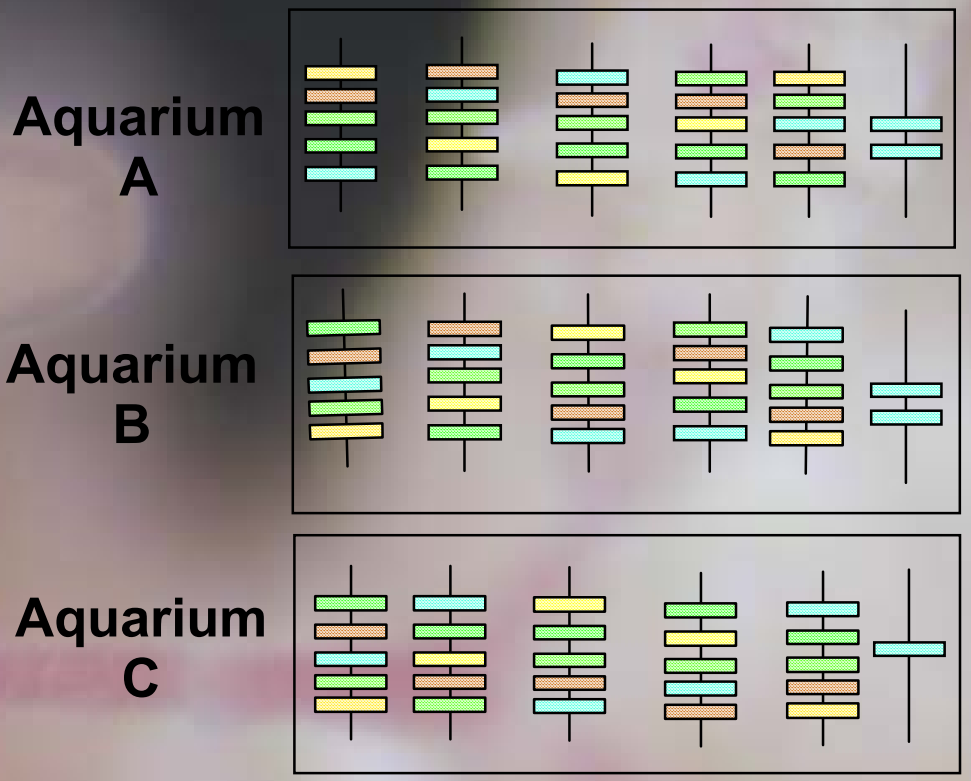
Larvae explore substrate before choosing a settlement site

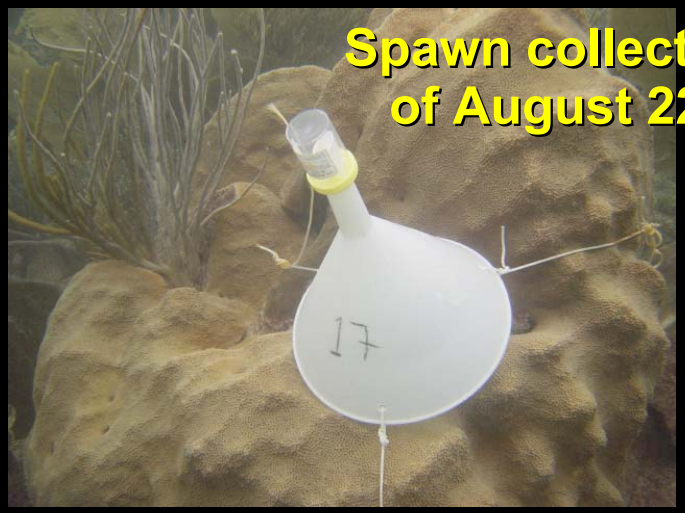
Experimental Summary:

- 3 locations: Pelotas, Turrumote, Buoy
- 2 depths (5 and 10 m) at Pelotas and Turrumote
- 15 plates per depth for Pelotas and Turrumote
- 20 plates at Buoy

Settlement Procedure:

- Total of 80 plates randomly assigned in sets of one plate from each site/depth per rod (5 extras from Buoy on additional rods)
- Therefore 5 plates from each location in each of three aquaria
- 30,000 larvae of Montastraea faveolata added to each aquarium
- Larvae allowed to settle and attach for one week before mapping

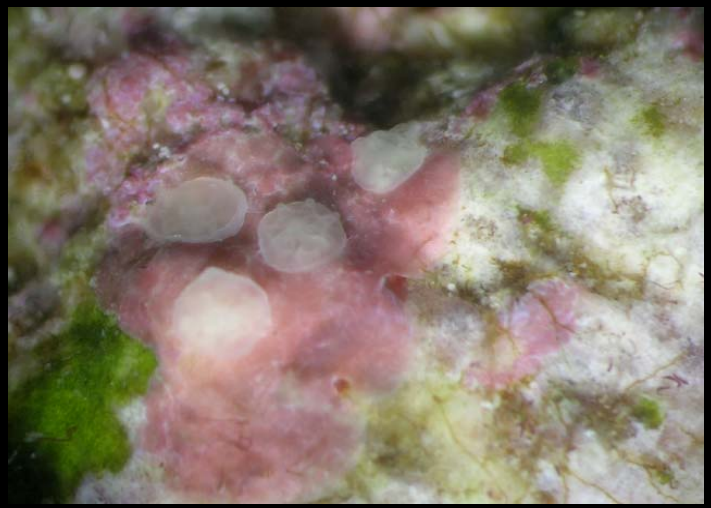




Plates mapped week of Sept 6

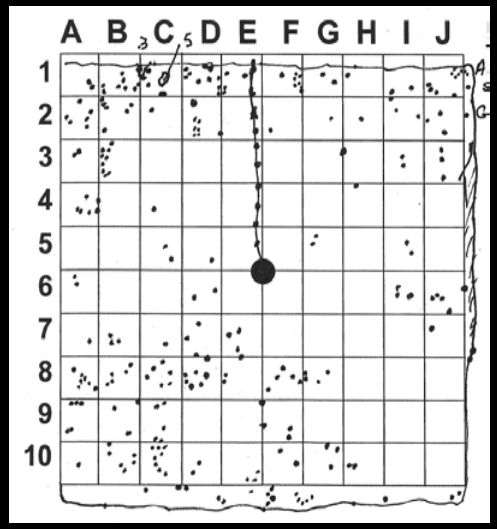
APPROACH

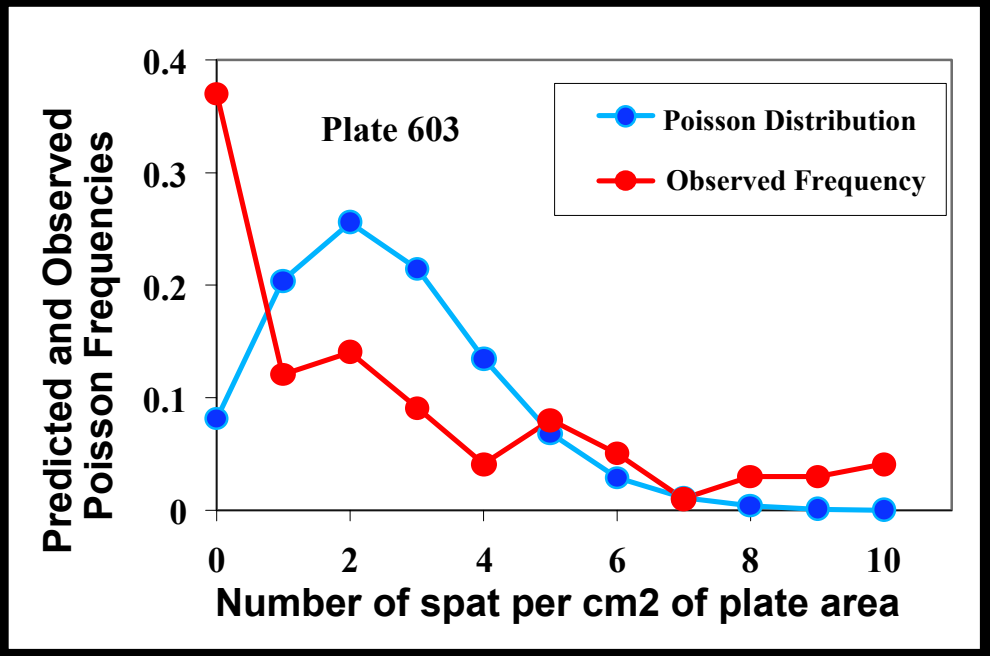
Plates redeployed to reefs week of Sept 10, 2005



Survivorship was assessed after ca. 30 days and 90 days

Example of a settlement map and statistical analysis of settlement patterns

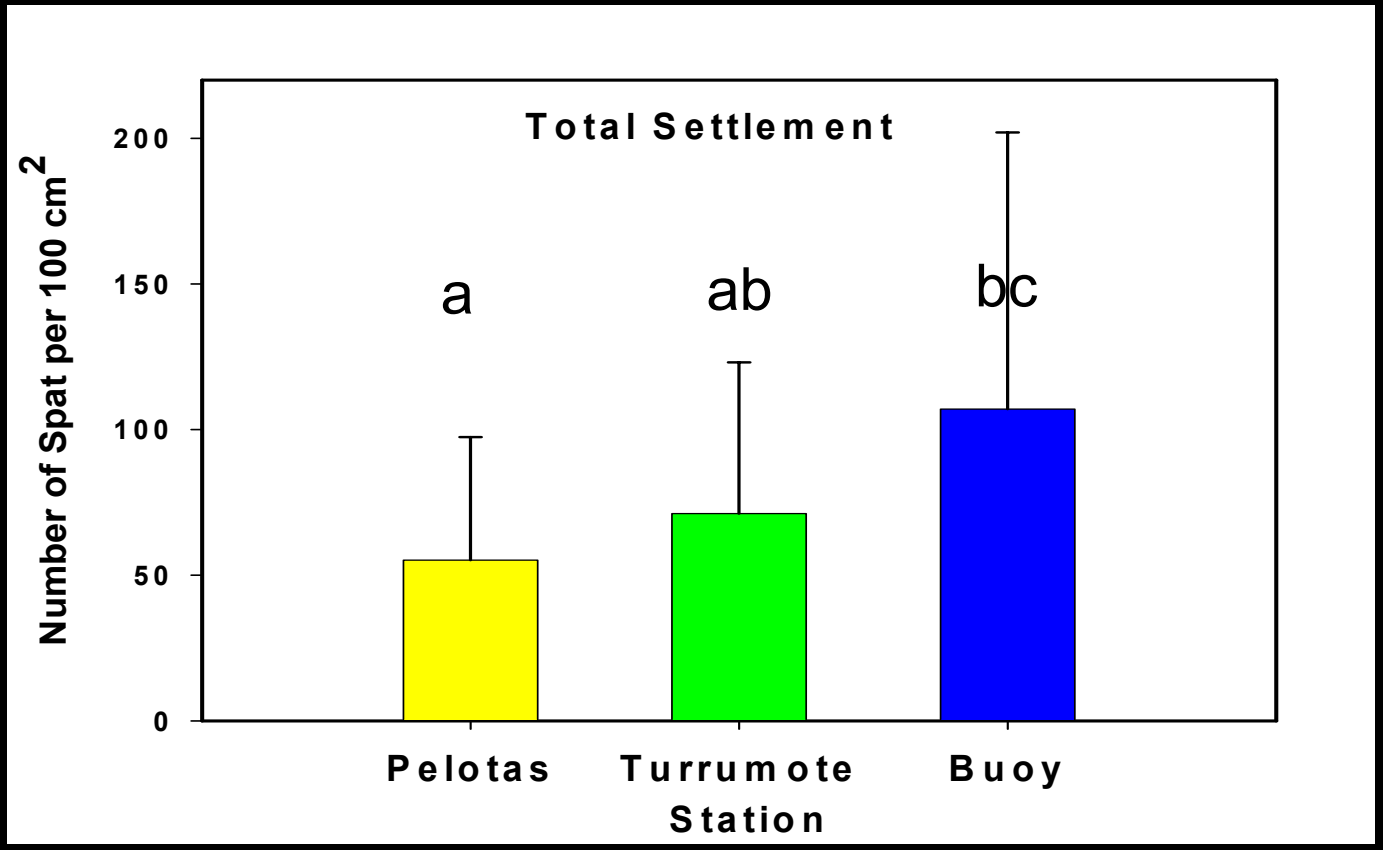




Settlers of Montastraea faveolata have a strongly aggregated pattern:

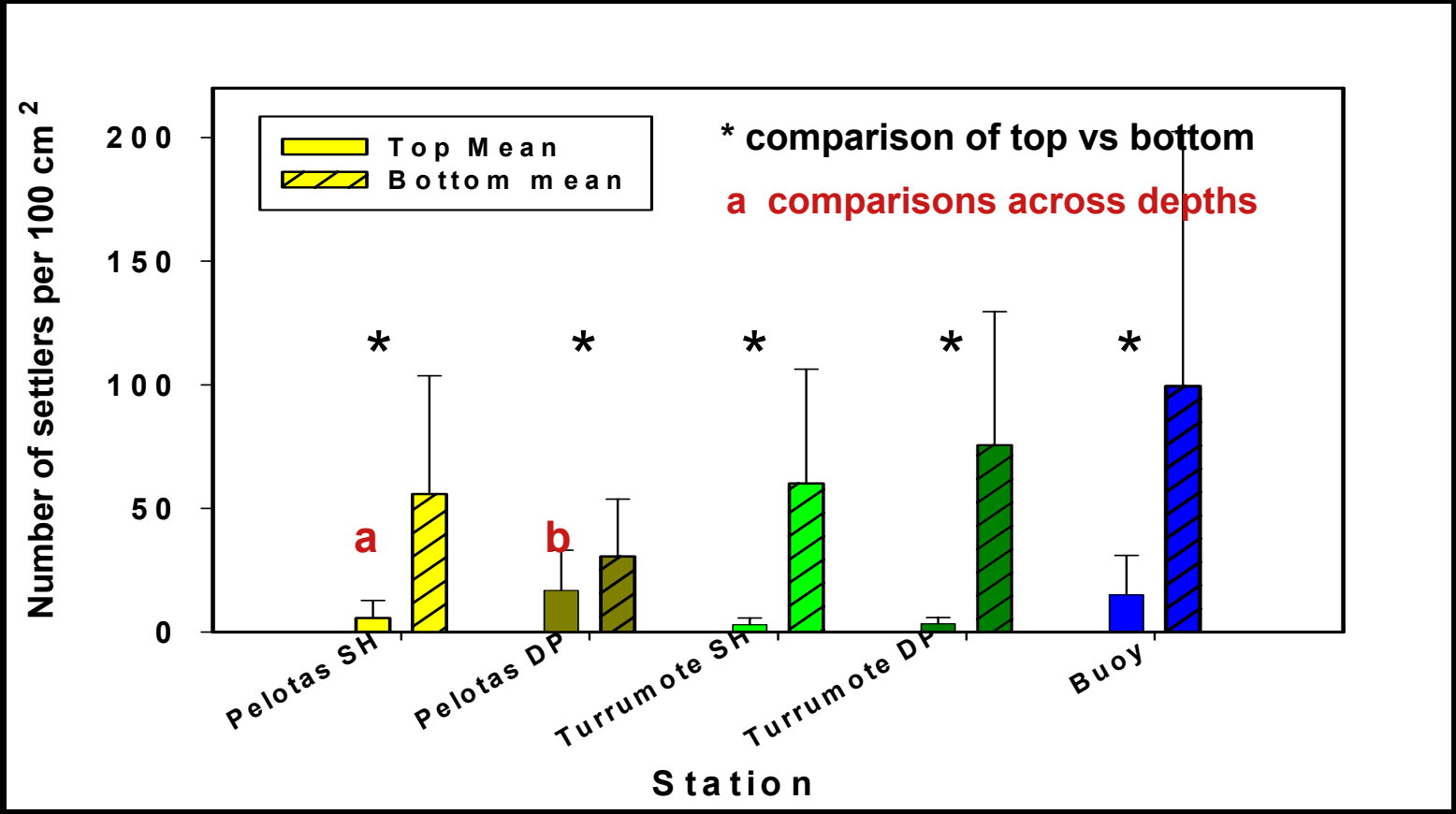
This suggests presence of settlement cues:

crustose coralline algae or microbial films?



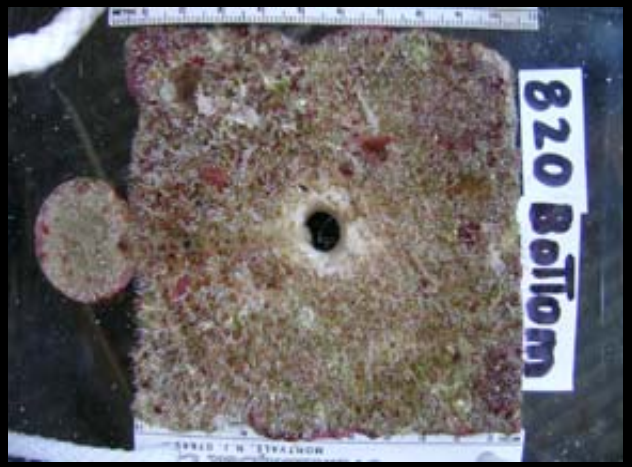
- Settlement was significantly higher on Buoy plates than on Pelotas plates
- Settlement was higher but not significantly different on Turrumote than on Pelotas
- Experimental settlement densities were in the order of 5,000 to 10,000 per m^2

Tops vs Bottoms of Plates at Each Site



- Larval settlement was significantly greater on plate undersides than on tops for all stations (confirming previous findings)
- Pelotas Deep had significantly more settlers on plate tops than the other stations
- There were no differences between depths for Pelotas bottoms or for either surface at Turrumote


820 TOP


820 Bottom

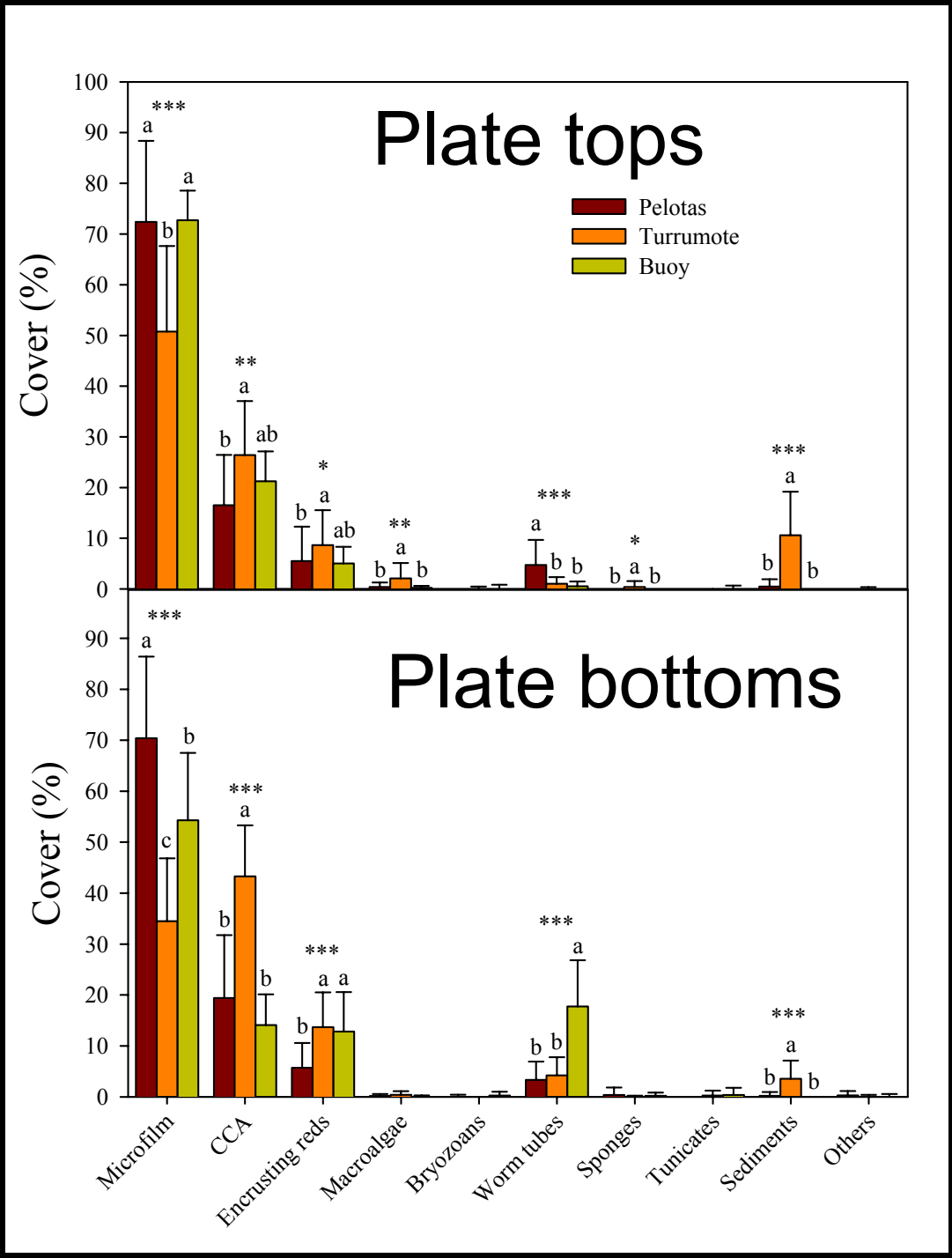
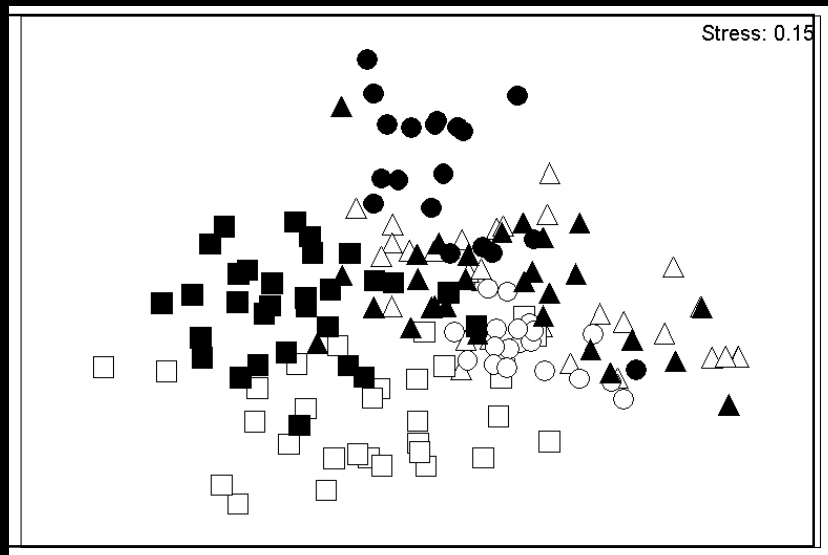
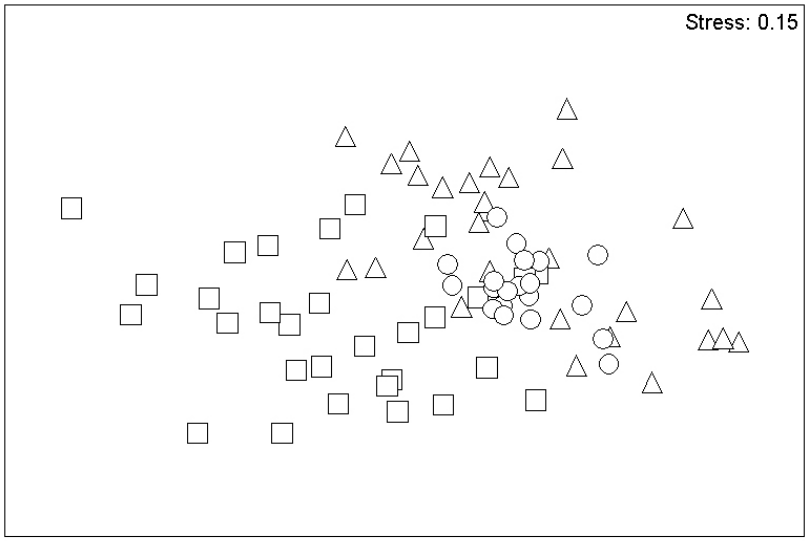


Plate tops
Pelotas
Turrumote
Buoy
Cover (%)
Plate bottoms
Microfilm
CCA
Encrusting reds
Macroalgae
Bryozoans
Worm tubes
Sponges
Tunicates
Sediments
Others

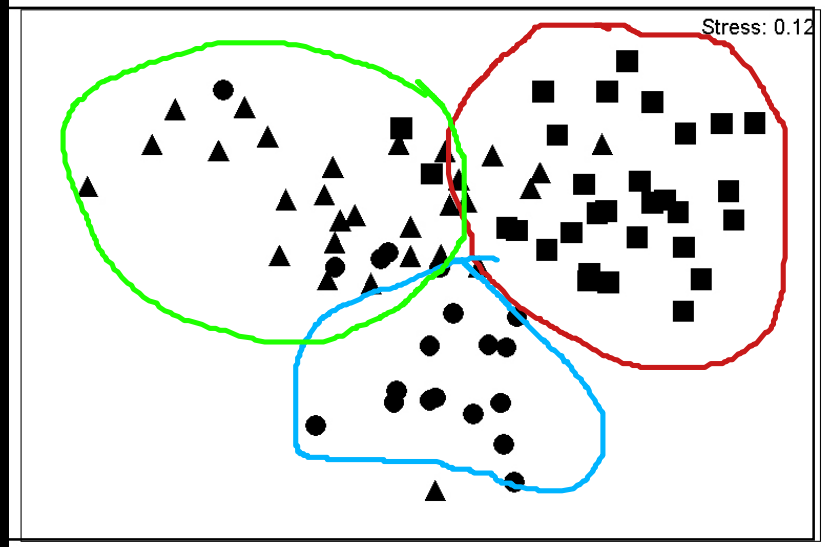
Multivariate analysis using Primer

Community structure of tops differs from bottoms





Community structure of plate bottoms differ



	Top	Bottom
Pelotas	△	▲
Turrumote	□	■
Buoy	○	●

Survivorship trends at the three stations:

1. **Mortality was generally higher the first 30 days**
2. **Survivorship was higher at the more turbid Pelotas station**
3. **Survivorship was lowest for settlers at the station with the highest settlement (Buoy)**

% Survivorship

	TOPS		BOTTOMS		TOTAL	
Station	Sept-Oct	Oct-Dec	Sept-Oct	Oct-Dec	Sept-Oct	Oct-Dec
Pelotas 5 m	5	0	3	7	3	6
Pelotas 10 m	7	28	19	8	15	11
Turrumote 5 m	0	0	5	20	4	10
Turrumote 10 m	2	0	2	5	2	5
Buoy	3	0	2	0	2	0

SUMMARY OF ACCOMPLISHMENTS

1) We were able to culture large numbers of *Montastraea faveolata* larvae (500K+), but only small numbers of *M. cavernosa*, *Acropora palmata* and *Diploria strigosa*

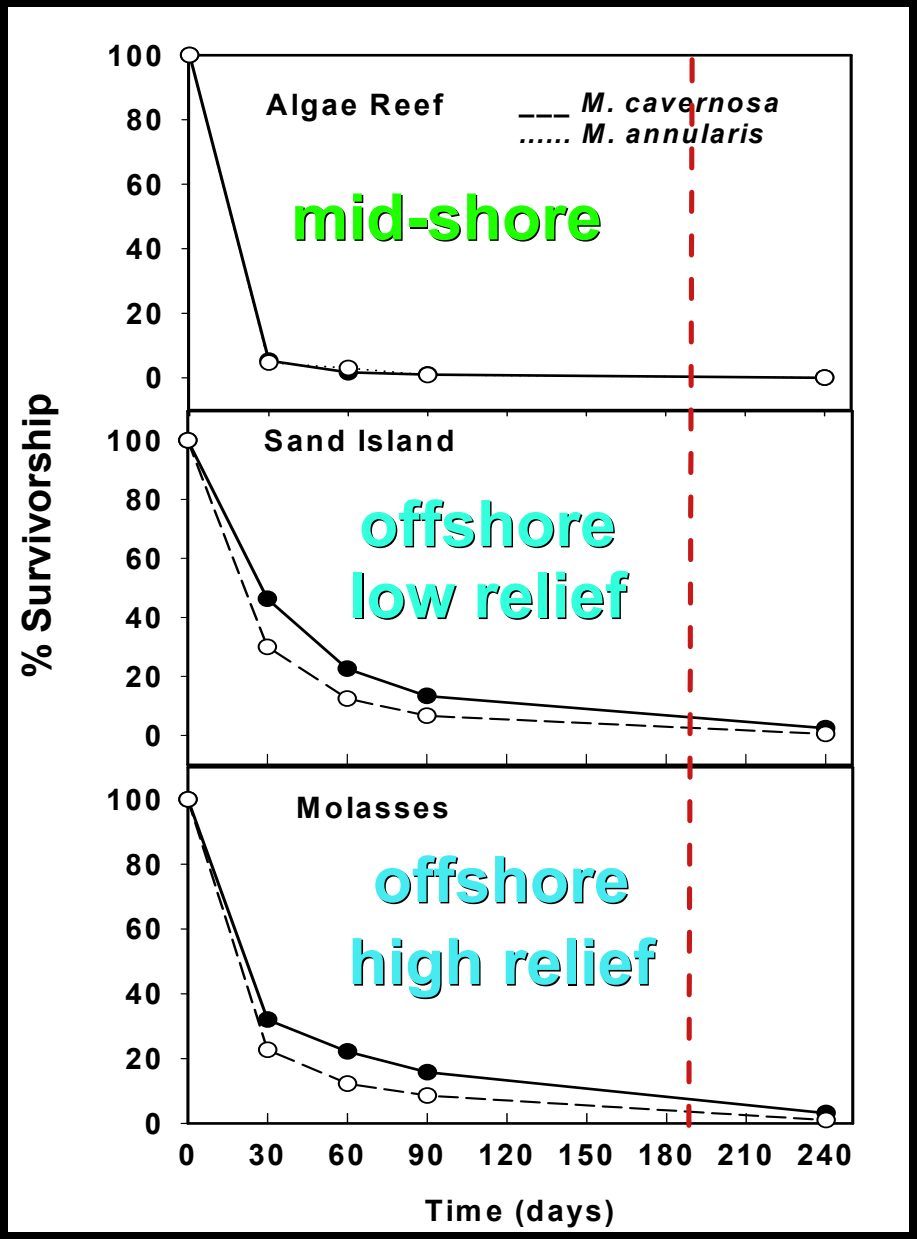
2) Therefore only *M. faveolata* was used for the survivorship study (ca. 5500 *coral spat settled and mapped on 80 settlement plates)*

3) We got good settlement and evidence for an environmental gradient in substrate quality that affects coral larval settlement

4) Survivorship results are disappointing, but poor survivorship this past summer could have been related to the extreme bleaching event that happened during this experiment

5) In spite of low survivorship, scaled densities of survivors from the artificial seeding are in the order of 7 to 100 spat per m^2. We'd be *very pleased* if field surveys can across such densities of recruits *!*

For Comparison:
2004 Survivorship in Florida Keys

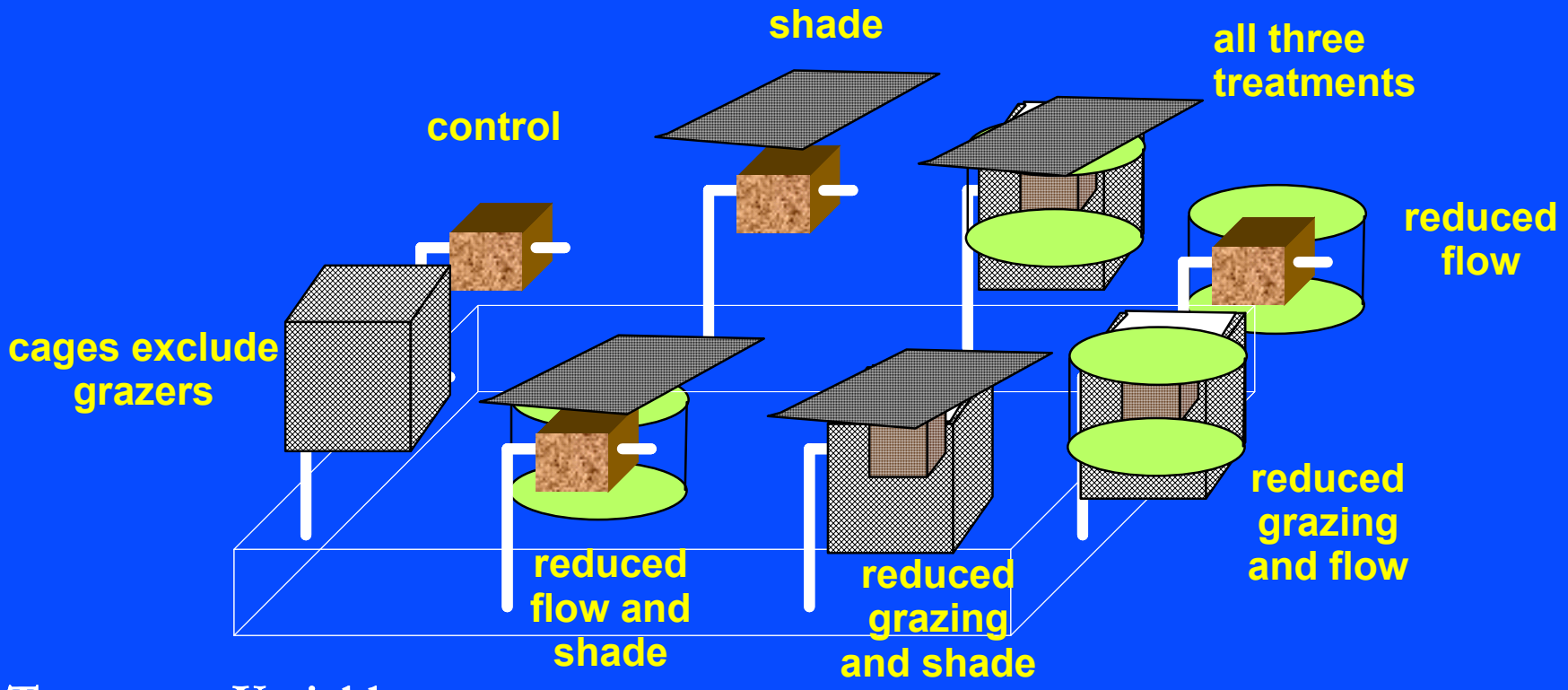


Survivorship results from a similar experiment in the Florida Keys yielded much higher survivorship over the same 90 day time-frame

Future Directions

- Complete analysis of substrate characteristics of plates from various sites
- Focus in on factors affecting substrate community structure that supports greater coral settlement (bottoms vs top phenomenon; inshore vs offshore)
- Multifactorial experiment in which we vary environmental conditions (water flow; light; grazing) to which settlement plates are exposed during aging period
- More work on early survivorship and polyp feeding

Physical Determinants of Substrate Community and the effect on Larval Settlement Preference



Treatment Variables:

1. Light
2. Flow
3. Grazing

8 treatments = all permutations

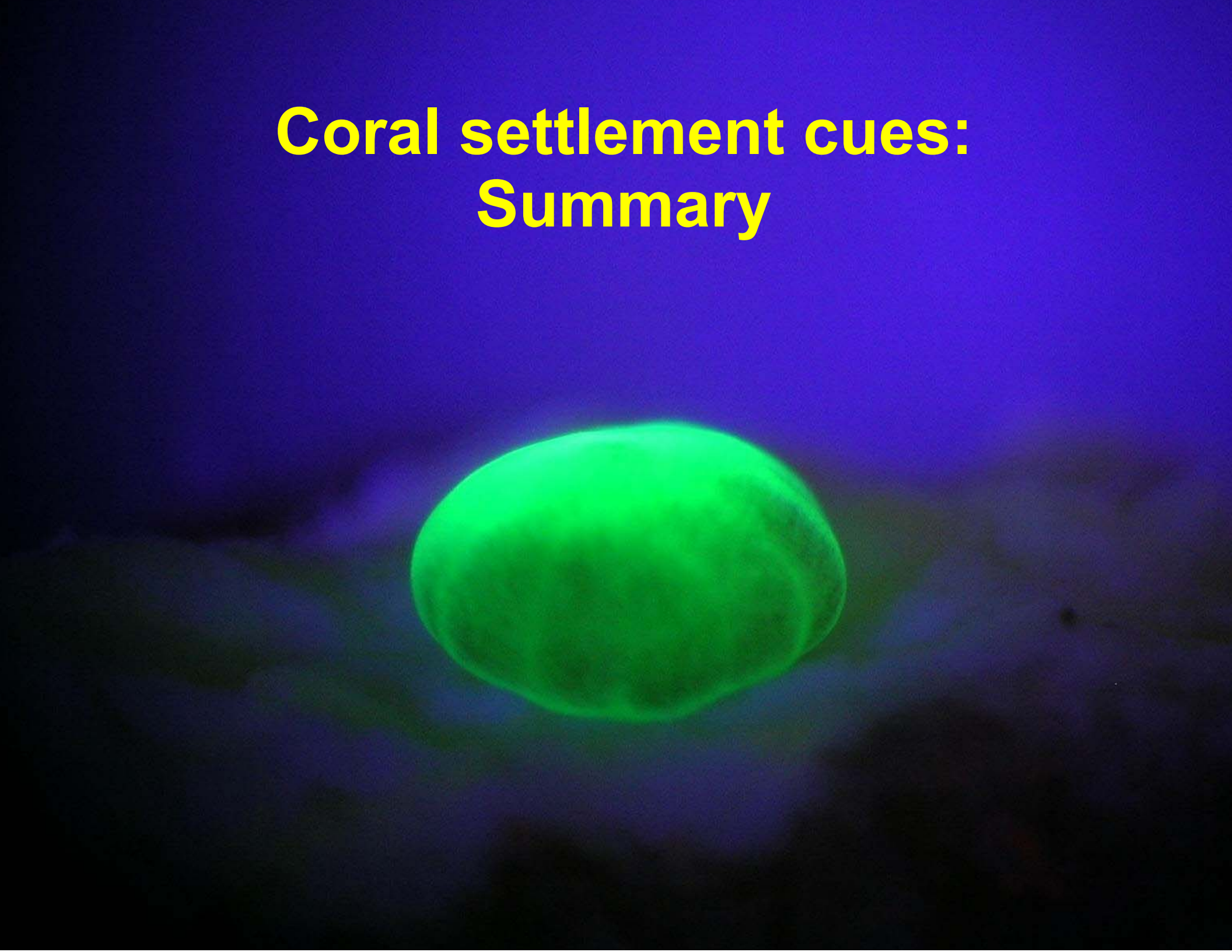
➢ 6 month conditioning period followed by larval seeding and settlement

Research Objectives Summer 2005:

SECONDARY:

- Continue research on settlement cues and preferences
- Begin work on effects of feeding on survivorship
- Continue research on larval behavior
- Capacity building in this research topic

Coral settlement cues: Summary



Background

- Coral larvae have been shown to settle in response to crustose coralline algae (CCA) (Morse et al.) and bacteria isolated from CCA (Negri et al).

- We still have very little information on the natural inducers and associated chemicals driving settlement in Caribbean corals.

Research Objectives

Testing coral settlement response to:

1. **Extracts from several species of CCA**
2. **Bacteria isolated from the same CCA**
3. **Preconditioned glass slides (biofilm)**

Future Directions

- Follow the successional development of the microbial and algal communities on the glass slides to determine when they begin to have larval induction properties.
- Test preconditioned slides exposed to specific inhibitors that will selectively modify the existing communities (e.g. antibiotics, GeO2).
- Identify, culture and test algae present on preconditioned slides.

ACKNOWLEDGEMENTS

- Work funded by NOAA CCRI to RUM, by World Bank Targeted Research Program, and by NSF Bio-GenEn grant

- Field and lab assistance from Ernesto Weil's wonderful lab group (Aldo, Emmanuel, Jan, Katie and Sara), UNCW grad student Darcy Lutes and post-doc Maggy Nugues, Dr. Miguel A. Ruiz Zarate from Mexico, and Aihnoa Leon Zubillaga from Venezuela

Dr. Weil and Szmant's groups celebrating the end of spawning and plate reading!