Does Climate Change Drive Immunological Memory in Lower Invertebrates?

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Louisiana Universities Marine Consortium

Introduction

- Adjacent to 100 countries
- 0.5 billion people w/in 100 km (Best et al. 2001)
- 1% of the worlds ocean 25% of biota
- High productivity and habitat connectivity
- Intrinsic and Extrinsic Value

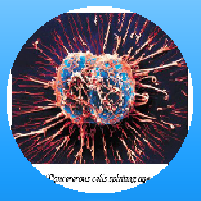




Commercial Fishing



Tourism

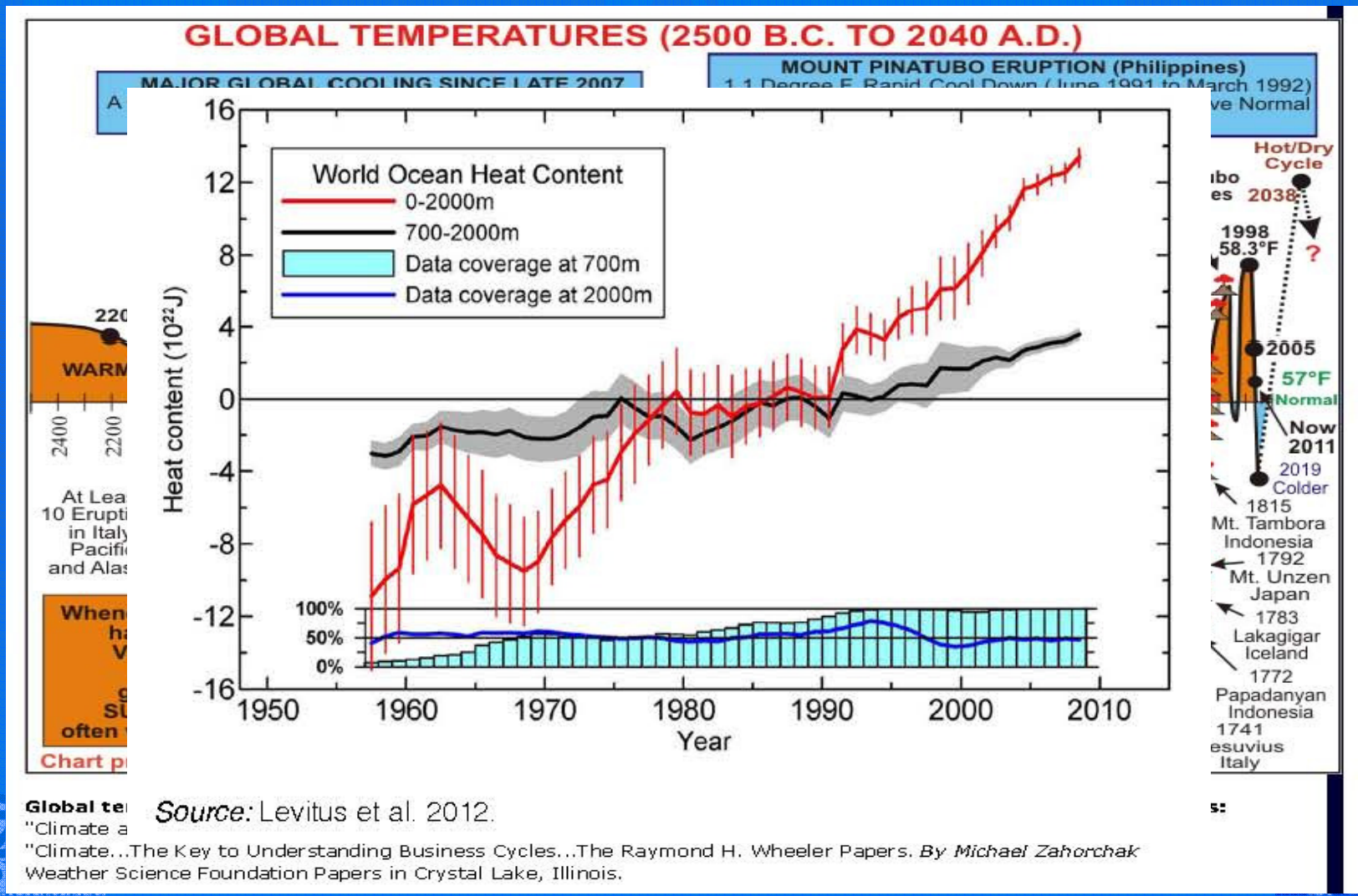


Derived Medicine



Storm Protection

Introduction



Source: Levitus et al. 2012.

"Climate...The Key to Understanding Business Cycles...The Raymond H. Wheeler Papers. *By Michael Zahorchak* Weather Science Foundation Papers in Crystal Lake, Illinois.

Introduction



Introduction

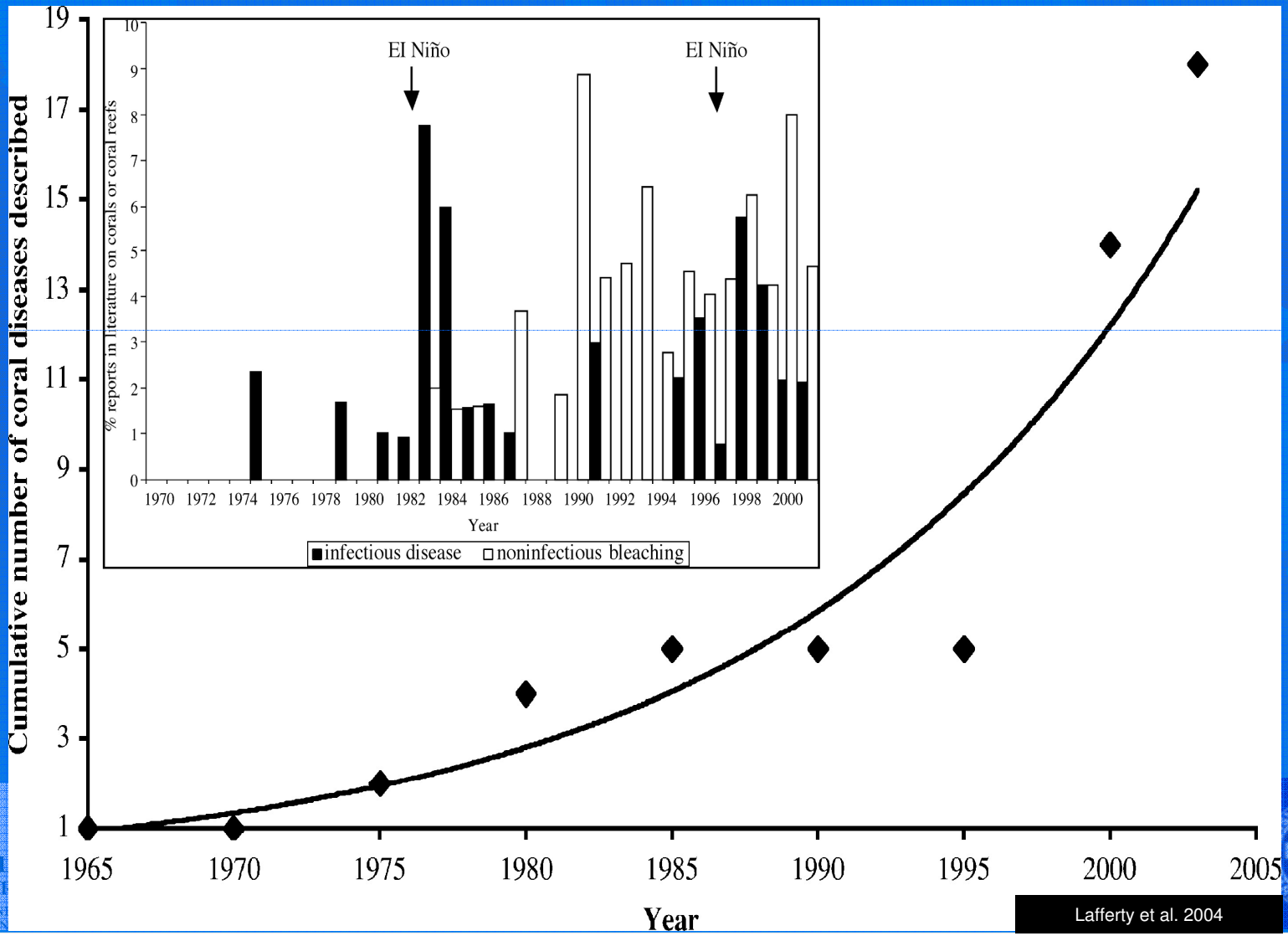
Table 1. Some of the most commonly found coral diseases.

Disease	Acronym	Pathogen	# of Species Infected	
			COR	OCT
CARIBBEAN				
Black band	BBD	*P. corallyticum, Desulfovibrio, Beggiatoa* sp	19	6
White band I	WBD-I	Gram (-) bacterium	2	
White band II[2]	WBD-II	*Vibrio carchariae*	2	
White plague I	WP-I	Gram (-) bacterium	12	
White plague II[2]	WP-II	*Aurantimonas coralicida*	41	
Aspergillosis[2]	ASP	*Aspergillus sydowii*		10
White pox[2]	WPX	*Serratia marcescens*	1	
Growth Anomalies[1]	TUM	*A. endozoica* (algae) and other causes	7	5
Red band	RBD	*Oscillatoria* sp. and other cyanobacteria	13	1
Yellow blotch	YBS	*Vibrio* sp ?	11	
Dark spots I	DSS-I	*Vibrio* sp ?	10	
Dark bands	DBS-II	?	8	
INDO-PACIFIC-MEDITERRANEAN				
Porites trematodiasis	PTR	*Podocotyloides stenometra*	4	
Skeletal eroding band	SEB	*Halofolliculina corallasia*	2	
Brown band	BrB	New species of ciliate—not described	2	
Porites ulcerative white spots	PUWS	*Vibrio* sp	3	
Bacterial bleaching[2]	BBL	*Vibrio shiloi*	1	
Bacterial bleaching[2]	BBL	*Vibrio coralliilyticus*	1	
White-plague	WP	*Thalassomonas loyona*	5	

[1]Growth anomalies include hyperplasias and algal tumors.
[2]Koch's postulates fulfilled.

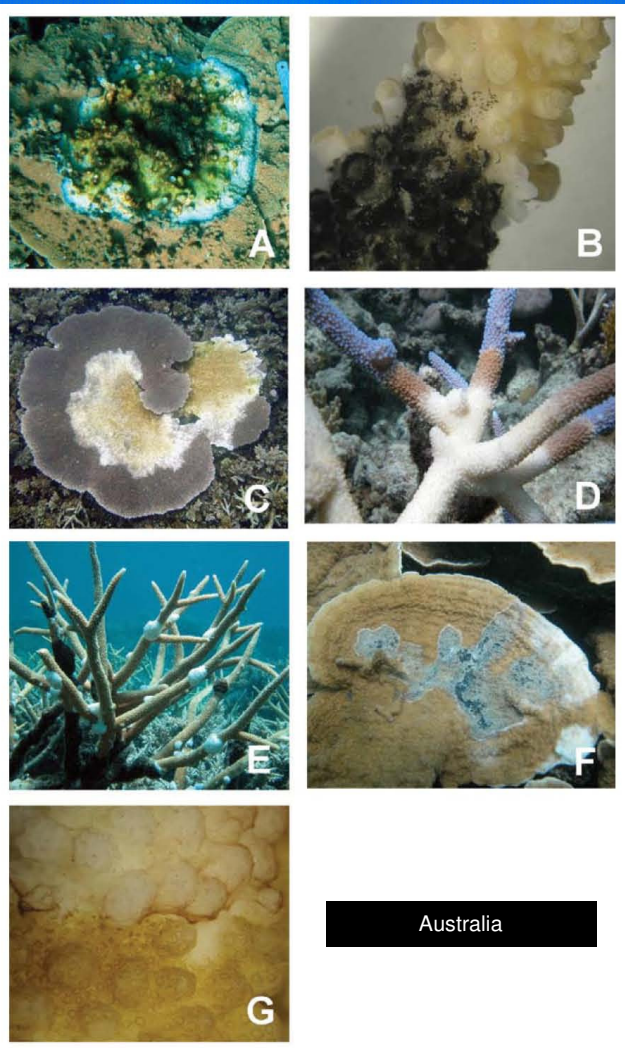
Harvell et al., 2007

Introduction

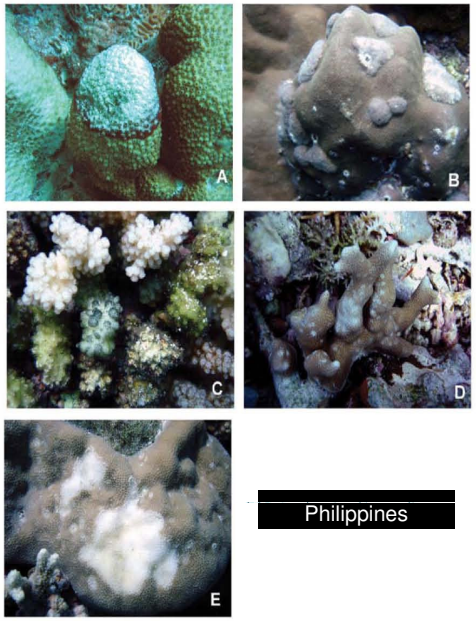


Lafferty et al. 2004

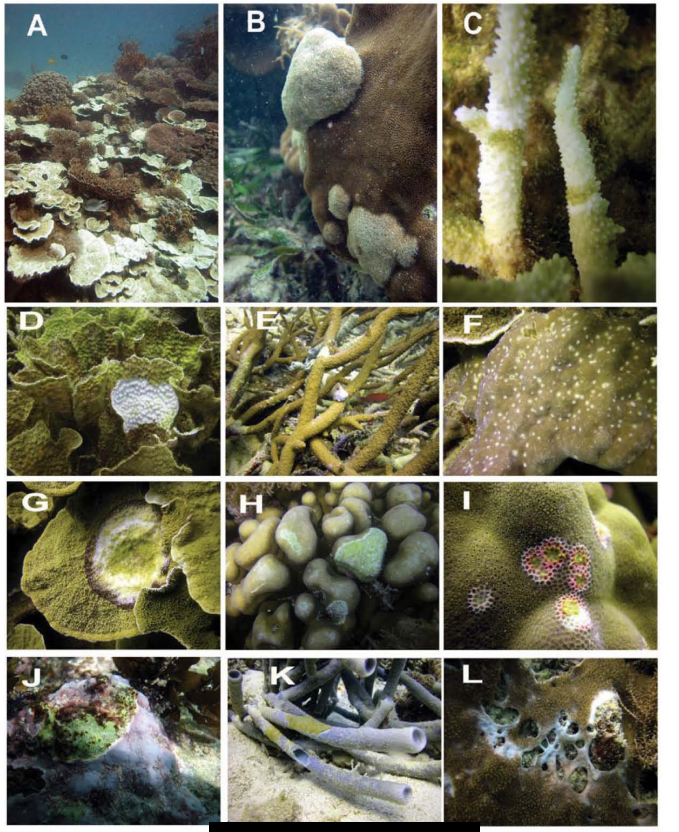
Introduction



Australia



Philippines



East Africa

Harvell et al., 2007

Introduction





Introduction

Hypotheses

1. Hard corals: immuno-compromised

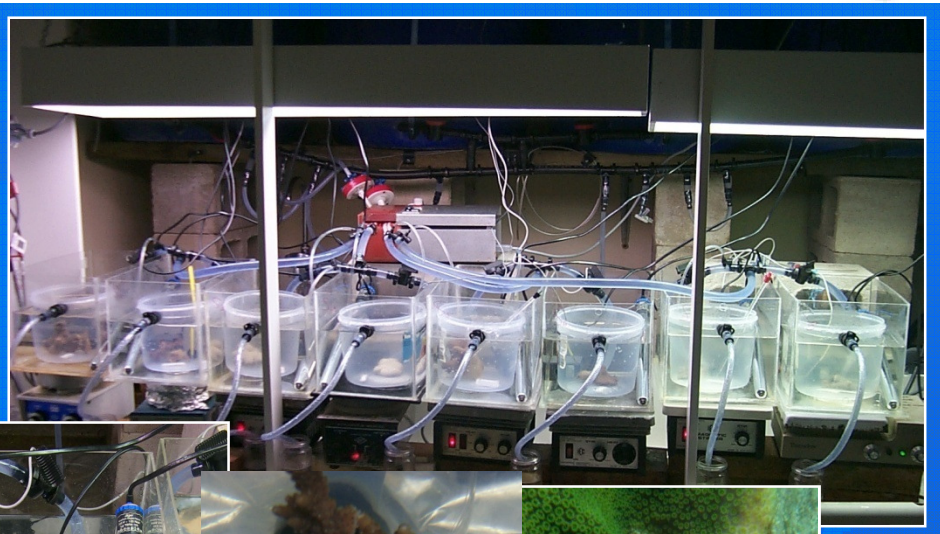
2. Soft corals: immune system NOT as compromised

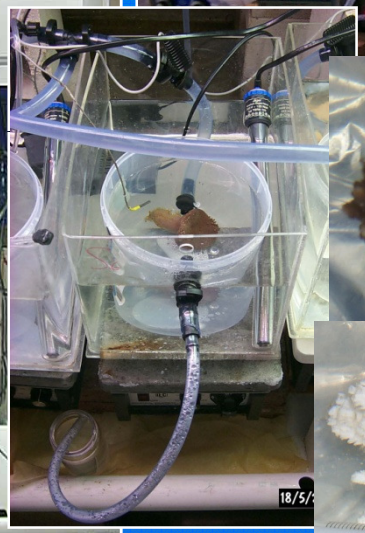


Better heat resistance
Better disease resistance
Better fitness

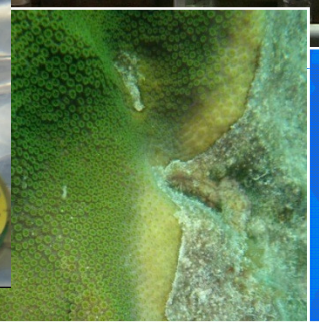
Methods













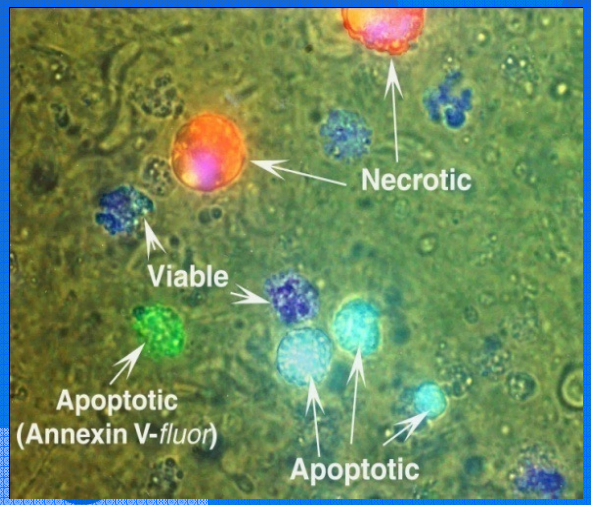


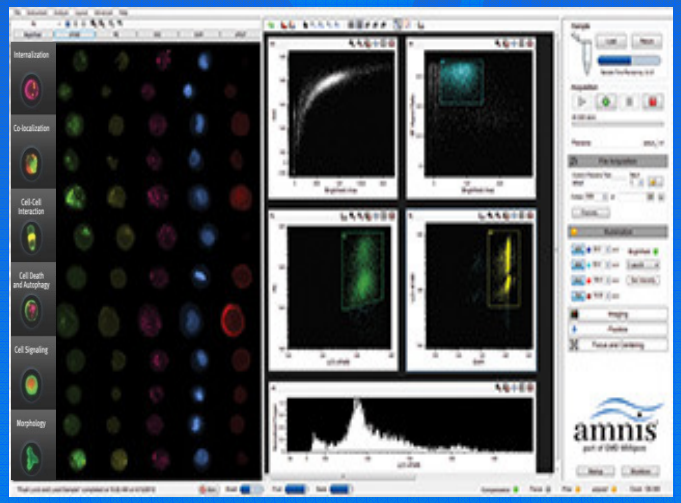
Methods

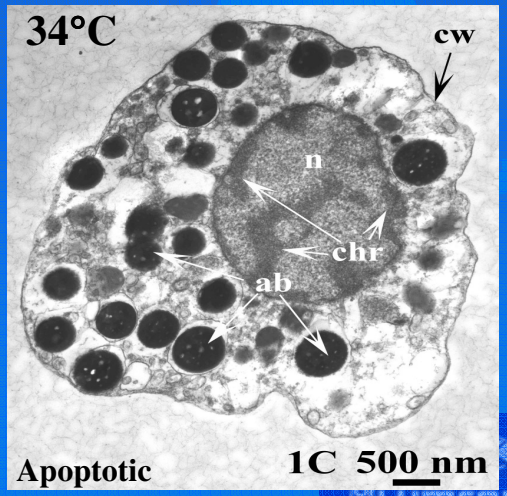



imageStream^F mk II
amnis


TECNAI


Necrotic
Viable
Apoptotic
(Annexin V-fluor)
Apoptotic


amnis


34°C
cw
n
chr
ab
Apoptotic
1C 500 nm



Methods

Fluorescent conjugates

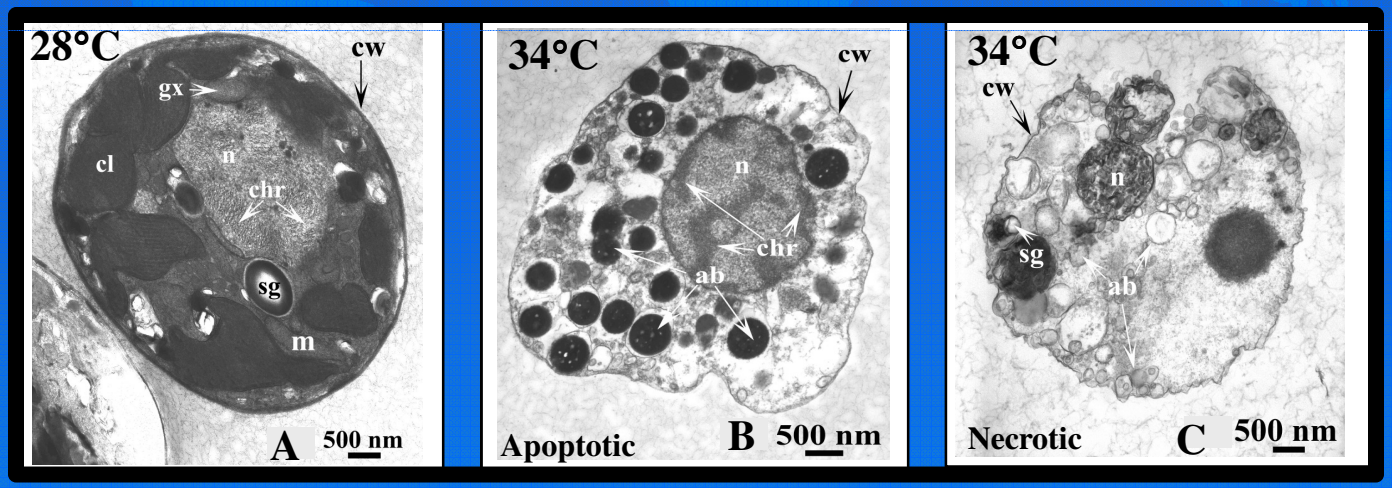
1. Apoptosis and Necrosis;
2. Phagocytosis fluorometric assays;
3. Pattern-recognition receptor (PRR) probes: FLS2
4. Caspases

Results

Fluorescent conjugates

1. Apoptosis and Necrosis;

Apoptosis of *Symbiodinium* from host *Acropora hyacinthus*

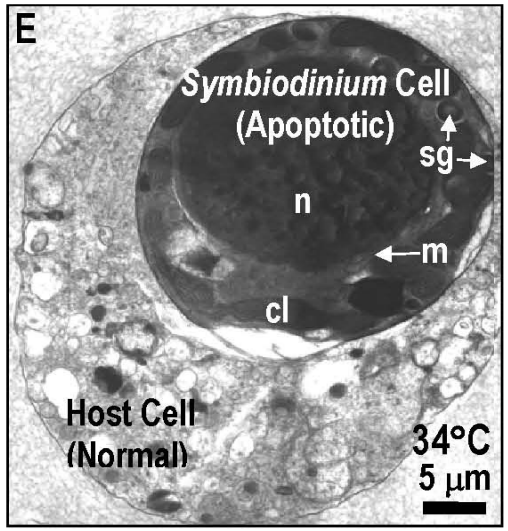


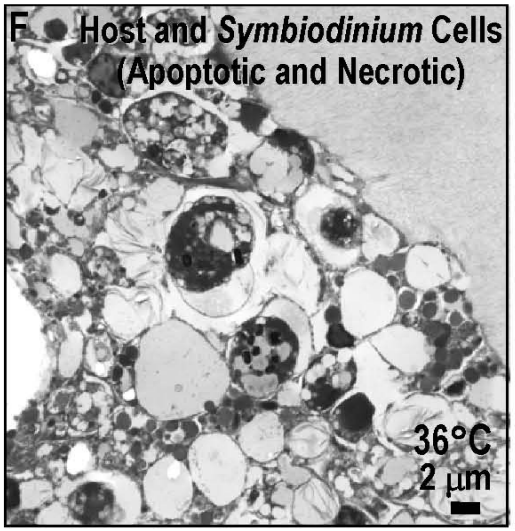
Results

Fluorescent conjugates

1. Apoptosis and Necrosis;

Apoptosis of host *Acropora hyacinthus*

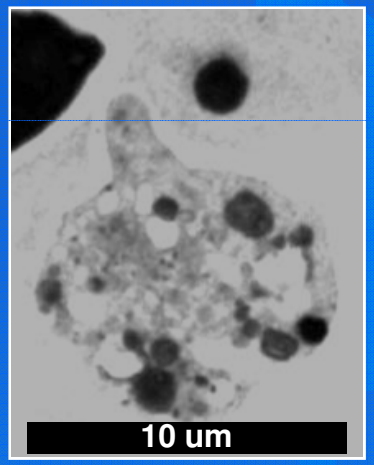


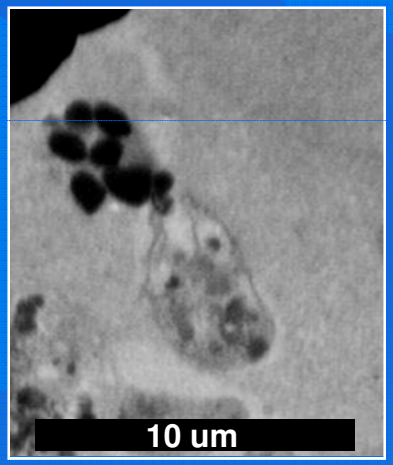


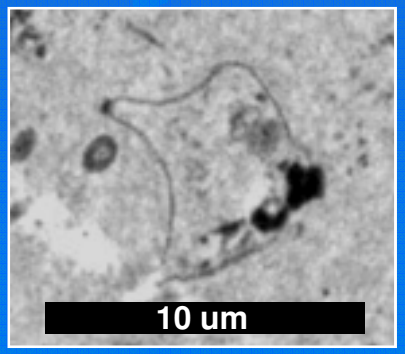
Results

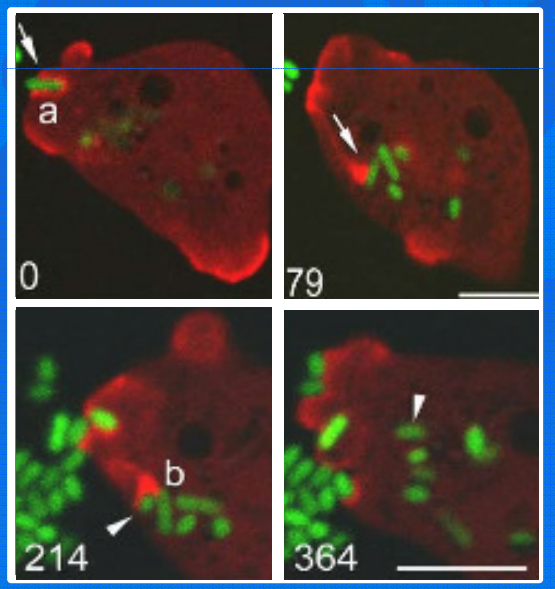
Fluorescent conjugates

1. Apoptosis and Necrosis;
2. Phagocytosis fluorometric assays;







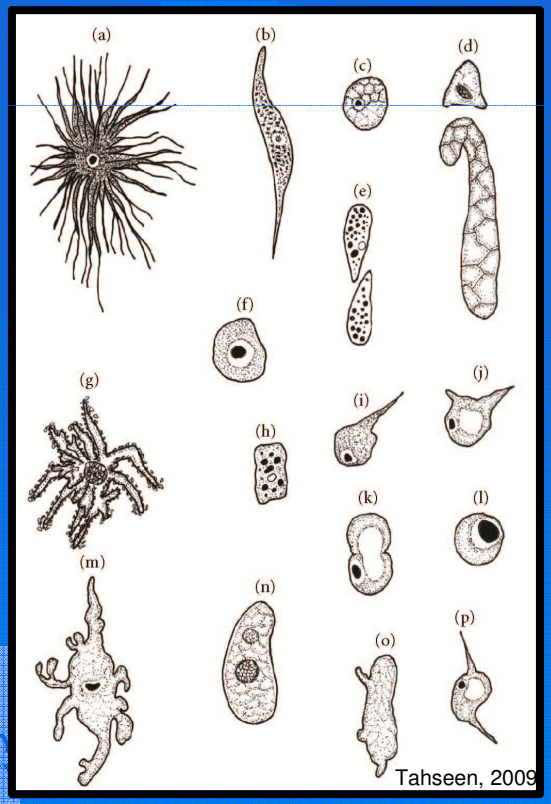


Clarke and Maddera, 2006;
bar = 5 um

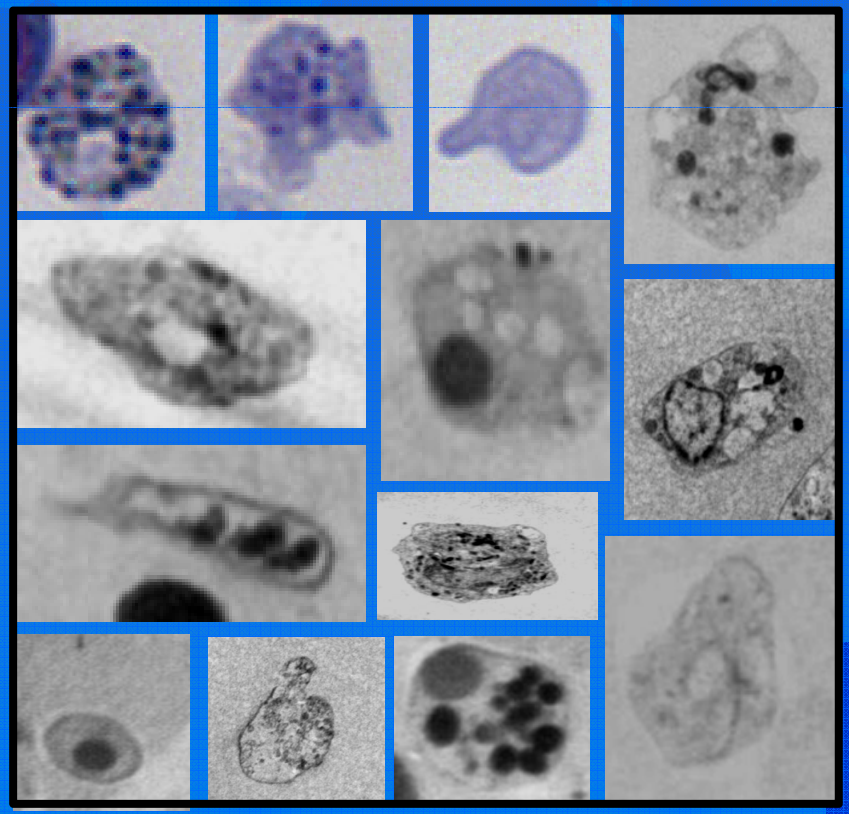
Results

Fluorescent conjugates

1. Apoptosis and Necrosis;
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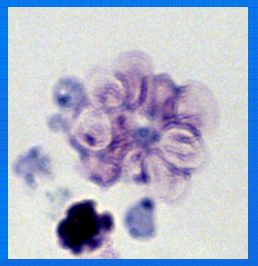


Tahseen, 2009



Results

Fluorescent conjugates



Swarming?

1. Apoptosis and Necrosis;
2. Phagocytosis fluorometric assays;
3. **Pattern-recognition receptor (PRR) probes: FLS2**
   - **flagellin protein in bacteria**

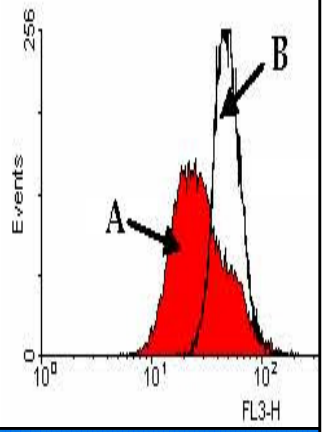
Temperature (℃)

Results

Fluorescent conjugates

1. Apoptosis and Necrosis;
2. Phagocytosis fluorometric assays;
3. Pattern-recognition receptor (PRR) probes: FLS2
4. **Caspases**

Figure 3. Cytometric analysis of *Montastraea cavernosa* cells using CaspaTag assay kit. Note the increased expression of caspase proteins after exposure to heat stres at 34°C for 12 hr (B) *vs* the incubated control at 26°C for 12 hr (A).



Class of Protiens	Function
Activators	
Caspase 2	Initiates apoptosis
Caspase 3	Metamorphosis
Caspase 8	Initiates apoptosis
Caspase 9	Initiates apoptosis
Effector Caspases	
Caspase 6	Induces apoptosis
Caspase 7	Induces apoptosis
Cytokine Processors	
Caspase 1	Inflammation

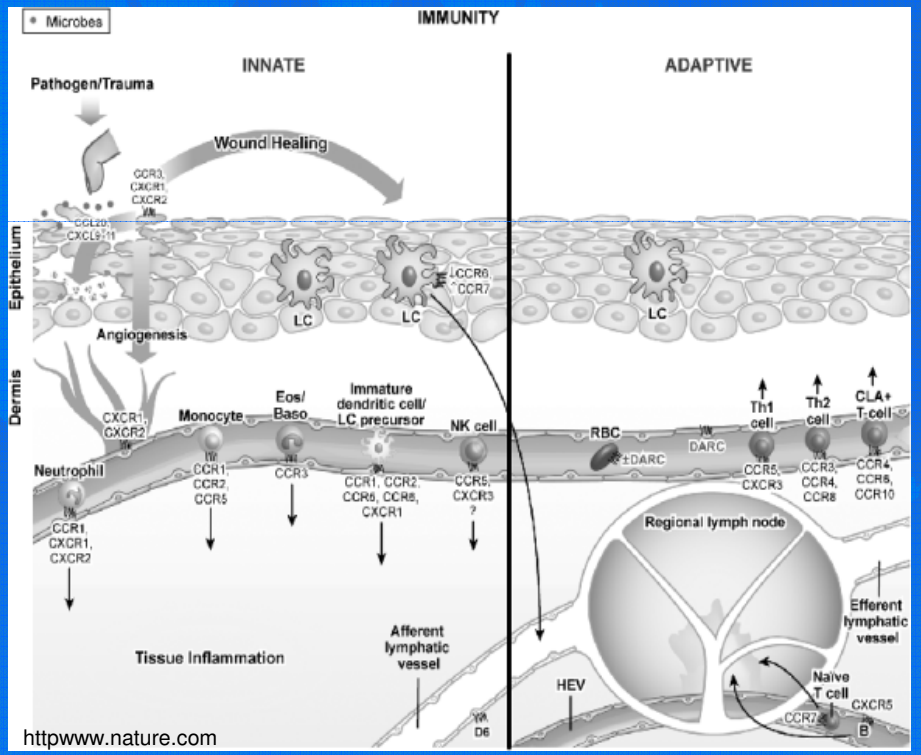
Summary

Innate vs Adaptive Immunity

(reprise)

Innate	Adaptive
(Phagocytosis, Inflammation)	(Lymphocytes)
• *Nonspecific*	• *Specific*
– Defends against *any* pathogen upon *first* exposure	– Responds to specific pathogens on 2nd or later exposure
– Responds to:	– Comes into play *after* nonspecific responses have begun.
• infectious agents	
• chemical irritants	
• tissue injury	
• burns	

Tuffery, 2010





"Holy great mother of God, I've been cloned!"