Defense Systems

What might scare an aquatic organism?

Defense Systems

- Anatomic Features
- **Immunity**
- Response to Pollution

Anatomic Features

Chemical

Anatomic Features

Escape

Key reference: Arnott, S. A., Neil, D. M. and Ansell, A. D. (1999). Escape trajectories of the brown shrimp *Crangon crangon*, and a theoretical consideration of initial escape angles from predators. *J. Exp. Biol*. **202**, 193-209.

Anatomic Features

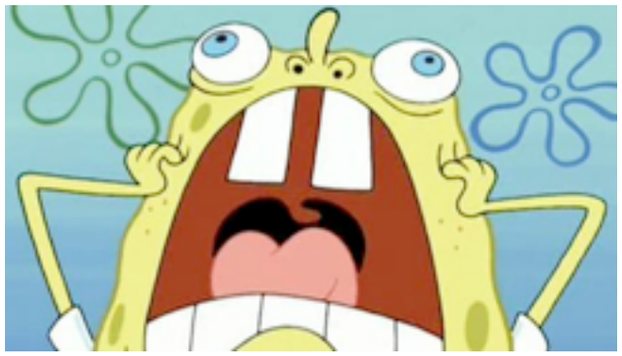
Reproductive Strategy

FLOWER GARDEN BANKS
NATIONAL MARINE SANCTUARY

tinyurl.com/cgbso7

What is the overarching fear in those three examples?

What is the overarching fear in those three examples?



What is the overarching fear in those three examples?

Defense Systems

- Anatomic Features
- **Immunity**

Immune System

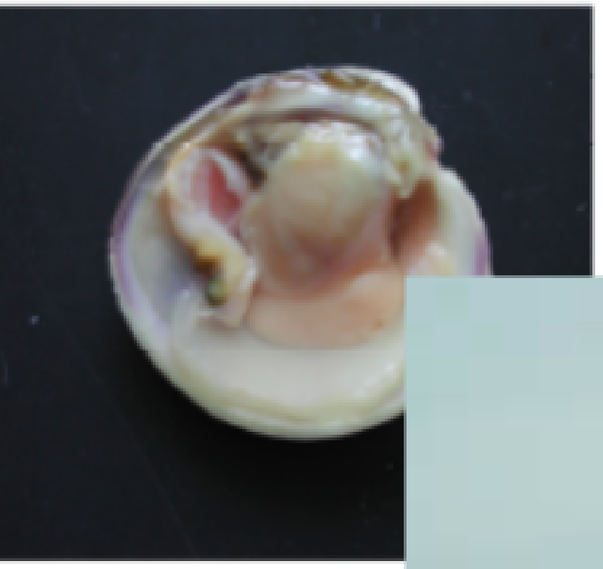
- Defense against *pathogens*
- Removal of "worn-out" cells and tissue debris (wound healing and tissue repair)
- ID and destruction of abnormal cells that originate in the body.

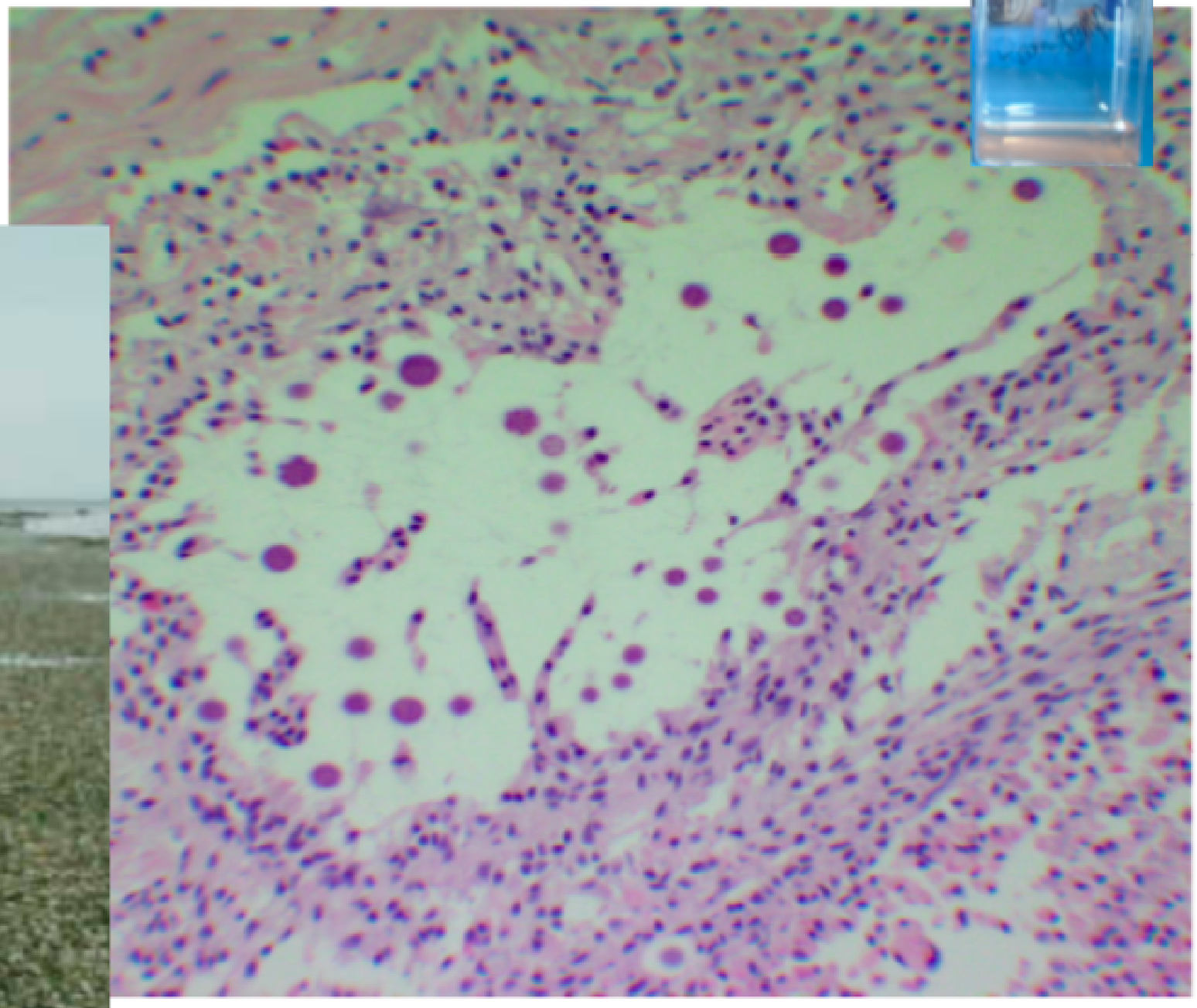
Pathogens

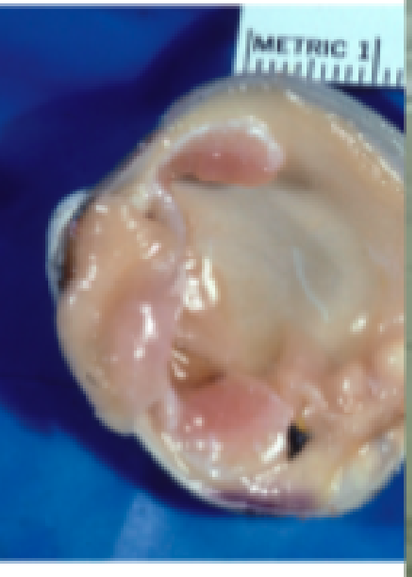
- Disease producing power known as _____
- Bacteria - release enzymes or toxins
- Internal parasites (larger; protozoa, fungi) - use resources, damage tissue
- Virus - not self sustaining; lack ability to for *energy production* and *protein synthesis*

Bacteria - Vibrio

Fungi - QPX



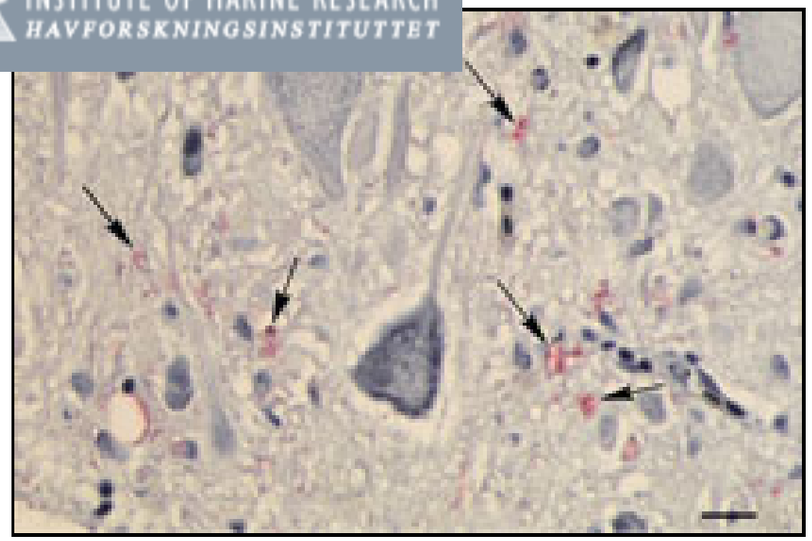




Roxanna Smolowitz

Virus - Nodavirus

INSTITUTE OF MARINE RESEARCH
HAVFORSKNINGSINSTITUTTET



Brain of salmon contaminated by nodavirus.

Development of diagnostic and management techniques to select cod broodstocks and hatchery stocks free from nodavirus

Northeastern Regional AQUACULTURE Center

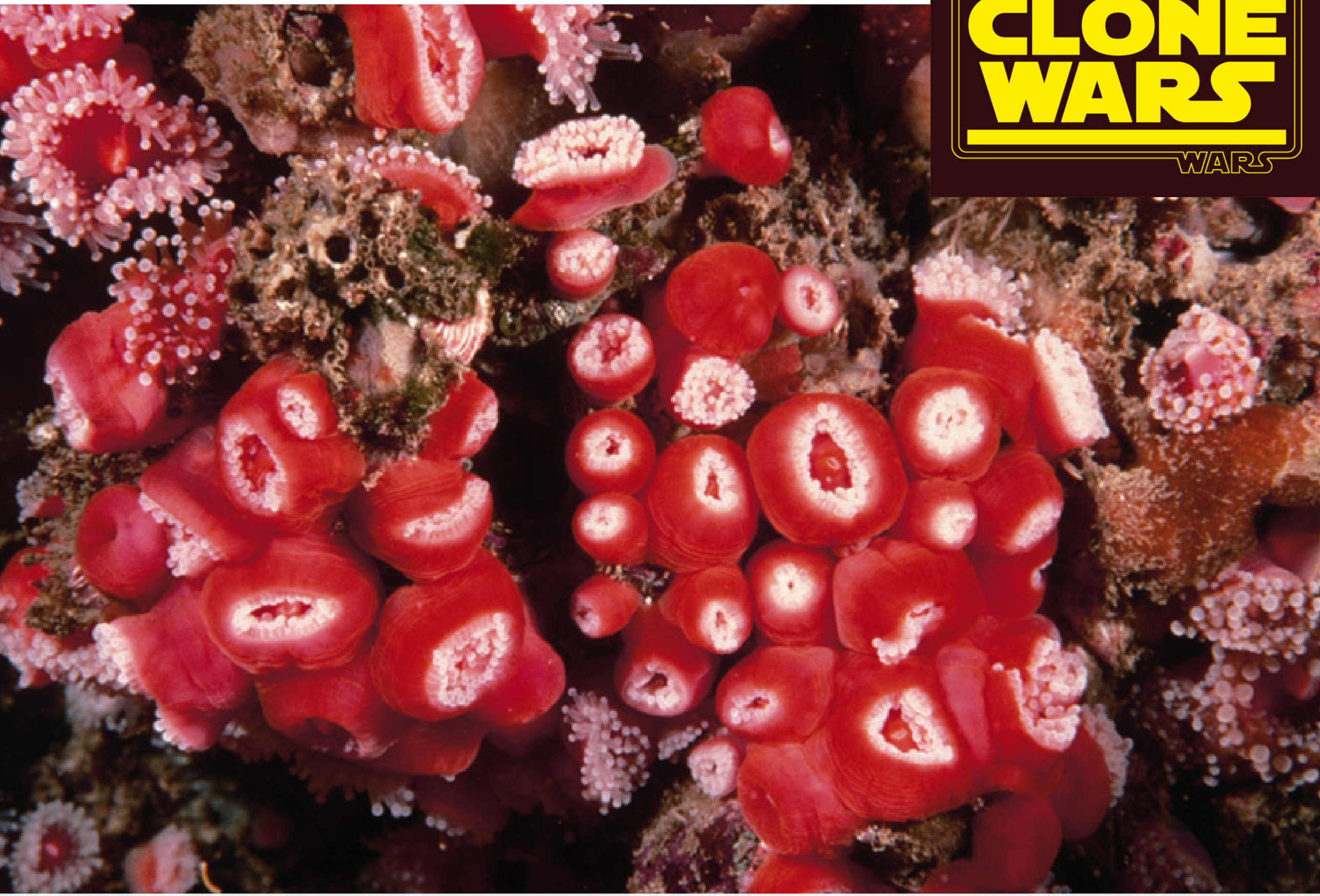
Immune Response

- Innate Immunity - non-specific
- Acquired Immunity- adaptive; selectively targets

Immune Response

- **Innate Immunity - non-specific**
- Acquired Immunity- adaptive; selectively targets

How do organisms distinguish self from non-self?



This is a picture of two *A elegantissima* or *A. sola* fighting with acrorhagia. Taken at San Simeon, CA by Dave Cowles i

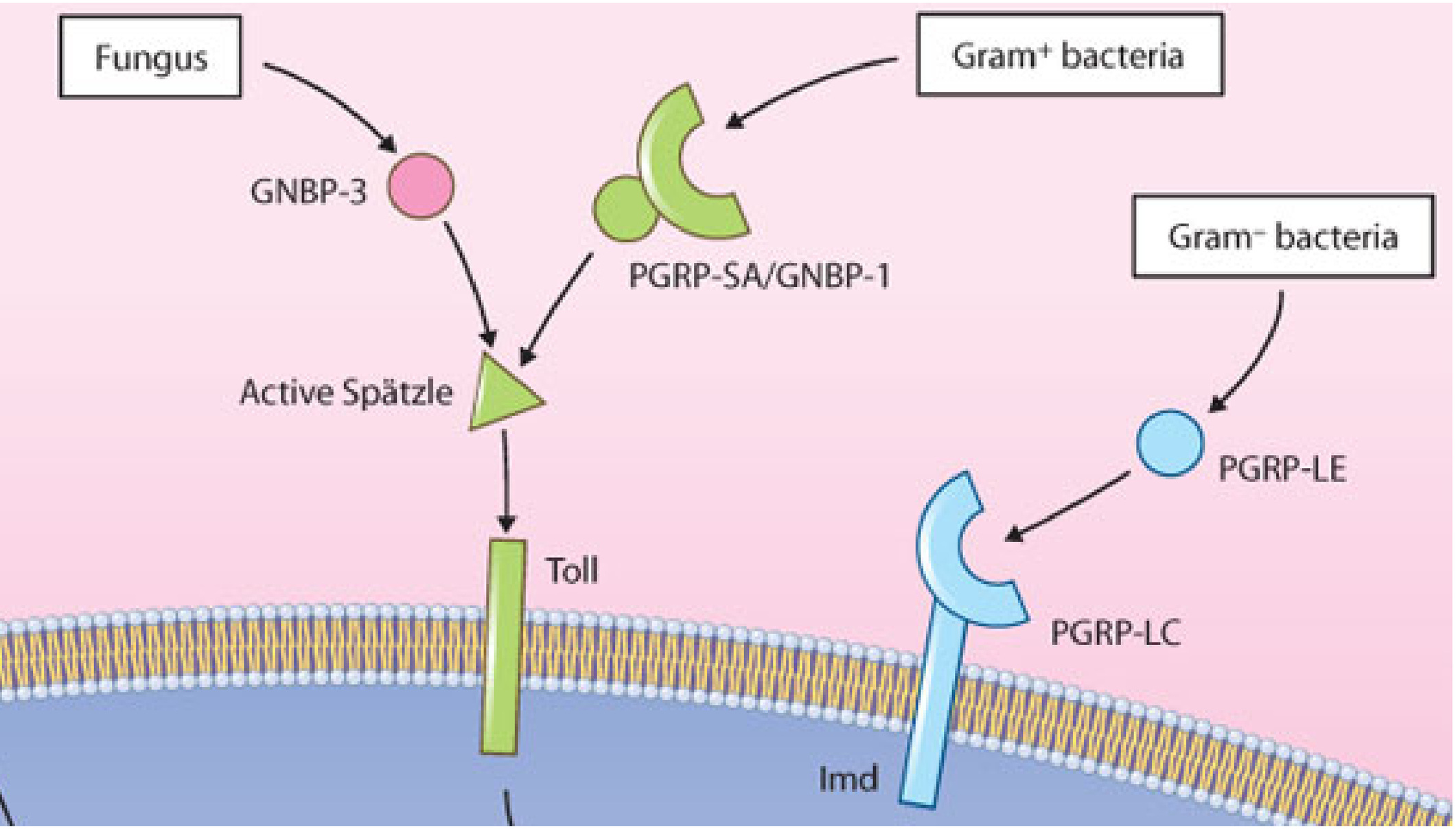
more images @ tinyurl.com/am3ncs

This is a picture of two *A elegantissima* or *A. sola* fighting with acrorhagia. Taken at San Simeon, CA by Dave Cowles

How do organisms distinguish self from non-self?

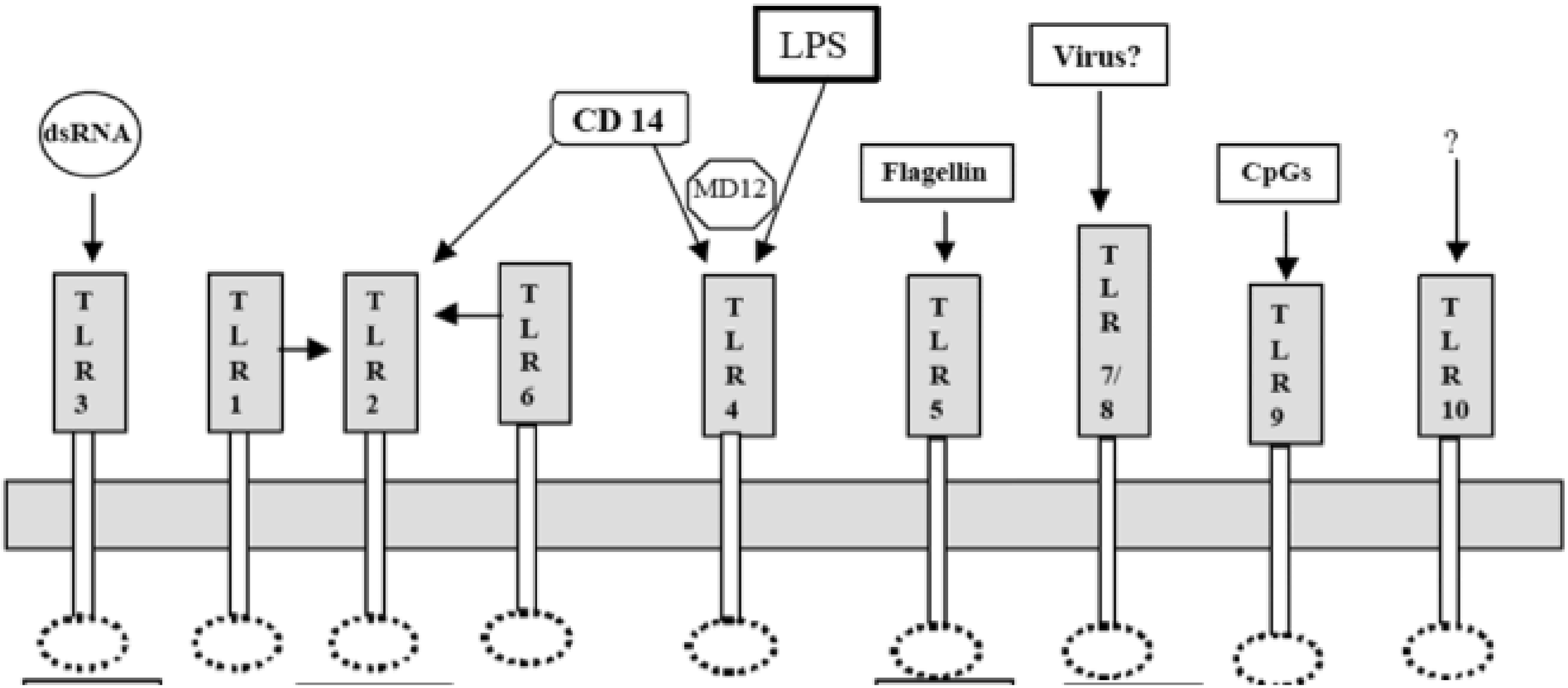
pattern recognitions proteins (PRPs)

PRPs



Toll-like Receptors
Peptidoglycan recognition proteins

PRPs - Toll-like Receptors

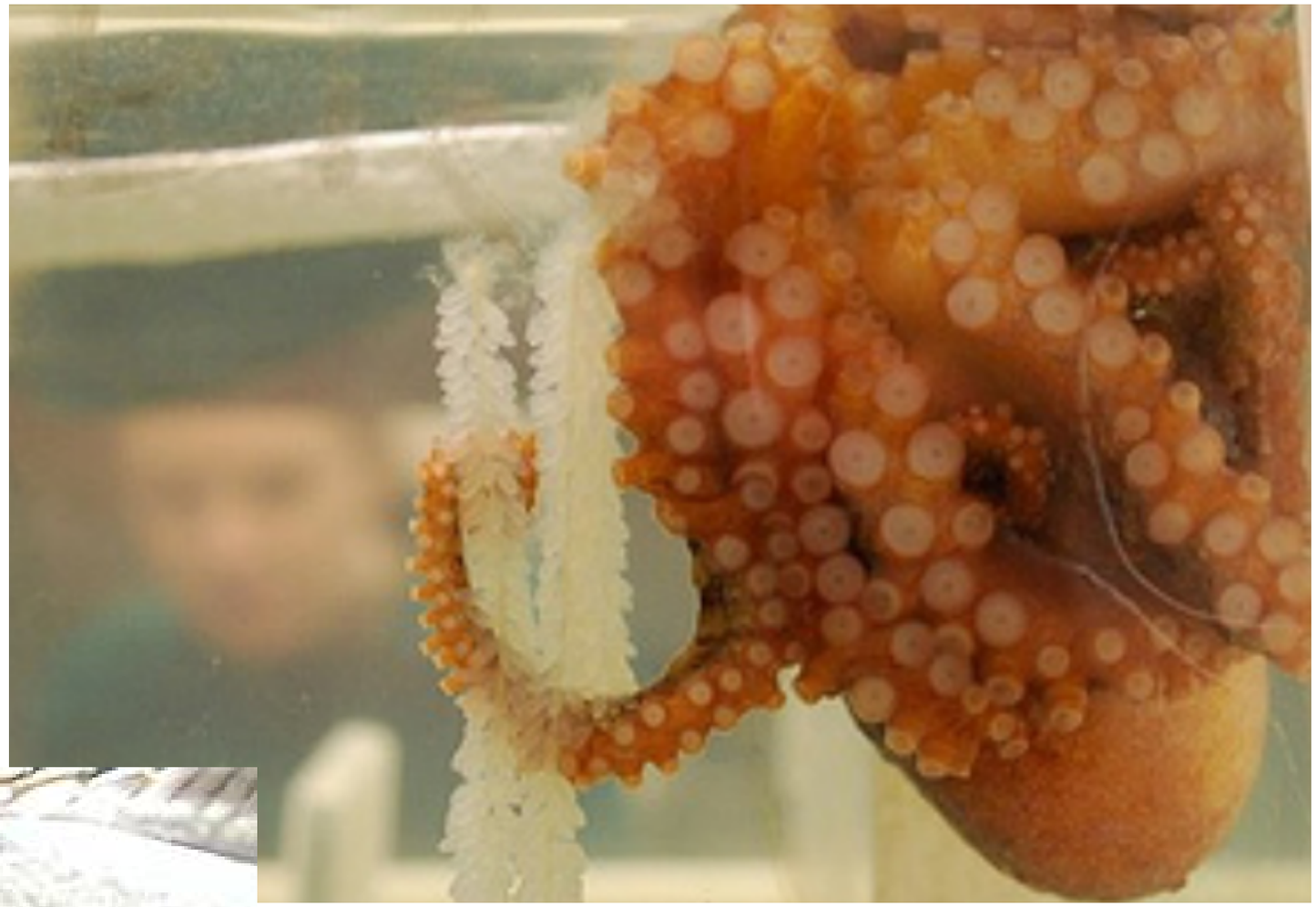


That's how the immune system knows bad things are there...

Innate Immunity

- Barrier tissue
- Inflammation
- Complement System

Chemico-physical Barrier



anti-microbial peptides

beneficial microbial communities

Innate Immunity

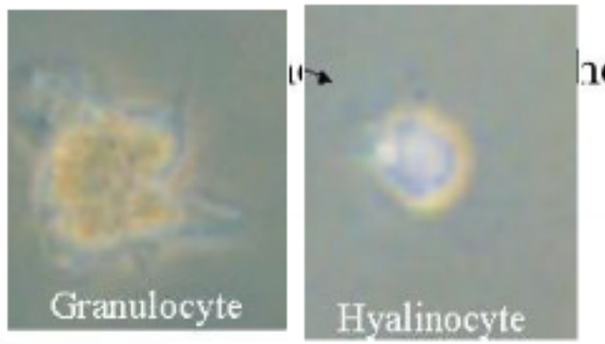
- Barrier tissue
- Inflammation
- Complement System

Innate Immunity

Chemico-physical barrier (shell, mucus)

Hemolymph

CELLS:



hemocytes

SERUM:
soluble lectins
hydrolytic enzymes
antimicrobial peptides

chemokinesis
chemotaxis
binding and internalization
oxidative burst activation
lysosomal enzymes
antimicrobial peptides

Laura Canesi, Gabriella Gallo, Miriam Gavioli, and Carla Pruzzo
Bacteria–hemocyte Interactions and Phagocytosis in Marine Bivalves. 2002. Microscopy Research And Technique 57:469–476

Phagocytosis

- How do they know where to go?
- What do they do when they get there?

Chemotaxis

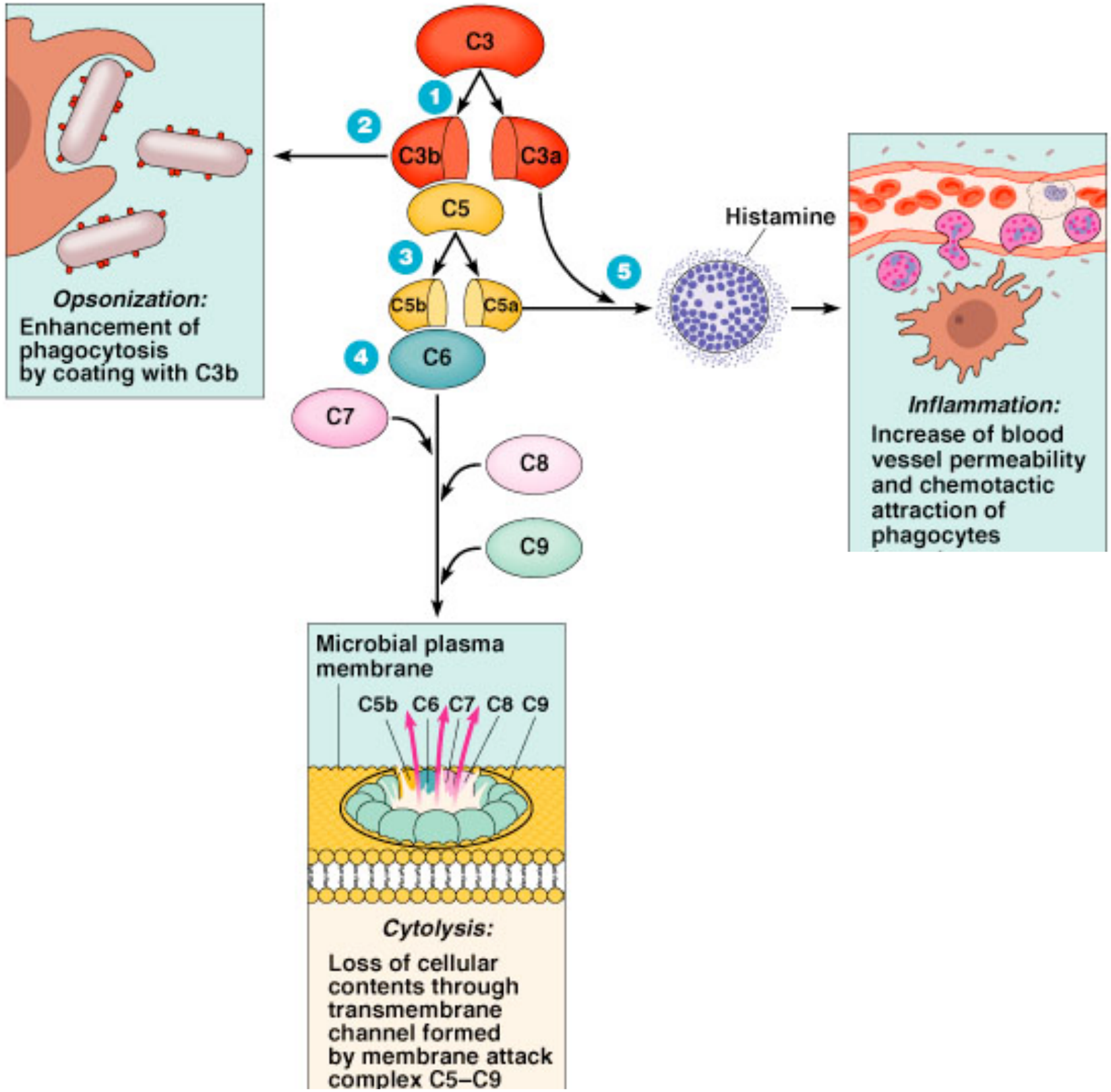
Phagocytosis

- How do they know where to go?
- What do they do when they get there?

Non-phagocytic Destruction

- Nitric oxide
- Reactive oxygen species
- Lactoferrin
- Complement System

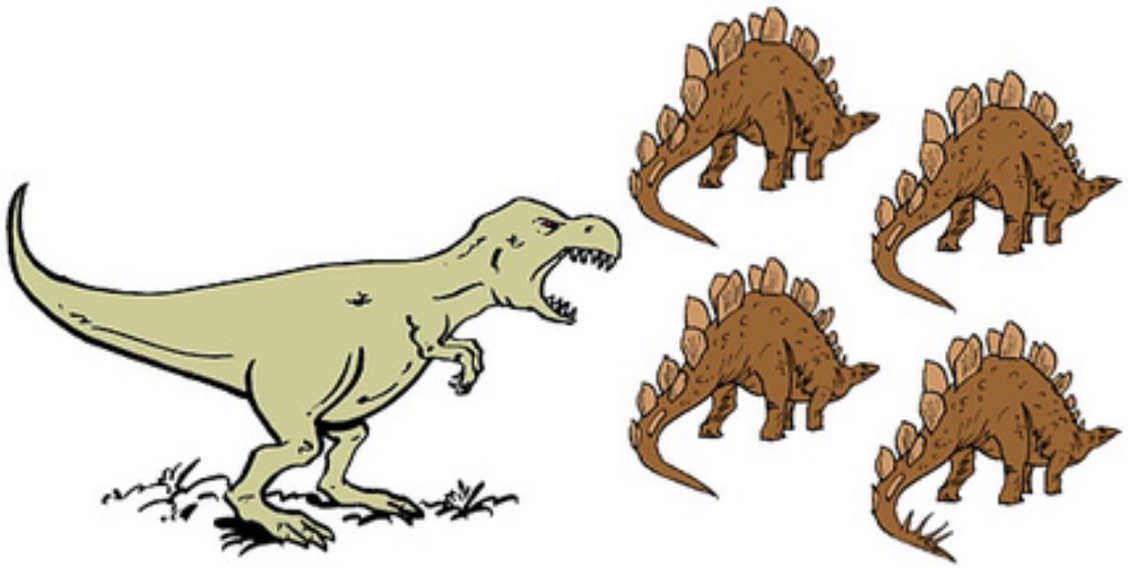
Complement System



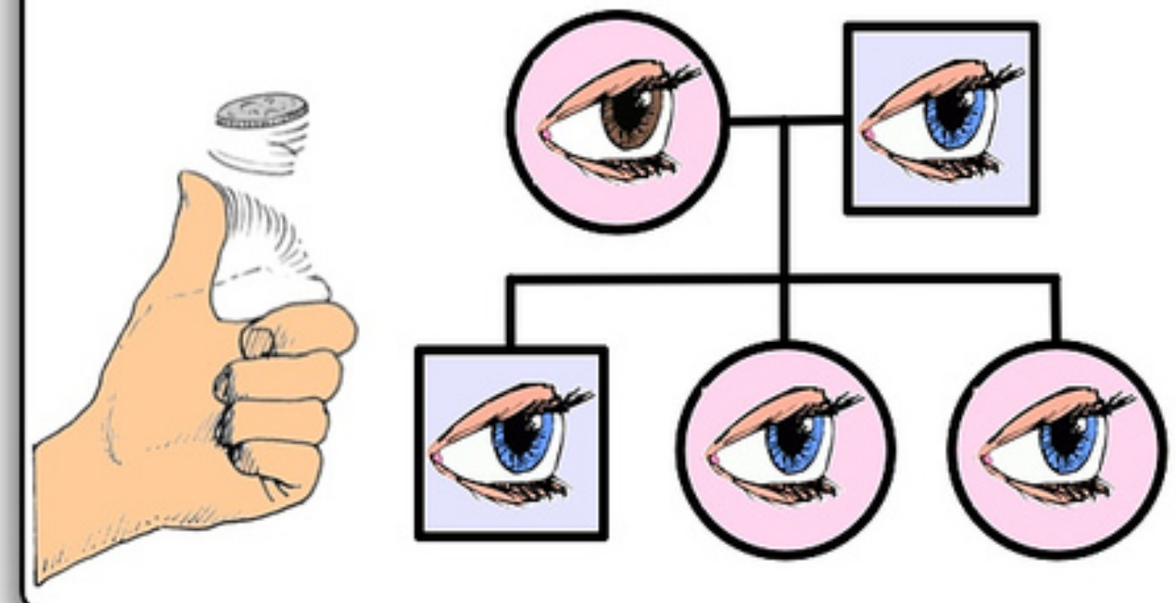
Immune Response

- **Innate Immunity** - non-specific
- Acquired Immunity

NATURAL SELECTION

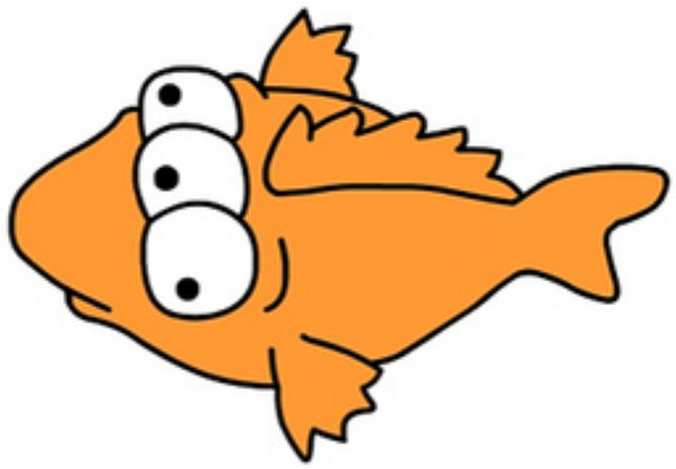


GENETIC DRIFT

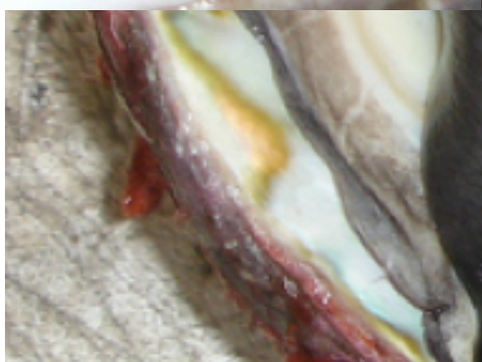


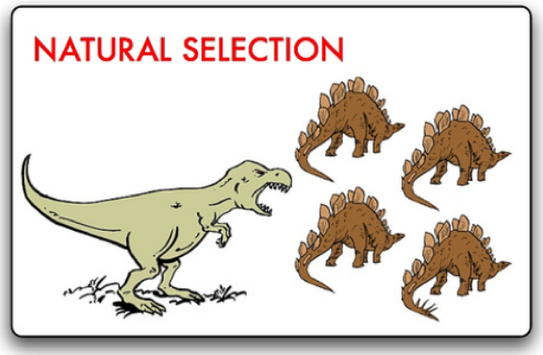
MIGRATION

MUTATION



Two part story

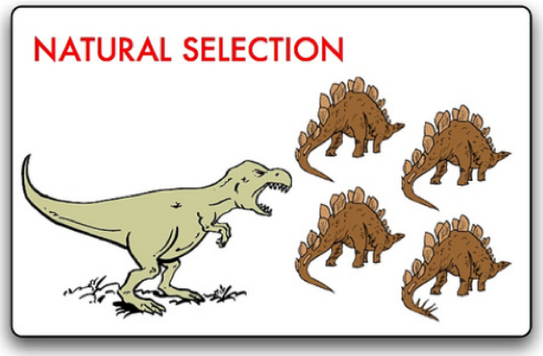




flickr | cpurrin l

Roxannna Smolowitz
Rick Karney

Disease Resistance ?



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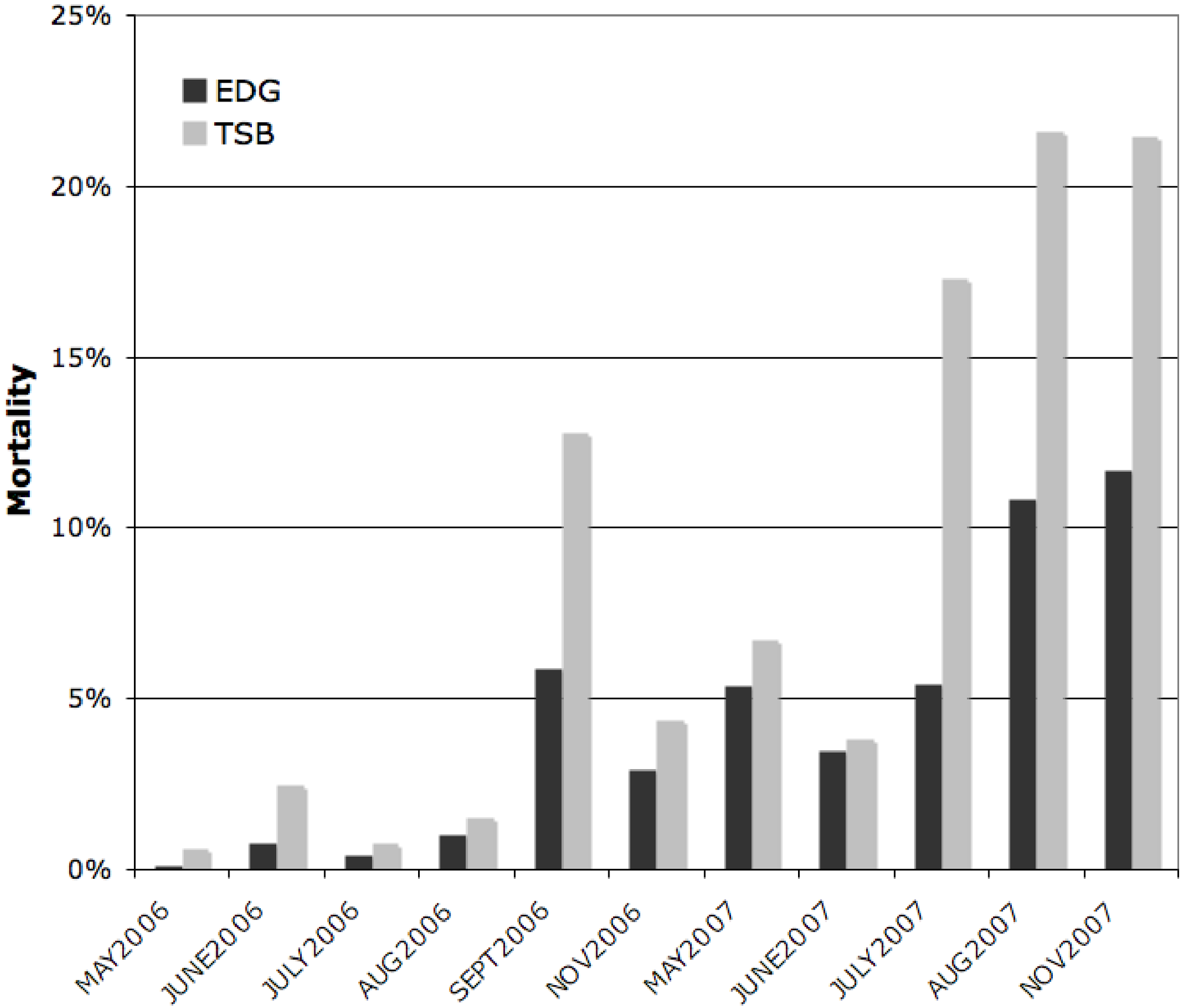
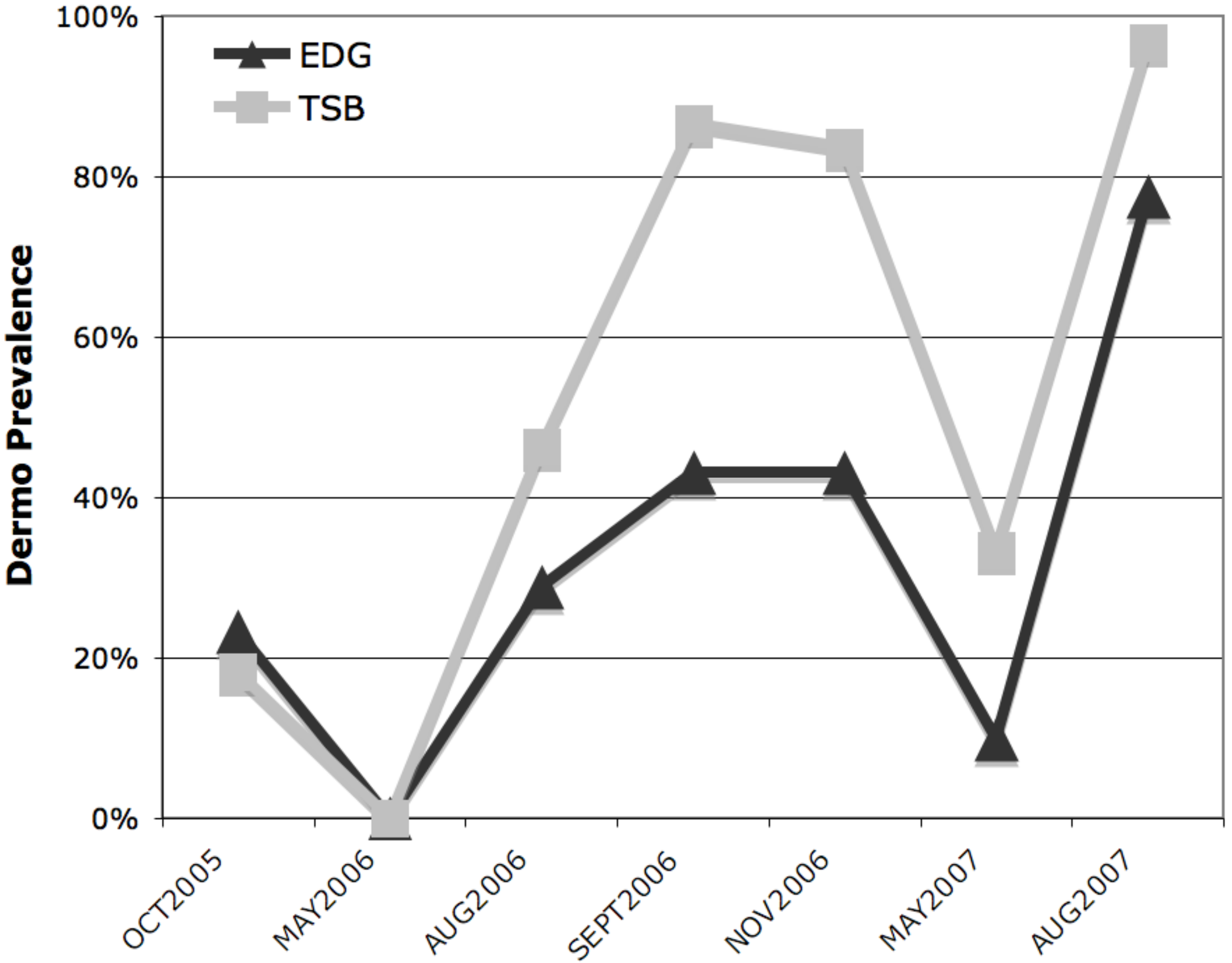
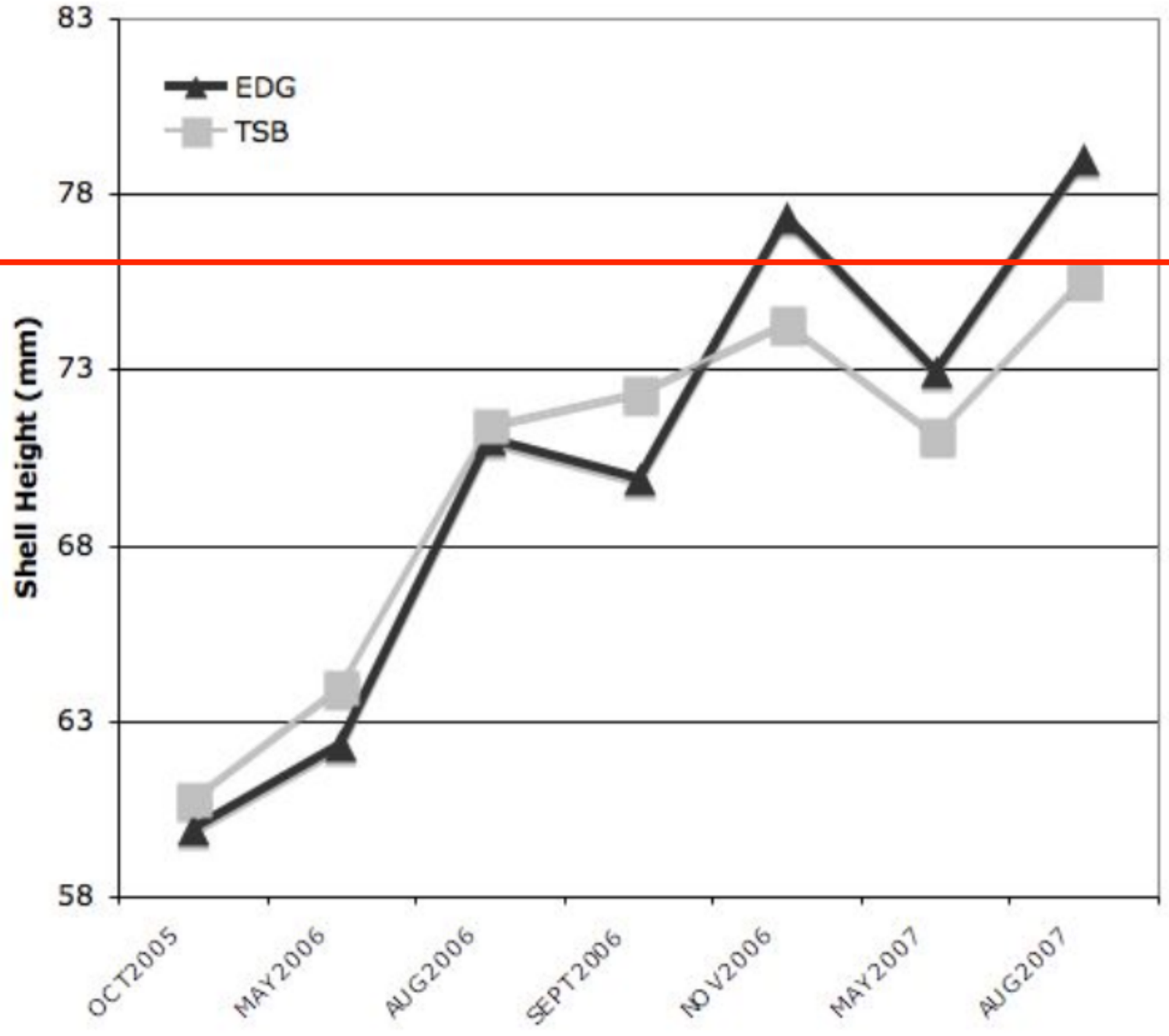
Roxannna Smolowitz
Rick Karney


Water Rd
Bold Water Rd
Kanonika Rd
Kanonika Rd
Brown
Meeting House Way
Hotchkiss Ln
Wilson's Landing
Rd to the Plains
Court St
Zoll Rd
Wilson's Landing
Wilson's Landing
Meeti
Jacob's Neck Rd
Bold Water Rd
Turkeyland Cove Rd
Turkeyland Cove Rd
Kingspoint Way
Loon Cove Rd
Slough Cove Rd
Motick Trail
Jacob's Neck Rd
Jacob's Neck Rd
Swan Lake Farm
Eastern Point
Jobes Neck Cove Rd
Eastern Point
Swan Lake Farm
Edgartown
Great Pond
Slough Cove Rd
Herring Creekfarm Rd
Herring Creekfarm Rd
Fuller's Cove Rd
Crackatuxet Cove Rd
Great Pai
Garden Cove Rd
Crackatuxet
Cove


25%
20%
15%
10%
5%
0%
Mortality
EDG
TSB
MAY2006
JUNE2006
JULY2006
AUG2006
SEPT2006
NOV2006
MAY2007
JUNE2007
JULY2007
AUG2007
NOV2007


100%
80%
60%
40%
20%
0%
Dermo Prevalence
EDG
TSB
OCT2005
MAY2006
AUG2006
SEPT2006
NOV2006
MAY2007
AUG2007

Market size


83
78
73
68
63
58
EDG
TSB
Shell Height (mm)
OCT2005
MAY2006
AUG2006
SEPT2006
NOV2006
MAY2007
AUG2007

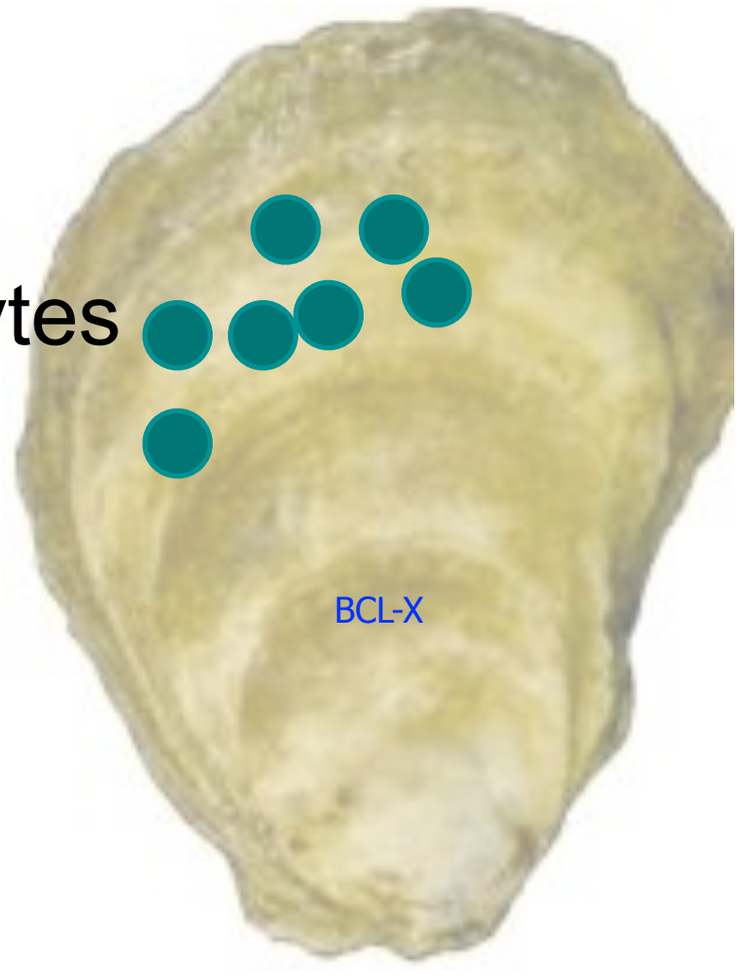
Mechanisms

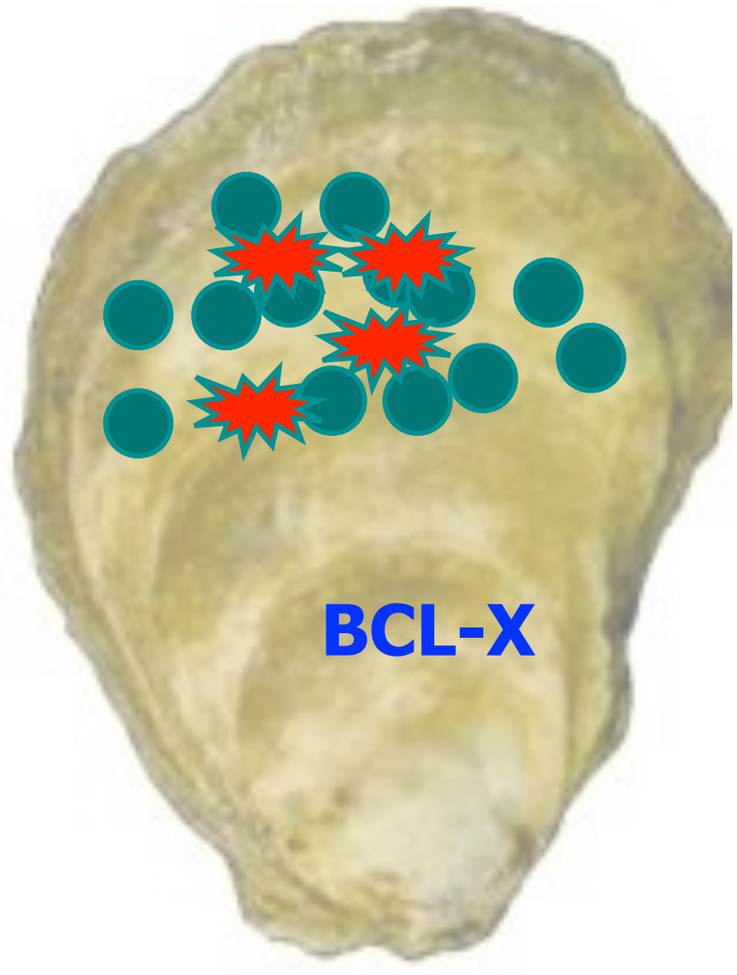
They are different,
but how / why?

Schematic

Parasite

Hemocytes





Resistant

Wild-type

Apoptosis – BCL-X

- Resistant oyster strains could downregulate apoptosis suppression

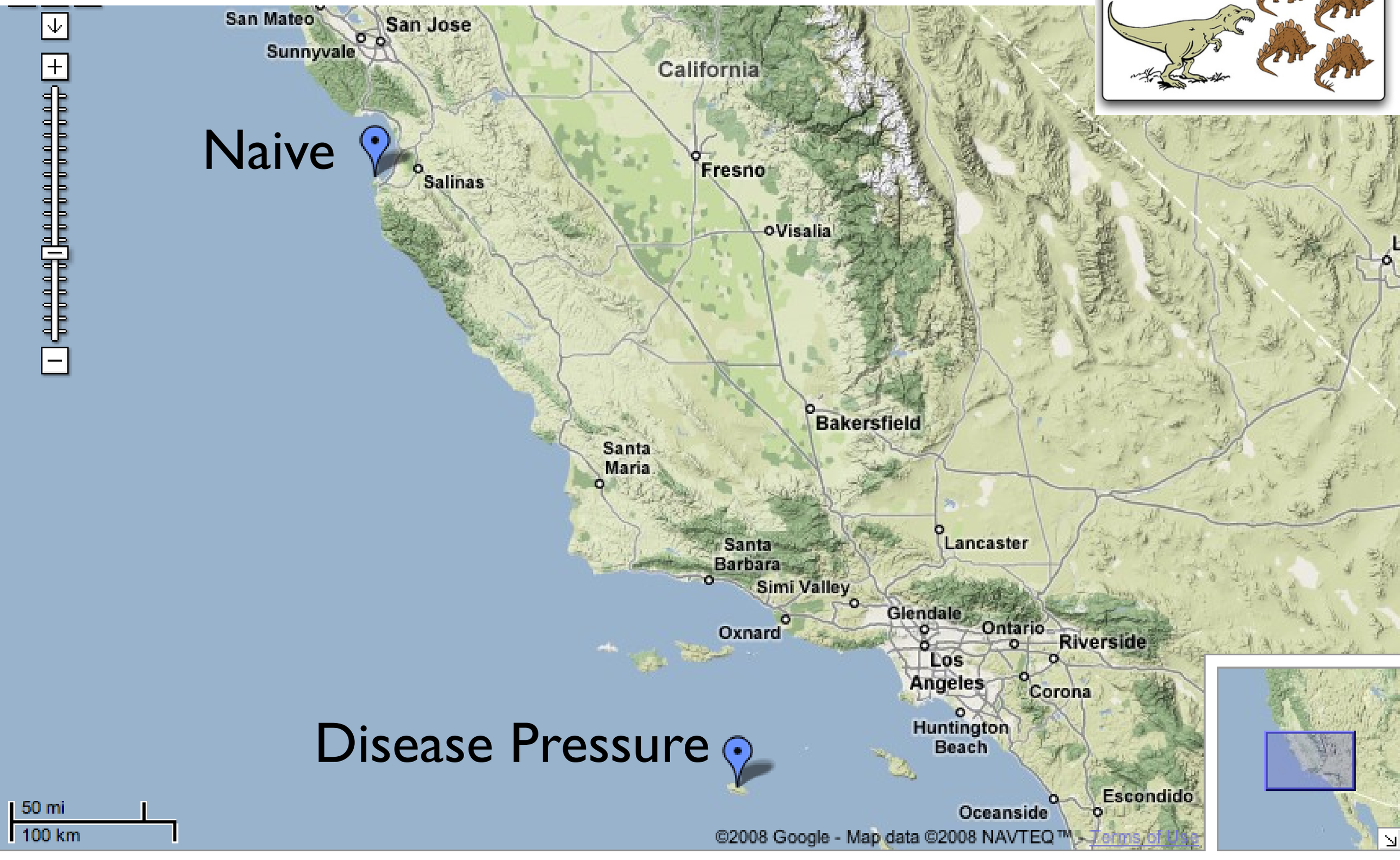
- Allowing for increased apoptosis

- Decreasing number of cells available for *Perkinsus* proliferation

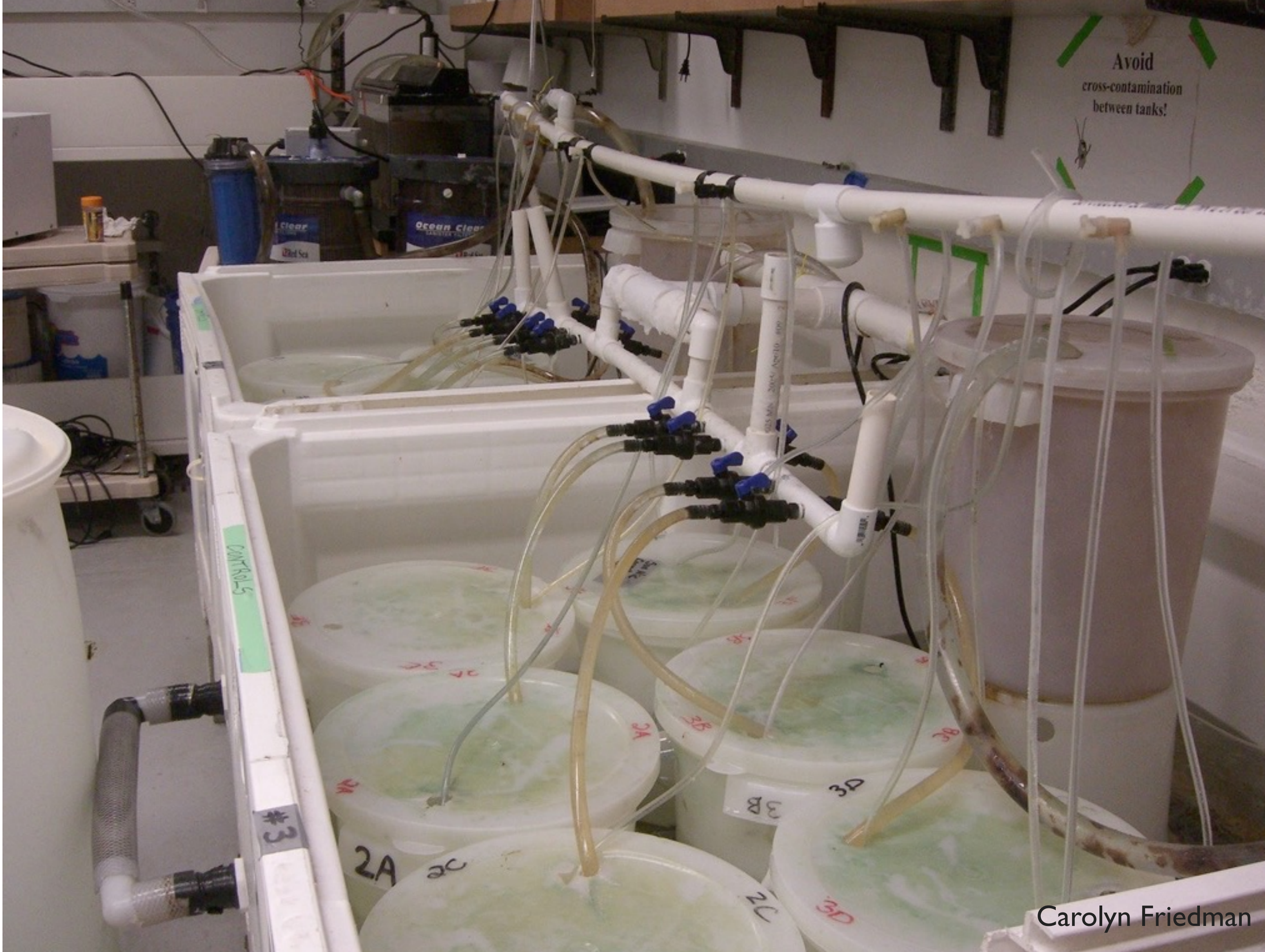
Summary - Oyster

- Offspring of survivors of heavy disease pressure are more tolerant to disease
- Mechanisms involved in host responses to *P. marinus* include proteases and apoptosis

Abalone

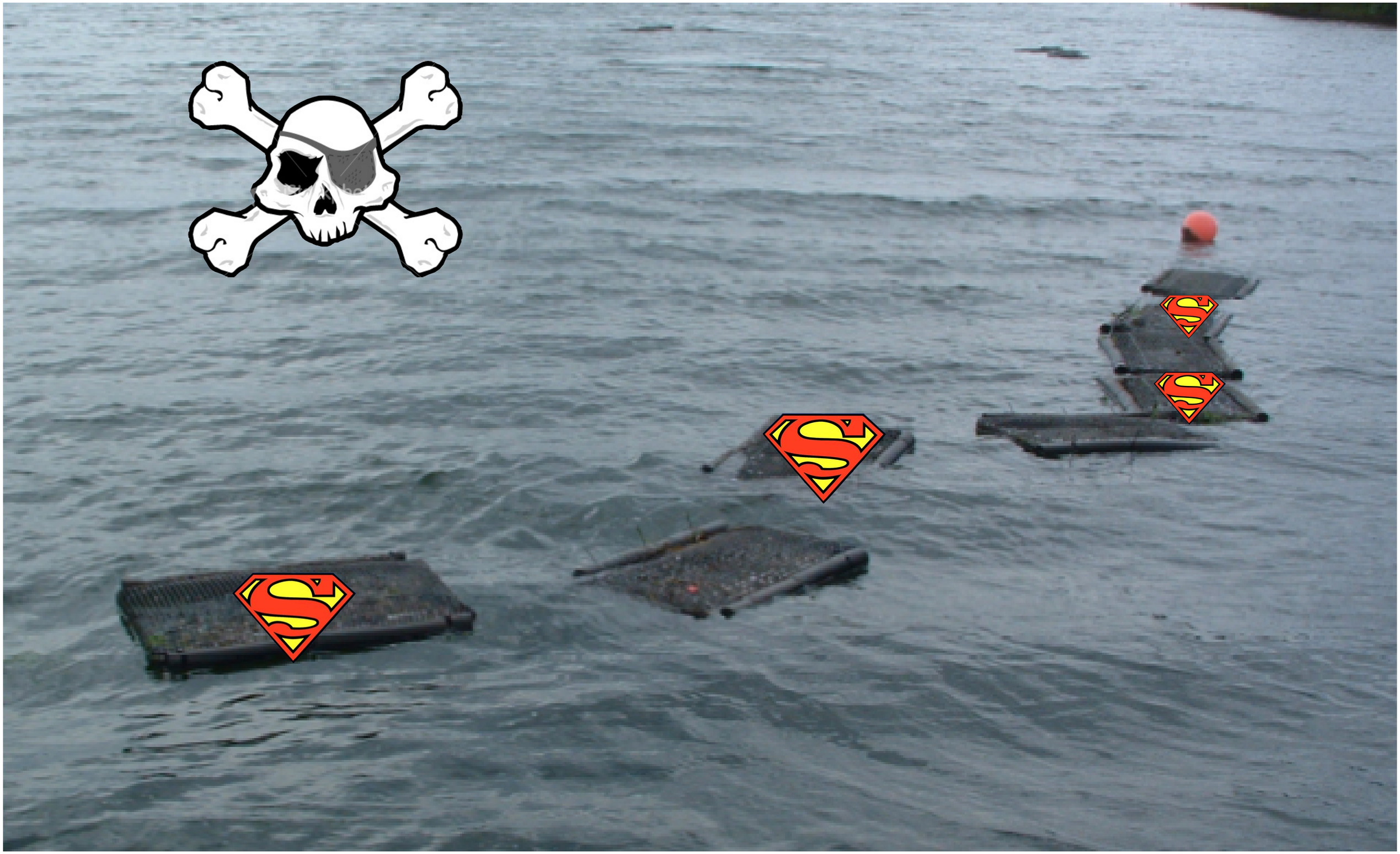


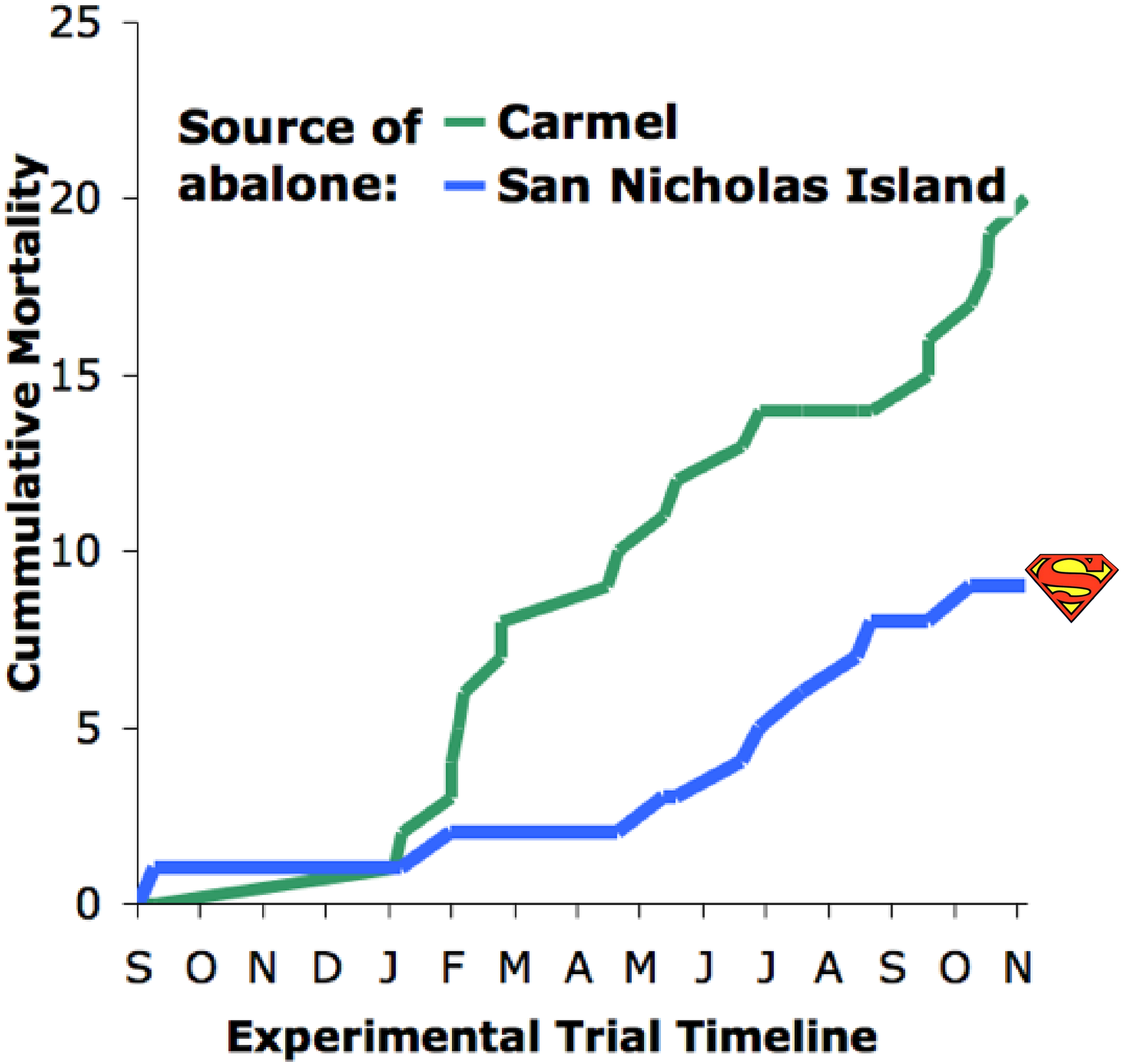
Glenn VanBlaricom, Carolyn Friedman

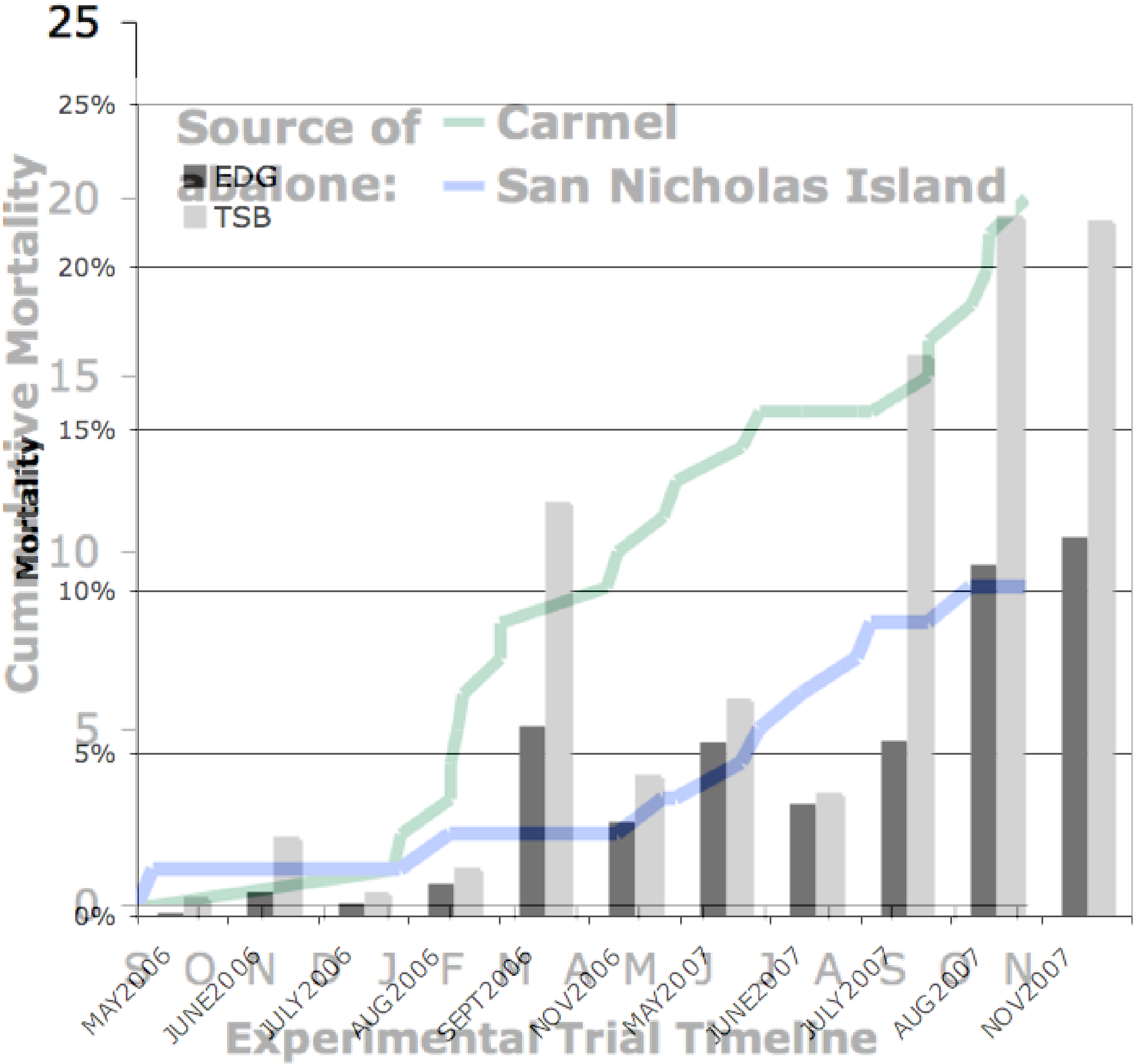

Avoid
cross-contamination
between tanks!
Ocean Clear
Red Sea
CONTROLS
#3
2A
2C
3B
3D
Carolyn Friedman

Carolyn Friedman

analagous to ...




Source of abalone:
Carmel
San Nicholas Island
Cumulative Mortality
25
20
15
10
5
0
S O N D J F M A M J J A S O N
Experimental Trial Timeline


25
25%
20
20%
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15%
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10%
5
5%
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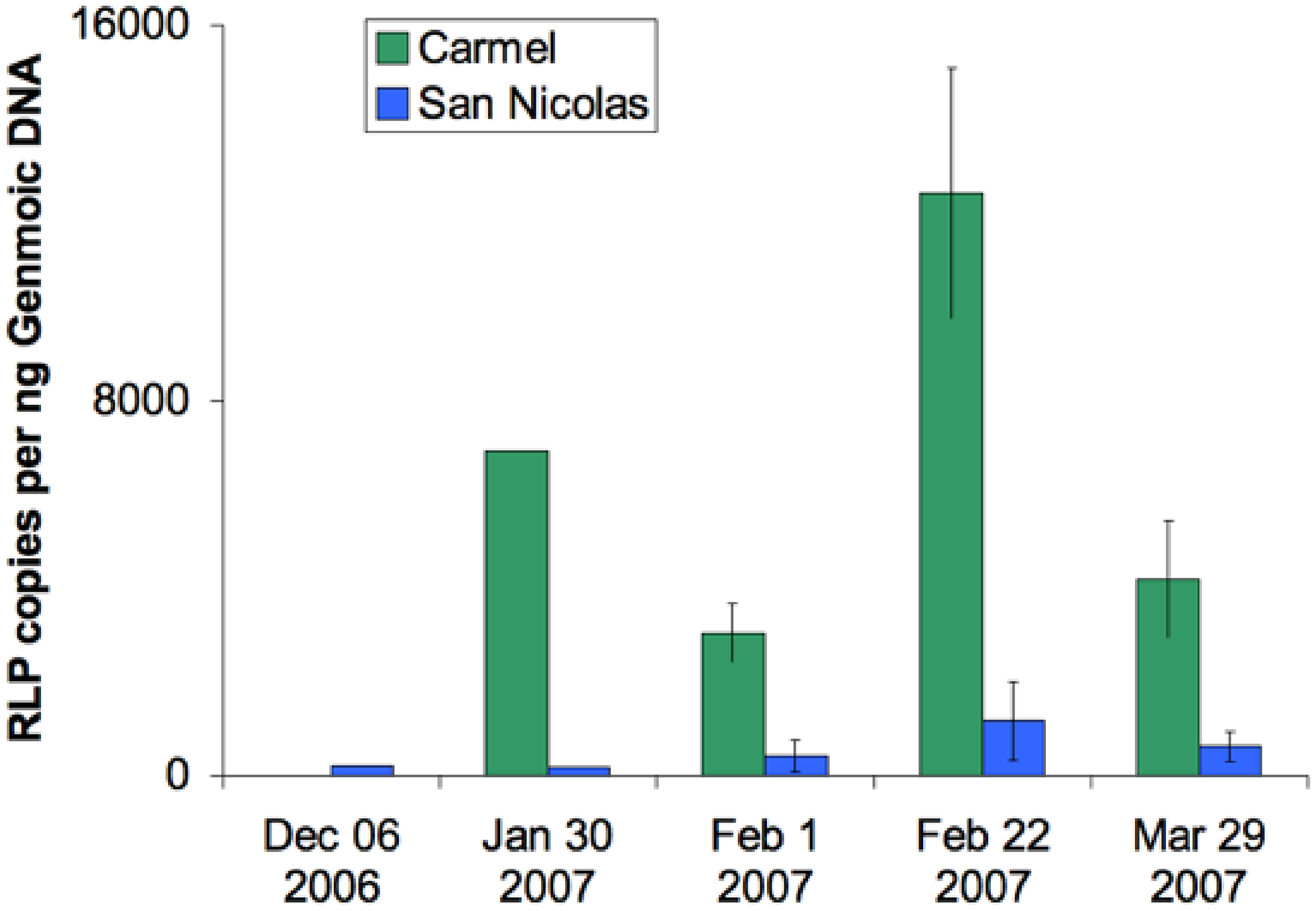
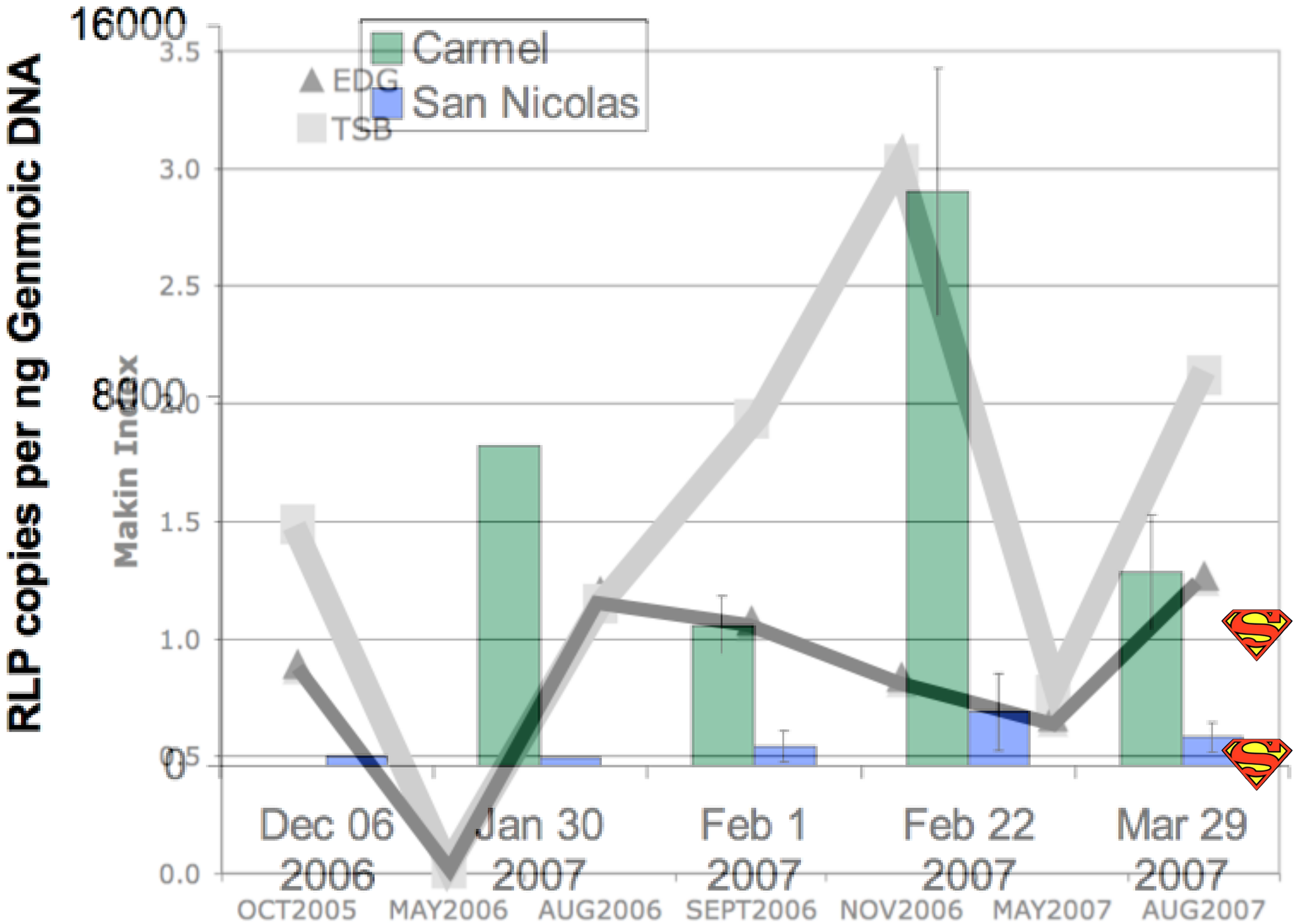
0%
Cumulative Mortality
Source of abalone:
Carmel
San Nicholas Island
EDG
TSB
MAY2006
JUNE2006
JULY2006
AUG2006
SEPT2006
NOV2006
MAY2007
JUNE2007
JULY2007
AUG2007
NOV2007
Experimental Trial Timeline


RLP copies per ng Genmoic DNA
16000
8000
0
Carmel
San Nicolas
Dec 06
2006
Jan 30
2007
Feb 1
2007
Feb 22
2007
Mar 29
2007


RLP copies per ng Genmoic DNA
Makin Index
16000
8000
0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Carmel
San Nicolas
EDG
TSB
Dec 06
2006
Jan 30
2007
Feb 1
2007
Feb 22
2007
Mar 29
2007
OCT2005
MAY2006
AUG2006
SEPT2006
NOV2006
MAY2007
AUG2007

Increased Resistance

Better survival AND less pathogen load

How?

Differences?

Factors involved in tissue change, general immune responses, recognition of the pathogen....

Gene	Molecular Function	Biological Process
Rab1	GTPase activity	Vesicle-mediated transport
Rab7 (WSSV Receptor)	GTPase activity, protein binding	Intracellular Protein Transport
Catalase	Catalase activity, antioxidant activity	Determination of life span, response to oxidative stress
Toll Interacting Protein (TOLLIP)	Protein binding, signal transducer activity	Inflammatory response, intracellular signaling cascade
Bacterial Recognition Protein (BRP)	Bacterial binding	Regulation of innate immune response
Manganese Superoxide Dismutase (MnSD)	MnSD activity, antioxidant activity	Response to oxidative stress
Plancitoxin	Deoxiribonuclease II activity	DNA catabolism process, DNA binding

Summary - Abalone

- Just as with oysters, processes of natural selection have resulted in populations with increased tolerance.
- Important mechanisms involved in the immune response to WS are associated with initial pathogen recognition.

Small pockets of  shellfish.

What are the implications?

Who cares?