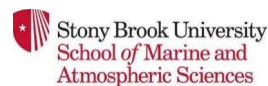


# Towards a better understanding of bay scallop health and disease

**Bassem Allam**

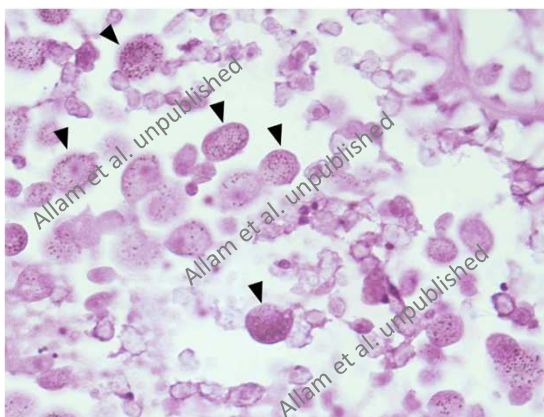
Marinetics Endowed Professor  
Marine Animal Disease Laboratory  
School of Marine and Atmospheric Sciences  
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## Original findings (reported 1/31/2020)

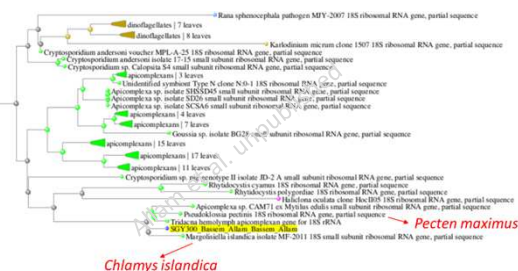
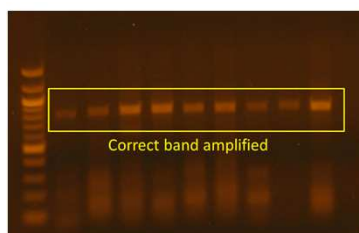
- Discovery of a member of the apicomplexan (coccidian, dubbed bay scallop coccidian or BSC) in scallop kidneys



Extensive disorganization of kidney tissues in severely-infected scallops

## Molecular investigations

- Used Apicomplexan primers to amplify a DNA fragment by PCR
- Sequencing of the amplified fragment clustered BSC with other scallop coccidians



## Many, many, questions to be answered, including:

- Is this a new parasite?
- Does it infect only kidney tissues?
- Does it infect other species?
- Why now?
- What is its impact on the bay scallop population?
- Can it be mitigated/managed?

## Is this a new parasite?

- Unlikely, since similarly looking parasites have been described earlier in bay scallop
- It is possible however that different strains exist
- Leibovitz (1984) suggested that bay scallop may be infected by multiple coccidian species

## Field and Lab investigations

**Project title:** *A matter of life or death:  
Identifying factors that regulate  
susceptibility or resistance of bay scallops  
to an emergent coccidian parasite*



**Funding agency:** National Science Foundation

**Duration:** 1 year

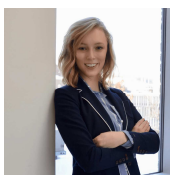
**Start date:** 6/15/2020

**PIs:** Allam, Pales Espinosa, Tettelbach

## The Team (led by B. Allam)



Emmanuelle Pales Espinosa, Research Associate Professor



Madison Muehl, PhD candidate



Sabrina Geraci-Yee, Lab support specialist and PhD candidate



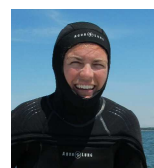
Many MADL members



Stephen Tettelbach, Shellfish Ecologist



Scott Hughes, Marine Resources Specialist



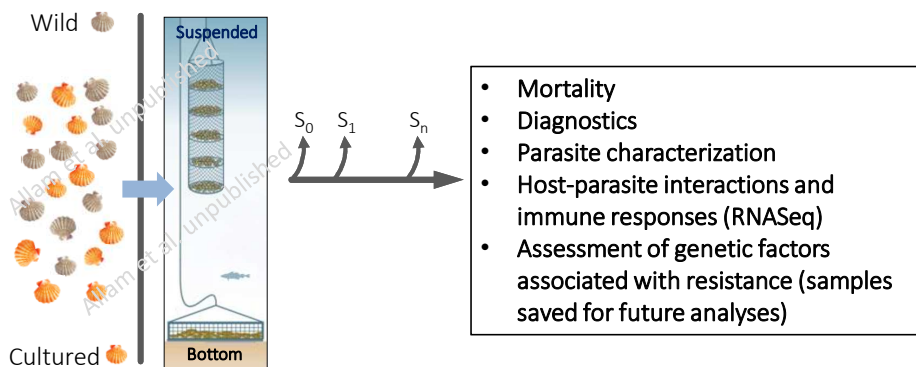
Kaitlyn O'Toole, Bay Scallop Intern

## Project Goals

- Answer basic biological questions to characterize BSC (life cycle, virulence factors)
- Identify biological (scallop immunity, genetic background) and environmental factors that regulate disease development
- Host-pathogen interactions and disease outcomes

**Hypothesis:** Stressful environmental factors exacerbate scallop physiological conditions leading to severe BSC infections and scallop mortality

## The field component

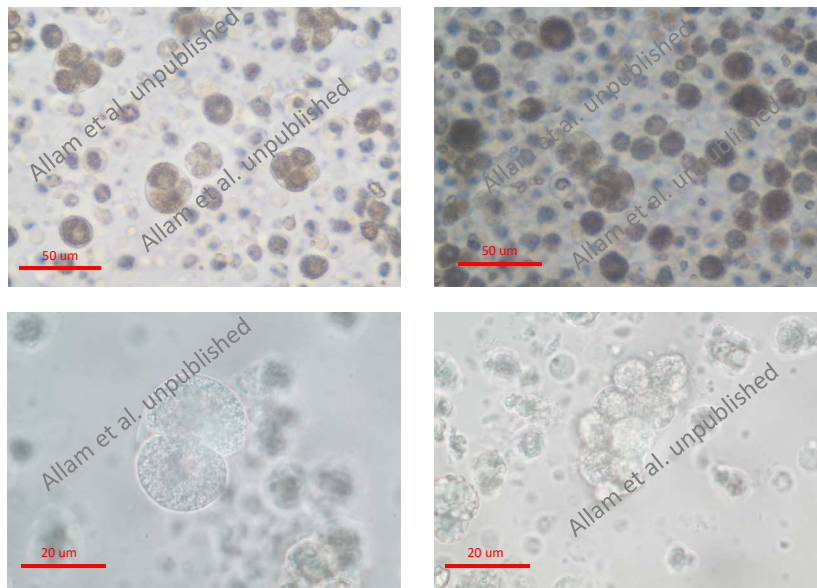


- Wild and aquacultured scallops (2019 year class) collected from Orient Harbor on 6/23/2020
- Deployed in replicated lantern nets and ADPI bags in 2 sites: Orient Harbor and Flanders Bay
- Resampled monthly on 4 occasions (July through October)
- A total of 840 scallops processed (include control samples from CCE's long lines, and 2 control samples from Nantucket)

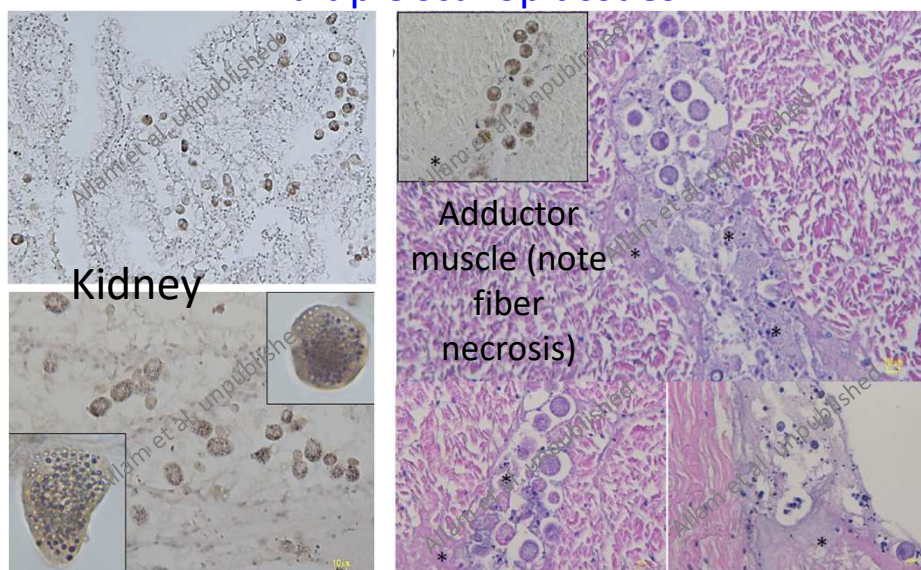
## Short summary of the findings

- A sensitive rapid test was developed to assess presence of parasite cells in scallop kidney fresh preparations
- Parasite found in each and every scallop processed
- Parasite numbers and activity (cell division) were much higher in summer as compared to the (few) samples we analyzed during winter 2020
- Parasite not only limited to kidney but can severely infect other tissues
- Marked difference in mortality trends between sites, strains and deployment method

## Observations

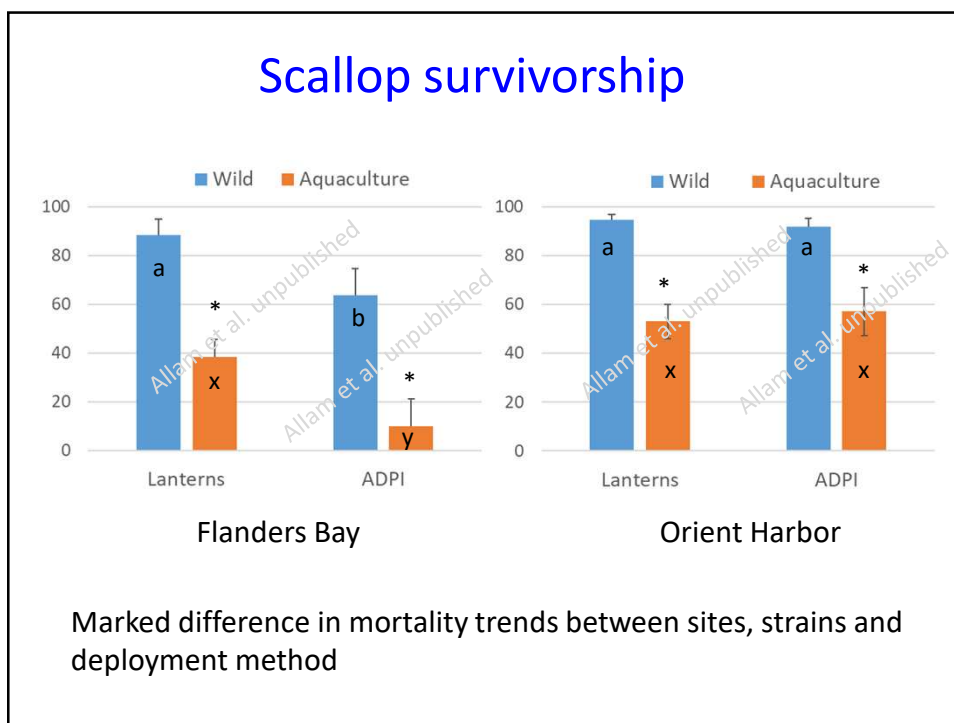
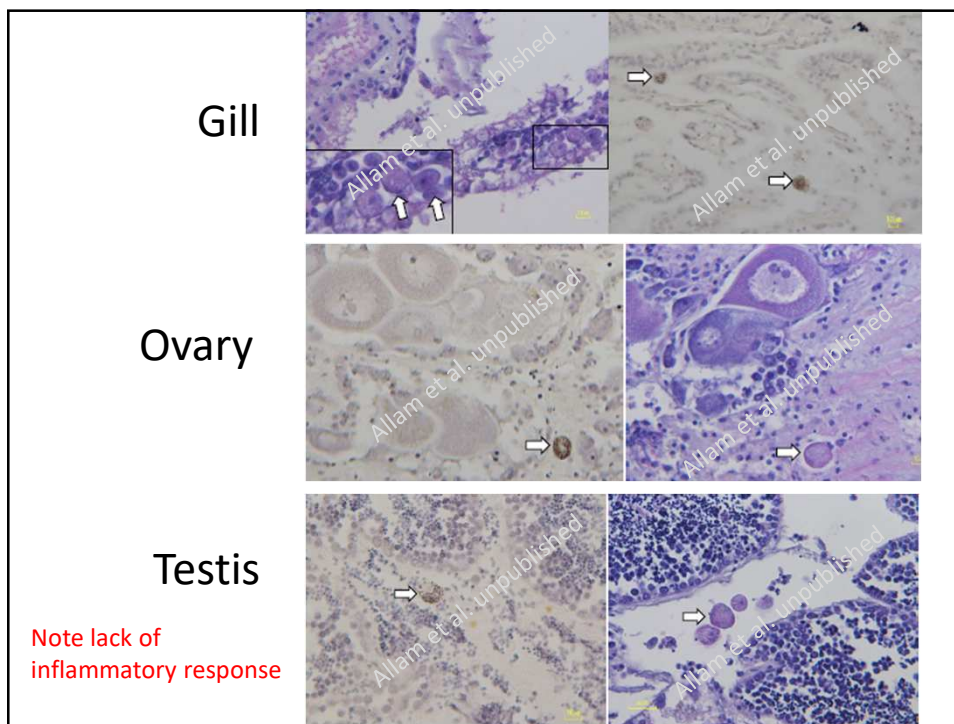


## DNA probes\* confirmed that BSC is present in multiple scallop tissues



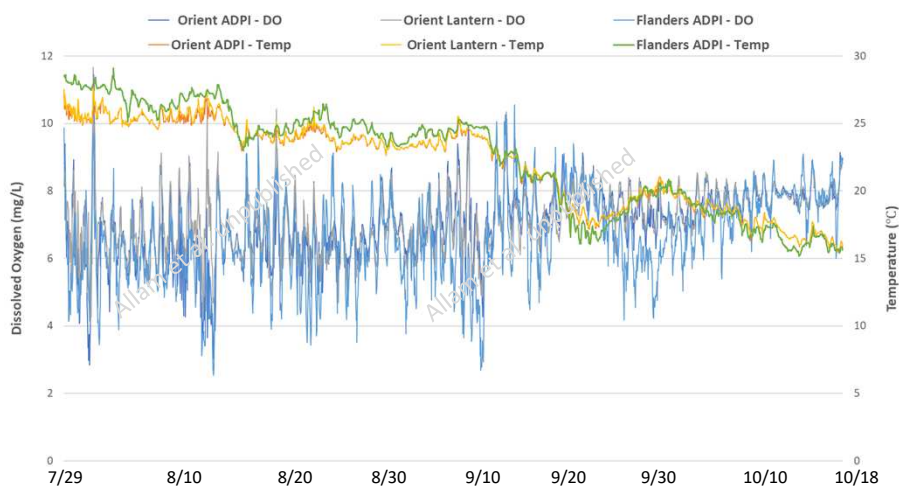
\* Work done in collaboration with Dr. Arni Kristmundsson (University of Iceland)



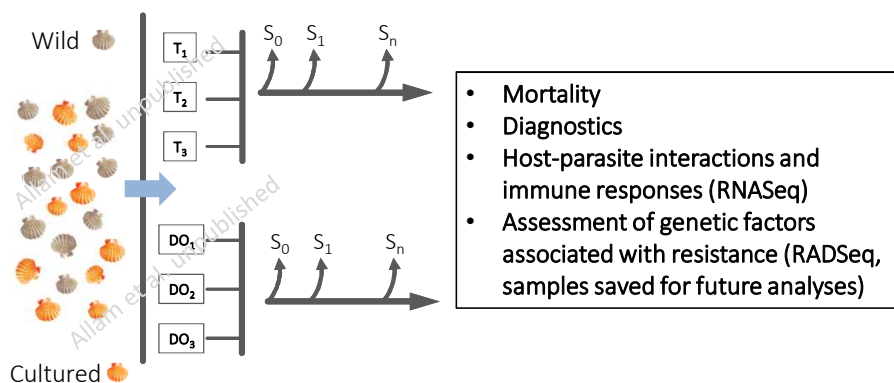


## Environmental conditions

	DO			Temperature		
	Orient ADPI	Orient Lantern	Flanders ADPI	Orient ADPI	Orient Lantern	Flanders ADPI
Average	7.0	7.1	6.7	22.0	22.0	22.4
Min	2.8	4.1	2.5	15.4	15.5	15.2
Max	11.5	11.7	10.6	27.5	27.7	29.1



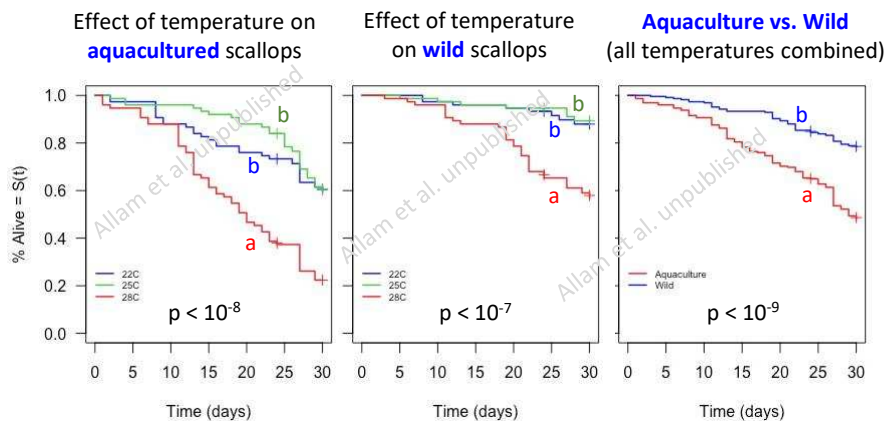
## The Lab component



- Same batch of wild and aquacultured scallops used in the field experiment
- Used in replicated lab experiments to evaluate the effect of key environmental factors on BSC progress and scallop health and survivorship
- More scallops to process!!!



## Scallop survivorship: temperature experiment



Each curve in the first two panels represents the average of 3 replicate tanks with 25 scallops each. Each curve in the last panel represents the average of a total of 225 scallops (in 9 replicates). P values are derived from Kaplan-Meier survival analyses. Different letters (a, b) within each panel indicate statistically different groups.

## Pending (but important) question:

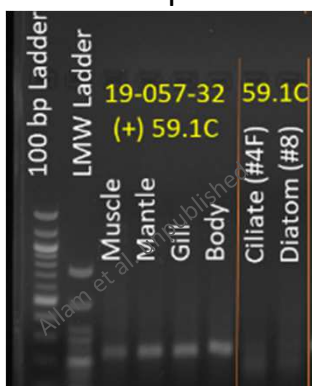
Does this parasite infect other species? Or does it complete its life cycle in scallop?

- Need highly specific molecular detection methods
- We are following 2 strategies to do so:
  - Use available molecular information to identify BSC-specific DNA sequences (very challenging because of lack of information!)
  - Generate and use new molecular information

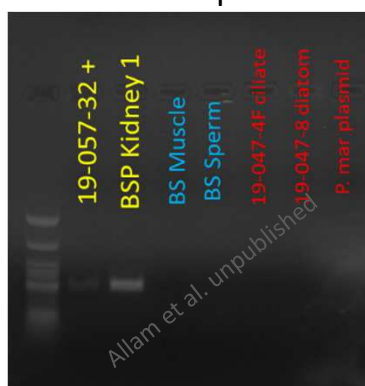
## Developed 2 pairs of PCR primers for testing (240 and 221 bp)

Used previous positive sample, negative samples (diatom, ciliate, *Perkinsus marinus*), and parasite kidney concentrate

### Primer pair 1



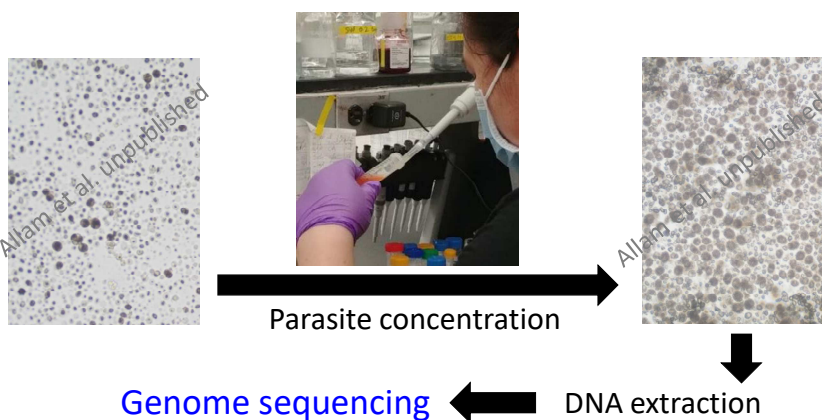
### Primer pair 2



Now testing these primers on samples (3 different coccidian species infecting other scallop species) sent to us by Dr. Arni Kristmundsson

## Generate new molecular data: BSC genome sequencing

Needed for parasite characterization (and for development of highly specific detection methods!)



## Where all this leaves us?

- Is this a new parasite? **Unlikely**
- Does it infect only kidney tissues? **No, significant alterations are seen in other tissues**
- Does it infect other species? **No information yet (need highly specific detection methods)**
- Why now? **Disease seems to worsen in summer and lab experiments strongly suggest a role for temperature (other parameters are being investigated too)**
- What is its impact on the bay scallop population? **Likely different in different areas, need a real survey!**
- Can it be mitigated/managed? **Likely**

**Why now?**

*Journal of Shellfish Research*, Vol. 24, No. 3, 761-765, 2005.

**A PROLONGED THERMAL STRESS EXPERIMENT ON THE AMERICAN LOBSTER, HOMARUS AMERICANUS**  
ALISTAIR D. M. DOVE<sup>1\*</sup>, BASSEM ALLAM,<sup>2</sup> JASON J. P. MARK S. SOKOLOWSKI<sup>2</sup>

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**Effects of temperature on hard clam (*Mercenaria mercenaria*) immunity and QPX (Quahog Parasite Unknown) disease development: I. Dynamics of QPX disease**  
Soren F. Dahl<sup>1,2</sup>, Mickael Perrigault<sup>1,2</sup>, Qianqian Liu<sup>2</sup>, Jackie L. Collier<sup>2</sup>, Debra A. Barnes<sup>2</sup>, Bassem Allam<sup>2,\*</sup>

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**Comparative Biochemistry and Physiology, Part A**  
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**Effects of salinity on hard clam (*Mercenaria mercenaria*) defense parameters and QPX disease dynamics**  
Mickael Perrigault<sup>1</sup>, Soren F. Dahl<sup>1</sup>, Emmanuelle Pales Espinosa, Bassem Allam<sup>2</sup>

*Journal of Shellfish Research*, 2017, 48, 1269-1278

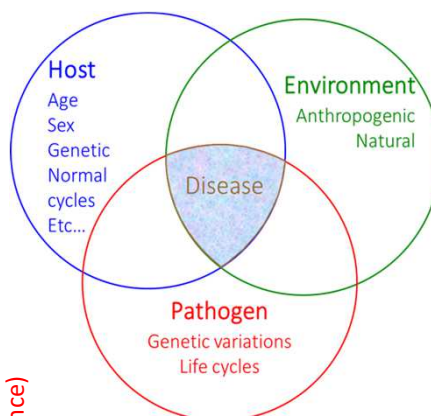
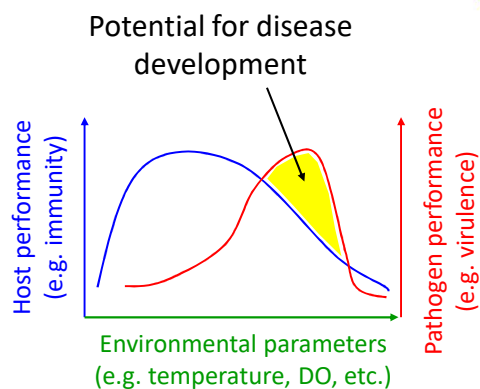
**Seasonality of QPX disease in the wild hard clam (*Mercenaria mercenaria*)**  
Qianqian Liu, Jackie L. Collier & Bassem Allam  
School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY

The influence of temperature stress on the physiology of the Atlantic surfclam, *Spisula solidissima*  
Jesse Hornstein, Emmanuelle Pales Espinosa, Robert M. Cerrato, Kamazima M.M. Lwiza, Bassem Allam<sup>\*</sup>

journal homepage: www.elsevier.com/locate/fsi

Full length article  
**Alterations of the immune transcriptome in resistant and susceptible hard clams (*Mercenaria mercenaria*) in response to Quahog Parasite Unknown (QPX) and temperature**  
Kailai Wang<sup>1</sup>, Emmanuelle Pales Espinosa<sup>2</sup>, Arnaud Tanguy<sup>3</sup>, Bassem Allam<sup>1,2,\*</sup>

## Shellfish health: a fragile balance



## Can it be mitigated/managed?



From sequence to consequence: genomic selection to expand and improve selective breeding for the eastern oyster.

Guo et al. (Allam is lead of the SBU award)  
\$4,363,092 funded by the ASMFC



East Coast Hard Clam Selective Breeding Collaborative

Allam (lead PI) et al.  
\$1,200,000 funded by NOAA Aquaculture

## >>>> Moving forward >>>>

- **Characterization** of the parasite (life cycle, factors affecting virulence, other hosts?)
- Identification of **factors** that modulate disease intensity and resulting mortality (ongoing, need more funding)
- Understanding of **spatial and temporal distribution** of the disease in the Peconic (need funding)
- Evaluation of **mitigation strategies** (need funding - selective breeding seed proposal pending with the USDA –B. Allam (lead), E. Pales Espinosa, S. Tettelbach, K. Rivara, E. Green-Beach)

## Questions?

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Cornell University  
Cooperative Extension  
of Suffolk County

