Pushing the Limits: Heat Tolerance in Soft Shell Clams

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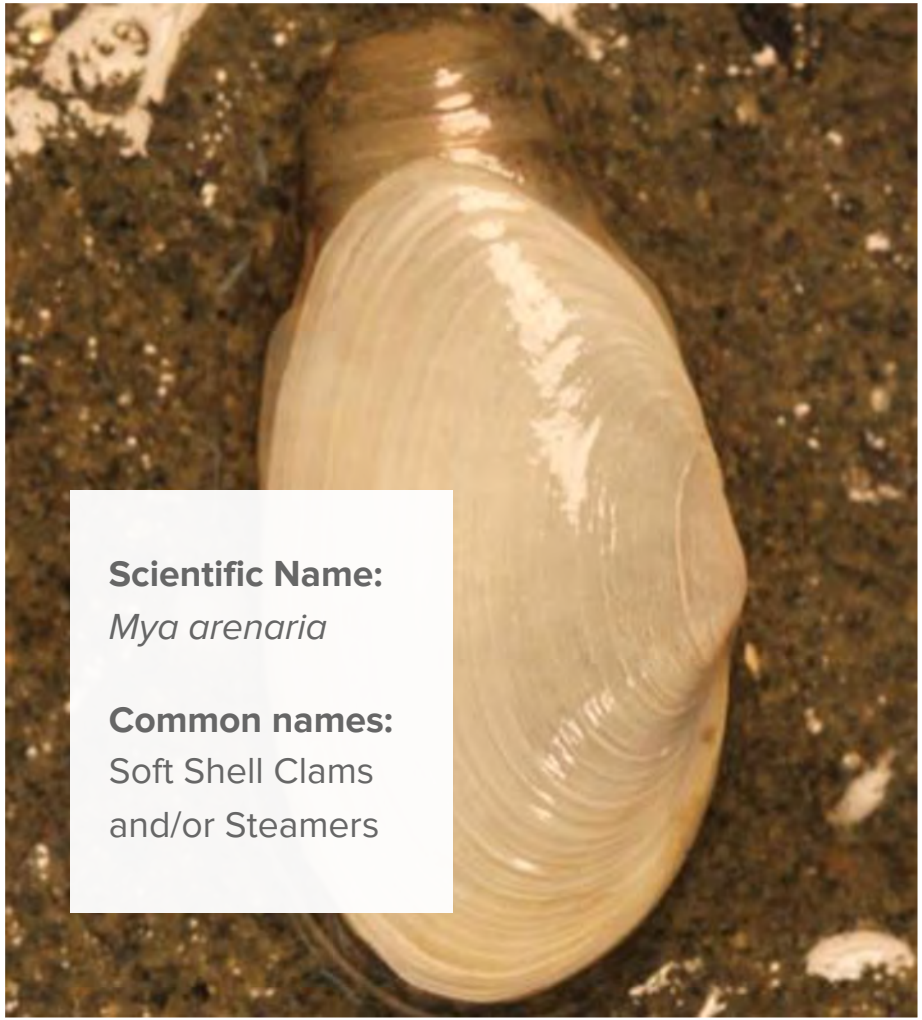
Background



Scientific Name:
Mya arenaria

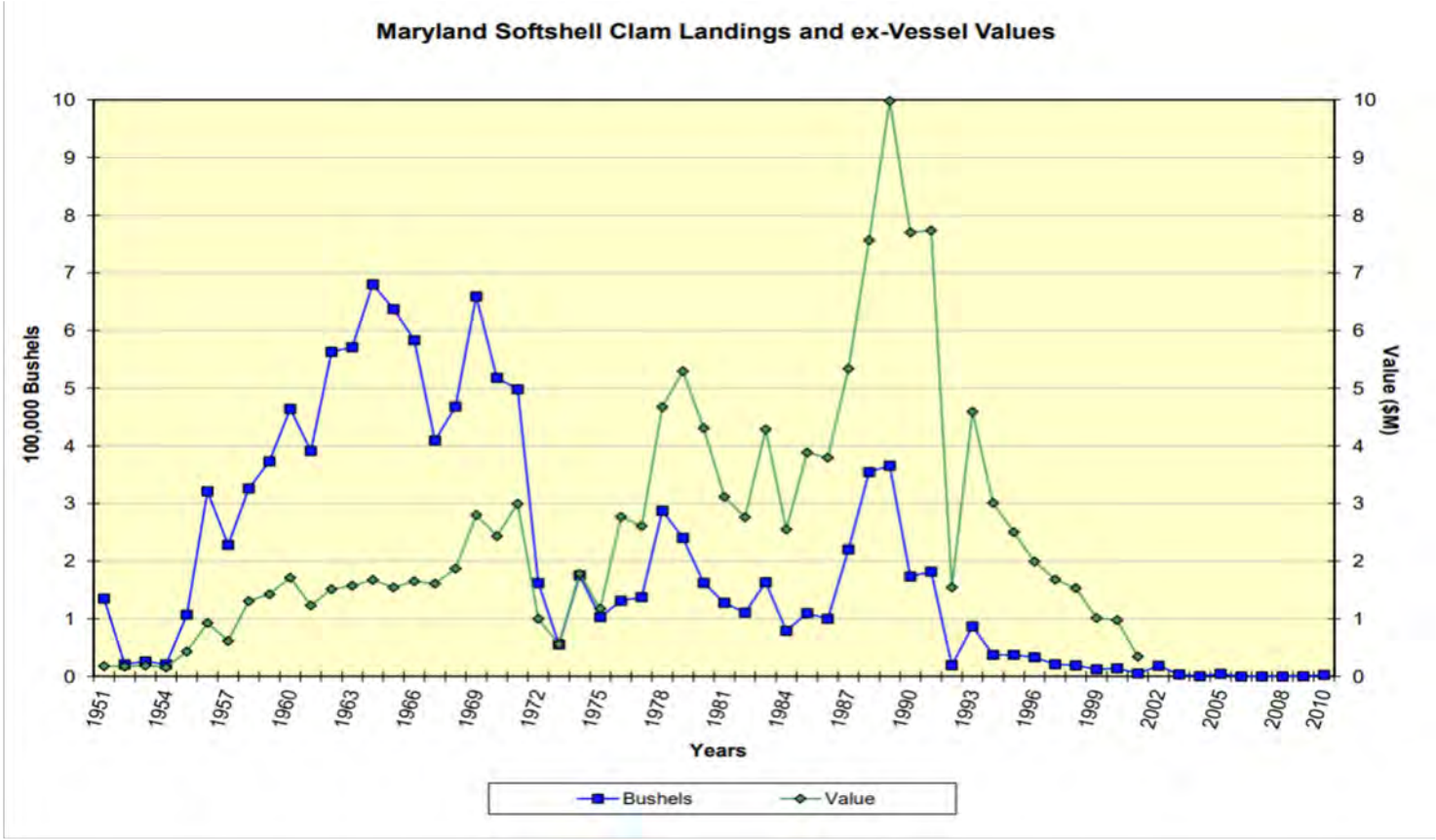
Common names:
Soft Shell Clams
and/or Steamers

Distribution:
Maine to Virginia

Economic Value

- $5-10 million annual industry in Maine (Beal, 2002)
- In 2019, the industry was valued at 54 million dollars with wholesalers, distributors, and others (Downeast Institute, 2020)

History in Maryland



Number of bushels and value of Soft Shell Clams in Maryland from 1951-2010

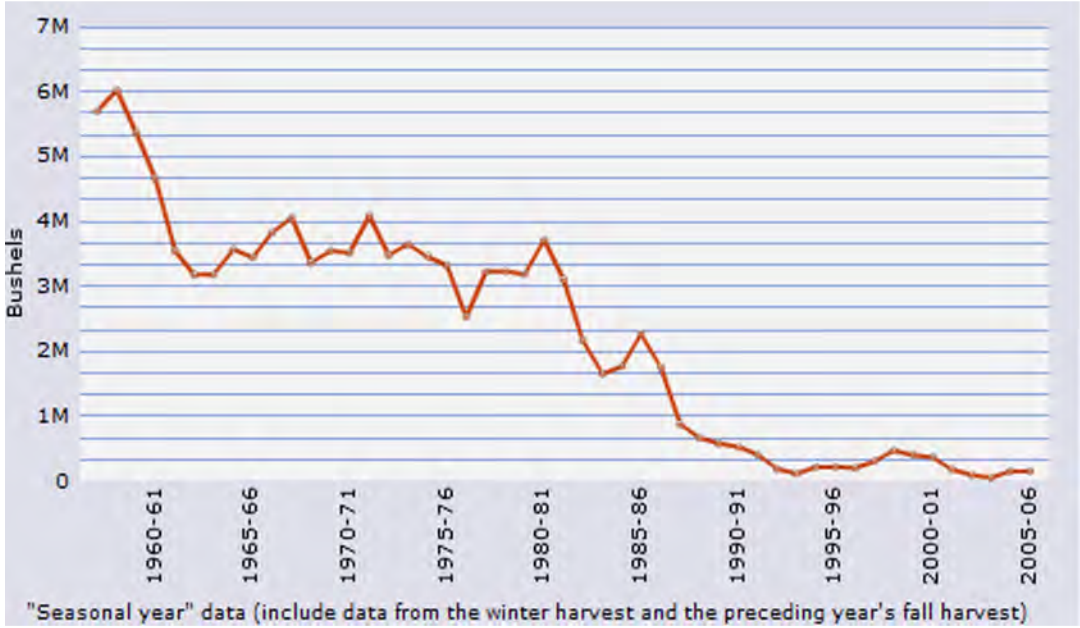
Potential for Maryland Aquaculture

Main species harvested/caught in the Chesapeake Bay are:

Oysters, Blue crabs, Atlantic Menhaden, etc. (Chesapeake Bay Foundation)

Soft Shell Clam Benefits:

- Create a new species in aquaculture
- More tolerant and grow faster in low salinity conditions than oysters
- Reaches commercial size in two years or less (Baker and Mann, 1991)



Number of Bushels of Oysters in the Chesapeake Bay from 1960-2006. This population decline due to overharvesting, disease, and pollution.

Challenges for developing Soft Shell Clam Cultures in MD

1. Seed production
2. Culture method
3. Heat stress

Heat Stress

Can survive: -2C to 28C

Optimal temperature: 17C to 23C

Objectives

1. Achieve breeding success: successfully spawned juvenile clams in April and we now have ~468K
2. Improve heat tolerance
3. Selective breeding based on phenotypic and genotypic breeding methods for heat tolerance

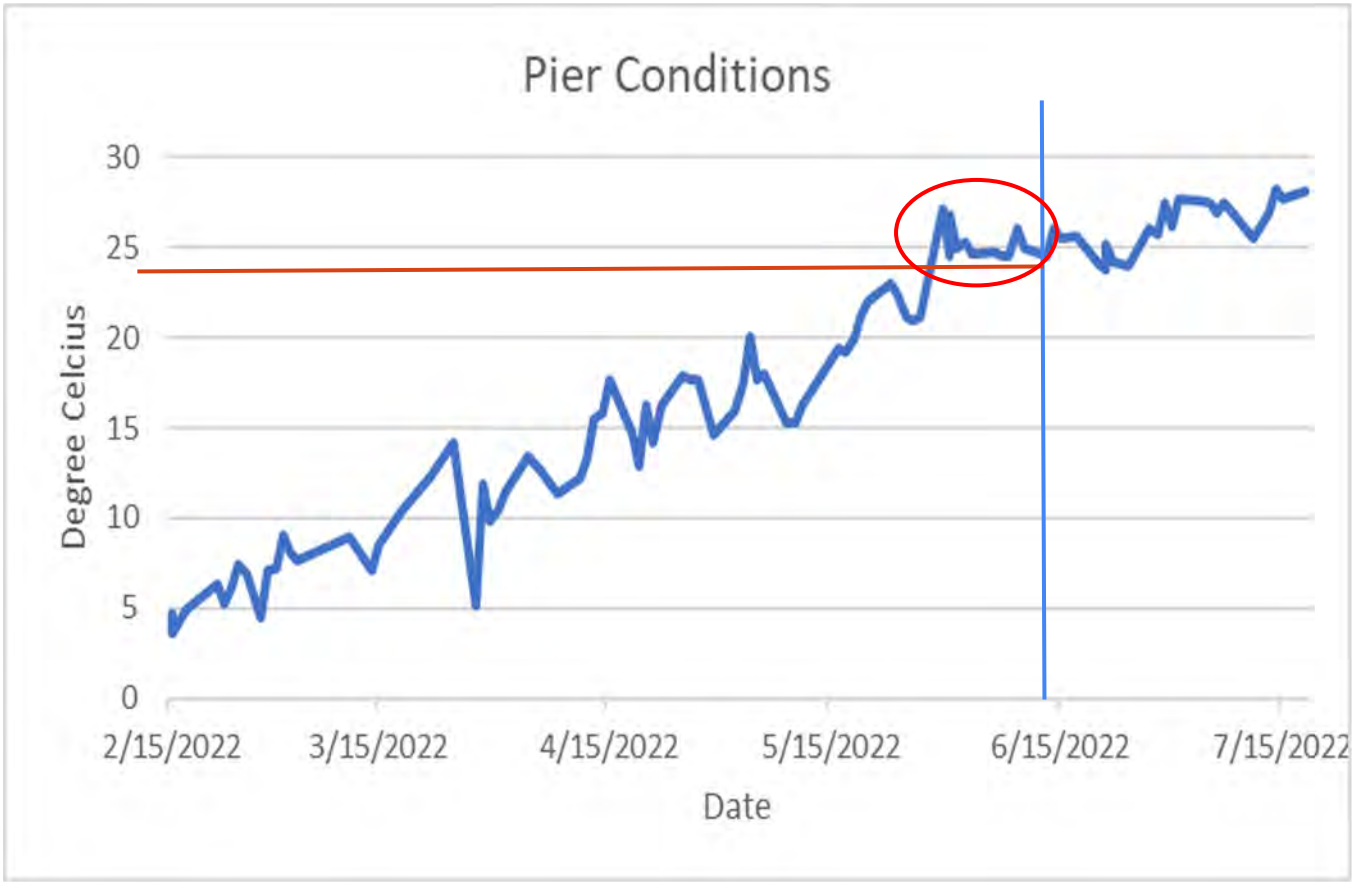
Methods

Selective Breeding Strategies

Phenotypic Approach

Genotypic Approach

Phenotypic Approach



Original Plan:
Compare 600 adult and juvenile

However, pier conditions spiked over the 17-23C optimal temperature before they were taken to the lab

Remaining number:

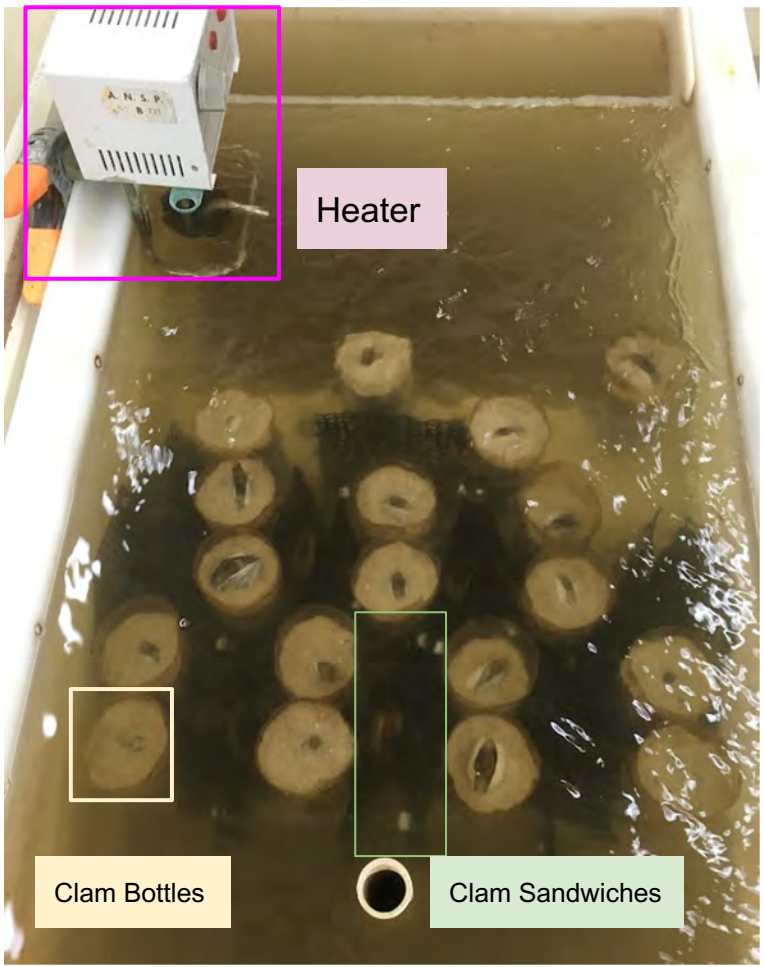
~75 adults
~150 juvenile

Genotypic Approach

Heat shock treatment	RNA sequence	Identify heat shock genes	Identify Markers on Genes	Marker associated selection
Heat shock a smaller amount of clams and sample the alive clams.	Prepare the rna from the gills to send to a lab to be sequenced.	Receive sequence from lab and identify genes upregulated or downregulated. Validate these genes using RT PCR. Also, compare gene expression in different organs.	Sequence top genes from heat shock or use target region sequencing to find markers of desired genes.	Use the markers to select clams to breed

Results

For each BS tank:
18 clams bottles
18 sandwiches



BS tank#1: Control ~19-23C

BS tank #2: Heat Stress ~30C

Bottle vs. Sandwich Debate

For Bottle:

- Sand could insulate and protect from challenging conditions
- Mimics the natural environment
- Prevents overcrowding
- Protects against accidents better

For Sandwich:

- Easier to setup and maintain
- Less prep work
- Can hold a higher density of clams in one place
- Do not have to deal with anoxic sand

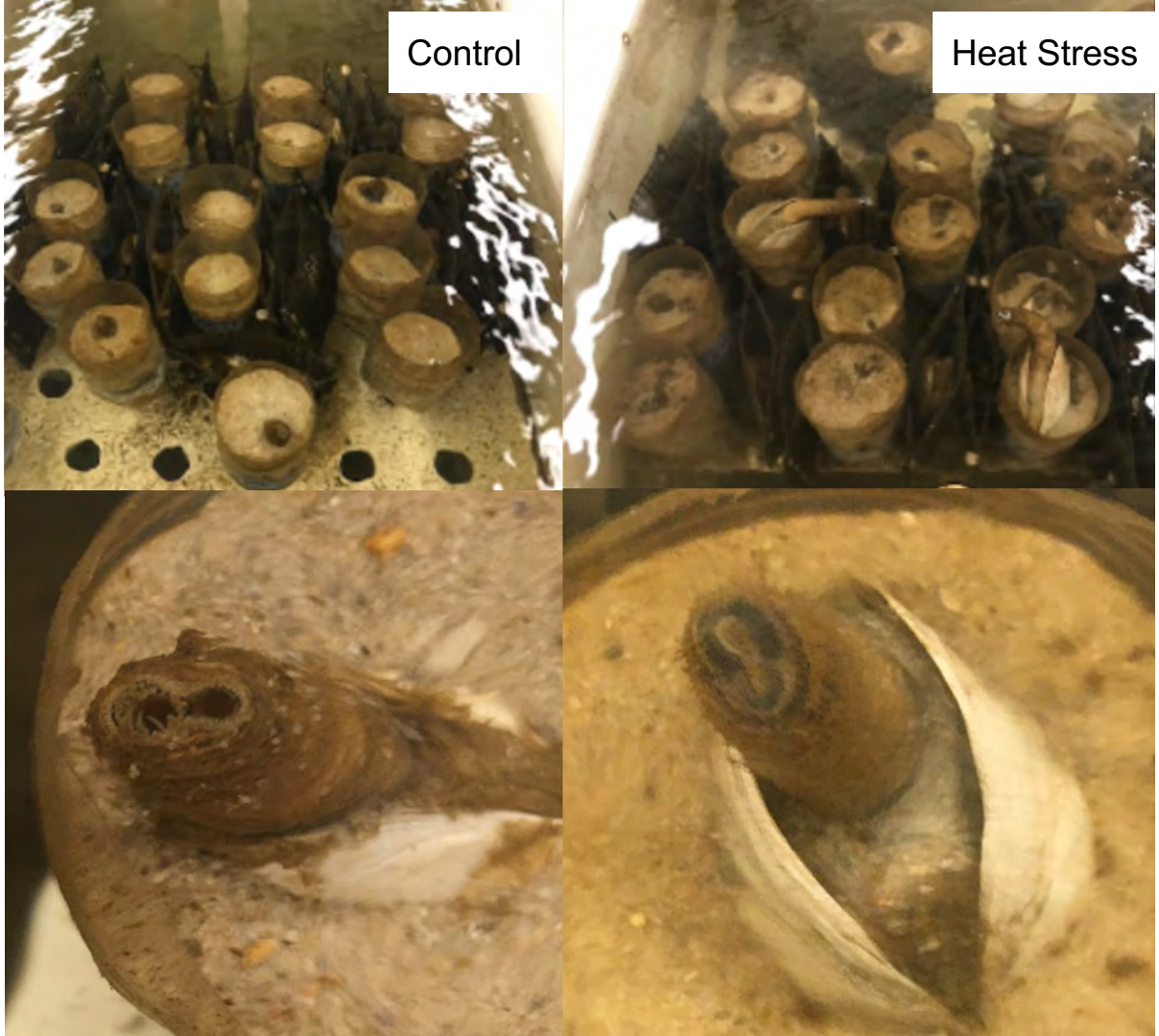
Observations

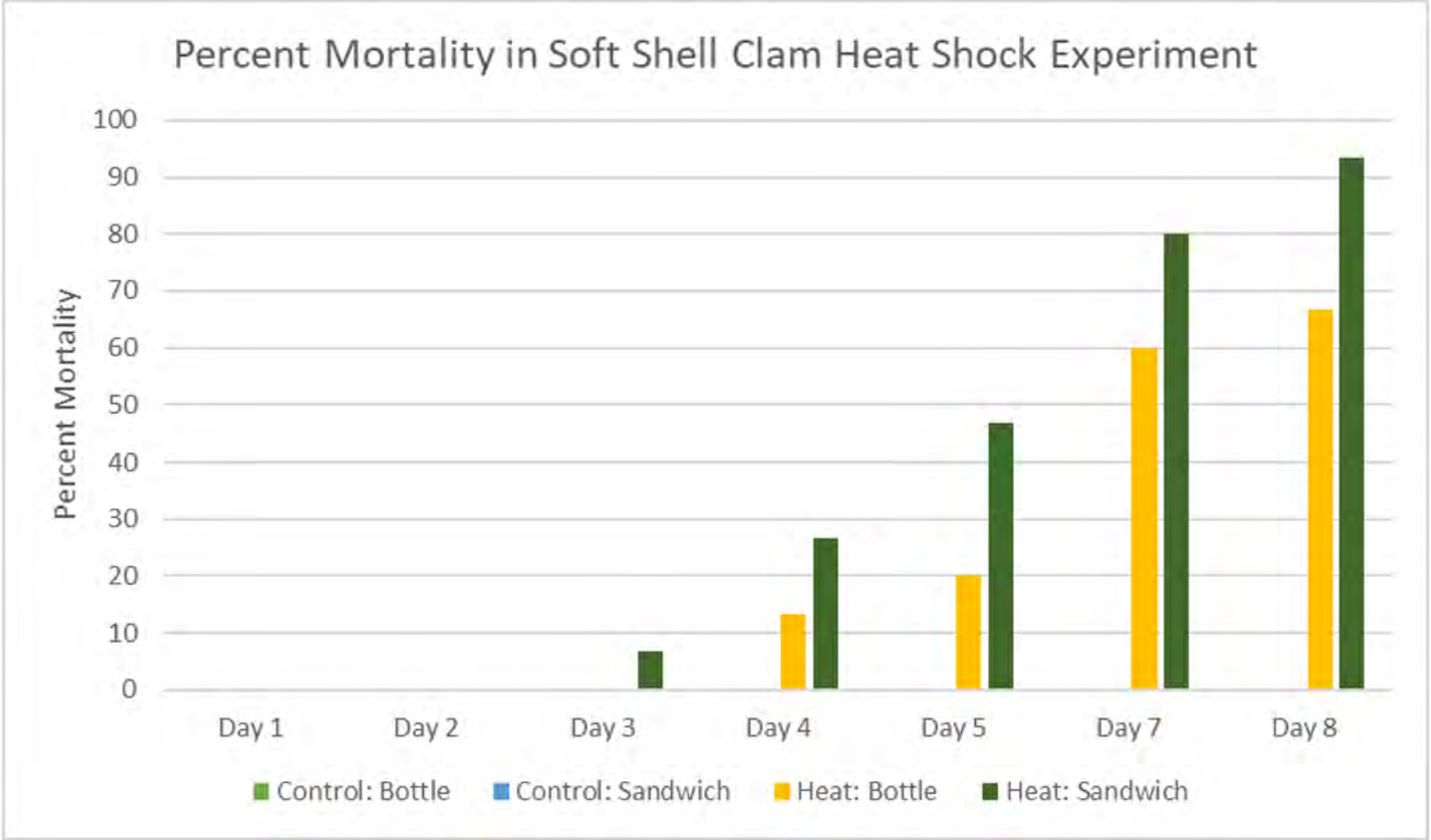
In Heat Stress Conditions:

1. More siphons were extended

1. Siphons were partially closed in most

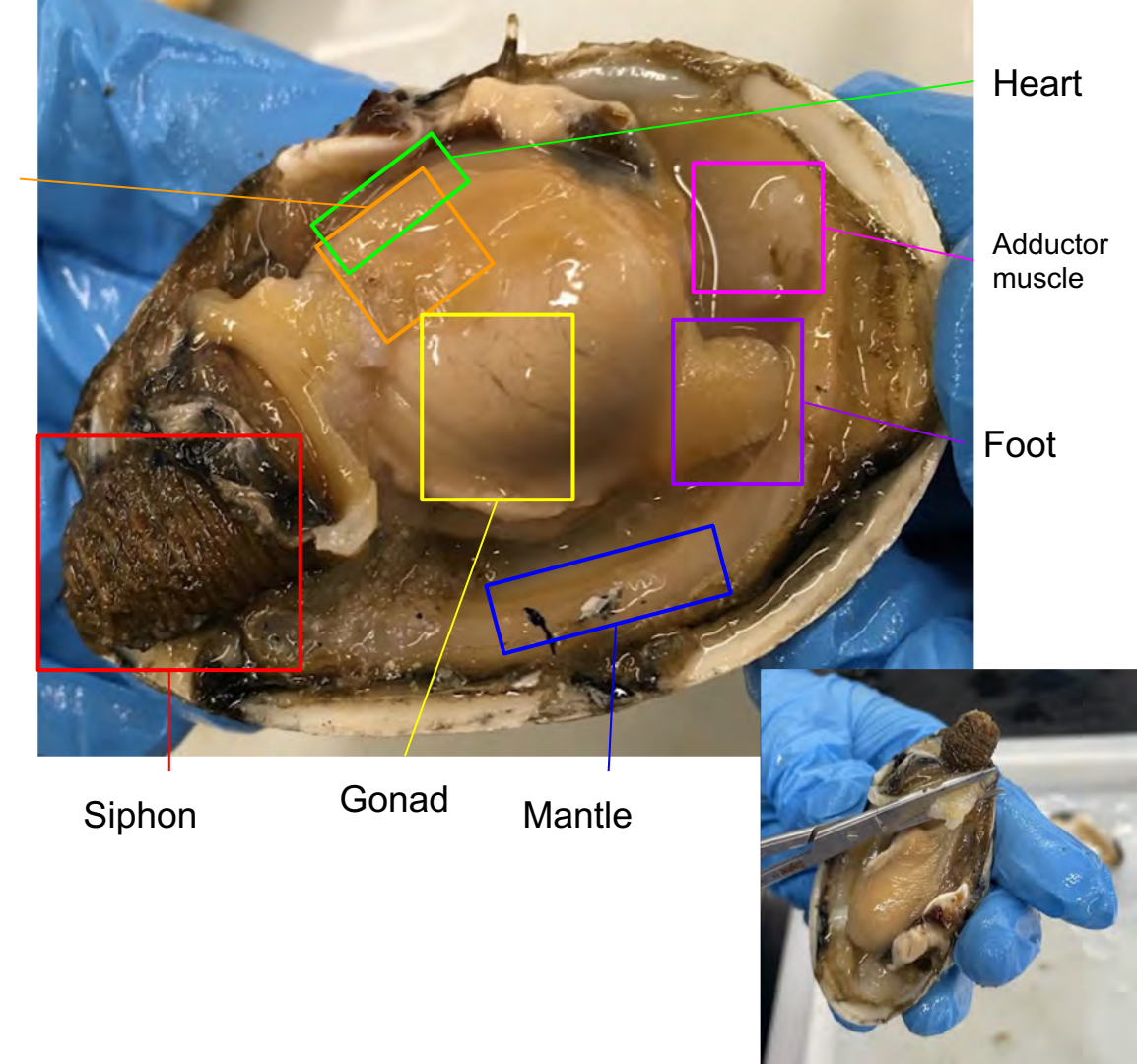
1. Siphons responded slower to proding

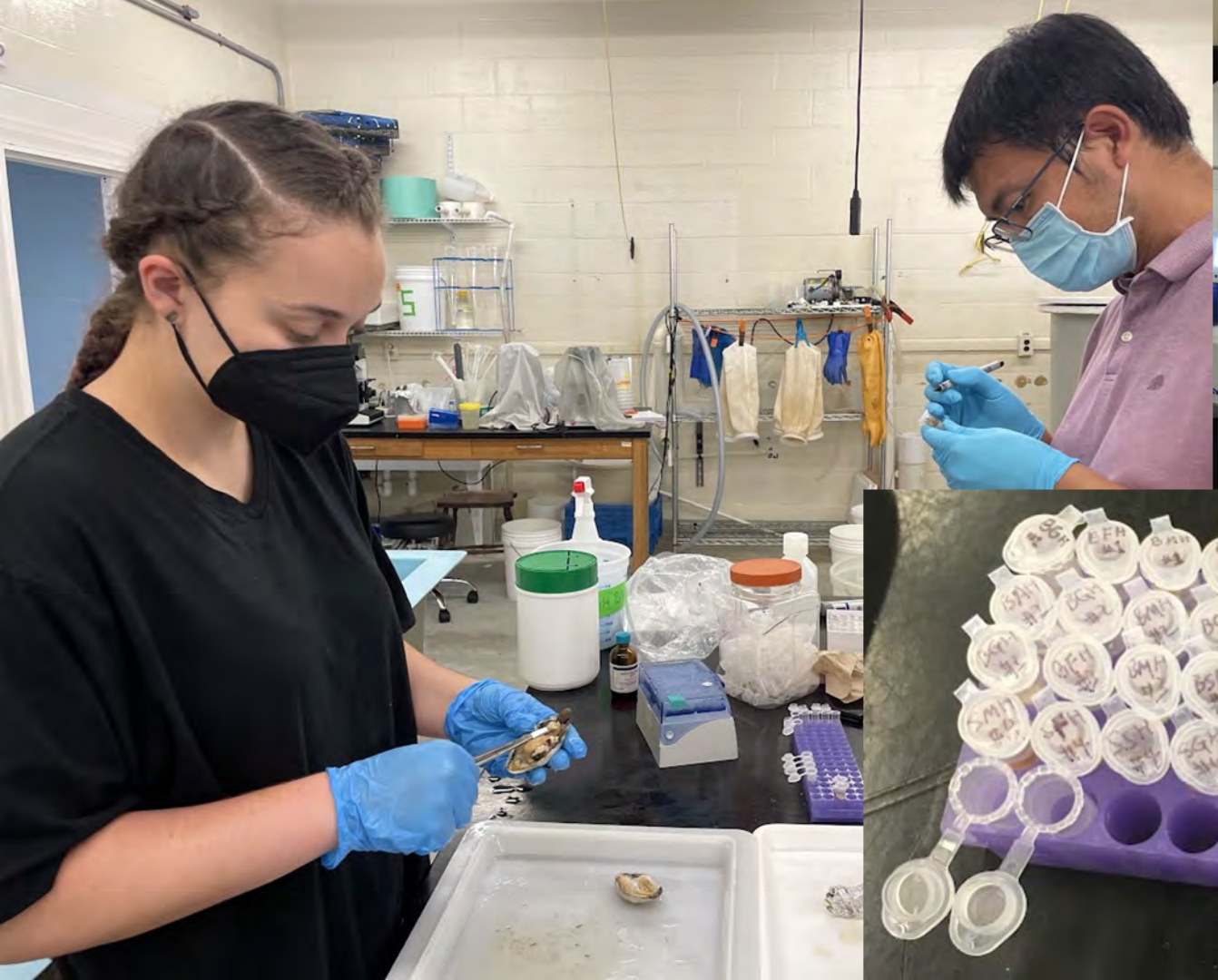



Percent Mortality in Soft Shell Clam Heat Shock Experiment
Percent Mortality
100
90
80
70
60
50
40
30
20
10
0
Day 1
Day 2
Day 3
Day 4
Day 5
Day 7
Day 8
Control: Bottle
Control: Sandwich
Heat: Bottle
Heat: Sandwich

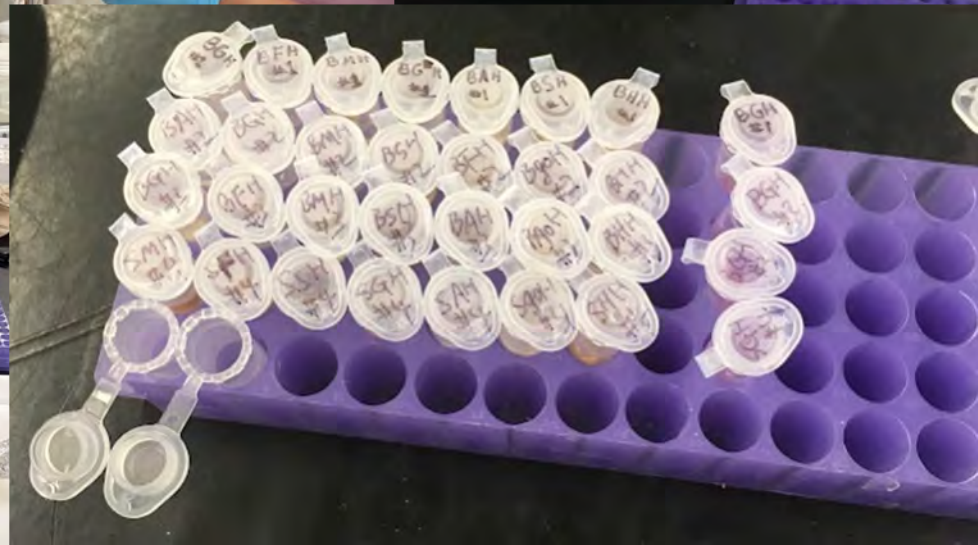
Sampling

- First death on 7/27/22
- Sampled 3 live clams from each group (total of 12 samples)
- **For Real Time PCR:** took samples from each gill, heart, adductor muscle, foot, mantle, gonad, and siphon
- **For RNA sequencing:** repeated gill samples






Centrifuge 5425



Conclusion

- **In Heat Stress:** more clams in sandwiches died
- **In Control:** no clams died, so both methods worked

Future Steps

Selective Breeding:

1. Send gills samples to lab to be RNA sequenced
2. Find these candidate genes and validate them using RT-PCR
3. Perform another heat shock with the 600 clams for phenotypic breeding strategy
4. Sequence the genes from phenotypic breeding group and their genetic markers
5. Use this data to spawn best individuals and run trials on those offspring

***Also continue research on Bottle vs. Sandwich**

Acknowledgements

Maryland Sea Grant: Diversification of Maryland Shellfish Aquaculture

Development and Assessment of a Subtidal Grow-out and Method for Culture of Soft-shell Clams (Mya arenaria)

Morgan State University OTT I-GAP grant: Develop heat-tolerant soft-shell clams

Citations

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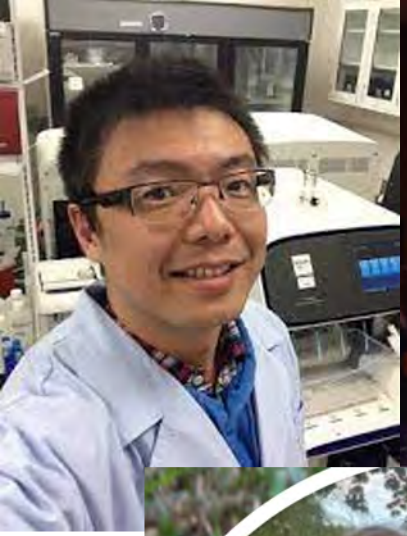

Questions?

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