SCHOOL OF FOREST, FISHERIES, AND GEOMATICS SCIENCES

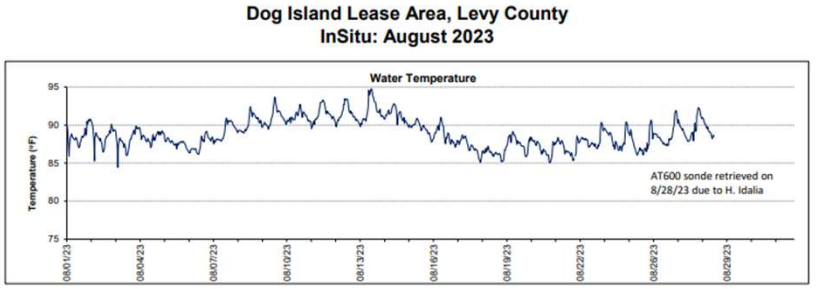
Breathless Bivalves:

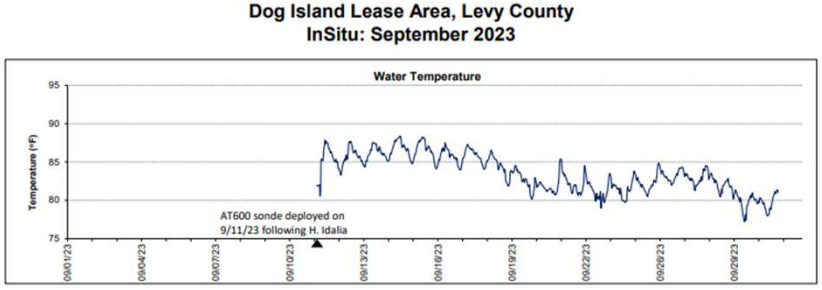
The Physiology Behind Summer Stress

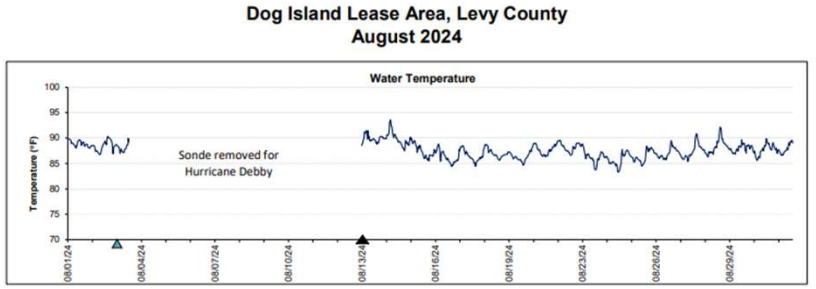
Shirley Baker, Fisheries and Aquatic Sciences

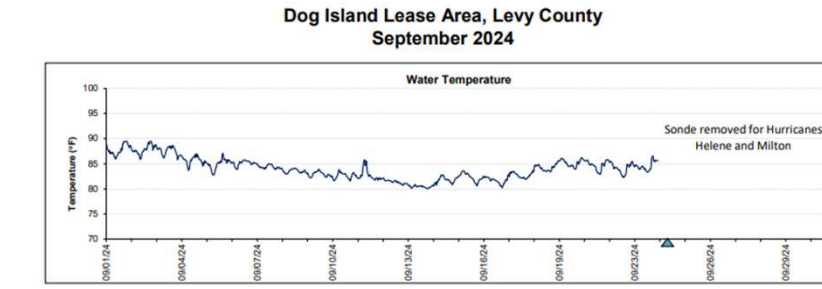
UF IFAS UNIVERSITY of FLORIDA

Hot Water, Hard Hits



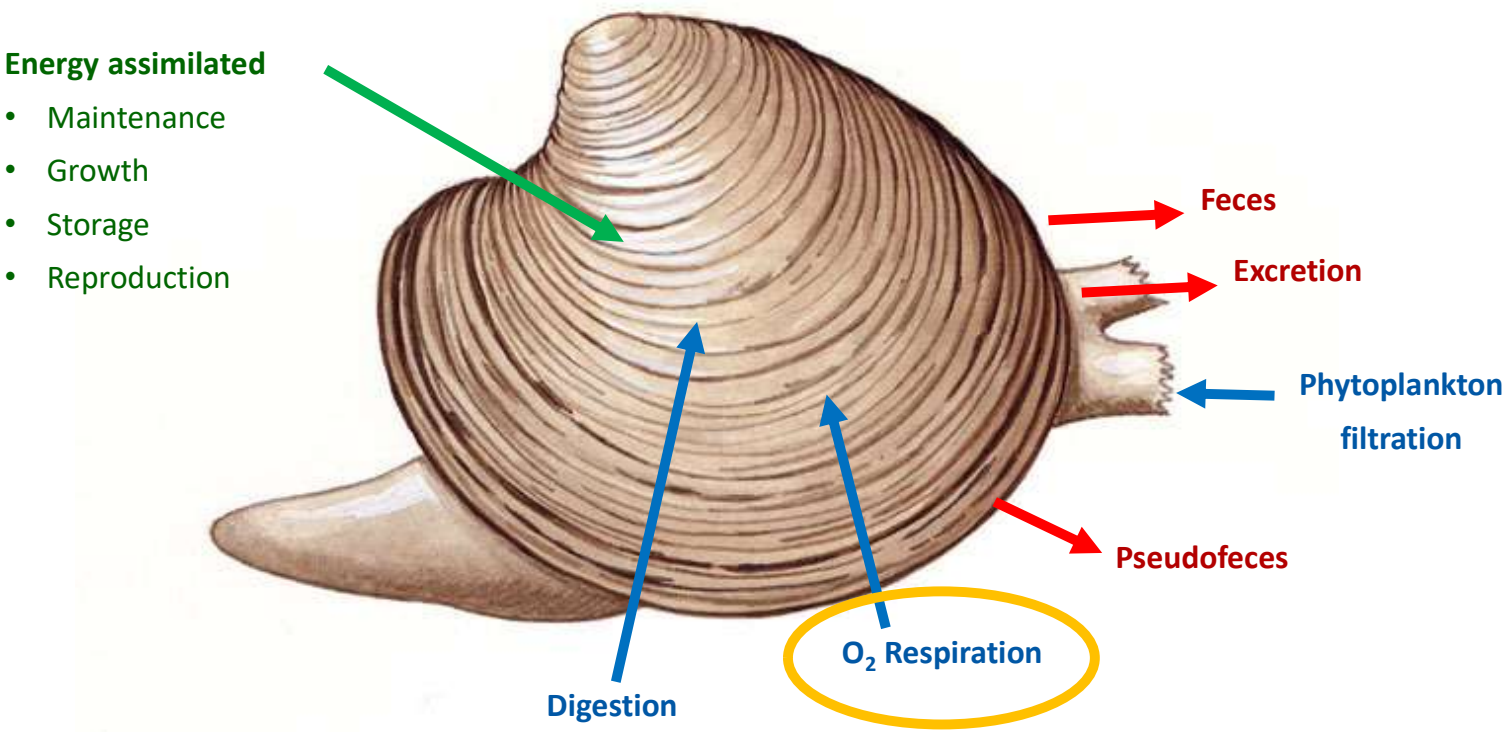






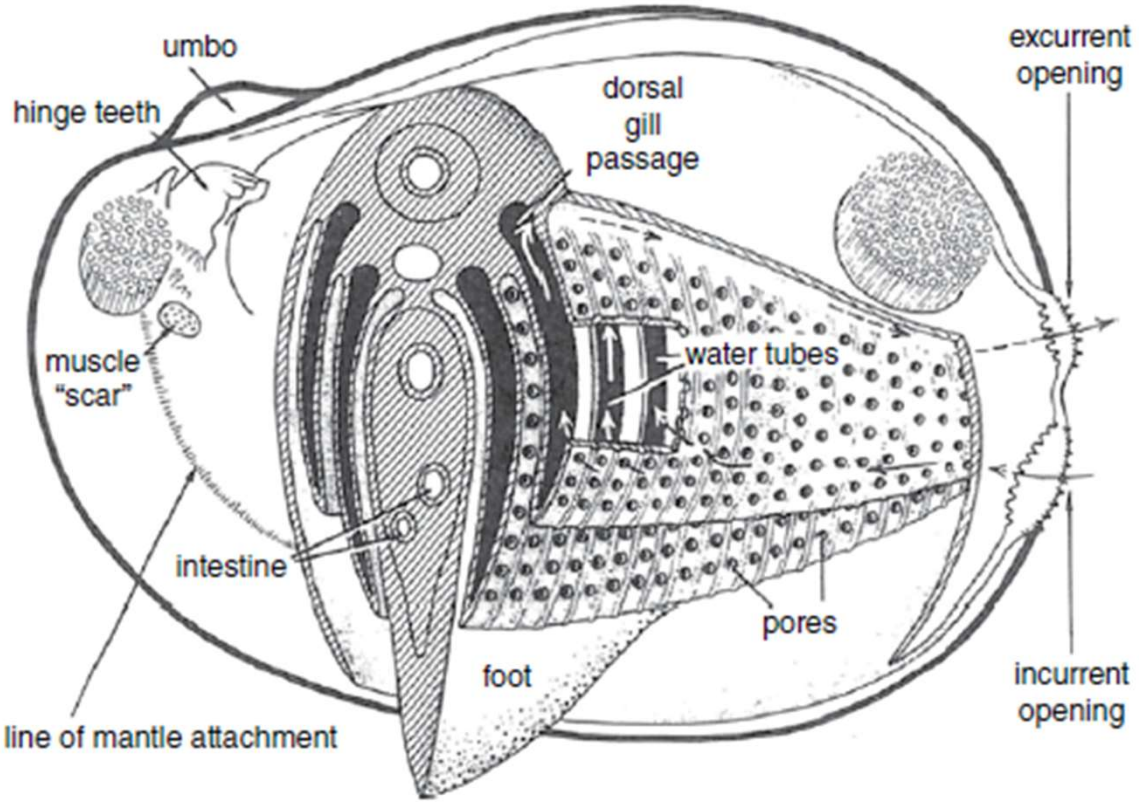
Warm water means clams have to work harder

How clams spend their energy



Clam Basics: How They Breathe

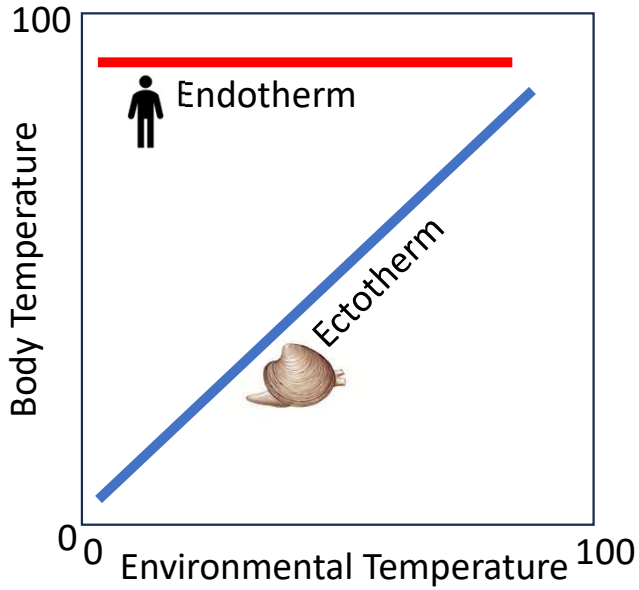
- Gills
- Open circulatory system

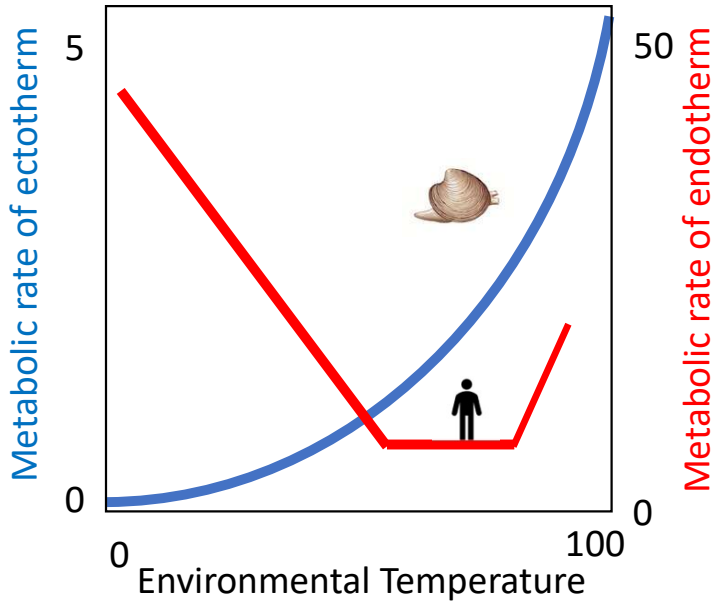


Pearse et al., 1987

Clams are Ectotherms: Why Temperature Matters

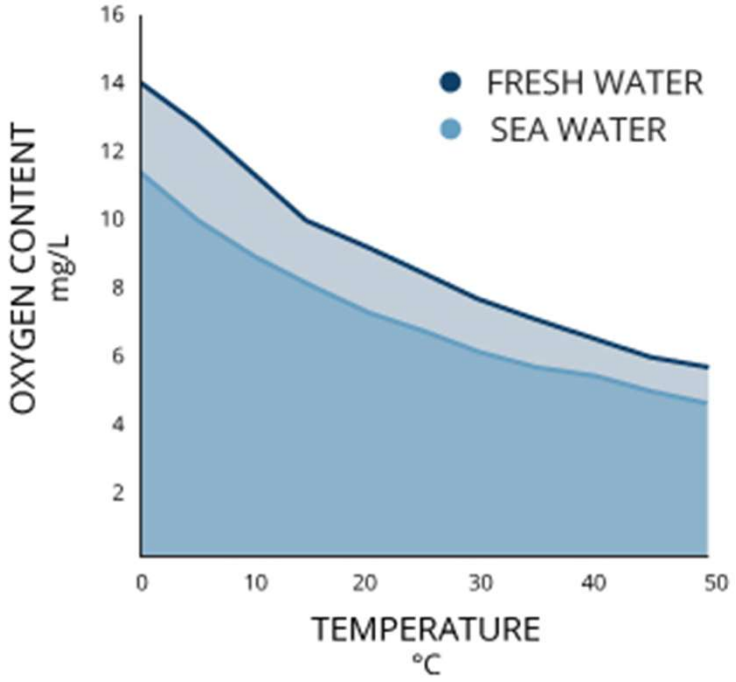
- **Ectotherms**
  - Clams don't make their own heat – their bodies match the environment
- **Why it matters:**
  - Metabolism, behavior, and survival tightly linked to water temperature
  - Small increases in temperature alter physiological function

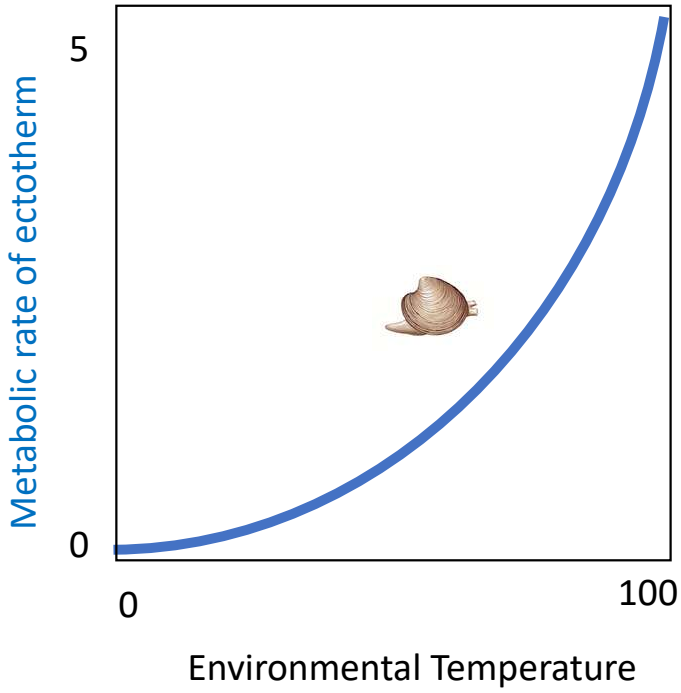




Warm Temperature - Low Oxygen: Dangerous Duo

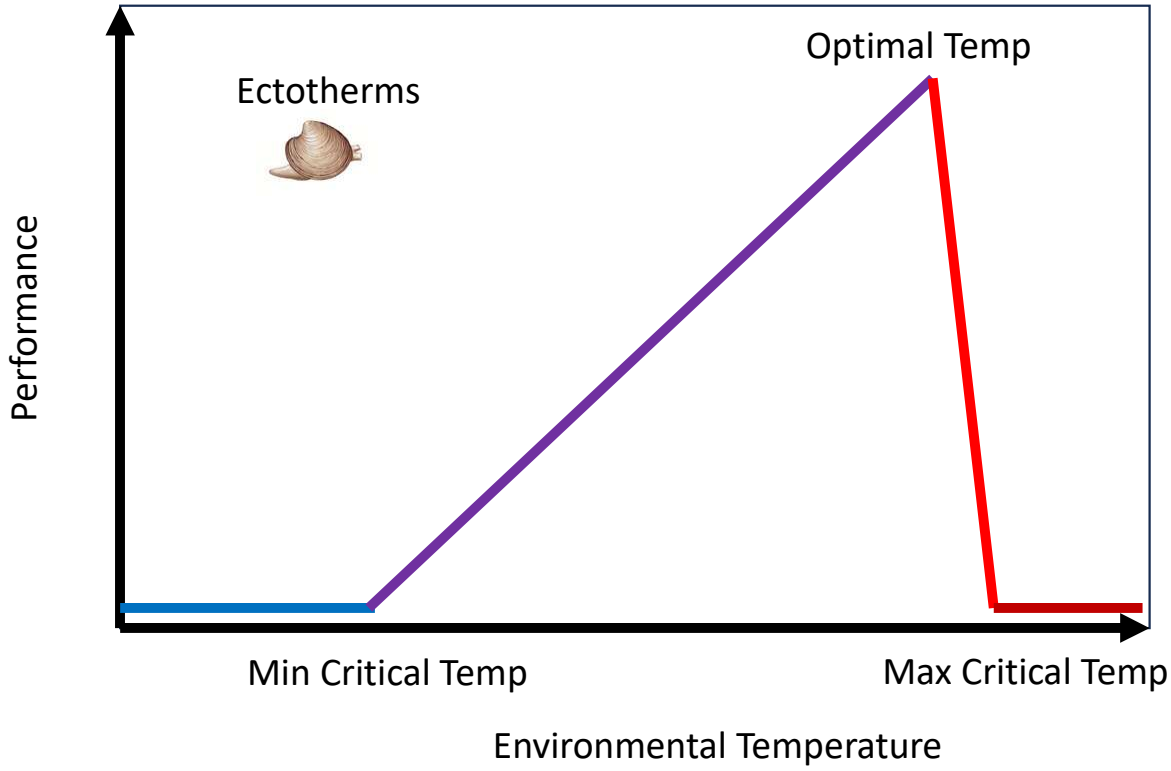
- As water warms:
  - Oxygen drops
  - Clam metabolism increases
- Greater need for oxygen at the same time there is less
- Stress, reduced growth





Damage Becomes Deadly

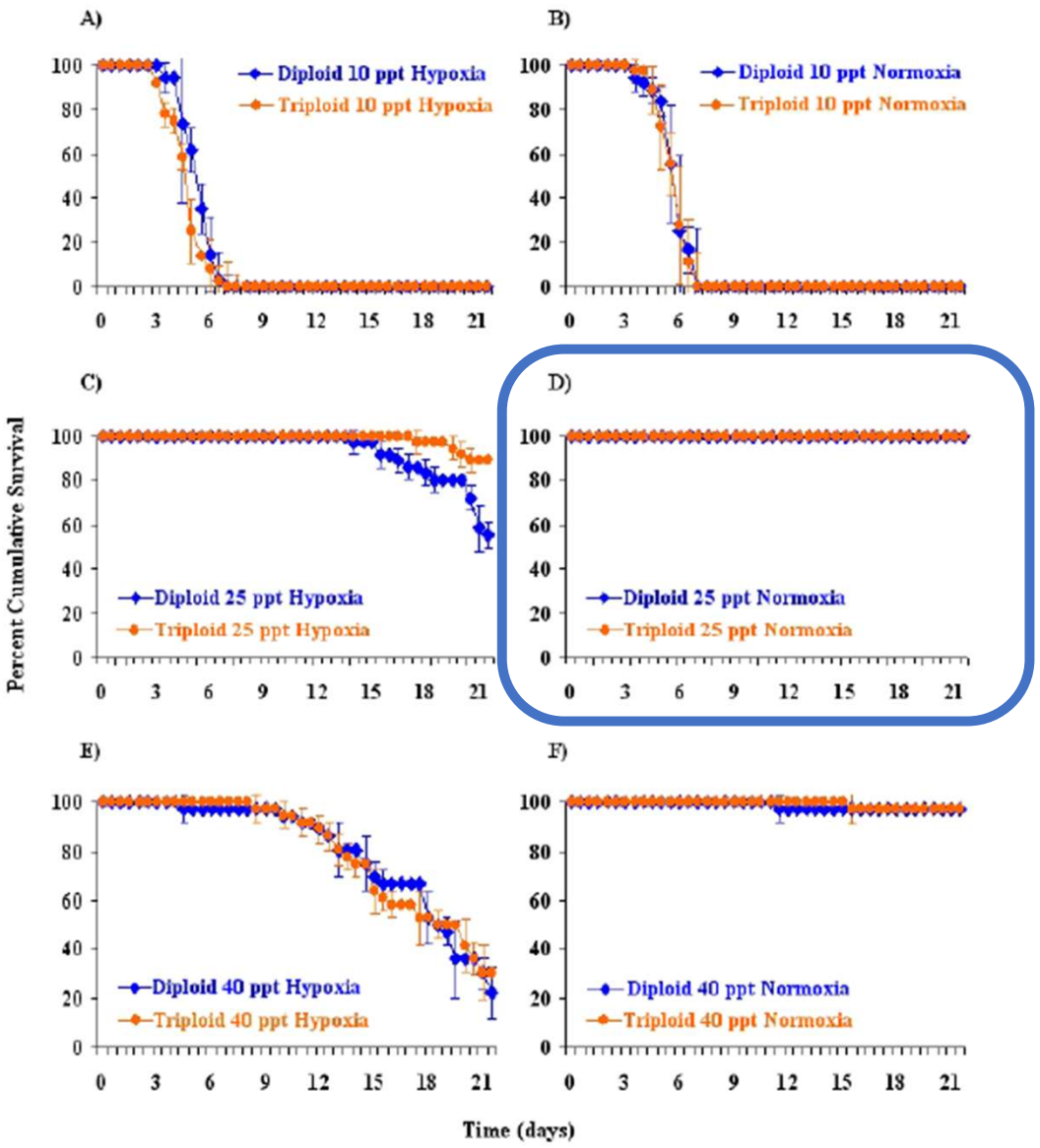
- Extreme temperatures
  - Proteins and enzymes unravel
  - Can't repair fast enough
  - Wastes build up
  - Use stored energy to survive



Older Experiments Didn’t Exceed 89°F

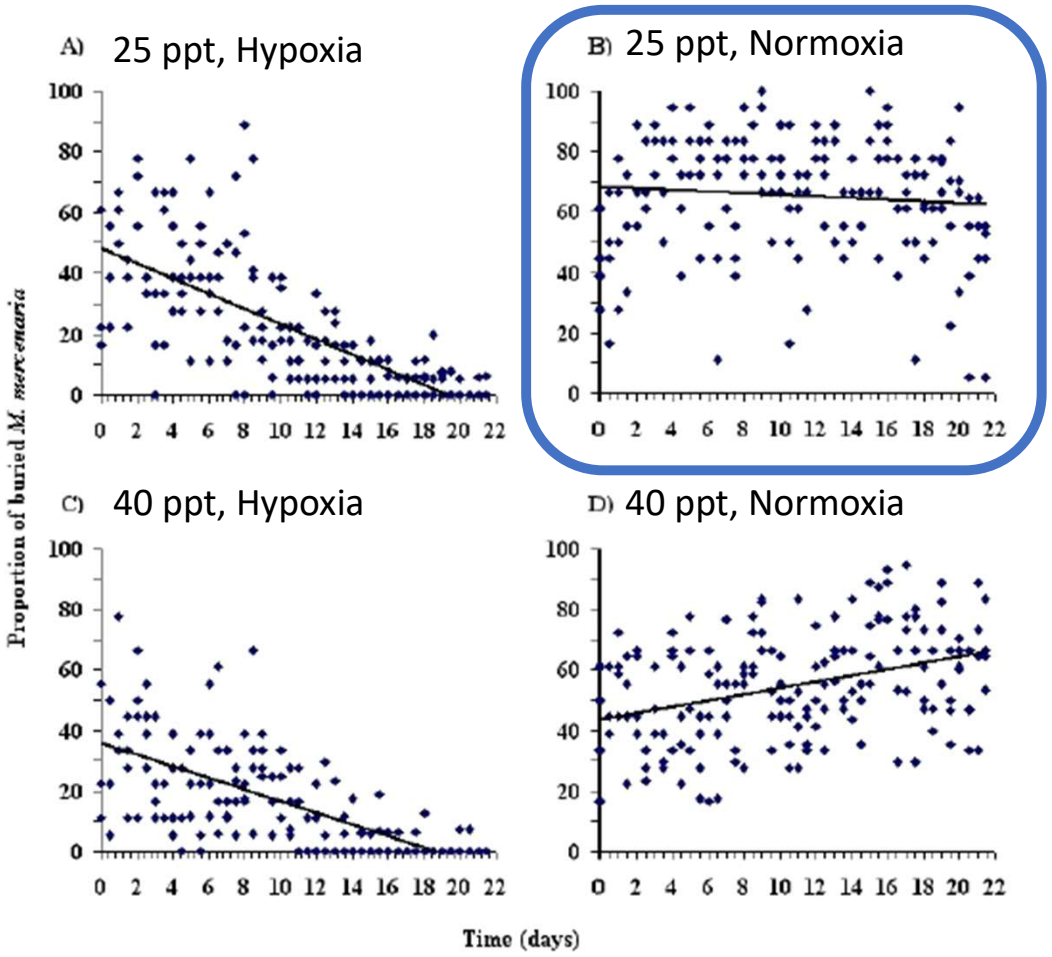
Clam Survival at 89°F

Hoover, 2007



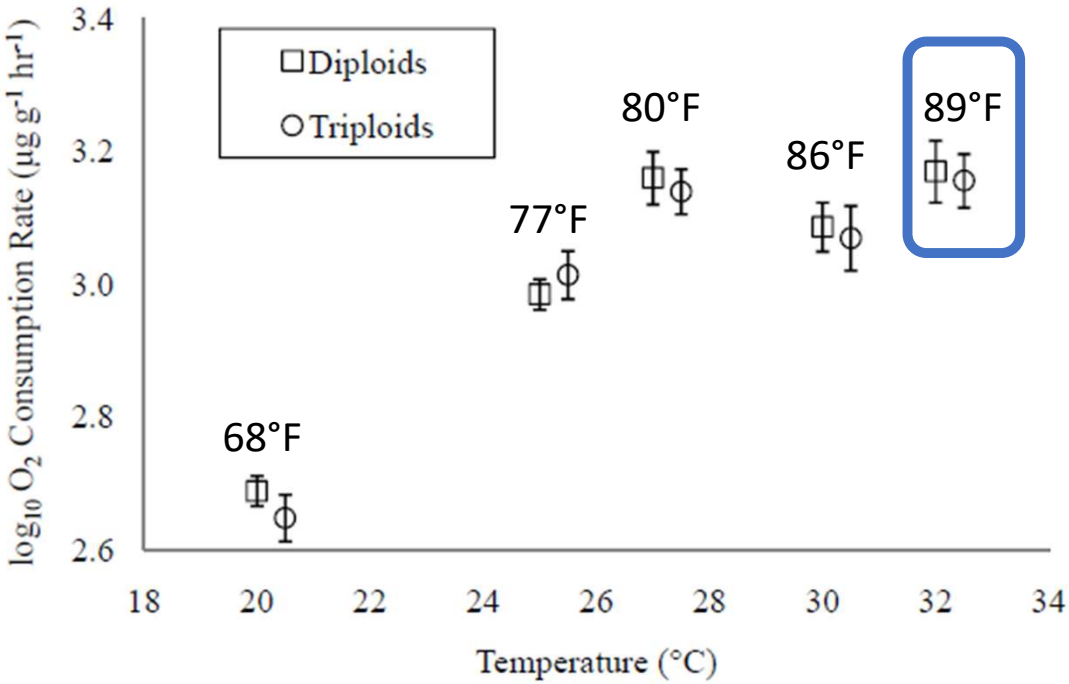
Burial Behavior: Salinity x Oxygen Interactions at 89°F

Hoover, 2007

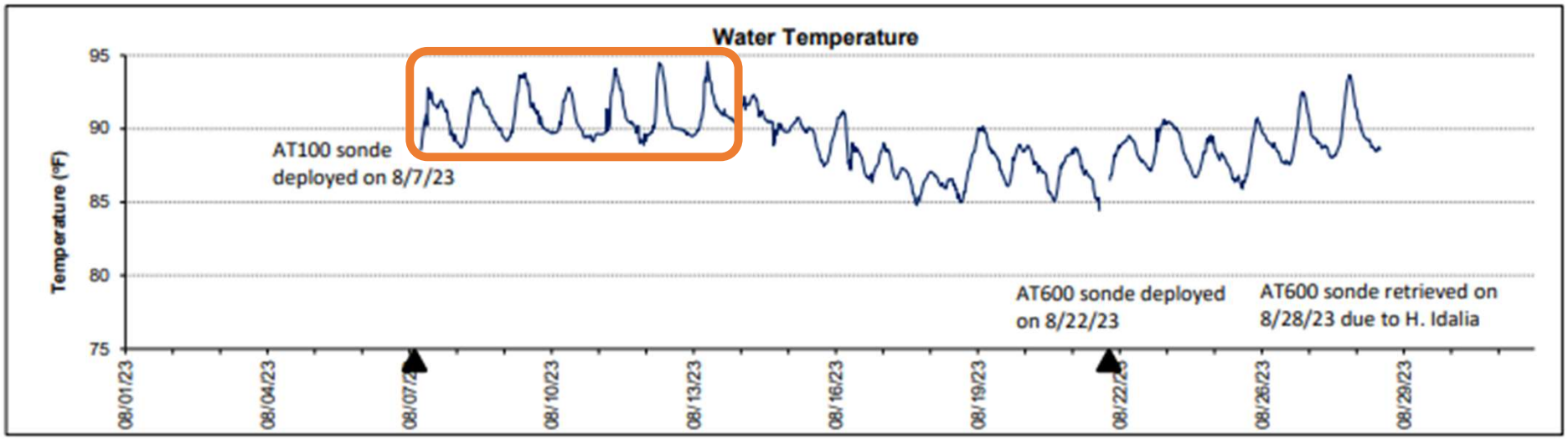


Oxygen Uptake

Weber, 2008

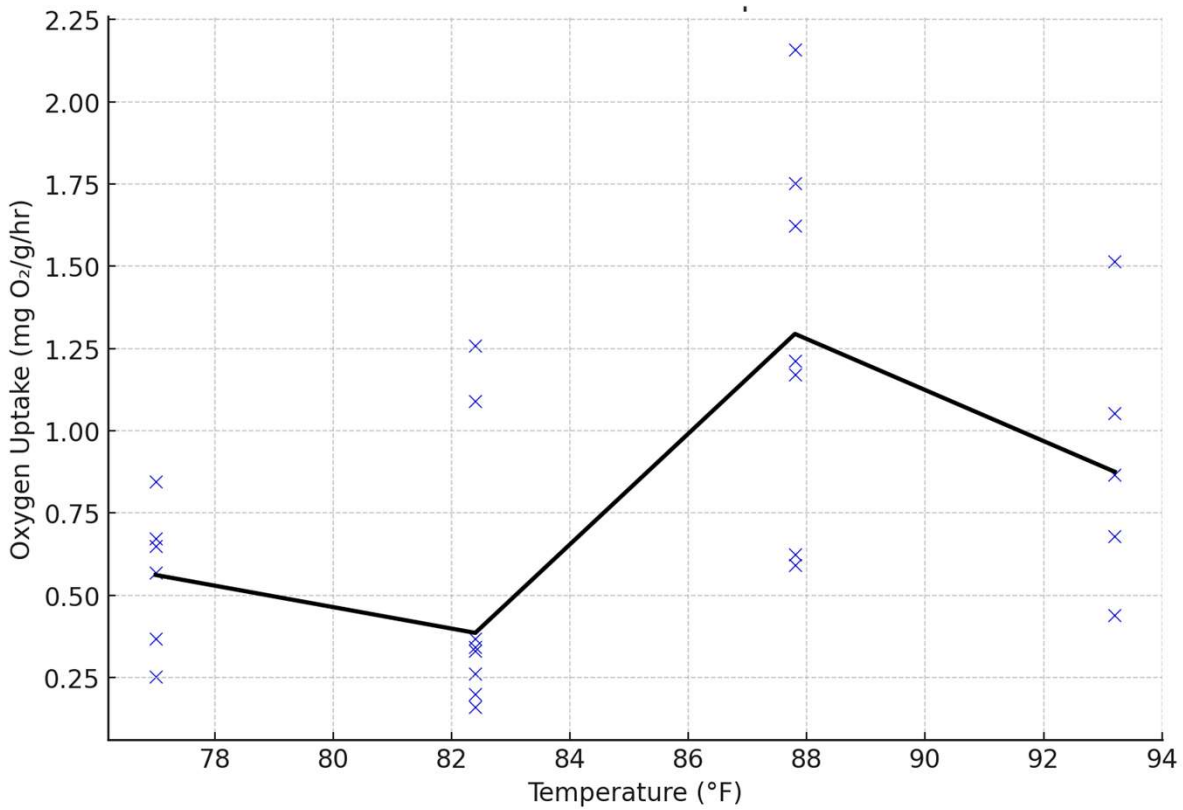


Gulf Jackson Lease Area, Levy County
InSitu: August 2023



Clam Oxygen Uptake

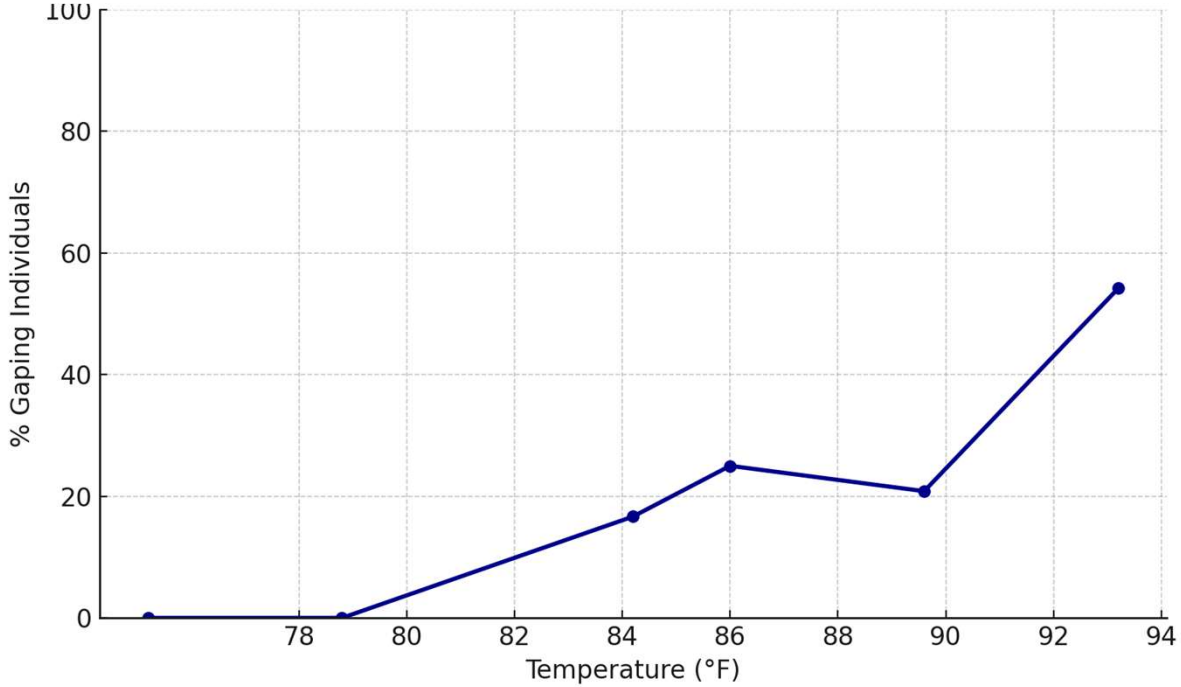
- Oxygen uptake peaks at 88°F
- Greater variability at 88°F
  - Some clams performing well
  - Others approaching physiological limits
- Reduced uptake at 93°F
  - Thermal stress
  - Breakdown of normal function



Clam Behavior

- Stress response
  - Gaping
  - Highly extended siphons
  - Slow reaction to stimuli
- Implications
  - Increased vulnerability to predators and pathogens
  - Impaired feeding
  - Early-warning of mortality

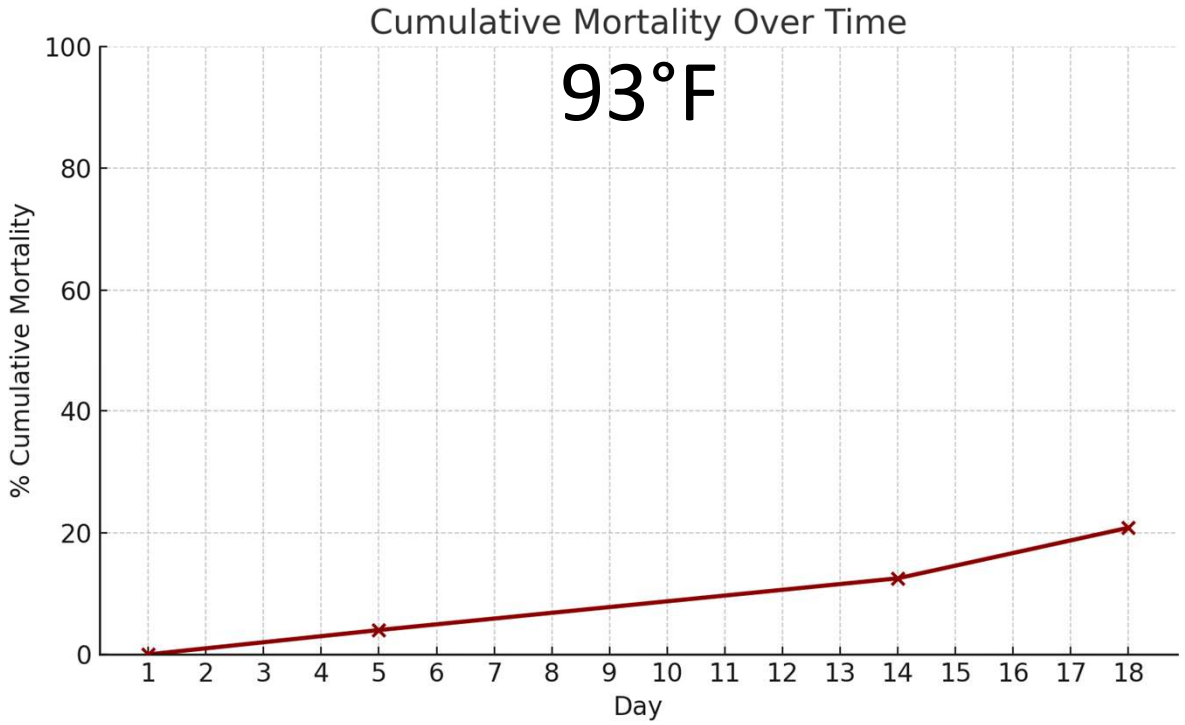
At 93°F, > 50% of clams exhibit abnormal behavior



Clam Mortality

- No immediate lethal effects
- Delayed but significant impact of chronic heat

- 93°F is above thermal optimum; extended exposure leads to increasing mortality risk



Clam responses

Metabolic Performance

- Oxygen uptake peaks near 88°F, then declines at 93°F
- Suggests thermal stress limits metabolic capacity
- High individual variation indicates differential tolerance

Behavioral Stress

- Gaping behavior increases sharply above 90°F
- Over 50% of clams gape at 93°F, signaling acute stress

Cumulative mortality

- > 20% by Day 18 at 93°F
- Delayed mortality shows cumulative effects of chronic heat exposure
- Clams can cope, but long-term survival is compromised

Overall Takeaway

93°C is a physiological tipping point

Metabolic, behavioral, and survival data align to show progressive breakdown under thermal stress

Future Research?

What will contribute to possible management practices?

Recovery After Heat Exposure

- **Goal:** Assess whether clams can recover from temporary exposure
  Measure: Survival, gaping, and oxygen uptake during recovery
- **Why:** Whether heat stress effects are reversible or cause lasting damage

Compare Selected Clam Lines

- **Goal:** Test thermally selected clams
  Measure: Mortality, behavior, metabolic performance
- **Why:** Evaluate lines for resilience traits

Individual Monitoring

- **Goal:** Link behavioral and physiological traits to survival on an individual level
  Measure: Repeatedly track individuals' oxygen uptake and gaping behavior
- **Why:** Identify predictors of mortality and resilience

Multi-Stressor Experiments

- **Goal:** Simulate more realistic environmental challenges (e.g., heat + low salinity)
  Measure: Survival, gaping, and oxygen uptake
- **Why:** Test for interacting effects of stress tolerance

SCHOOL OF FOREST, FISHERIES, AND GEOMATICS SCIENCES

Shirley Baker
sbaker25@ufl.edu
Office: 352-273-3627
Cell: 352-213-3808

UF IFAS UNIVERSITY of FLORIDA