Comparing the performance of diploid and triploid blue mussel (*Mytilus edulis*) larvae reared at constant and fluctuating temperatures

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INTRODUCTION

As anthropogenic climate change alters our ocean environment, a need to enhance hatchery-produced mussel seed is critical to sustain the aquaculture industry[1,2] and ensure sustainable food production[3]

Triploidy in Blue Mussels

Favoured due to	Disadvantaged because of
Effective sterility[4,5]	Lower upper thermal tolerance[5,6]
Increased growth rates[5]	Yet to be commercialized in North America
Higher meat yields[5]	Limited hatchery production knowledge

- Ectotherms exhibit natural intraspecific variation across geographic regions[7,8] due to either **local adaptation**[9,10] or **developmental phenotypic plasticity**[9]
- **Carryover effect -** early life thermal stress may enhance thermal tolerance later in life[8]
- Adult mussels from Sober Island Pond, NS, demonstrate > thermal tolerance compared to those from St. Peters, PE[11]

OBJECTIVES

To assess the performance (growth and survival) of blue mussel larvae across three factors:

1) **ploidy** - diploid vs. triploid
2) **temperature regime** - constant vs. fluctuating
3) **source** - NS vs. PE

HYPOTHESES

Ploidy: triploids survival ↓ particularly under thermal stress[6], but achieve ↑ shell length by the end of the experiment[4]

Temperature: larvae under constant temperature regimes will have ↓ survival and growth than fluctuating regimes[10]

Source: NS larvae will have survival and mean length > PE larvae[11,12]

METHODS

Spawning & Pressure Shock

- Induced spawning of NS and PE mussels by **heat shock method**[13]
- Triploid groups subject to **8000 PSI for 6 min, 18 min post-fertilization**[14]

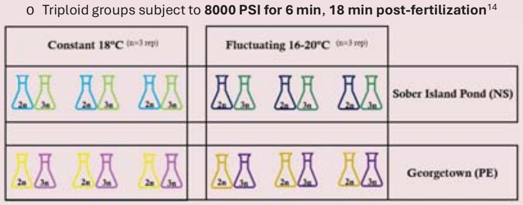

Figure 1. Factorial design of source (NS vs. PE), ploidy (diploid vs. triploid), and temperature regime (constant 18 °C vs. fluctuating 16-20 °C) with half-sibling families included in triplicate per treatment.

Larval Husbandry

- Fed daily after D-stage metamorphosis using a target algae cell concentration
- Flask water changed, growth and survival of larvae assessed every other day

Survival and Growth Assessments

Ploidy Determination

- Flow cytometry conducted at 8 and 20/22 days post-fertilization to determine percentage of triploids

Statistics Analysis

- Bayesian models

RESULTS

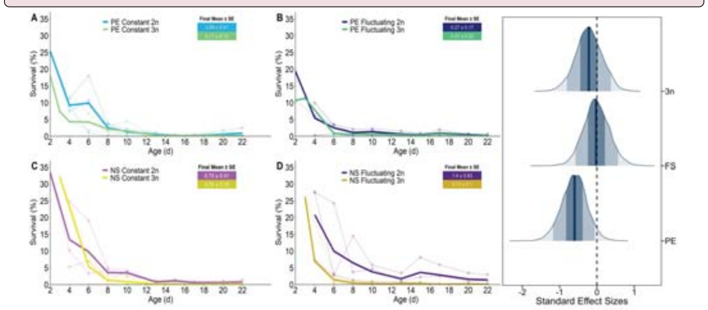

Figure 2. Effect of ploidy, temperature regime, and source on the survival of *Mytilus edulis* larvae from 2 to 22 days post-fertilization. Line graphs show the survival of diploid and triploid larvae from Prince Edward Island at a constant temperature of 18 °C (A) and a fluctuating temperature of 16–20 °C (B), as well as for larvae from Nova Scotia under the same constant (C) and fluctuating (D) temperature conditions. The Bayesian model on day 22 suggests a lower survival in triploids with moderate certainty (UI: 72.71%), a negligible effect of temperature regime on survival (UI: 52.35%), and lower survival of Prince Edward Island mussels, with high certainty (UI: 96.38%).

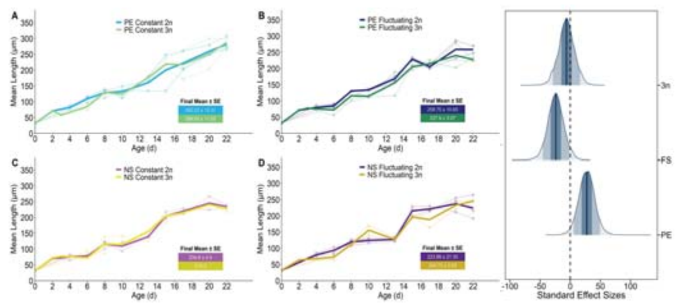

Figure 3. Effect of ploidy, temperature regime, and source on the mean length of *Mytilus edulis* larvae from 2 to 22 days post-fertilization. Line graphs show the mean length of diploid and triploid larvae from Prince Edward Island at a constant temperature of 18 °C (A) and a fluctuating temperature of 16–20 °C (B), as well as for larvae from Nova Scotia under the same constant (C) and fluctuating (D) temperature conditions. The Bayesian model of surviving families on day 22 indicates a lower mean length in triploids with a moderate certainty (UI: 69.19%), a lower mean length under fluctuating temperature with high certainty (UI: 95.96%), and a high certainty that PE larvae have a higher mean length (UI: 97.97%).

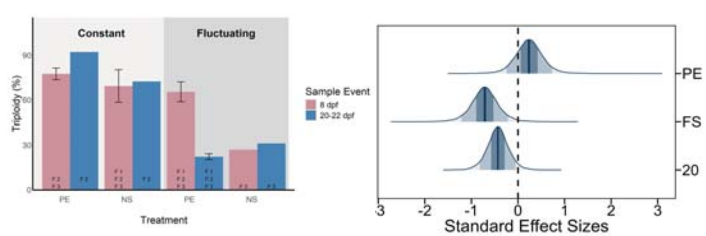

Figure 4. Percentage of triploid *Mytilus edulis* at 8 and 20/22 days post-fertilization across treatment groups with constant and fluctuating temperature regimes on larvae from Prince Edward Island and Nova Scotia sources. The Bayesian model indicates a higher triploid percentage in Prince Edward Island larvae with moderate certainty (UI: 80.46%), a reduction in triploidy occurrence under fluctuating temperature conditions with high certainty (UI: 98.55%), and a reduction in triploidy percentage from day 8 to day 20/22 with high certainty (UI: 96.07%).

DISCUSSION

***Ploidy:** triploids survival ↓ particularly under thermal stress, but ↑ shell length by the end of the experiment*

- **Fail to reject -** Triploidy survival ↓ diploid survival[6]
- **Reject -** Triploid length < diploid length[5,15]
  - Possibly due to lack of sexual maturation[5,16]

***Temperature:** larvae under constant temperature regimes will have ↑ survival and growth than fluctuating regimes[10]*

- **Reject -** Survival is similar independently of temperature regime[17]
  - However triploid individuals are decimated, reducing % triploids
    - Possibly due to differences in protein expression[6]
- **Fail to reject -** Growth is ↓ under the fluctuating temperature regime

***Source:** NS larvae will have survival and mean length > PE larvae[11,12]*

- **Fail to reject -** NS survival > PE
- **Reject –** PE length and triploidy rates > NS
  - Due to potential physiological differences[7]

CONCLUSION

This study is an initial step to inform hatchery techniques that improve mussel performance under variable thermal conditions, with the goal of developing a resilient hatchery-produced seed

Key conclusions

- Triploids should maintain a constant hatchery standard temperature (~18°C)
- Triploids do not obtain higher growth rates during larval stages
- Diploids are unaffected by thermal fluctuations compared to triploids

Future studies

- Study potential carryover effects of fluctuating treatments among diploid groups[12]
- Determine when triploid size surpasses diploids
- Further compare larval thermal resistance at juvenile stages

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