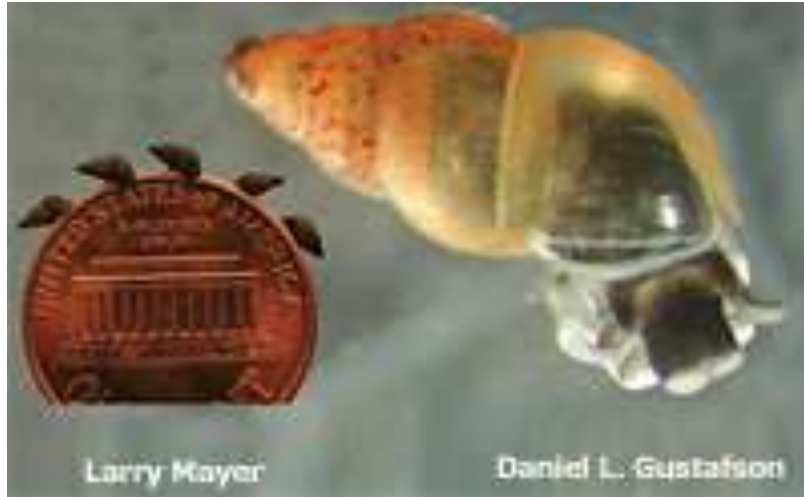


Examining a possible advantage of diploidy in the freshwater snail *Potamopyrgus antipodarum* in a phosphorus-limited environment

Tonya Chamberlain & Amy Krist
Wyoming EPSCoR Summer 2010



New Zealand Mudsnail

Potamopyrgus antipodarum (*P. antipodarum*)

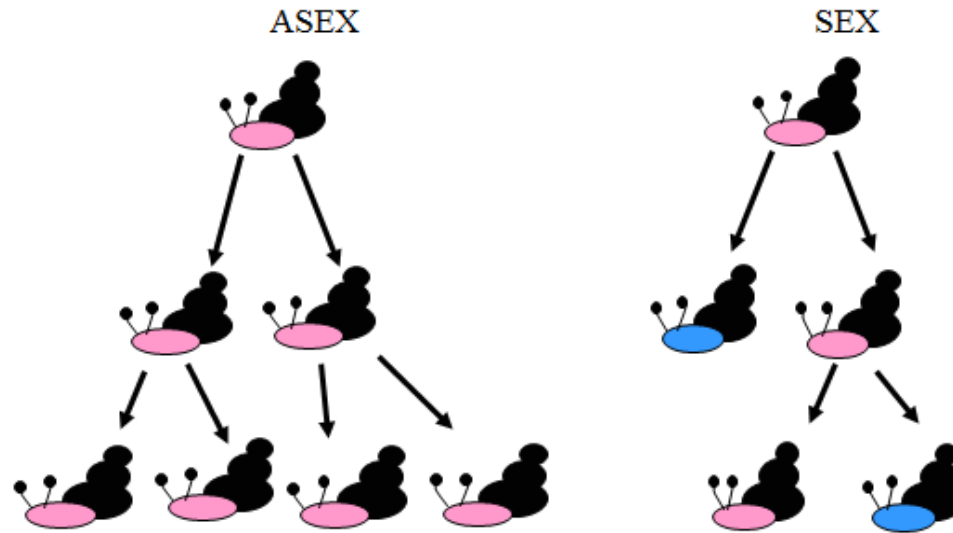
http://www.seagrants.umn.edu/newzealand_mudsnail

Study animal

- ❖ Native to New Zealand
- ❖ Freshwater; pristine alpine lakes
- ❖ Feed on algae
- ❖ **Two** forms of reproduction within populations in NZ:
 - sexual (cross-fertilization)
 - asexual (clone production)

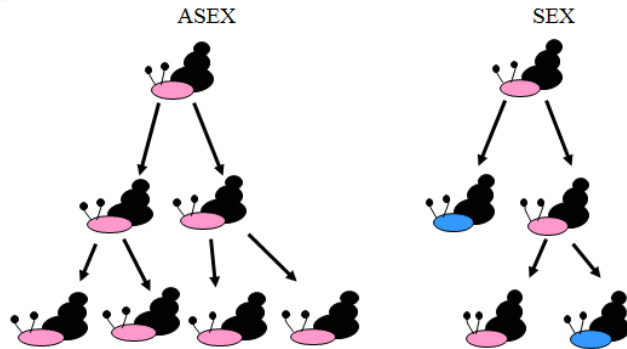
(Dybdahl and Lively, 1995)

The persistence of two forms of reproduction within populations is significant:

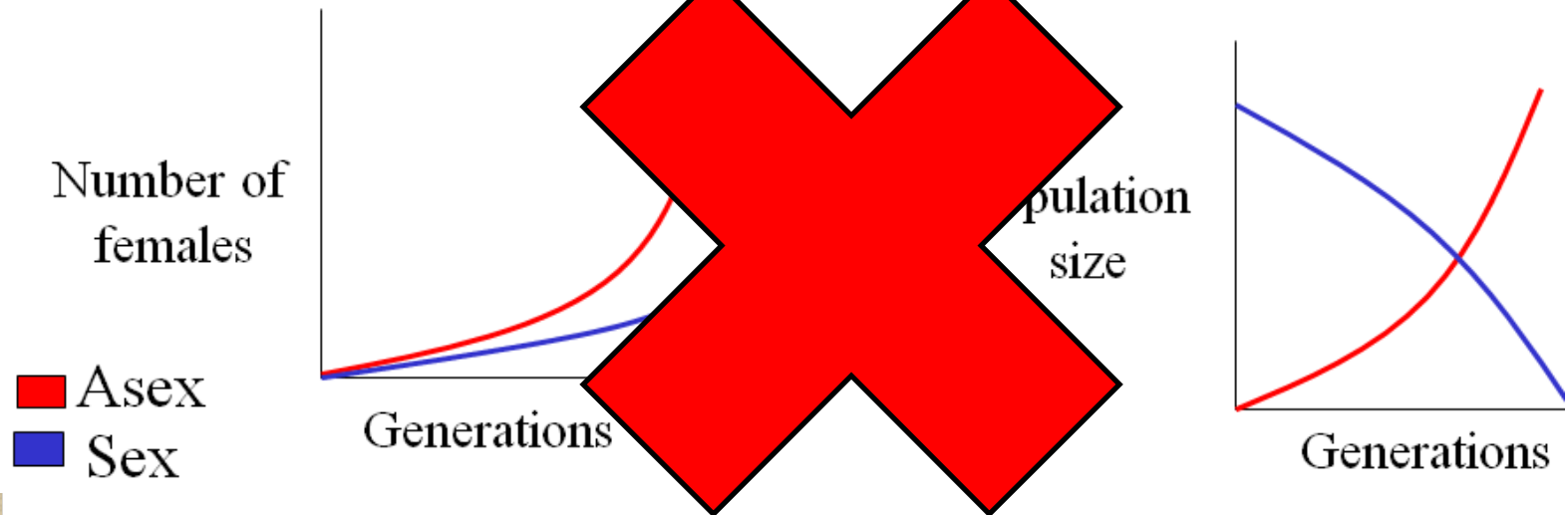


- Figure: all else being equal, asexual females will produce four times as many granddaughters as sexual females after three generations

The persistence of two forms of reproduction within populations is a mystery in evolutionary biology:



- Asexual mutants in a population should rapidly replace a sexual population (*Maynard Smith, 1978*)



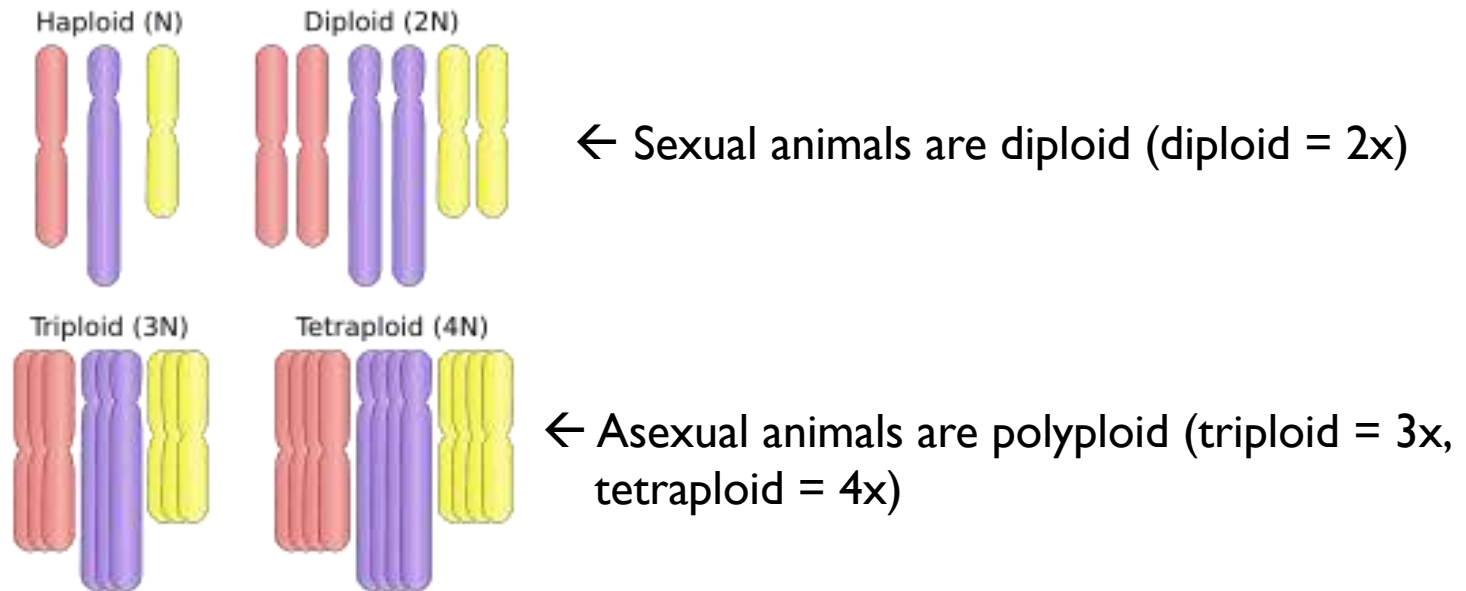
“So why do so many species reproduce sexually, given the costs of sex and the widespread potential for asexual reproduction?”
-- Sally Otto (2009)



ASEXUALITY MUST CONFER A COST

Possible cost of polyploidy?

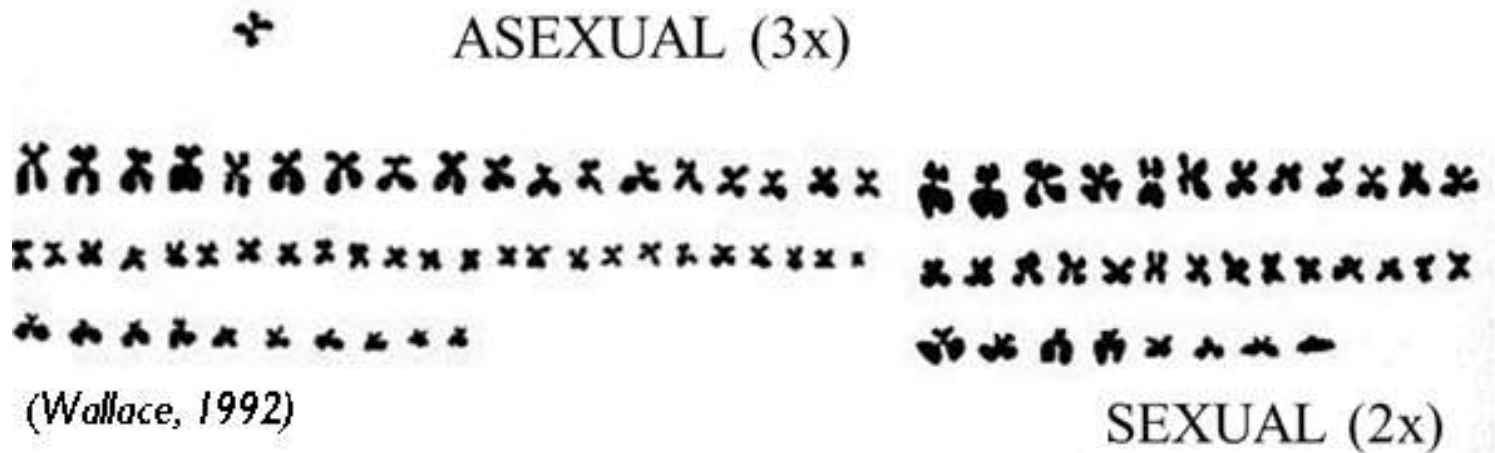
- **If polyploids require extra nucleic acids, sexual diploids may have an advantage!**



- Polyploids have one or more additional sets of chromosomes

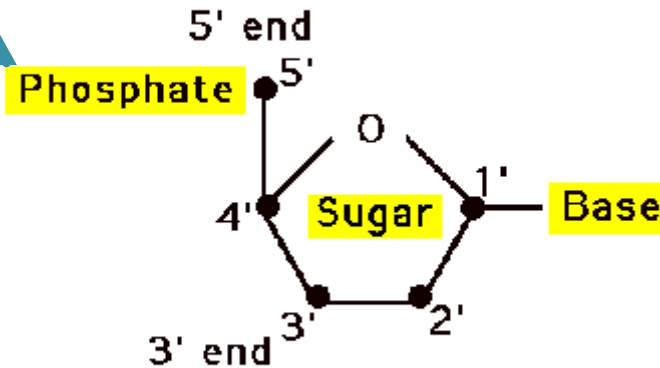
Possible cost of polyploidy?

- New Zealand mudsnail asexuals are polyploid:



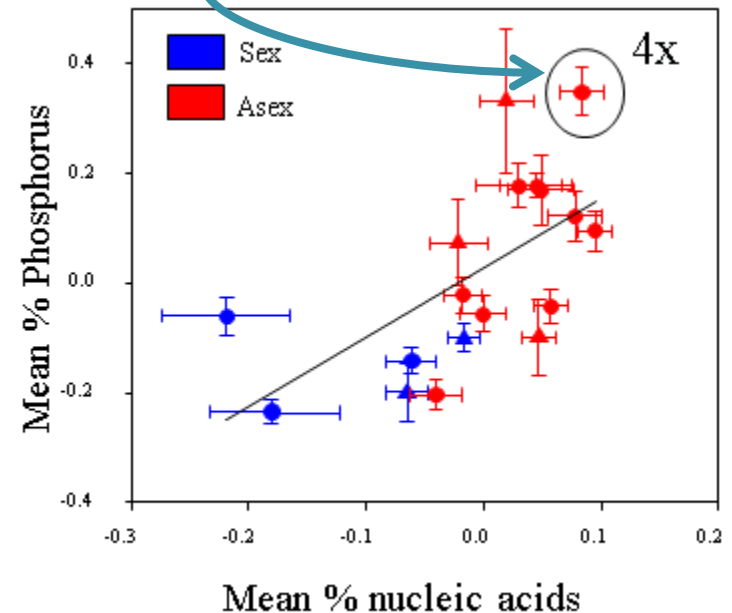
Possible cost of polyploidy?

- Nucleic acids can make up a large portion of organismal dry weight
- Nucleic acids are rich in phosphorus
- Phosphorus is a key limiting nutrient in aquatic environments
- **Higher body content of nutrient = higher dietary requirement**



nucleotide

Retrieved 4/28/11 from:
<http://lc.brooklyn.cuny.edu/smarttutor/corcl321/macromolec.html>



“Higher content of P = Higher dietary requirement”

**ASEXUAL POLYPLOIDS MAY BE
MORE LIMITED BY PHOSPHORUS
AVAILABILITY THAN SEXUALS**

Our QUESTION:

- Does P-limitation differently affect individual growth rate across ploidy levels of the New Zealand mudsnail?

What we KNOW:
 • Larger ploidy requires more P
 • Smaller ploidy requires less P

What we EXPECT:

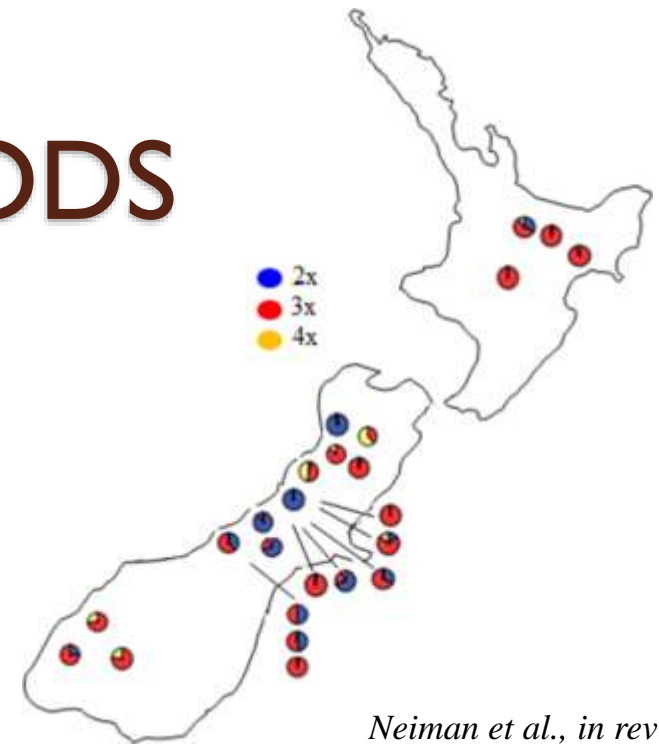
	Low P	High P	Sex
Individual level (Empirical growth rate)	$2x > 3x > 4x$	$2x \leq 3x \leq 4x$	Asex
Population growth rate	$2x \geq 3x > 4x$	$2x \ll 3x \leq 4x$	

METHODS

- 3 diploid lineages (2x)
- 20 triploid lineages (3x)
- 5 tetraploid lineages (4x)

- High-P food treatment
 - (12 aquaria)
- Low-P food treatment
 - (12 aquaria)

- = 24 aquaria
- Each with a representative of each lineage
- = 672 snails!



Neiman et al., in review



Gastro-tron

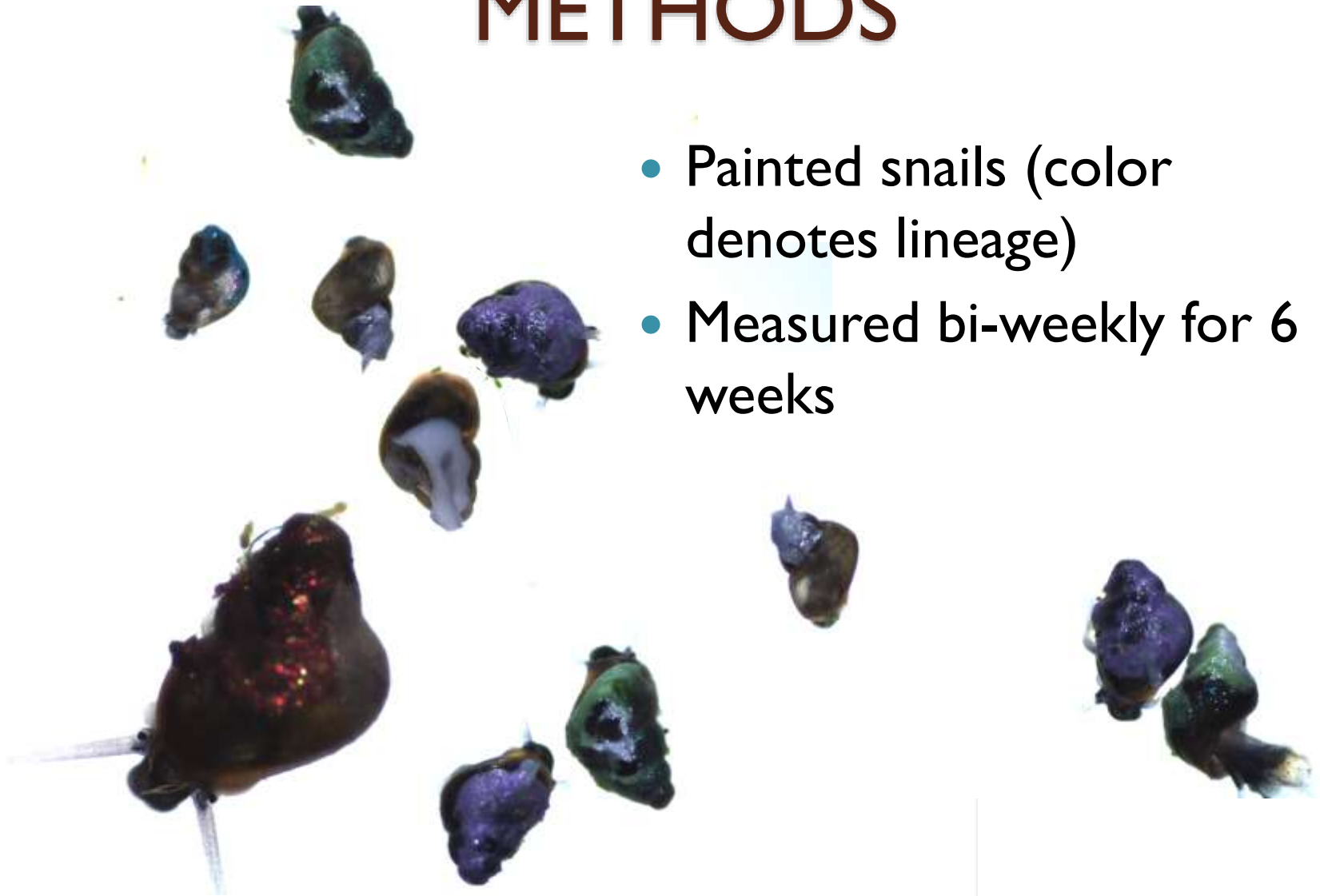
METHODS

- *Scenedesmus acutus* ← algae
 - High-P food
 - Low-P food
- Automated chemostat

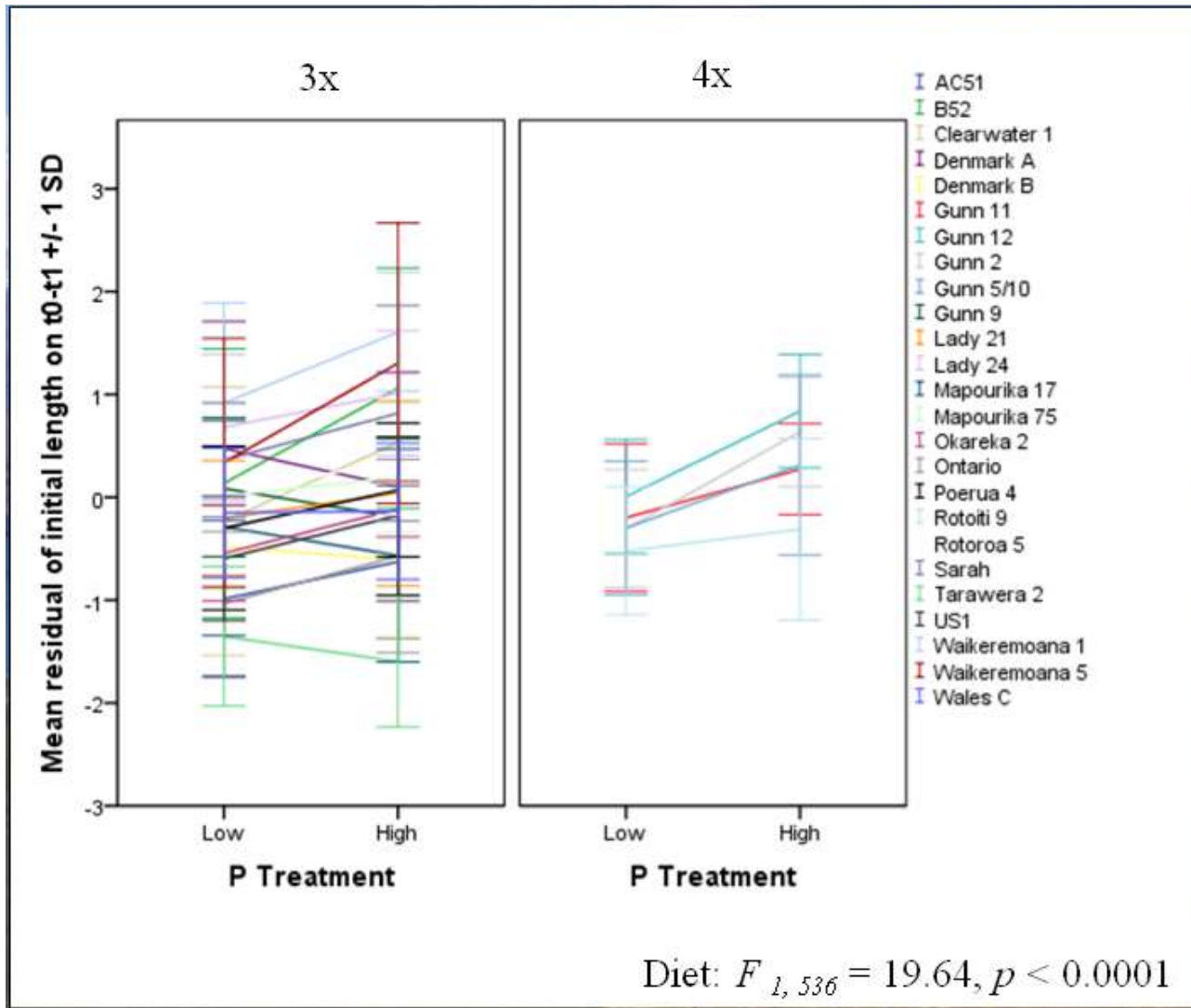


METHODS

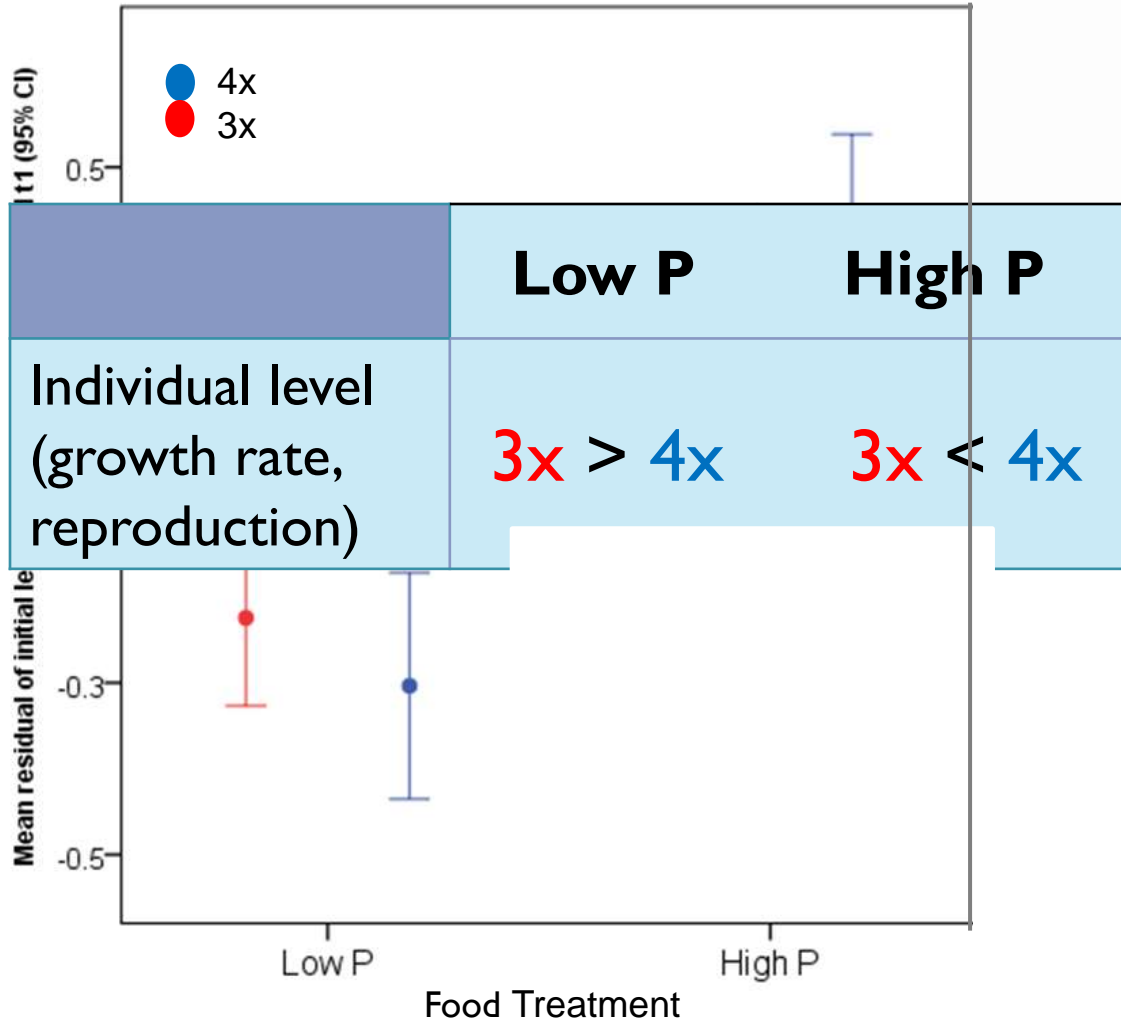
- Painted snails (color denotes lineage)
- Measured bi-weekly for 6 weeks



RESULTS



RESULTS



RESULTS – Summary

- High variation in growth rate throughout lineages and ploidy level
- Growth Hi-P > Lo-P
- As expected:
 - 3x lineages grew faster than 4x in Low-P
 - 4x lineages grew faster than 3x in High-P

	Low P	High P	Sex Asex
Individual level (Embryo production, growth rate)	$2x > 3x > 4x$	$2x \leq 3x \leq 4x$	
Population growth rate	$2x \geq 3x > 4x$	$2x \ll 3x \leq 4x$	

Conclusion

- In low-P environments, lower-ploidy asexuals should be favored.
- In high-P environments, higher-ploidy asexuals should be favored
- Large genome size in higher-ploidy asexual New Zealand mudsnails may contribute to lower growth rate if phosphorus is limited.

Conclusion

- In low-P environments, sexuals could outcompete higher-ploidy asexuals in growth and reproduction.
 - an advantage to diploidy!
- Strong advantage to sexual reproduction in a P-limited environment



Current project...

- Wild-caught sexuals instead of lab-reared
- Reproduction

Dr. Amy Krist

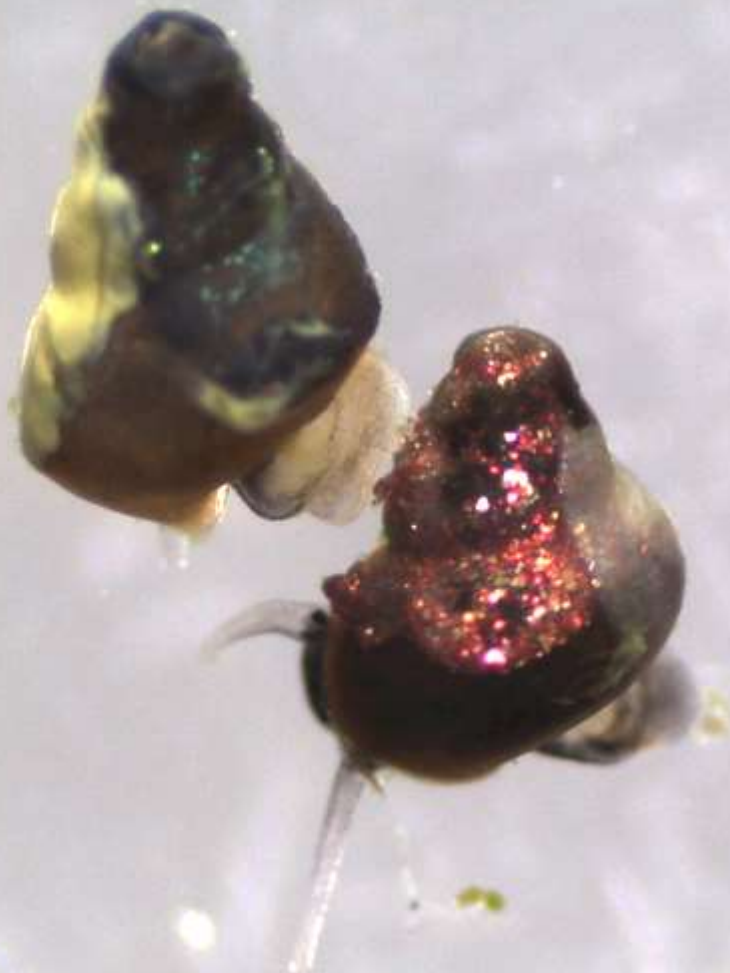
Dr. Maurine Neiman

Wyoming EPSCoR

Labbies: Rachel Bilka, Charlotte Narr, Brenna Hansen, Melissa Kerr, Heidi Meador, & Chris McAlexander



THANK YOU



Questions?