Cedar Key Aquaculture Workshop

Report on Genetic Diversity in Florida Commercial Hard Clams, *Mercenaria mercenaria*

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What is genetic diversity?

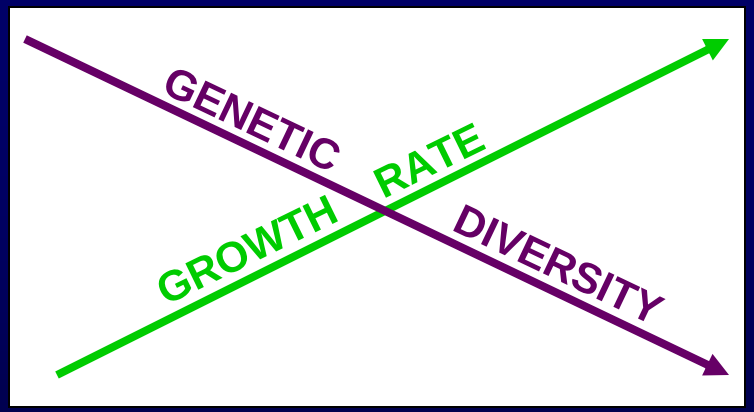
- **In most organisms, the genetic code (DNA) varies slightly between individuals.**

- **Differences in a DNA fragment, measured across many individuals, are used to estimate genetic diversity within a population.**

- **Population size, age, history, and connections to other populations can all affect genetic diversity.**

Should producers care about genetic diversity?

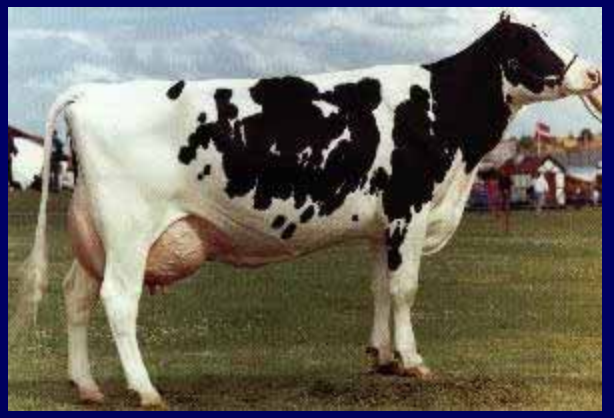
- **Clam producers want high clam performance.**
- **Enhanced performance (mainly growth and survival) achieved through selective breeding.**
- **Selective breeding usually reduces genetic variability as a side effect.**



- **Performance and diversity are difficult to maintain simultaneously.**

What is Inbreeding Depression?

- **Inbreeding results in an increase of rare and sometimes harmful alleles (gene forms).**
- ***Inbreeding depression* is a common consequence of selective breeding.**
- **Inbred lineages may perform well for some traits, but poorly for others.**



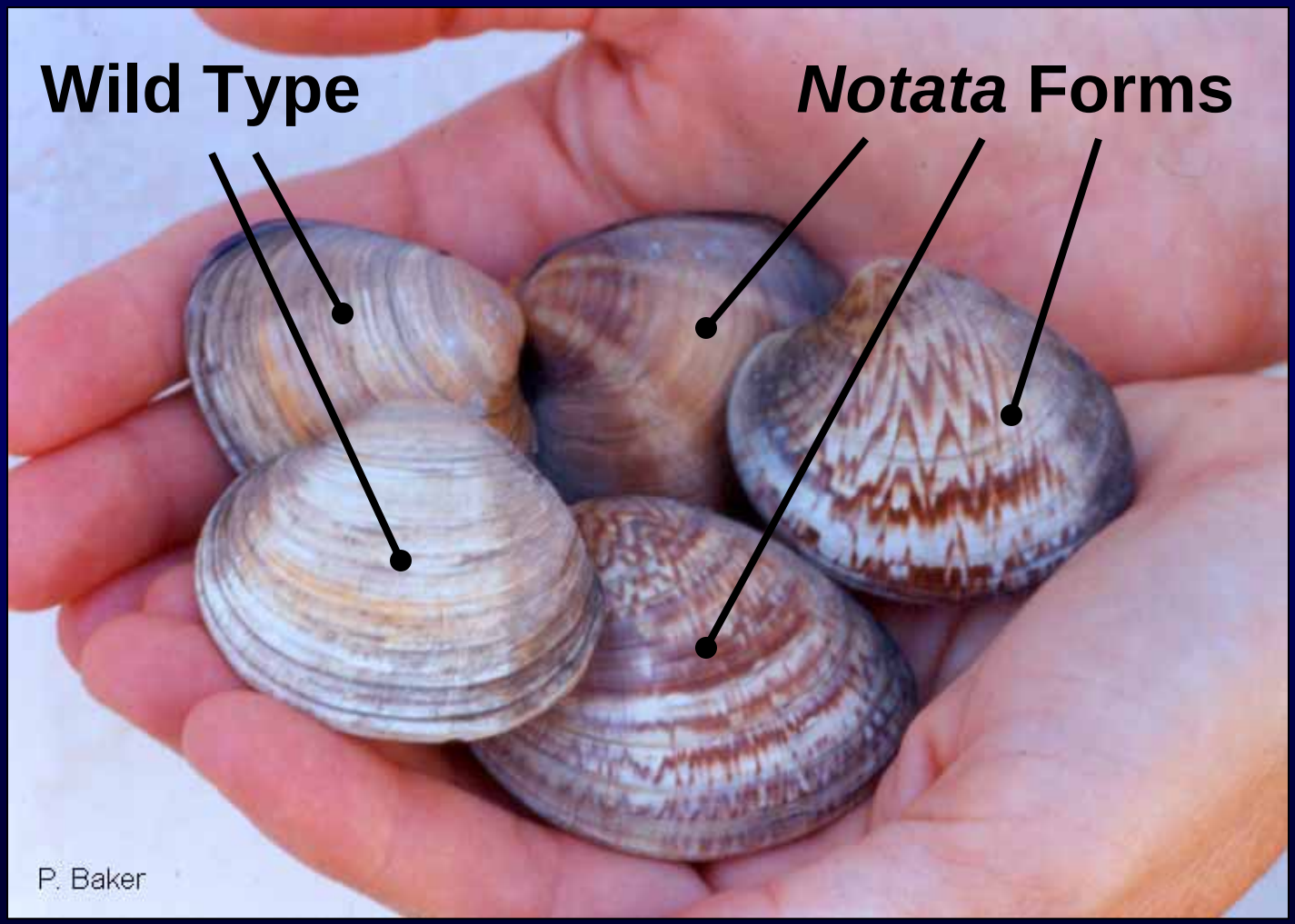
- **Inbreeding depression is poorly understood. Effects on bivalves, including clams, remains unclear.**
- **Should producers be concerned? Maybe… but don't stop selective breeding programs yet.**

Should industry managers care about genetic diversity?

- **Clams that are selectively bred to perform well in one environment may perform poorly if the environment changes.**
- **A single-strain crop may be wiped out by a disease, while a genetically diverse crop suffers only partial mortality.**
- **To individual producers, risks from low genetic diversity may be outweighed by benefits of selective breeding**
- **From a manager's or insurer's perspective, low genetic diversity increases the risk of industry-wide crop losses.**

potato blight

Selective Breeding of Hard Clams, *Mercenaria mercenaria*



- *Notata* -

0-6% of wild populations

22-97% of hatchery stocks sampled

Questions

1. Is genetic diversity of commercial stocks of hard clams, *Mercenaria mercenaria*, lower than in wild stocks?

2. Does genetic diversity correlate with clam performance under commercial conditions?

Methods

1. Sample wild and hatchery clam stocks, compare molecular genetic sequences (mitochondrial DNA, COI gene fragment).

2. Rear multiple hatchery stocks under identical blind* conditions and compare performance (growth & survival) to genetic data.

*Researchers did not know identity of hatchery stocks.

Genetic Diversity Results

Stock	*notata* % wildtype	heterozygosity mean	heterozygosity s.d.
Prince Edward Island	76	0.76	0.05
Long Island	79	0.79	0.07
Chesapeake Bay	83	0.83	0.06
North Carolina	91	0.91	0.04
Georgia	85	0.85	0.05
Matanzas River, Florida	81	0.81	0.04
Indian River, Florida	85	0.85	0.05
Cedar Key, Florida	90	0.9	0.04
Hatchery	3	0.74	0.04
Hatchery	5	0.76	0.08
Hatchery	14	0.63	0.13
Hatchery	37	0.83	0.06
Hatchery	20	0.43	0.1
Hatchery	32	0.84	0.03
Hatchery	38	0.9	0.03
Hatchery	43	0.83	0.05
Hatchery	30	0.51	0.04
Hatchery	79	0.89	0.04
Hatchery	8	0.59	0.1

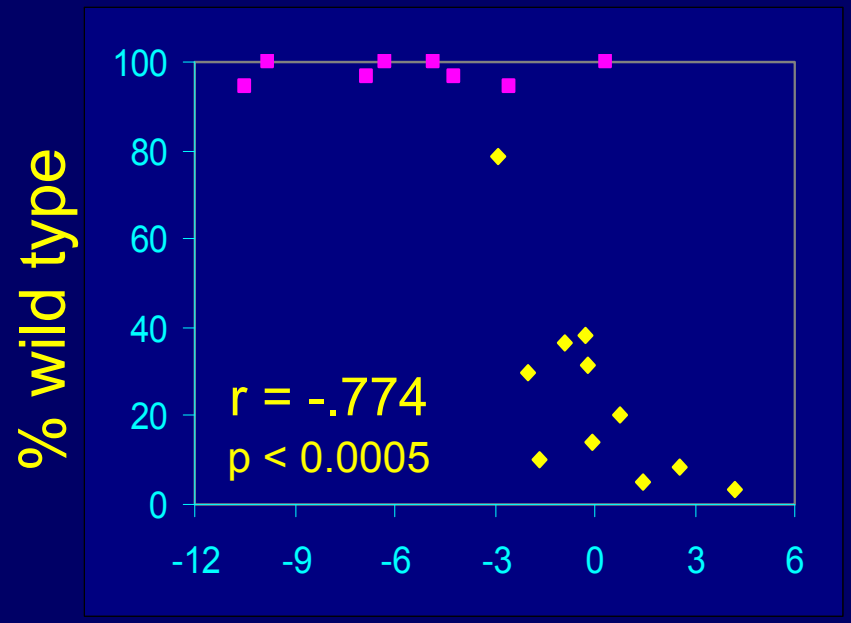
Hatchery stocks tend to have lower genetic diversity* than wild stocks, as estimated by heterozygosity.

However, heterozygosity of hatchery stocks is high in most cases

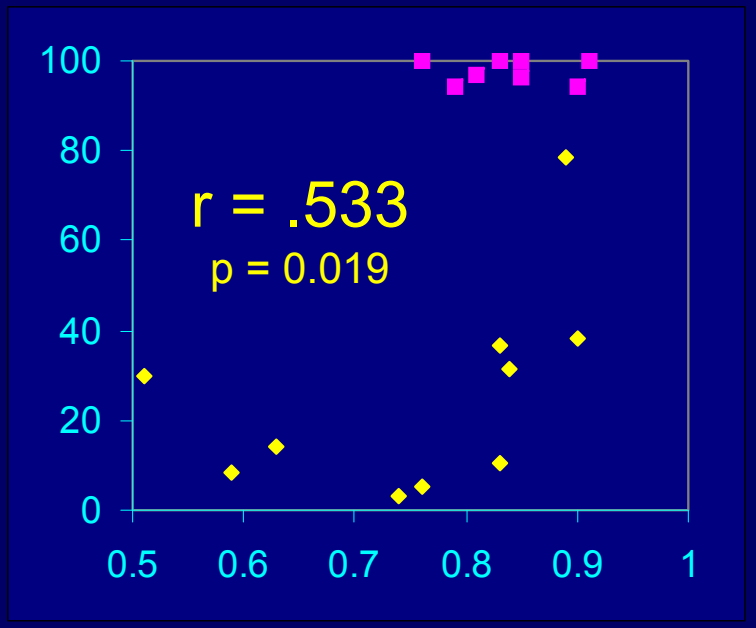
*significant at $\alpha = 0.05$

Can wild-type vs *notata* be used as an index of reduced genetic diversity?

Fu's Index (selection)



Heterozygosity (diversity)

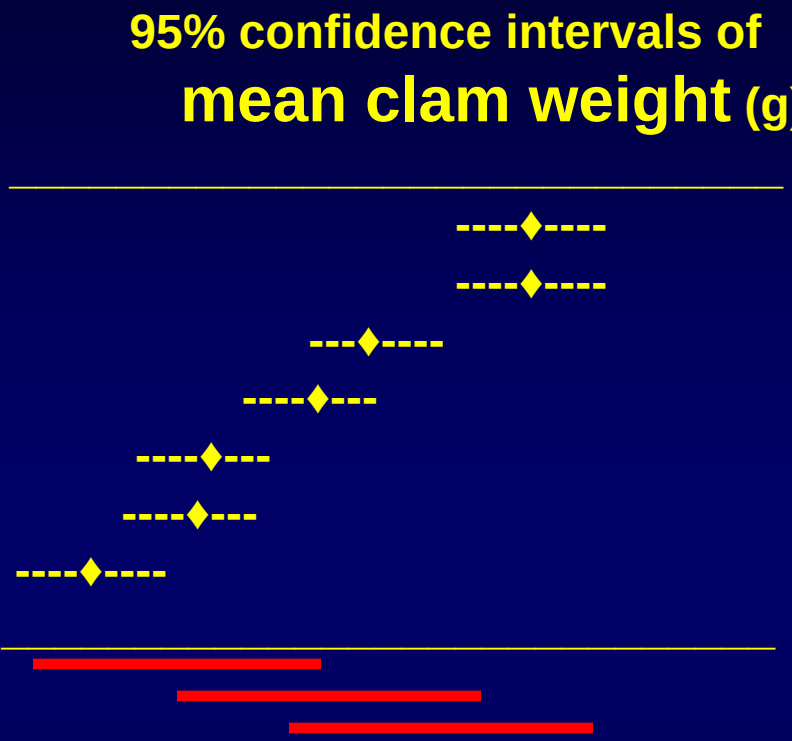


Notata appears to be correlated with reduced genetic variability, <u>but</u> it can account for only about about half of the variation in the data.

Hatchery Stock Performance

Hatchery Stock	N	Mean	S.D.
1	300	38.27	10.65
2	300	38.18	10.38
3	300	36.11	10.27
4	300	35.41	10.66
5	300	34.65	12.03
6	300	34.40	8.80
7	288	32.66	11.84

(red bars connect averages that do not differ significantly)

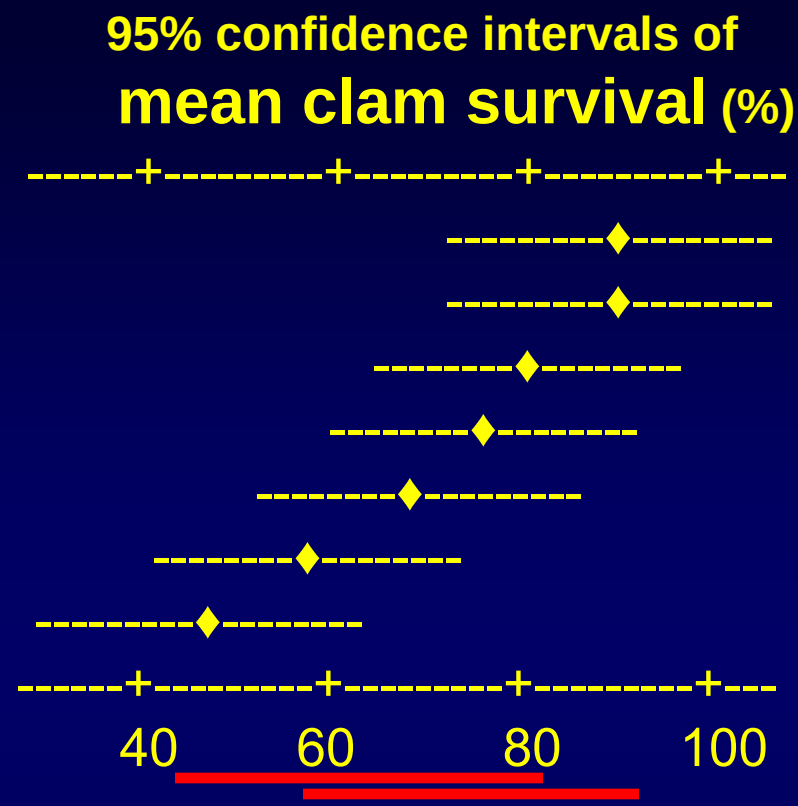


- Hatchery stocks reared under identical conditions varied significantly in size. (Length & height data were similar.)
- Differences were small and possibly within the performance variation of any individual hatchery.

Hatchery

Stock	N	Mean	s.d.
1	6	85.37	11.11
6	6	85.08	15.56
7	6	78.30	16.36
4	6	72.00	12.03
2	6	66.40	31.59
3	6	56.32	35.55
5	6	47.18	22.73

(red bars connect averages that do not differ significantly)



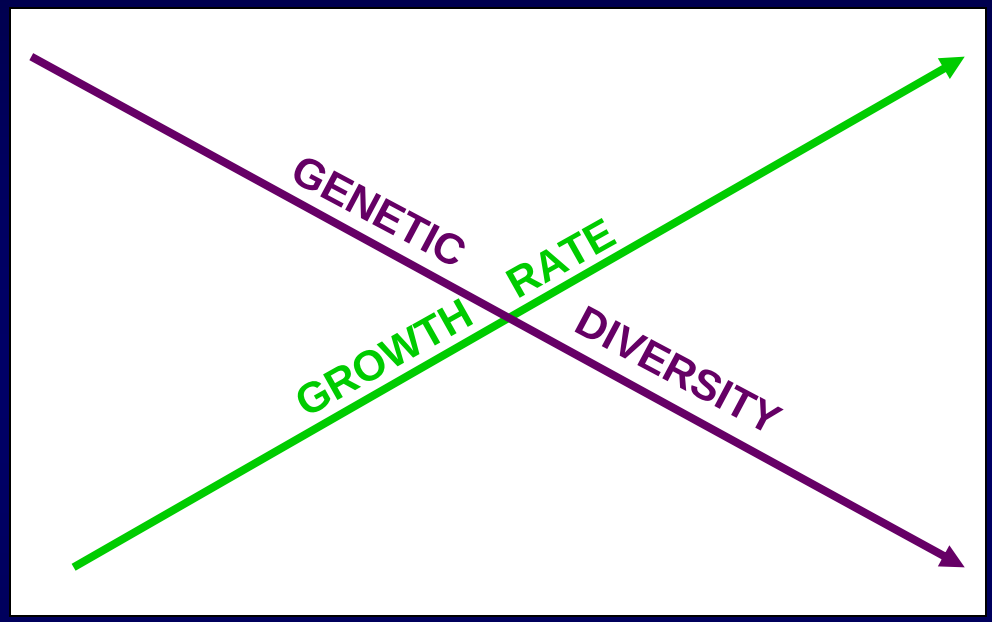
- Hatchery stocks reared under identical conditions varied significantly in survival rates.
- Within-stock variability nearly masked between-stock variability.
- Growth and survival were not correlated.

Genetic diversity was not correlated with performance

- Three indices of performance:
  clam weight, clam length, cohort survival
- Four molecular genetic indices:
  Tajima's D, Fu's Test, Mean Pairwise Differences, and heterozygosity
- None of the performance indices correlated with any of the genetic indices
  (Pearson's Correlation)

Conclusions

- Commercial hard clam stocks in Florida show some evidence of reduced genetic variability.
- Overall, however, genetic variability of hatchery stocks remains high.
- There is no evidence that genetic variability is related to stock performance.



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