



**Estimates of heritability and genotype by
environment interactions in the purple
freshwater pearl mussel *Hyriopsis cumingii***

**Zhiyi Bai
Shanghai Ocean University**

Santiago de Compostela

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Outline

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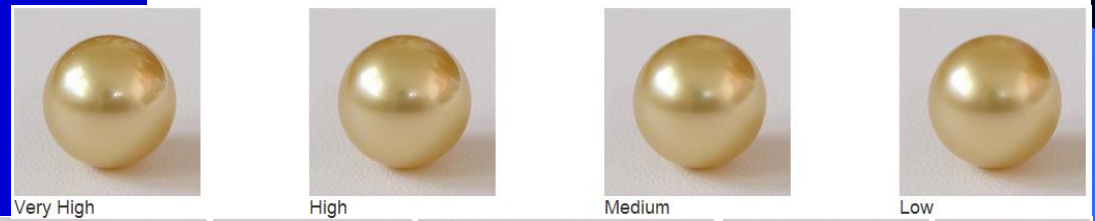
Conclusion and discussion



1. The selection breeding of purple pearl mussel

Factors affected on Pearl quality

■ Pearl quality is evaluated based mainly on the size, color, luster, shape and complexion.



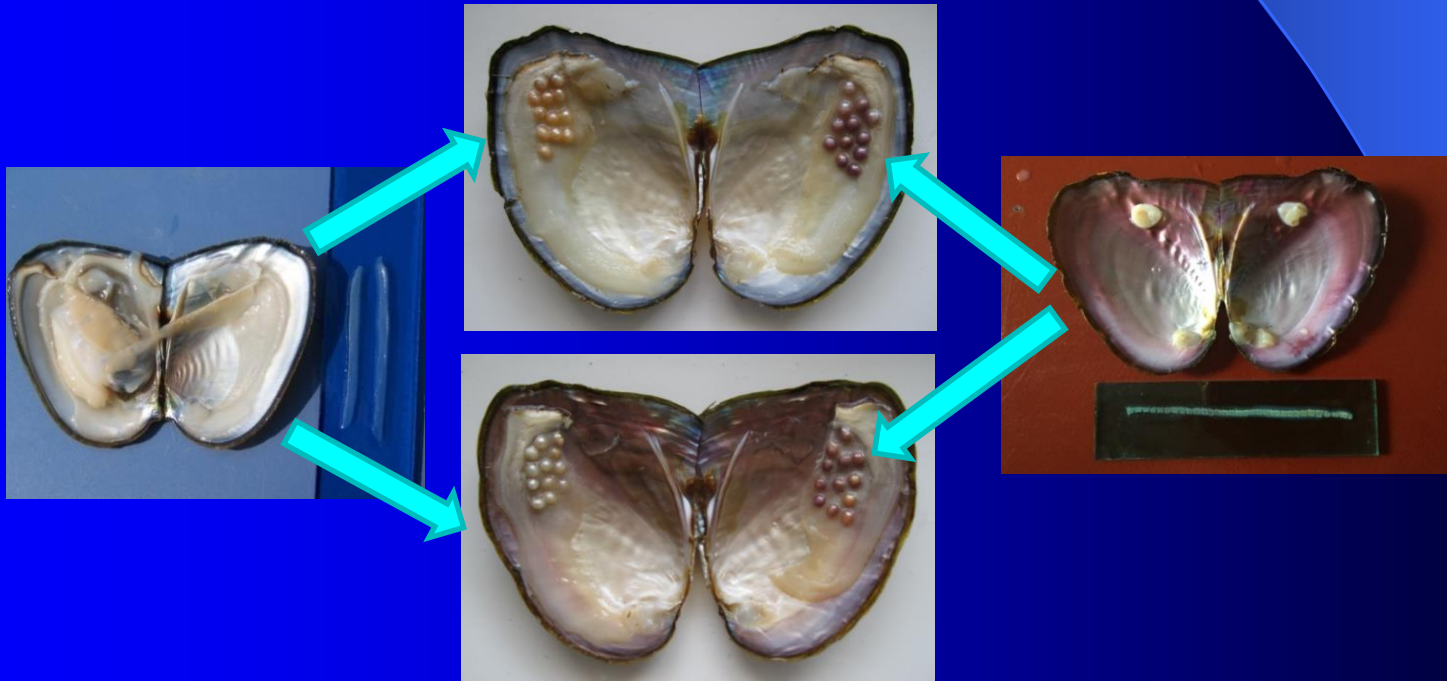
Why for purple pearl?

- Trends and rarity of color play on the “beauty is in the eye of the beholder” rule, and change the cost of a given pearl based on its color.
- Purple pearl is rare, about 3%, is more expensive in freshwater pearl. So purple pearl have better market prospect.



How to produce purple pearl?

The color of a pearl is produced by the mussel as the pearl is being formed. Implanting saibo made of mantle covering on purple inner shell will mainly produce purple pearls, . Implanting saibo made of mantle covering on white inner shell will mainly produce white pearls.



Selection breeding of purple pearl mussel



- **Pearl mussel:** *Hyriopsis cumingii*, the most commercially important freshwater pearl mussel.
- **Objective trait:** Inner shell color is purple.
- **Basic population for selection breeding:** Wild pearl mussel with purple inner shell collecting from Poyang Lake and Dongting Lake in 1998.
- **Breeding method:** Population selection for F1-F4.

The purple pearl production status of F4 population

Trial	Proportion of each color of pearl (%)			
	White	Yellow	Pink	Purple
White hosts with white saibos	61.23 ± 12.31 ^{a*}	34.98 ± 12.11 ^{a*}	2.50 ± 1.22 ^{c*}	0.91 ± 2.87 ^{d*}
White hosts with purple saibos	10.66 ± 11.16 ^{b*}	32.51 ± 16.11 ^{a*}	12.50 ± 12.21 ^{b*}	37.92 ± 16.31 ^b
Purple hosts with white saibos	47.50 ± 20.86 ^{b*}	32.51 ± 16.11 ^{a*}	12.50 ± 12.21 ^{b*}	7.44 ± 9.59 ^{c*}
Purple hosts with purple saibos	5.53 ± 12.11 ^d	16.97 ± 9.64	35.41 ± 15.28 ^a	42.32 ± 24.54 ^a

Only half of pearls are purple. How to increase the ratio of purple pearl?

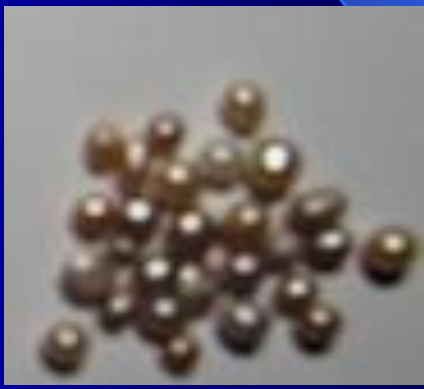
Light purple inner shell

Lower ratio of purple pearl



Deep purple inner shell

Higher ratio of purple pearl

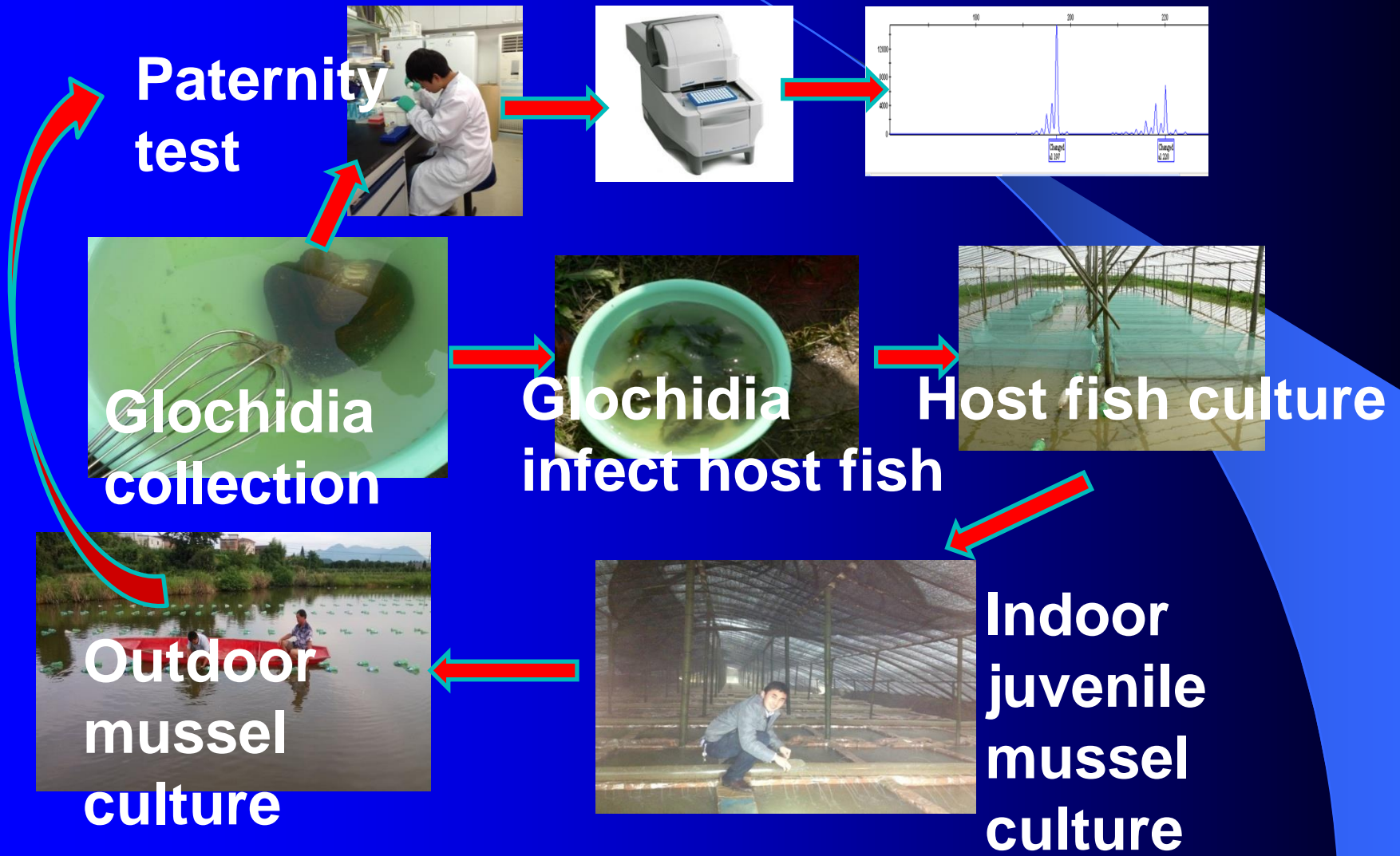


Next step is to select mussels with deeper purple inner shell.

Before, we treated purple inner shell as qualitative trait, it is genetic. Now, we should treat the purple degree of inner shell as quantitative trait. Is it affected by genetics or environment? So we should answer the question first before selection breeding.

2. Heritability estimates of inner shell color and growth traits

2.1 Family construction



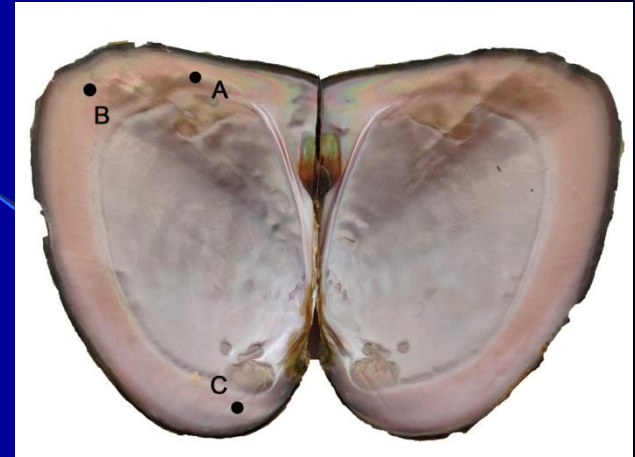
2.2 Data collection



At 12 months of age, a total of 1200 mussels, 600 from each sites, were collected randomly from each cage. Shell length, shell height and shell width were measured to 0.01 mm using a digital Vernier caliper. Body weight, shell weight and mantle weight were measured to 0.01 g on an electronic balance. Mantle weight largely affect pearl size and roundness. So, this trait was considered in this study.

Shell color measure point:

A, the mantle scar near posterior adductor muscle scar; B, the cross of posterior ridge and mantle scar; C, the mantle scar near anterior adductor muscle scar.



Color parameter:

The CIE 1976 color space, L^* (lightness), a^* (redness) and b^* (yellowness) and total color change (dE) were measured by Lovibond-RT200 surface colorimeter.





2.3 Heritability estimates of inner shell color

	L*	a*	b*	dE
L*	0.33 ± 0.19	-0.34 ± 0.04	-0.18 ± 0.04	-0.98 ± 0.01
a*	-0.32 ± 0.70	0.17 ± 0.10	0.01 ± 0.04	0.39 ± 0.04
b*	-0.29 ± 0.58	-0.05 ± 0.47	0.69 ± 0.17	0.10 ± 0.04
dE	-0.94 ± 0.09	0.34 ± 0.65	0.24 ± 0.55	0.33 ± 0.19

Heritability (in bold at the diagonal), genetic correlations (below the diagonal) and phenotypic correlations (above the diagonal).

For all the color parameters, the heritability is moderate or high. It is suggested that the purple degree of inner shell may be improved by selection breeding.



2.4 Heritability estimates of growth traits

	Shell length	Shell height	Shell width	Body weight	Shell weight	Mantle weight
Shell length	0.20±0.03	0.61±0.02	0.71±0.02	0.98±0.01	0.82±0.03	0.69±0.02
Shell height	0.56±0.12	0.16±0.06	0.53±0.02	0.64±0.00	0.53±0.02	0.45±0.02
Shell width	0.63±0.08	0.55±0.11	0.17±0.02	0.88±0.01	0.71±0.04	0.59±0.03
Body weight	0.71±0.02	0.56±0.11	0.69±0.02	0.23±0.01	0.97±0.01	0.79±0.02
Shell weight	0.68±0.05	0.54±0.11	0.64±0.04	0.71±0.00	0.31±0.03	0.68±0.03
Mantle weight	0.64±0.19	0.51±0.24	0.61±0.29	0.66±0.13	0.63±0.13	0.15±0.06

As other studied species, the heritability in all the growth traits are moderate or high. No significant relation was found between growth and inner shell color. It is necessary to improve the traits simultaneously for producing high quality pearl.

3. Genotype by environment interactions



Exception of b^* , all growth traits and inner shell color parameters showed the possibility of genotype by environment interactions in mussel families grown in Chongming and Jinhua.

Traits	r_g
Shell length	0.35 ± 0.27
Shell height	0.37 ± 0.21
Shell width	0.36 ± 0.22
Body weight	0.31 ± 0.29
Shell weight	0.24 ± 0.33
Mantle weight	0.34 ± 0.28
L^*	0.09 ± 0.29
a^*	0.27 ± 0.37
b^*	0.79 ± 0.11
dE	0.68 ± 0.22



Selection of superior families

Considering growth and purple inner shell, the F09 and F10 families are more suitable for culturing in Chongming; the F20, F23, and F34 families are more suitable for culturing in Jinhua; and the F21 and F22 families are suitable for both sites.



4. Conclusion and discussion

- 1 The heritability in all the color parameters and growth traits are moderate or high. No significant relation was found between growth and inner shell color. It is necessary to improve the traits simultaneously for producing high quality pearl.
- 2 Genotype by environment interactions should also be considered in future breeding programs
- 3 There is lower correlation between two color parameters, redness (a) and yellowness (b). There may be different genetic mechanism behind them. They determine purple degree of pearl together.



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