

Project Highlights

Preliminary Growth Comparison of Three *Macrobrachium rosenbergii* Stocks and their Reciprocal Crosses in Four Environments⁶

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Introduction

Three stocks of *Macrobrachium rosenbergii* namely, “AAGRDI” (Aquatic Animal Genetic Research and Development Institute), “FARM” (Petchaburi Farm) and “WILD” stocks were used for the selective breeding program. Generally, a good base population for genetic improvement should have high genetic variability and the stock should have traits that make them adaptable in each local environment. Therefore, all possible crosses of these three stocks should be evaluated on both performance traits and genetic diversity before selective breeding takes place. Hence, the proposed genetic improvement program was divided into two parts: (1) evaluation of growth performance of the three stocks and their reciprocal crosses in four environments; and (2) the establishment of improved economic traits in the best cross using a suitable selection procedure. The four environments used were: 20 m² concrete pond located at the Aquatic Genetic Research and Development Research Center (AAGRDI), Pathumtani Province; and in 5 x 5 x 1.5 m² net cages at the three Fisheries Test and Research Centers in Chumphon, Buriram and Uttaradit Provinces. The “AAGRDI” stock was the *M. rosenbergii* selected for improved growth rate for two generations in the AAGRDI environment (Uraiwan *et al.*, 2003). The “FARM” stock originally came from a private hatchery in Petchaburi Province in 2002, which was also reared at the AAGRDI for one generation. The “WILD” stock was collected from the river in Chantaburi Province in 2002. This “WILD” stock has been domesticated under hatchery conditions at the AAGRDI for one generation. This experiment deals with the growth performance comparison and the genetic variations of these stocks conducted simultaneously by Sodsuk *et al.* (2005).

Methodology

Parent generation

In June 2003, fifty (50) pairs of *M. rosenbergii* from each of three stocks were collected to form the base population. Each stock has been spawned and reared separately, and their offspring were reared in three 20 m² concrete ponds at the AAGRDI. The growth of *M. rosenbergii* from the three stocks was observed from August 2003 to January 2004 (Uraiwan and Sodsuk, 2004). The results showed that the AAGRDI *M. rosenbergii* stock performed better than those of the “WILD” and “FARM” stocks at average length increment of 4% and 9-15% weight gain, respectively. In addition, allozyme electrophoresis has been carried out to estimate genetic variabilities (heterozygosity and number of alleles per locus) of the three stocks. Results showed that they were similar to *M. rosenbergii* from the natural waters {number of alleles 1.30 (1.29-1.33), heterozygosity 0.032(0.027- 0.036), Sodsuk and Sodsuk, 1998}, Uraiwan and Sodsuk (2004). There is no difference on the genetic diversity of the three (3) stocks (Sodsuk *et al.*, 2005).

Performance growth test on nine crosses

Reciprocal crosses of the three stocks were conducted from November 2004 to August 2005 to establish nine crossbred lines. The crosses are identified by the male and female parents of each cross, starting with the male parents followed by the female parents, these are as follows: AAGRDI x AAGRDI, WILD x WILD,

⁶based on activities from late 2004-2005; title modified based on preliminary data presented during the 3rd Roundtable Discussion



FARM x FARM, AAGRDI x FARM, FARM x AAGRDI, AAGRDI x WILD, WILD x AAGRDI, FARM x WILD and WILD x FARM. Each cross was produced from 10 pairs of *M. rosenbergii*. The hatchery and nursery phases were completed at the AAGRDI and the Petchaburi Fisheries Test and Research Center at different periods, and the post larvae were stocked for the performance growth test in four environments as indicated in following table:

Month and Year	Hatchery and nursery location	Location of performance tests
November 2004	AAGRDI	18 cages, Uttradit Fisheries test and Research center
July 2005	AAGRDI	18 cages, Buriram Fisheries Test and Research Center
August 2005	Petchaburi Fisheries Test and Research Center	18 cages, Chumphon Fisheries Test and Research Center
August 2005	AAGRDI	18 concrete ponds, AAGRDI

The nine crosses have been reared in the aforementioned environments for eight months. Standard experimental procedures such as stocking density, feeding regime and measurement schedules were adopted in all the test locations. The stocking rates of 10 and 1 prawn/m² were used during the 1st to the 4th month and the 5th to the 8th month of the experiment, respectively. The prawns were fed commercial shrimp pelleted feed three times a day at 3.4% of body weight. Length-weight measurements were taken monthly.

Results

Growth Comparison

Due to the difference in the stocking dates, the recorded data were *M. rosenbergii* growth (length and weight increments) at the second month for the AAGRDI and the Chumphon Fisheries Test and Research Center, and at the third and fourth months for the Buriram and Uttradit Fisheries Test and Research Centers, respectively.

AAGRDI environment

Mean lengths and weights during the second month of the nine crosses are shown in Table 1. The cross WILD x WILD had the highest length and weight increments. These were significantly higher by 15% in length and 39% in weight than those of the AAGRDI x AAGRDI stock and by 17% in length and 43% in length and weight compared to the FARM x FARM stock.

Table 1. Mean lengths/weights and standard deviations (+sd) of nine crosses of *M. rosenbergii* reared in concrete ponds for two months at the AAGRDI environment

Crosses (M X F)	Length (cm) + sd	Weight (g) + sd
WILD X AAGRDI	7.516 + 0.864 ^b	3.905 + 1.687 ^c
AAGRDI X WILD	7.224 + 0.872 ^c	3.588 + 1.327 ^b
AAGRDI X FARM	7.992 + 1.102 ^b	4.963 + 2.306 ^c
FARM X AAGRDI	6.706 + 1.175 ^a	3.156 + 1.819 ^b
WILD X FARM	7.628 + 1.098 ^b	4.546 + 2.096 ^f
FARM X WILD	8.329 + 0.866 ^f	5.244 + 1.851 ^b
FARM X FARM	7.113 + 0.899 ^d	3.299 + 1.329 ^b
WILD X WILD	8.583 + 0.843 ^f	5.854 + 1.851 ^b
AAGRDI X AAGRDI	7.232 + 0.656 ^a	3.559 + 1.054 ^b

The different letters illustrate significant difference at P-value < 0.05



Chumphon Fisheries Test and Research Center environment

Mean length and weight data on the second month of the nine crosses are shown in Table 2. The cross WILD x AAGRDI had the highest length and weight increments. The results were significantly higher at 10 and 23% in length and weight increments than those of the AAGRDI x AAGRDI, respectively.

Buriram Fisheries Test and Research Center environment

Mean lengths and weights on the third month of the nine crosses (Table 3) showed that the cross AAGRDI x FARM had the highest increments in terms of length and weight. These were 5, 3, 4% and 24, 25 and 15% significantly higher in length and weight than the AAGRDI x AAGRDI, the FARM x FARM, and the WILD x WILD, respectively.

Table 2. Mean lengths/weights and standard deviations (+sd) of nine crosses of *M. rosenbergii* grown in cages for two months at the Chumphon Fisheries Test and Research Center

Crosses (M x F)	Length (cm) + sd	Weight (g)+ sd
1. WILD x AAGRDI	8.122 + 1.074 ^b	4.681 + 1.870 ^{bc}
2. AAGRDI x WILD	7.676 + 1.468 ^c	4.036 + 2.393 ^a
3. AAGRDI x FARM	7.300 + 1.058 ^a	3.690 + 1.718 ^a
4. FARM x AAGRDI	7.506 + 1.357 ^a	4.102 + 2.364 ^{ac}
5. WILD x FARM	7.456 + 1.196 ^a	3.634 + 1.698 ^{dc}
6. FARM x WILD	7.210 + 1.356 ^a	3.502 + 1.952 ^{de}
7. FARM x FARM	7.131 + 1.165 ^d	3.274 + 1.797 ^d
8. WILD x WILD	7.736 + 1.150 ^{bc}	4.006 + 1.724 ^e
9. AAGRDI x AAGRDI	7.280 + 1.260 ^a	3.609 + 1.985 ^a

The different letters illustrate significant difference at P-value<0.05

Table 3. Mean lengths/weights and standard deviations (+sd.) of nine crosses of *M. rosenbergii* grown in cages for three months at the Buriram Fisheries Test and Research Center

Crosses	Length (cm) +sd	Weight (g) + sd
1. WILD x AAGRDI	10.430 + 1.805 ^b	17.220 + 6.050 ^c
2. AAGRDI x WILD	10.783 + 1.234 ^{bc}	16.140 + 6.571 ^b
3. AAGRDI x FARM	11.061 + 1.055 ^b	20.709 + 6.258 ^c
4. FARM x AAGRDI	10.447 + 1.273 ^a	16.710 + 6.910 ^{abc}
5. WILD x FARM	10.618 + 1.331 ^{ac}	17.740 + 5.715 ^{bc}
6. FARM x WILD	10.049 + 0.865 ^d	15.040 + 5.029 ^{de}
7. FARM x FARM	10.687 + 1.198 ^{eb}	15.450 + 6.162 ^{fb}
8. WILD x WILD	10.589 + 1.126 ^{ae}	17.430 + 5.375 ^a
9. AAGRDI x AAGRDI	10.496 + 0.738 ^a	15.770 + 4.394 ^a

The different letters illustrate significant difference at P-value<0.05

Uttaradit Fisheries Test and Research Center environment

Mean length and weight increment data on the fourth month for the nine crosses (Table 4) indicate that the cross AAGRDI x FARM had the highest length and weight increments, and these were significantly higher at 11, 12 and 13% than the AAGRDI x AAGRDI, the FARM x FARM and the WILD x WILD stocks, respectively.



Table 4. Mean lengths/weights and standard deviations (+sd) of nine crosses of *M. rosenbergii* grown in cages for four months at the Uttaradit Fisheries Test and Research Center

Crosses	Length (cm) + sd	Weight (g)+ sd
1. WILD x AAGRDI	12.982 + 1.094 ^a	24.354 + 8.143
2. AAGRDI x WILD	12.671 + 1.287 ^{ade}	24.449 + 6.478
3. AAGRDI x FARM	13.140 + 1.398 ^a	23.977 + 8.585
4. FARM x AAGRDI	13.822 + 1.872 ^b	22.083 + 7.900
5. WILD x FARM	12.500 + 1.565 ^{acc}	22.908 + 8.379
6. FARM x WILD	12.002 + 1.217 ^c	20.681 + 6.586
7. FARM x FARM	12.212 + 1.637 ^{dc}	21.965 + 8.802
8. WILD x WILD	12.044 + 1.160 ^c	22.035 + 8.375
9. AAGRDI x AAGRDI	12.267 + 1.588 ^{ec}	20.230 + 7.567

The different letters illustrate significant difference at P-value<0.05

Heterosis

The heterosis (in length and weight) for each hybrid cross was estimated using the following formula:

$$\% \text{ heterosis} = \frac{\text{reciprocal crosses' average value} - \text{parents' average value}}{\text{parents' average value}}$$

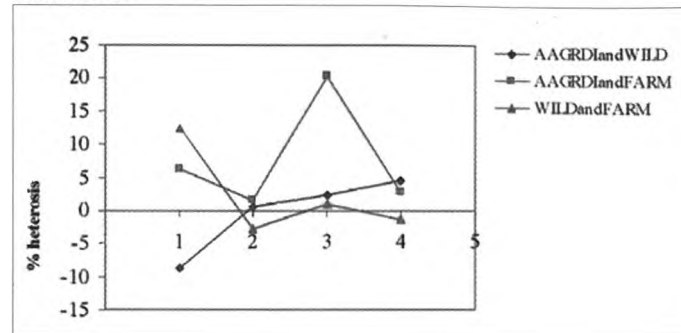
The heterosis of all reciprocal crosses is shown in Table 5. The hybrid stocks showed positive and negative heterosis values for each environment.

Table 5. Percent heterosis of growth (length and weight) of three reciprocal crosses of *M. rosenbergii* grown in four environments

Environments	Reciprocal Crosses	Heterosis %	
		Length	Weight
AAGRDI	AAGRDI & Farm	1.97	18.39
	AAGRDI & Wild	6.67	23.61
	Farm & Wild	1.66	6.96
CHUMPHON	AAGRDI & Farm	2.74	13.21
	AAGRDI & Wild	4.54	14.48
	Farm & Wild	1.35	1.98
BURIRAM	AAGRDI & Farm	1.58	19.86
	AAGRDI & Wild	0.61	0.48
	Farm & Wild	2.85	0.30
UTTARADIT	AAGRDI & Farm	20.28	9.16
	AAGRDI & Wild	2.28	15.47
	Farm & Wild	1.01	3.13



LENGTH



WEIGHT

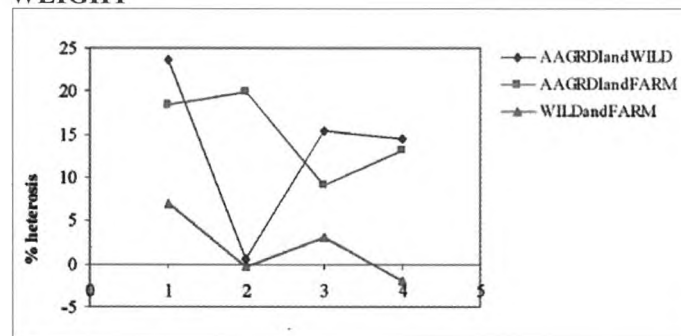


Figure 1. Percent heterosis in length-weight of three reciprocal crosses of *M. rosenbergii* (AAGRDI and WILD, AAGRDI and FARM, and WILD and FARM) grown in four different environments:

- 1= Aquatic Animal Genetics Research and Development Institute (AAGRDI)
- 2= Chumphon Fisheries Test and Research Center (CHUMPHON)
- 3= Buriram Fisheries Test and Research Center (BURIRAM)
- 4= Uttaradit Fisheries Test and Research Center (UTTARADIT)

Conclusions

There were differences in growth rate between three *M. rosenbergii* stocks and their hybrids. The heterosis of some crosses illustrated the possibility of improving the growth rate of *M. rosenbergii* by hybridization. However, selection within lines is necessary prior to hybridization. Likewise based on the results, the WILD x WILD cross is suitable for culture at the AAGRDI while the WILD x AAGRDI cross is suitable for culture at the Chumphon Fisheries Test Center. For the Buriram and Uttaradit Fisheries Test Centers, the AAGRDI x FARM and the FARM x AAGRDI crosses, respectively were found suitable. Finally, the differences in heterosis values in the different environments illustrated genotype-environment interaction on growth performance (Figure 1). Therefore, line performance growth test should be included at the early stages of the selective breeding program.



References

- Sodsuk KP, S Uraiwan, S Sodsuk. 2005. Allozyme marker based comparison on genetic variation among *Macrobrachium rosenbergii* populations produced from a cross-breeding system of three different stocks in Thailand. The Third Roundtable Discussion on the Development of Genetically Improved Strain of *Macrobrachium*. SEAFDEC. Thailand
- Sodsuk S, PK Sodsuk. 1998. Genetic diversity of giant freshwater prawn from three locations in Thailand. Technical paper No. 18/1998. National Aquaculture Genetic Research Institute, Department of Fisheries, Ministry of Agriculture and Cooperatives. 40 pp
- Uraiwan S, P Sodsuk. 2004. Selective breeding program for genetic improvement of *Macrobrachium rosenbergii* in Thailand. The Second Roundtable Discussion on the Development of Genetically Improved Strain of *Macrobrachium*. SEAFDEC, Phillipines
- Uraiwan S, S Sumanojitraporn, K Ampolsak, Jeemik. 2003. Genetic Response to within-family selection on growth rate of giant freshwater prawn (*Macrobrachium rosenbergii*). Technical paper no. 3/2003 Aquatic Animal Genetics Research and Development Institute. Department of Fisheries. 22 pp