



SELECTIVE BREEDING PROGRAM FOR GENETIC IMPROVEMENT OF *MACROBRACHIUM ROSENBERGII* IN THAILAND

I. Growth comparison of three *Macrobrachium rosenbergii* stocks and their reciprocal crosses grown in four environments

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INTRODUCTION

Three stocks of *Macrobrachium rosenbergii* including “AAGRDI” (Aquatic Animal Genetic Research and Development Institute), “FARM” (Petchaburi Farm) and “WILD” stocks were used for the selective breeding program. Generally, the good base population for genetic improvement program required high genetic variations as well as suitable stock that can be adapted for each local environment. Therefore, all proper crosses of these three stocks need to be evaluated on both performances and genetic variations before selective breeding program takes place. Thus, the program was divided into two parts: (1) evaluation of growth performance of the three stocks and their reciprocal crosses grown in four environments; and (2) establishment of improved economic traits of the best cross by 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 5x5x1.5 m² net cages at the three Fisheries Test and Research Centers in Chumphon, Buriram and Uttaradit Provinces. The “AAGRDI” stock was the *M. rosenbergii* that has been selected for improving growth rate of 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 pairs of *M. rosenbergii* from each three stocks were collected to initiate the base population. Each stock has been spawned and reared separately, the offspring of which were reared in three 20 m² concrete ponds at the AAGRDI. The growth performances of *M. rosenbergii* from the three stocks were observed from August 2003 to January 2004 (Uraiwan and Sodsuk, 2004). The results illustrated that the *M. rosenbergii* of the “AAGRDI” stock performed better than those of the “WILD” and “FARM” stocks at averages of 4% and 9-15% in lengths and weights, respectively. In addition, allozyme electrophoresis has been carried out to estimate genetic variabilities (heterozygosity and number of alleles per locus) of three stocks. were similar to those of *M. rosenbergii* from the natural waters {No 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 genetic diversity among the three (3) stocks (Sodsuk *et al.*, 2005).

Performance growth test on nine crosses

Reciprocal crosses of the 3 stocks were conducted from November 2004 to August 2005 to establish 9 cross-lines. The crosses identified by the male and female parents of each cross, starting with the male parents followed by the female parents, are as follows: AAGRDI x AAGRDI, WILD x WILD, 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 male and female *M. rosenbergii*. The hatching and nursing period took place at the AAGRDI and the Petchaburi Fisheries Test and Research Center in different periods, and the post larvae were stocked for the performance growth test in four environments as indicated in following table:



Month and Year	Place of hatching and nursing	Places and environments of cross-line performance growth test
November 2004	AAGRDI	18 cages at the Uttaradit Fisheries Test and Research Center
July 2005	AAGRDI	18 cages at the Buriram Fisheries Test and Research Center
August 2005	Petchaburi Fisheries Test and Research Center	18 cages at Chumphon Fisheries Test and Research Center
August 2005	AAGRDI	18 concrete ponds at the AAGRDI

The 9 crosses have been reared in the abovementioned environments for eight months. Similar experimental procedures such as stocking density, feeding regime and measurement schedules were used in all cases. The stocking rate of 10 and 1 prawn/m² was used during the 1st to the 4th month and the 5th to the 8th month of the experiment, respectively. The prawns were fed with commercial pellet shrimp 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 starting time, the monitored were the growth in lengths and weights of *M. rosenbergii* at the 2nd month for the AAGRDI and the Chumphon Fisheries Test and Research Center, and the 3rd and the 4th month for the Buriram and Uttaradit Fisheries Test and Research Centers, respectively.

1.1. The AAGRDI environment

Mean lengths and weights during the 2nd month of the 9 crosses are shown in Table 1. The cross WILD x WILD gained the highest in lengths and weights. It was significantly higher 15, 17 and 39, 43 % in lengths and weights than those of the AAGRDI x AAGRDI and the FARM x FARM, respectively.

Table 1. Mean lengths/weights and standard deviations (+sd.) of 9 crosses of *M. rosenbergii* grown in concrete ponds for two months at the AAGRDI environment

Crosses	Length (cm.) \pm sd.	Weight (g.) \pm sd.
1. WILD x AAGRDI	7.516 \pm 0.864 ^b	3.905 \pm 1.687 ^e
2. AAGRDI x WILD	7.244 \pm 0.872 ^c	3.588 \pm 1.327 ^g
3. AAGRDI x FARM	7.922 \pm 1.102 ^b	4.963 \pm 2.306 ^e
4. FARM x AAGRDI	6.706 \pm 1.175 ^e	3.156 \pm 1.819 ^b
5. WILD x FARM	7.628 \pm 1.098 ^b	4.546 \pm 2.096 ^f
6. FARM x WILD	8.329 \pm 0.866 ^f	5.244 \pm 1.851 ⁱ
7. FARM x FARM	7.113 \pm 0.899 ^d	3.299 \pm 1.329 ^h
8. WILD x WILD	8.583 \pm 0.843 ^f	5.854 \pm 1.851 ^a
9. AAGRDI x AAGRDI	7.232 \pm 0.656 ^a	3.559 \pm 1.054 ^g

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

1.2. The Chumphon Fisheries Test and Research Center environment

Mean lengths and weights on the 2nd month of the 9 crosses are shown in Table 2. The cross WILD x AAGRDI had the highest lengths and weights. It was significantly higher at 10 and 23% in lengths and weights than those of the AAGRDI x AAGRDI, respectively.

1.3. The Buriram Fisheries Test and Research Center environment

Mean lengths and weights on the 3rd month of the 9 crosses (Table 3) showed that the cross AAGRDI x FARM gained the highest in lengths and weights, which was 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 9 crosses of *M. rosenbergii* grown in cages for two months at the Chumphon Fisheries Test and Research Center environment

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

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

Table 3. Mean lengths/weights and standard deviations (+sd.) of 9 crosses of *M. rosenbergii* grown in cages for three months at the Buriram Fisheries Test and Research Center environment

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

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

1.4. The Uttaradit Fisheries Test and Research Center environment

Mean lengths and weights on the 4th month of the 9 crosses (Table 4) indicated that the cross AAGRDI x FARM had the highest lengths and weights, which was significantly higher at 11, 12 and 13% than the AAGRDI x AAGRDI, the FARM x FARM and the WILD x WILD, respectively.

Table 4. Mean lengths/weights and standard deviations (+sd.) of 9 crosses of *M. rosenbergii* grown in cages for four months at the Uttaradit Fisheries Test and Research Center environment

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

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

Heterosis

The heterosis in lengths and weights for each hybrid cross-line was estimated using the following formula:

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



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

2.1 The AAGRDI environment

- 2.1.1 The hybrid AAGRDI and FARM was significantly different from the AAGRDI and the FARM stocks (heterosis= 1.97% in length and 18.39% in weight).
- 2.1.2 The hybrid AAGRDI and WILD was significantly different from the AAGRDI and the WILD stocks (heterosis= -6.67% in length and -23.61% in weight).
- 2.1.3. The hybrid WILD and FARM was significantly different from the FARM stock (heterosis= 1.66% in length and 6.96% in weight).

2.2. The Chumphon Fisheries Test and Research Center environment

- 2.2.1 The hybrid AAGRDI and FARM was significantly different from the FARM stock (heterosis= 2.74% in length and 13.21% in weight).
- 2.2.2 The hybrid AAGRDI and WILD was significantly different from the AAGRDI stock (heterosis= 4.54% in length and 14.48 % in weight).
- 2.2.3 The hybrid WILD and FARM was significantly different from the FARM stock (heterosis= -1.35% in length and -1.98% in weight).

2.3. The Buriram Fisheries Test and Research Center environment

- 2.3.1 The hybrid AAGRDI and FARM was significantly different from the AAGRDI stock (heterosis= 1.58% in length and 19.86% in weight).
- 2.3.2 The hybrid AAGRDI and WILD was significantly different from the AAGRDI stock (heterosis= 0.61% in length and 0.48 % in weight).
- 2.3.3. The hybrid WILD and FARM was significantly different from the FARM stock (heterosis= -2.85% in length and -0.30% in weight).

2.4. The Uttaradit Fisheries Test and Research Center environment

- 2.4.1 The hybrid AAGRDI and FARM was significantly different from the AAGRDI stock (heterosis= 20.28% in length and 9.16% in weight).
- 2.4.2 The hybrid AAGRDI and WILD was significantly different from the AAGRDI stock (heterosis= 2.28% in length and 15.47 % in weight).
- 2.4.3. The hybrid WILD and FARM was significantly different from the FARM stock (heterosis= 1.01% in length and 3.13% in weight).

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
	Farn&Wild	1.66	6.96
CHUMPHON	AAGRDI&Farm	2.74	13.21
	AAGRDI&Wild	4.54	14.48
	Farn&Wild	-1.35	-1.98
BURIRAM	AAGRDI&Farm	1.58	19.86
	AAGRDI&Wild	0.61	0.48
	Farn&Wild	-2.85	-0.30
UTTARADIT	AAGRDI&Farm	20.28	9.16
	AAGRDI&Wild	2.28	15.47
	Farn&Wild	1.01	3.13



CONCLUSION

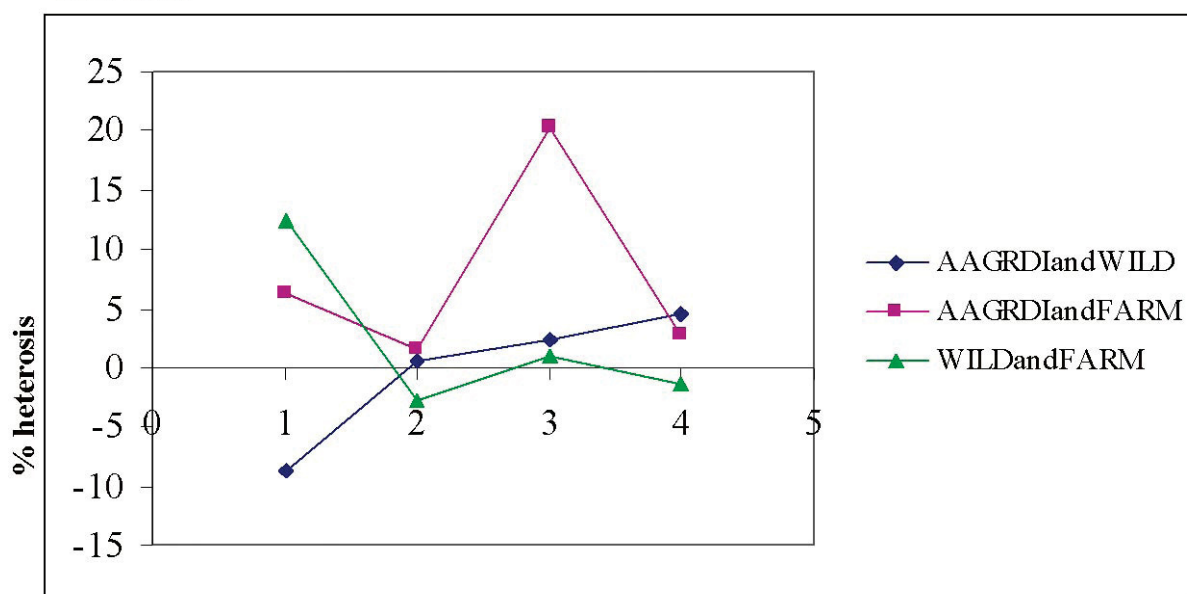
1. There were differences in growth rate between three *M. rosenbergii* stocks and their hybrids.
2. The heterosis of some crosses illustrated the possibility of improving the growth rate of *M. rosenbergii* by hybridization. However, the selection within lines is needed before the hybridization.
3.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

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LENGTH



WEIGHT

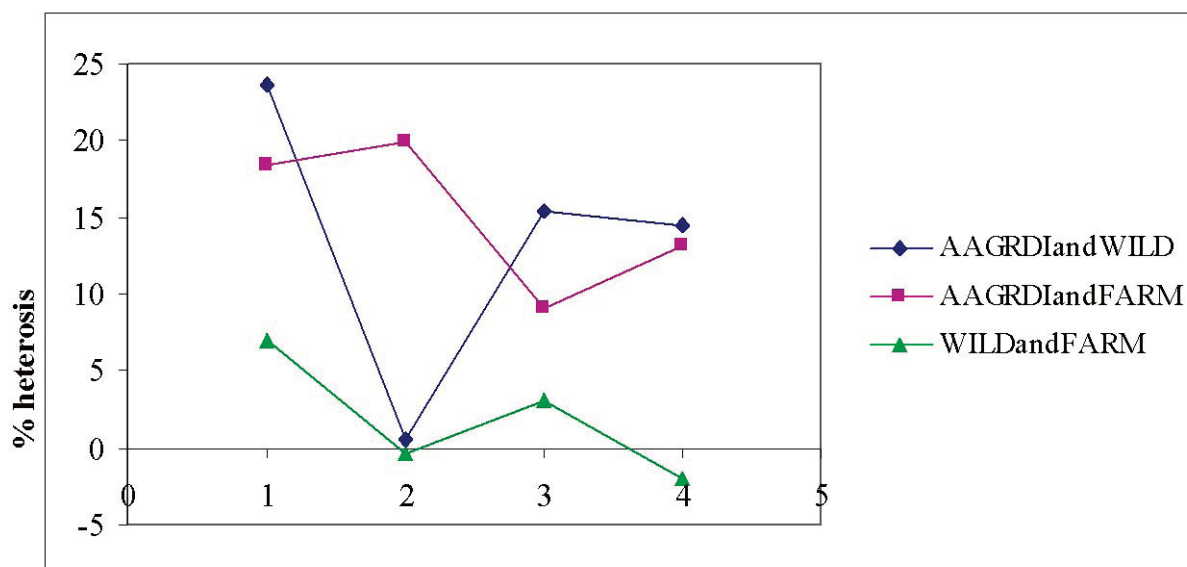


Fig. 1 Percent heterosis in length -weight of 3 reciprocal crosses of *M. rosenbergii* (AAGRDI and WILD, AAGRDI and FARM, and WILD and FARM) grown in 4 different environments:

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)