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Studies of Morphometric and Meristic Characters and Early Growth of Different Strains and Crossbred of Silver Barb, *Barbodes gonionotus* Bleeker

Tahmina Akhter, [1]M. Sadiqul Islam, [1]Lutfun Hussain and [2]M.G. Hussain
[1]Department of Fisheries Biology and Genetics,
Bangladesh Agricultural University, Mymensingh -2202,
[2]Bangladesh Fisheries Research Institute, Mymensingh, Bangladesh

Abstract: Two wild strains of *Barbodes gonionotus* obtained from Indonesia and Thailand and an existing stock were used to develop a crossbred (F_3) through selective breeding using 3 x 3 diallele crossing method and characterized by morphometric, meristic and growth study. Morphometric studies showed that there was no significant difference among the strains. Relationship of body length with body weight, head height, head length, body width, caudal peduncle length, pectoral fin length and pelvic fin length of these four strains was linear. The crossbred gave significantly ($P<0.05$) higher value for anal fin rays than that recorded for other three strains. Three days old larval size was significantly different among the strains, Bangla and crossbred showed higher length than that of others. In frequency distribution analysis of 3 days old larval size showed comparatively great percentage of lower length group (3 mm) in Thai and Indo strain and comparatively great percentage of higher length group (4.5 mm) in Bangla and crossbred strain. Bangla and crossbred showed better quality performance among the four strains. In outdoor growth (g/day), crossbred (0.0057) showed higher than that of Bangla strain (0.0043) but they were not significantly different. Survival rate of crossbred (12%) also higher than that of Bangla (10%) strain. Several desired effects of different characters of crossbred in general observed in the present experiment have tempted to conclude that this stock may economically be cultured in Bangladesh.

Key words: Morphometric, meristic, crossbred, *Barbodes gonionotus*

INTRODUCTION

An improved stock, crossbred can be developed through selective breeding and crossbreeding. Crossing between native and introduced strain can accumulate large number of genetic variability. The Jian carp was developed through a combined breeding technique that integrated family selection, inter-line cross and gynogenesis. It demonstrates some distinguishing characteristics such as fast growth, beautiful body shape (long figure) and grayish color (Sun *et al*., 1995).

Silver barb (*B. gonionotus*) is a popular species among fish farmers in the present days in Bangladesh and else where in South-West Asia (Gupta and Rab, 1994). Two wild germplasms of *B. gonionotus* obtained through ICLARM from Thailand and Java, Indonesia in 1994 and one existing stock introduced from Thailand in 1977 were reared for genetic stock improvement in Freshwater Station (FS), Bangladesh Fisheries Research Institute (BFRI), Mymensingh. These three stocks had been bred through three generations and a 3rd generation crossbred (F_3) obtained through selective breeding and line crossing technique. Considering the need for an investigation the present study was undertaken to determine the morphometric and meristic characteristics and growth performance of these three stocks and F_3 crossbred generation.

MATERIALS AND METHODS

Two wild germplasms (Thai and Indo) and one existing stock (termed as Bangla) of *B. gonionotus* were reared in three earthen ponds separately in FS, Bangladesh Fisheries Research Institute (BFRI). In initial year 1994, they mated themselves under normal breeding programme to produce F_1 generation.

During the spawning season of 1996, all F_1 generations (Thai x Thai, Indo x Indo, Bangla x Bangla) were cross mated following a 3x3 complete diallele

Table 1: Complete diallele crossing among three strains of *B. gonionotus*

F / M	I	T	B
I	II	IT	IB
T	IT	TT	TB
B	IB	TB	BB

I = Indonesian stock, T = Thai stock,
B = Bangla stock, M = Male, F = Female

crossing scheme as shown in Table 1 with a goal to know the baseline information on the performances of pure stocks and their reciprocal crosses. A total of nine genetic groups consisting of six different crosses and three control progenies were derived from diallele crosses. Among diallelic crossed 9 groups, only 6 crossbred populations were taken into consideration to be putatively outbred and heterogeneous i.e. having a high degree of heterozygous loci. The F_2 six genetic groups were reared communally to reduce the problem of pond effect and differential survival effects. In 1997 three full sib groups of spawn produced from three pairs of brood with in each crossbred groups, only 125 x 3 = 375 spawn were taken and as such a total of 15 full sib families from 15 pairs of broods 125 x 15 = 1875 spawns were nursed communally in two ponds. This F_3 crossbred generation of these stocks and purebred were used in this present study. The stocking density and feeding of each experimental pond were same during the study period. Fig. 1 showed the morphometric, meristic and growth characters of crossbred and purebred.

Total weight of fishes was taken by a sensitive electric balance (Metler AJ. 100, Metler Toled OAG). Measurements of the total length were made by placing the fish sample on a measuring board, to the centimeter. The depth of the body, head length, head height, pectoral fin length, length between pectoral and pelvic, length of anal fin base, caudal peduncle length, pelvic fin length, anal fin length, body width were measured with a varnier caliper, to the nearest centimeter. Vertebrae count was made after removing flesh carefully with forceps from a properly boiled fish.

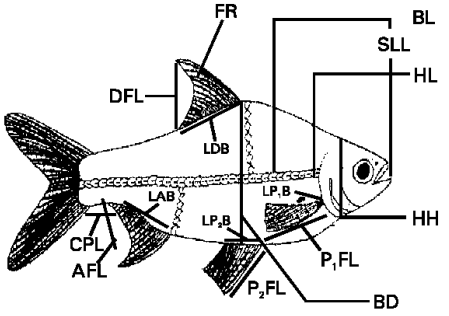

Fig. 1: Schematic diagram of *B. gonionotus* showing the methods of morphometric and meristic study (BL - body length, HL - head length, HH-head height, BD - body width, SLL - scales on lateral line, CPL-caudal peduncle length, P_1FL - pectoral fin length, P_2FL - pelvic fin length, DFL-dorsal fin length, AFL - anal fin length, LAB - length of anal base, LDB-length of dorsal base, LP_1B - length of pectoral base, LP_2B - length of pelvic base and FR- fin ray).

Due to limitation of nursery pond growth study was measured only in crossbred and Bangla strains. The male and female brood was collected from ponds for hypophysation (Hussain *et al.*, 1987). Hatchlings were reared in a well manage nursery pond. Sampling for growth (length and weight) estimation was done at weekly intervals up to harvest. The ponds were harvested after 36 days rearing by repeated netting followed by ultimate drying of the ponds, after which the growth, specific growth rate and survival of fingerlings were estimated.

All statistical analyses were performed by SPSS program in computer (Version 7). Statistical differences within groups for each character were determined following the LSD test for means with unequal number of replication.

RESULTS

Four experimental groups of strain were observed to evaluate their morphometric and meristic characters. All groups of *B. gonionotus* have strongly compressed body, small head minute barbels. Body length, body weight, head length, body height, pectoral fin length, caudal peduncle length, pelvic fin length, anal fin length, body width, of four strains were measured and their mean values were shown in Table 2. The morphological analysis showed that there was no significant difference among the four experimental strains. However, body length, head length, pectoral, pelvic and anal fin lengths were found to be higher in Thai strain compared to others. In general, crossbred recorded intermediate values for most of the measurements related to external characteristics. The body height of crossbred was higher (7.69 cm) than that of pure strains (6.78 cm). The ratio between body length, head height (BL/HH), length of anal base (BL/LAB) and also pectoral fin length (BL/P_1FL) of crossbred were significantly ($P<0.05$) lower than that of other strains (Table 3). However, ratios related to body length and head length (BL/HL), body width (BL/BD) and also caudal peduncle length (BL/CPL) of the different strains were not significantly different ($P<0.05$) between the strains.

The regression equations obtained with regard to some of the morphological characters of the four strains of *B. gonionotus* are given below along with the 'r' values.

1. Regression equation between body length (BL) and body weight (BW):

i.	Crossbred,	BW = - 4.981 + 10.85	BL (r = 0.968 P<0.01)
ii.	Bangla,	BW = - 2.847 + 9.82	BL (r = 0.862 P<0.01)
iii.	Thai,	BW = - 4.94 + 11.10	BL (r = 0.935 P<0.01)
iv.	Indo,	BW = - 2.037 + 8.92	BL (r = 0.819 P<0.01)

Table 2: Morphological characteristics of four different strains of *B. gonionotus*

Parameter	Strain				
	Bangla (n = 11)	Thai (n= 9)	Indo (n = 11)	Crossbred (n = 11)	CV (%)
Body length (cm)	18.82	19.83	18.65	18.34	10.06
Body weight (g)	185.802	40.20	175.33	209.09	41.88
Head length (cm)	4.35	4.63	4.44	4.23	12.28
Body height (cm)	6.78	7.63	6.60	7.69	16.04
Pectoral fin length (cm)	4.00	4.43	4.22	4.09	10.06
Length between pectoral and pelvic (cm)	4.65	4.88	4.58	4.79	15.08
Length of anal fin base (cm)	2.44	2.59	2.43	2.58	12.49
Caudal peduncle length (cm)	2.88	2.83	2.58	2.56	15.53
Pelvic fin length (cm)	3.93	4.16	4.06	4.09	9.36
Anal fin length (cm)	3.55	3.82	3.65	3.72	11.29
Body width (cm)	2.99	3.20	2.89	3.15	16.26
3 days old larval size (mm)	4.25^{b}	3.40^{a}	3.48^{a}	4.15^{b}	16.20

Values in the parenthesis indicate sample size in each strain.
^{ab} mean values having different superscripts differ significantly (P<0.05)

Table 3: Ratio between body length and other morphometric measurement of different strains of *B. gonionotus*

Parameter	Strain				
	Bangla (n = 2)	Thai (n = 9)	Indo (n = 9)	Crossbred (n = 11)	CV (%)
BL/HL	4.33	4.28	4.19	4.48	10.76
BL/HH	5.22^{a}	5.24^{a}	5.83^{a}	4.98^{b}	7.50
BL/BD	6.31	6.29	6.47	5.90	7.87
BL/LAB	7.75^{b}	7.71^{b}	7.69^{b}	7.12^{a}	7.46
BL/CPL	6.58	7.07	7.39	7.30	11.16
BL/P_1FL	4.79^{b}	4.78^{b}	4.59^{a}	4.48^{a}	5.41

Values in the parenthesis indicate sample size in each strain.
^{ab} mean values having different superscripts differ significantly (P<0.05)

Table 4: Meristic traits of four different strains of *B. gonionotus*

Parameter	Strain				
	Bangla (n= 11)	Thai (n= 9)	Indo (n= 9)	Crossbred (n= 11)	CV (%)
Dorsal fin rays	10.00	10.00	10.00	10.00	-
Pectoral fin rays	14.82	14.88	14.66	14.82	3.48
Pelvic fin rays	8.82	9.00	8.78	9.18	4.34
Anal fin rays	7.90^{a}	8.00^{a}	8.22^{a}	9.00^{b}	7.81
Caudal fin rays	24.73	24.78	24.33	25.64	7.81
Scales on lateral line	31.73^{b}	31.00^{a}	32.22^{b}	30.64^{a}	3.27
Vertebrae 32.00	32.00	31.66	32.00	1.46	

Values in the parenthesis indicate sample size in each strain.
^{ab} mean values having different superscripts differ significantly (P<0.05)

2. Regression equation between body length (BL) and head length (HL):

I. Crossbred, HL = 0.00777 + 0.2406 BL (r = 0.502)
ii. Bangla, HL = 0.018 + 0.230 BL (r = 0.611 P<0.05)
iii. Thai, HL = - 0.00086 + 0.233 BL (r = 0.950 P<0.01)
iv. Indo, HL = 0.01 + 0.2394 BL (r = 0.812 P<0.01)

3. Regression equation between body length (BL) and head height (HH):

i. Crossbred, HH = 0.00073 + 0.201 BL (r = 0.877 P<0.01)
ii. Bangla, HH = 0.0044 + 0.1905 BL (r = 0.779 P<0.01)
iii. Thai, HH = - 0.01112 + 0.1924 BL (r = 0.906 P<0.01)
iv. Indo, HH = - 0.0033 + 0.171 BL (r = 0.844 P<0.01)

4. Regression equation between body length (BL) and body width (BD):

i. Crossbred, BD = - 0.0128 + 0.1712 BL (r = 0.920 P<0.01)
ii. Bangla, BD = - 0.00153 + 0.1569 BL (r = 0.900 P<0.01)
iii. Thai, BD = - 0.00195 + 0.1623 BL (r = 0.904 P<0.01)
iv. Indo, BD = - 0.0428 + 0.1536 BL (r = 0.926 P<0.01)

5. Regression equation between body length (BL) and caudal peduncle length (CPL):

i. Crossbred, CPL = 0.017 + 0.139 BL (r = 0.213)
ii. Bangla, CPL = 0.0018 + 0.1518 BL (r = 0.689 P<0.05)
iii. Thai, CPL = - 0.0088 + 0.1490 BL (r = 0.705 P<0.05)
iv. Indo, CPL = 0.0106 + 0.1329 BL (r = 0.607)

6. Regression equation between body length (BL) and pectoral fin length (P_1FL):

i. Crossbred, P_1FL = 0.00768 + 0.2216 BL (r = 0.678 P<0.05)
ii. Bangla, P_1FL = 0.0119 + 0.209 BL (r = 0.429)
iii. Thai, P_1FL = 0.00112 + 0.2096 BL (r = 0.890 P<0.01)
iv. Indo, P_1FL = 0.0061 + 0.219 BL (r = 0.763 P<0.05)

7. Regression equation between body length (BL) and pelvic fin length (P_2FL):

i. Crossbred, P_2FL = 0.0304 + 0.2360 BL (r = 0.899 P<0.01)
ii. Bangla, P_2FL = 0.0201 + 0.2094 BL (r = 0.810 P<0.01)
iii. Thai, P_2FL = 0.0086 + 0.2167 BL (r = 0.904 P<0.01)
iv. Indo, P_2FL = 0.0244 + 0.2322 BL (r = 0.777 P<0.05)

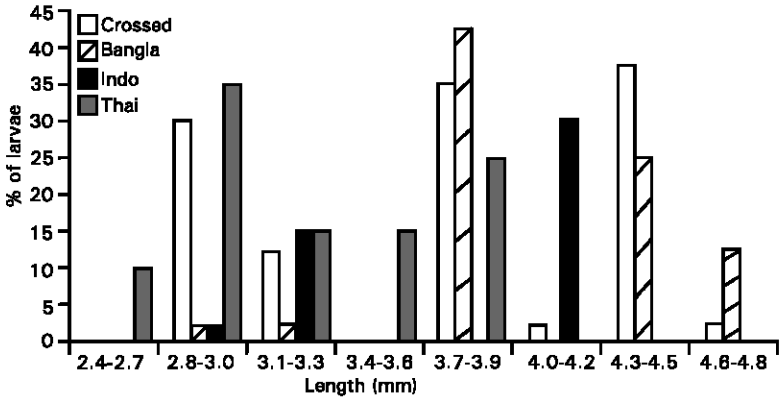

Fig. 2: Frequency distribution of length of 3 days old larvae of four different strains of *B. gonionotus*

Table 5: Outdoor (in nursery pond) growth and survival rate of two strains of *B. gonionotus* in the period of 36 days

				Growth					
Strain	No. of hatchling/m^2	Mean Initial length (mm)	Mean Initial weight (g)	Growth g/day	Specific growth rate/day(%)	No. of fry survival/m^2	Mean final length (mm)	Mean final weight (g)	Fry survival (%)
Crossbred	342	3.88	0.00058	0.0057	0.056	41	27.23	0.206	11.89=12
Bangla	342	4.20	0.00048	0.0043	0.082	33	25.58	0.158	9.69=10

It was evident from the results that the body weight, body width, head height, pelvic fin length of each strain were highly correlated with body length ($P<0.01$). While caudal peduncle length of Thai and Bangla strain showed correlation with body length at 5% level of significance, but the relationship showed by caudal peduncle length of Indo and crossbred was not correlated with body length. The pectoral fin length of Thai had correlation with body length at 1% level of significance and Indo and crossbred had correlation at 5% level of significance. The relationships of body length with body weight, head length, head height, body width, caudal peduncle length, pectoral fin length, pelvic fin length of these four strains were found to be linear.

In the meristic characteristics there was significant variations among the strains for certain traits. The crossbred gave significantly ($P<0.05$) higher mean value for anal fin rays than that recorded for other three strains. In contrast, lateral line scales of crossbred and Thai strains were significantly ($P<0.05$) lower than that of Bangla and Indo strains. Lower value for this trait was recorded for crossbred while highest value was observed in Indo strain (Table 4). The length of 3 days old larval size was significantly different. The Bangla and crossbred strains showed significantly higher length than that of other strains (Table 2). In nursery pond, significantly higher growth (g/day) was found in crossbred (0.0057) than that of Bangla (0.0043). The specific growth rate from 1st week to 2nd week in Bangla strain (0.082 % day) showed higher growth than that of crossbred (0.056% day). Survival rate of crossbred (12%) was higher than that of Bangla strains (10%) (Table 5). In frequency distribution analysis of 3 days old larval size showed that comparatively greater percentage of lower length group (3 mm) were in Thai and Indo strains and comparatively greater percentage of higher length group (4.5 mm) were in Bangla and crossbred strains (Table 7).

DISCUSSION

The evaluation of various characteristics is an important part of any biological study aimed at genetic improvement of fish stock. Phenotypic variations among the strains and correlation between certain characteristics, indoor and outdoor growth studies are the most prominent characteristics, which can be used as an indicator for improved breed in aquaculture.

No statistical significant variations were found among strains based on morphological data indicating that these four strains are morphologically identical. Presumably, the crossbred would have characteristics that are intermediate among the pure strains for most of the measurements related to external characteristics. However, body height of crossbred had the highest value compared to the other strains. The hybrids may appear morphologically intermediate for all characters combined, but for a specific character it may closely resemble one of the two parental cyprinid species (Ross and Cavender, 1981; Leary and Annendorf, 1983). Differences occurred only in the ratio of length of anal base and head height to body length among the strains. Crossbred had higher proportion of head length and lower proportion of body

width in relation to body length. Indo stock had higher body depth, higher caudal peduncle length and anal base length. Bangla stock had relatively high pectoral fin length. The deep and wide body and relatively small head (higher body length/head length value and lower body length/body depth) are the most preferred characteristics as these are related to the edible parts of the fish body. This ratio measurement provides that the crossbred had small head and deep body i.e. the most preferred characteristic. The high values of correlation coefficient (r = 0.213 - 0.968) indicated that the variables are highly correlated in all the four strains tested with respect to their body length, pectoral fin length and pelvic fin length. The result indicated that these four strains are also similar morphometrically.

Meristic characters, as illustrated by the number of rays in dorsal fin, pectoral fin, pelvic fin, caudal fin, vertebrae of four strains of *B. gonionotus* are almost similar. However, differences exist between anal fin rays and lateral line scale. In this study, the number of lateral line scale ranged from 30-33 and the number of anal fin rays ranged from 8-9, crossbred had higher number of anal fin rays. Some minor differences occur between four strains these measurements xhibit considerable overlap. In the later case, were difficult to measure rapidly and accurately. Etnier (1968) showed that scale and fin ray counts do not reveal enough differences between the sunfish hybrid in three Mennesota Lake. Islam *et al.* (1973) reported that meristic characters like the number of scale rows, vertebrae, fin rays, branchiostegal rays etc. can be modified by changing the water temperature at the time of early development. Hussain *et al.* (1995) studied phenotypic variations (various fin rays and scale counts) in meiotic and mitotic gynogenetic diploid of the Nile tilapia *Oreochromis niloticus* (L). They studied two main trends in majority of the traits – a decrease in the mean of each trait in the ranked order normal diploid > meiotic gynogenetic > mitotic gynogenetic an expansion of its phenotypic variation in the order normal diploid < meiotic gynogenetic < mitotic gynogenetic.

There was significant difference in the length of 3 days old larvae between the strains. Crossbred and Bangla strain showed significantly higher length than other strains. In general larger fry permits to produce larger fish. The observed strain to strain differences was probably due to strain to strain variation in egg sizes. Larger egg size may be an important index because larger egg produces larger fry (Gall 1974, Dunham *et al.*, 1983). In the frequency distribution analysis of 3 days old larvae showed that comparatively greater percentage of lower length group (3 mm) were found in Thai and Indo strain and comparatively greater percentage of higher length group (4.5 mm) were found in Bangla and crossbred strain. A comparison of 36 day's growth in nursery pond between crossbred and Bangla strain indicated that no significant difference exists. The mean weight gain for the period from stocking day to draining for crossbred and Bangla was 0.206 and 0.158 g respectively. It indicated that crossbred grew at a faster rate than Bangla strain. This weight advantage may be resulted from genetic gains brought about by selection. Strain to strain variation was also observed in the survival rate. The survival rate of crossbred and Bangla was 11.89 and 9.69% respectively. However, the overall survival rate as obtained from the strains tested was lower than that reported by Tangtrongpiros *et al.* (1990). However, the quantity and quality of fingerlings depend on the way larvae are treated during this critical period.

Significant heterosis has been demonstrated in common carp when different strains were crossbred (Wohlfarth, 1993). Most production characters are the so-called polygenic characters; that is, they are controlled by many genes, are strongly influenced by environmental variation have a continuous phenotypic expression. The combination of high reproductive traits, high growth rate, along with large phenotypic variation of fish may be taken in consideration for mass selection to obtain faster growth in a given species. Present study reveals that better genetic strain in terms of morphometric and meristic characters and growth performances can be obtained from crossbred population compared to purebred stock.

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