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Growth performance and morphological variations of local and Thai climbing perch (*Anabas testudineus*, Bloch)

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Abstract
Climbing perch locally known as koi (*Anabas testudineus*) is a popular food fish in our country. Thai climbing perch was introduced in Bangladesh from Thailand. To explore the variation in growth performance and morphological features of local and Thai climbing perch a study was undertaken. The highest gain in length, weight and SGR were found in Thai koi 12.23±0.38 cm, 55.83±0.53 g and 7.92±0.11 %/day respectively. Fourteen morphometric characters were studied where eleven (TL, SL, HL, HBD, LBD, DFL, PECFL, PELFL, AFL, UJL and LJL) showed significant difference ($p<0.01$) in Thai koi from the local ones. Of the meristic characters no. of dorsal fin rays (hard), anal fin rays (hard), caudal fin rays and scale along lateral line (upper and lower) as recorded from the Thai koi were significantly higher ($p<0.01$) than that of the local koi. The no. of dorsal fin rays (soft) in Thai koi were also significantly higher ($p<0.05$) from that of local koi. The number of vertebra were also variable in local and Thai climbing perch (25 incase of local koi and 26 incase of Thai koi). Hence, the results obtained form the present study satisfy the characteristics of *A. testudineus* which reveals that both the local and Thai koi belongs to the same species. Growth performance of Thai koi was better compared to local koi reared in same conditions.

Key words: Growth performance, Morphological variation, *Anabas testudineus*

Introduction

Climbing perch locally known as koi, *Anabas testudineus* is widely distributed in South and South- East Asia and is a highly esteemed food fish. Once upon a time it was abundantly available in almost all freshwater bodies of Bangladesh. But its recent trends showing a continuous dilapidated tendency due to various manmade interventions and as well as to natural factors. A decade ago the contribution of koi was 2.83% in the total inland catch of Bangladesh (DoF 1992) but latter it turned down to 0.85% (DoF 1999). Hence fisheries biologists are thinking of its cultivation through intensive farming (DoF 2002). The main impediment is the unavailability of seed for any viable stocking program. Therefore, hormone induced breeding could be the possible alternative for

commercial culture of this species. Side by side attempts were also made to boost up the aquaculture production through incorporation of Thai koi. Thai koi is more or less resembles to our local koi and its great aquaculture potentiality has already been inspired our farmers for pond aquaculture due to its domesticated characteristics.

Growth is the function of time, environment, hormone and synthesis of absorbed food materials into tissue of the living system of organism (Hasan 2003). Research on growth performance of Indian major carps is being performed in our country. The distinguishing characteristics of *A. testudineus* have also been provided by Sterba (1973), Kottelat *et al.* (1993) and Talwar and Jhingran (1991). But the growth performances and morphological comparison between local and Thai koi still needs to be standardized to be recommended at the poor farmer level for commercial cultivation. Therefore, objectives of the present study are to compare the growth performance of local and Thai koi and identification of morphological differences between local and Thai koi.

Materials and methods

Sample collection: The local koi was collected from the adjacent paddy field around the Bangladesh Agricultural University campus area and Thai koi was collected from the Brahmaputra Fish Seed complex, Shambugonj, Mymensingh. Details of the sample collection, sample size and date of collection are given in Table 1. After collection of samples they were reared in six newly constructed ponds (9.5x6.1x0.8 m^3) at the Southern side of the Fisheries Faculty Building under the same feeding strategy (common supplemental feed administered twice a day). Thirty individuals were collected randomly from each stock and subjected to morphological analysis after completion of the growth study.

Table 1. Source, sample size and collection date of the experimental fish

Source	Sample size	Date of Collection
Local koi (wild)	600	July 10, 2004
Thai koi [Brahmaputra F.S. complex]	600	July 7, 2004

Growth study: Six newly constructed small (9.5x6.1x0.8 m^3) rectangular ponds with outlet and inlet facilities at the southern side of Fisheries Faculty Building were used for the growth study of *A. testudineus*. The experiment was carried out for fifty days and sampling were done at 10 days interval to record length gain (cm) and weight gain (g).

Pond preparation: The experimental ponds were fenced by nylon net with the help of bamboo sticks to ensure the experimental fishes remain confined in their respective ponds even if the ponds get inundated due to sudden excessive raining. Lime at the rate of 1 kg/40m^2 was applied to all the experimental ponds. Ten days after liming, cow dung at the rate of 20 kg/40m^2 and wheat flower at the rate of 1 kg/40m^2 was applied to all the

experimental ponds for huge production of zooplankton. Netting was done to remove small frogs and water bugs from the experimental ponds before three days of fingerling stocking.

Stocking of fry: Fry colleted from two different localities were kept in indoor cisterns for about 10 hours for conditioning prior to releasing in ponds. Then samples were stocked in the experimental ponds having three replications for each population after proper conditioning at the afternoon. Each replication contained 200 fries (average length 1.95±0.58 cm and weight 0.55±0.19 g in case of local koi and 2.40±0.53 cm and 1.28±0.42 g in case of Thai koi).

Feeding and rearing of the experimental fish: The stocked fry were reared separately for 50 days and a common supplemental feed containing 50% fish meal, 20% wheat bran, 20% rice bran, 10% soybean meal was administered to all the stocked fishes twice a day. Initially the feeding rate was 12% and prior to the last sampling it was 8% (on the basis of the body weight of the stocked fry). Because, the quantity of feed was adjusted every 10 days depending upon the increase in the average body weight of the stocked biomass. Fish meal, soybean meal, wheat bran and rice bran were ground into powder form and the required quantities of all ingredients mixed homogenously in such a way to make them into small sized balls and spread it to the pond surface.

Proximate composition of feed ingredients: Proximate composition of the feed ingredients were determined following the standard methods given by Association of Official Analytical Chemists (AOAC 1980) in the Fish Nutrition Laboratory of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh. Proximate composition of the different feed ingredients is shown in Table 2.

Table 2. Proximate composition of the feed ingredients

Ingredients	Dry matter (%)	Protein (%)	Lipid (%)	Ash (%)	NFE*(%)
Fish meal	91.66	60.95	8.16	14.28	8.27
Soybean meal	90.14	44.65	1.37	7.51	36.61
Rice bran	91.35	13.63	4.00	11.25	62.47
Wheat bran	89.83	12.58	3.54	4.47	69.24

*NFE=Nitrogen free extract calculated as 100 - (moisture + protein + lipid + ash)

Water quality parameters: Physico-chemical parameters like temperature, pH, dissolved oxygen (DO) of the water of the ponds were measured periodically to assess the water conditions remained within acceptable limits and water was exchanged as required. Temperature was recorded by using a Celsius thermometer, D.O. and pH were measured directly by a portable digital DO meter (Lutron DO-5509) and a digital pH meter (CORNING, Model 445) respectively. Before taking a measurement pH meter was properly adjusted with buffer solution pH 7.

Sampling procedure: The culture potentiality based on the growth performance under the same feeding strategy was assessed by recording the rate of growth in terms of gain in length (cm) and in weight (g) of fish every ten days. The length and weight were recorded by random sampling of 30 fish from each pond by using a small seine net. Weight was taken with a spring balance (DONGIL-15 kgx50 g) and length with a measuring scale.

Data analysis of growth parameters: One-way analysis of variance (ANOVA) was used to determine the effect of the same feeding strategy over the growth performance of three replications for each population. This was done by following Duncan's New Multiple Range Test (Duncan's 1955) to identify the significant differences between the two populations of koi.

Morphological study

Morphometric characters: The 14 morphometric characters were measured following the conventional method described by Hubbs and Lagler (1958) with slight modification as noted below: Total length (TL), Standard length (SL), Head length (HL), Pre-orbital distance (PrOD), Post orbital distance (POD), Eye length (EL), High body depth (HBD), Low body depth (LBD), Dorsal fin length (DFL), Pectoral fin length (PECFL), Pelvic fin length (PELFL), Anal fin length (AFL), Upper jaw length (UJL), Lower jaw length (LJL) to the nearest 0.1 cm using a slide calipers.

Meristic characters: The nine meristic characters were measured following Hubbs and Lagler (1958) and these were: Branchiostegal rays, Dorsal fin rays (hard and soft), Pectoral fin rays, Pelvic fin rays (hard and soft), Anal fin rays (hard and soft), No. of vertebrae, Caudal fin rays and Scale on lateral line. A magnifying glass was used to count the fin rays.

Other external features of local and Thai koi: Besides the difference in different morphometric and meristic characters some observable variations were also found in different external features like- occipital shape, mouth shape, ventral view etc.

Morphological data analysis: Non-parametric statistical analysis was used in all the comparisons (Zar 1996). Differences in morphometric characters and meristic counts of fish were analyzed using the Kruskal-Wallis non-parametric analysis of variance (ANOVA). In case of significant differences between two groups non-parametric post hoc test (Zar 1996) was conducted.

Results

Growth study

The growth parameters i.e., length gain, weight gain and specific growth rate have been shown in Table 3. The highest gain in length, weight and specific growth rate were found in Thai koi and the parameters were significantly different from that of local koi (Table 3). The samplings were conducted at every ten days intervals to monitor diseases infestation and external injury but that type of phenomenon were not found during the entire period of experiment. Fish mortally was keenly monitored and effective record keeping procedure was maintained to deduct the number of dead fish from the final harvest.

Table 3. Effects of feed on the growth of local and Thai koi

Parameters	Local koi ($\bar{x}$ ± SE)	Thai koi ($\bar{x}$ ± SE)	*P*-value
Initial length (cm)	1.95±0.11	2.44±0.09	0.0002**
Final length (cm)	12.72±0.24	14.67±0.38	0.0001**
Length gain (cm)	10.77±0.25	12.23±0.38	0.0028**
Initial weight (g)	0.55±0.21	1.40±0.19	0.0000**
Final weight (g)	27.08±2.20	57.83±2.93	0.0000**
Weight gain (g)	26.54±0.47	55.83±0.53	0.0000**
Specific growth rate (SGR) (%/day)	7.05±0.14	7.92±0.11	0.0236*
Survival rate (%)	62.67±3.81	81.67±3.51	0.5154

** Values of the parameter differ significantly ($p<0.01$).
* Values of the parameter differ significantly ($p<0.05$).

Morphological study

Of the fourteen morphometric characters studied eleven (TL, SL, HL, HBD, LBD, DFL, PECFL, PELFL, AFL, UJL and LJL) showed significant difference ($p<0.01$) in case of Thai koi from the local ones (Table 4). Different proportions of the morphometric characters presented in Table 5 reveals that the proportion of TL: HL, SL: HL and BD: JL were significantly higher in Thai koi than that of the local koi ($p<0.01$), nevertheless the proportion of HL: JL was also significantly higher ($p<0.05$) in Thai koi from the measured value of the local koi (Table 5).

Table 4. Mean values of 14 morphometric characters as recorded from 2 populations; n = 30 for each group of local and Thai populations

Characters	Local koi (x ± SE)	Thai koi (x ± SE)	*P*-value
Total Length (TL)	8.86±0.03	10.03±0.03	0.0000**
Standard length (SL)	7.00±0.01	7.94±0.02	0.0000**
Head length (HL)	2.40±0.01	2.63±0.21	0.0002**
Pre-orbital distance (PrOD)	0.50±0.00	0.50±0.00	
Post orbital distance (POD)	1.00±0.00	1.00±0.00	
Eye length (EL)	0.50±0.00	0.50±0.00	
Body depth (HBD)	2.40±0.07	2.72±0.06	0.0000**
Body depth at anus (LBD)	2.40±0.07	2.72±0.06	0.0000**
Dorsal fin length (DFL)	4.05±0.02	5.08±0.03	0.0000**
Pectoral fin length (PECFL)	1.53±0.01	1.85±0.01	0.0000**
Pelvic fin length (PELFL)	1.19±0.61	1.50±0.96	0.0000**
Anal fin length (AFL)	2.83±0.21	3.17±0.77	0.0001**
Upper jaw length (UJL)	1.71±0.02	1.81±0.01	0.0001**
Lower jaw length (LJL)	1.51±0.06	1.61±0.041	0.0000**

** Values of the parameter differ significantly ($p<0.01$).

Table 5. Different lengths ratio between local and Thai koi

Population	TL: SL	TL: HL	TL: BD	SL: HL	SL: BD	HL: JL	BD: JL
Local	1.27±0.00	3.68±0.02	3.70±0.03	2.91±0.02	2.91±0.02	1.40±0.01	1.40±0.01
Thai	1.27±0.00	3.86±0.04	3.72±0.03	3.02±0.03	2.93±0.02	1.45±0.02	1.50±0.01
P value	0.327	0.000**	0.572	0.009**	0.651	0.050*	0.000**

** Values of the parameter differ significantly ($p<0.01$).
*Values of the parameter differ significantly ($p<0.05$).

The nine meristic characters presented in Table 6 were recorded from Thai and local koi. The no. of dorsal fin rays (hard), anal fin rays (hard), caudal fin rays and scale along lateral line (upper and lower) as recorded from the Thai koi were significantly higher ($p<0.01$) from that of the local koi. Thai koi also exhibited significantly higher ($p<0.05$) value in case of dorsal fin (soft) count than the counted value of the local ones. The other meristic parameters were very close for both. The no. of vertebra were 26 incase of Thai koi and 25 incase of local koi.

Table 6. Mean values of nine meristic characters as recorded from 2 populations n = 30 for each group of Local and Thai populations

Characters	Local	Thai	*P* value
BR	10.0±0.00	10.0±0.00	
DFR (Hard)	16.80±0.09	17.47±0.14	0.0000**
DFR (Soft)	9.00±0. 07	9.03±0. 08	0.0218*
PECFR	13.77±0.10	13.60±0.09	0.2582
PELFR (Hard)	1.0±0.00	1.0±0.00	
PELFR (Soft)	5.0±0.00	5.0±0.00	
AFR (hard)	9.53±0.06	9.97±0.09	0.0001**
AFR (Soft)	10.0±0.00	10.0±0.00	
CFR	15.43±0.01	16.10± 0.01	0.0000**
No. of vertebrae	25.0±0.00	26.0±0.00	
Scale along lt. line (Upper)	11.50±0.53	11.87±0.50	0.0137**
Scale along lt. line (lower)	16.97±0.74	17.67±0.80	0.005**
Scale on lt. line (Upper)	4.17±0.07	4.20±0.09	0.0746
Scale on lt. line (lower)	7.73±0.11	8.03±0.11	0.0711

** Values of the parameter differ significantly ($p<0.01$).
*Values of the parameter differ significantly ($p<0.05$).

Discussion

Thai koi was incorporated in our aquaculture few years back form Thailand and its faster growth rate impressed the farmers. But the information about the comparative growth performance and morphological variation of local and Thai koi is still inadequate. Some authors conducted some works dealing with taxonomic comparison (Hassan *et al.* 2005) and growth and feed utilization of climbing perch by Mustafa *et al.* (2004) in Bangladesh. Hence, present study might be the first approach in Bangladesh to elucidate the growth performance and morphological variation of local and Thai koi.

In the present study the observed variation in the growth performance exhibited by the local and Thai koi was probably due to their genetic differences as all the populations were reared under the same feeding strategy. The water quality parameters such as temperature, dissolved oxygen, pH and alkalinity of the six experimental ponds were within the suitable range and same for fish farming during the entire study period. Availability of suitable feed in sufficient quantity is one of the indispensable requirements for proper rearing of fish, another crucial factor like stocking density having direct affect on the growth of fish and its production (Backiel and Le Cren, 1978), though it was alike in all experimental ponds.

The growth increment in terms of length and weight gain as obtained in the present study was appreciating and higher in comparison to Khan *et al.* (2004) who conducted an experiment with *Pangasius hypophthalamus*. The better genetic make up of koi population could be attributed in showing such performance. The reasons behind the lower growth performances of local koi than Thai koi can also be interpreted from the

genetic point of view. Local koi is an endangered species and supposed to breed within a confined group as the number of breeder is inadequate and this has endorsed the local koi is exhibiting poor growth performance than the Thai koi. On the contrary, Thai koi was imported from Thailand in our country and may be their original predecessors were enriched with better genetic variation that has resulted in showing better growth performances.

The SGR as obtained in the present study for Thai koi (7.92%) and local koi (7.05%) was higher than that (0.02 to 0.68%) found by Khan *et al.* (2004) for *P. hypophthalmus* but lower than the value of (8.09 to 9.21%) obtained by Samad *et al.* (2004) in case of *Heteropneustes fossilis*. Nevertheless, the deteriorative growth performance exhibited by the local koi than the Thai koi may be due to poor genetic variation of local koi than the Thai koi (Alam 2006).

In the present study some morphometric characters (TL, SL, HL, HBD, LBD, DFL, PECFL, PELFL, AFL, UJL and LJL) tend to be significantly different in two populations. But the observed morphological differences may be due to the fact that their genetic quality might be different. The present findings more or less agree with those of Yokogawa (1998) who reported that the average values of each character varied considerably by population, representing its unique characteristics.

Variation in the meristic counts as obtained in the present study might be due to the fact that Thai koi is an exotic fish, so the breeding and rearing conditions in new environments might have influenced some of this meristic count. Schreck and Moyle (1990) and Kurata (1975) reported that the meristic counts of fishes are considered to be affected by environmental factors such as water temperature, pH etc. in fresh water.

The taxonomic formula as well as morphological characters should be remaining within the same range for individuals of every species. In the present study, slight variation was observed in morphological characters but it was within the range of *Anabas* genus (Bardach 1972). According to Roberts (1989) both local and Thai koi belongs to the same species. Hence the observable difference found in local and Thai koi may be due to the origin of samples from two different geographical regions.

Finally, it can be concluded that, though the present study was a preliminary investigation to explore the variation in growth performance and morphological parameters conducted with limited number of individuals it provided some important information such as the growth performance of Thai koi was better than our local koi within the same feeding strategy and same physico-chemical parameters. Hence Thai koi would be culturally viable for our farmers. Yet additional compressive studies need to be undertaken to justify their genetic and other relevant status.

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