




Morphometric and meristic comparison of local and Thai *Anabas testudineus*

Ismot Ara • Md. Rafiqun Nabi

Department of Zoology, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh.

Correspondence

Prof Md. Rafiqun Nabi; Department of Zoology, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh.

 rafiqunnabi53@gmail.com

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Abstract

Local and Thai climbing perch, *Anabas testudineus* are locally known as koi in Bangladesh. These two are important natural and cultured fish. This study was carried out the comparative investigations on morphometric and meristic of local and Thai *A. testudineus*. Both the varieties were collected from different fish markets in and around Savar. The morphometric characteristics were higher in Thai koi than local and among them; total length, standard length (SL), length of 1st and 2nd dorsal fin bases, length of 1st and 2nd anal fin bases, abdominal regional length were found different. Proportion of SL and head length (HL), HL and snout length, SL and caudal peduncle length were different between the two varieties. Among the meristic characteristics; number of dorsal spines, dorsal fin rays, anal spines, scale on upper lateral line were found difference between local and Thai koi. The body spots and the colour at pelvic fin region were also different. The present study suggested that local and Thai koi are morphometrically and meristically different in many aspects.

Keywords: *Anabas testudineus*; morphometric; meristic; Thai koi; koi; climbing perch

1 | INTRODUCTION

The climbing perch, commonly known as koi is scientifically recognized by Bloch (1792) and termed it *Anabas testudineus*. This species naturally occurs in Bangladesh, India, Pakistan, Burma, Sri-Lanka, Thailand, China, Hong Kong, Philippines, Polynesia and Malaysia (Talwar and Jhingran 1991).

Few decades ago *A. testudineus* was abundantly available in almost all freshwater systems of Bangladesh, but its recent trends showing a continuous dilapidated tendency (Mohsin *et al.* 2013; Chaki *et al.* 2014; Galib 2015). The reasons for such trend are ecological degradation, indiscriminate fishing, use of pesticides and fertilizers, habitats

alteration, obstruction of breeding migration (Mohsin *et al.* 2014; Joadder *et al.* 2015; Galib *et al.* 2009, 2016, 2018). Fish biologists are thinking for its cultivation through intensive farming (DoF 2002). Recently attempts have been made to boost up the aquaculture production through incorporation of an exotic strain of *A. testudineus* known as Thai koi, which was introduced in Bangladesh by private sector in 2002 from Thailand (Biswas and Shah 2009). The rapid growth, bigger size, omnivorous feeding habit, air-breathing characteristics and high tolerance to a wide range of environmental conditions soon caught the attention of farmers for its potential aquaculture.

However, taxonomic ambiguity is still present in *A. testudineus* as Bleeker (1855) reported that Thai koi as a varie-

ty of *A. testudineus* and Axelrod (1974) described it *A. oligolepis* though the name *A. oligolepis* is no longer used and *A. testudineus* is widely used for both the varieties. As Thai koi competes and breeds with local koi in open water bodies being escaped from unfenced ponds (Biswas and Shah 2009), it is inevitable to investigate their taxonomic characters to provide significant tools for further consequences of their cross-breeding.

Typically climbing perch are grey to green in colour, with one dark spot at the caudal base and another just behind the gill plate. The edges of their scales and fins are brightly coloured (Axelrod 1974; Sterba 1973). The opercle and preopercle are both serrated. The single dorsal and anal are both long. Fin counts are as follows: dorsal XVI–XVIII, 8–10, anal VIII–XI, 9–11, and pectoral 14–15 (Talwar and Jhingran 1991). The body is moderately deep, its depth 3 to 3.5 times in SL. There are 21–29 scales in a lateral series. The mouth is fairly large and the teeth are villiform. The elaborate labyrinth organ is in a cavity above the third or upper portion of the first branchial arch (Jayaram 1981). Hence, in the present study, a detailed comparison on morphometric and meristics characters was made between the local and Thai varieties of *A. testudineus*.

2 | METHODOLOGY

2.1 | Collection and preservation

Specimens of local and Thai variety of *A. testudineus* were collected from the different fish markets in and around Savar, Dhaka. A total of 25 mature specimens of each variety were collected and brought to the Laboratory of Limnology and Fisheries, Department of Zoology, Jahangirnagar University, Savar, Dhaka, Bangladesh. The specimens were analysed in fresh condition and without using any preservative for qualitative observations. Afterwards, specimens were labelled and preserved in 5% formalin for further study.

2.2 | Morphometric data measurements

Different measurements (Figure 1) of the specimen were considered in this study following the method described by Lagler *et al.* (1977).

2.3 | Meristic data measurements

Various countable characteristics (e.g. number of spine or rays in different fins, number of scales above and below lateral line, number of scale on lateral line) were recorded. The lateral line of *A. testudineus* is broken (Rahman 2005). In this study, the lateral line was recorded separately as upper lateral line and lower lateral line and the sum of the scale of the two lines was considered the number of scale on lateral line. Three qualitative characteristics (body spot, spot on the caudal fin base and colour of pelvic fin base region) were also recorded.

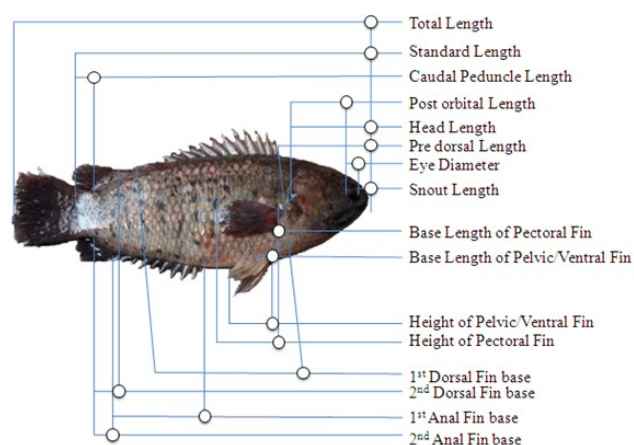


FIGURE 1 Different morphometric measurements of *Anabas testudineus* used in the present study

2.4 | Taxonomic formula

The taxonomic formula of local *A. testudineus* (Figure 2) and Thai *A. testudineus* (Figure 3) are as follows (Lagler *et al.* 1977; IUCN Bangladesh 2000):

Local koi: Br vi, D₁ xv–xvii, D₂ 7–9, A₁ ix–xi, A₂ 10, P 13–16, V i/5, TlR 30–38

Thai koi: Br vi, D₁ xvii–xix, D₂ 9–10, A₁ x–xi, A₂ 9–10, P 13–15, V i/5, TlR 26–35



FIGURE 2 Local variety of *Anabas testudineus*



FIGURE 3 Thai variety of *Anabas testudineus*

3 | RESULTS

Different morphometric characteristics of local and Thai *Anabas testudineus* have been presented in Table 1. The mean TL of local koi was found 11.98 cm, whereas the TL of Thai koi was 14.94 cm. The difference in mean SL was 9.99 cm in local and 12.64 cm in Thai koi. Most of the other morphometric characteristics differed between the

two varieties having greater value in Thai koi among which head length (HL), eye diameter length (ED), postorbital length, predorsal length, and caudal peduncle length (CP) were higher in local variety. Though in rest every case, values were higher in Thai koi than the local koi; snout length of local koi was 0.60 cm and 0.70 cm in Thai koi did not vary greatly. Again their increment of eye diameter, height of anal fin, height of pelvic fin, height of pectoral fin of each variety were increased in relation to increase in total length in contrast to that of the every type of koi. But these differences were very negligible, whereas considering growth rates were almost similar in both local and Thai varieties of *A. testudineus*.

As the morphometric variations may come from age, food and physiological conditions of fish, the proportion between morphometric characters as well as meristic characters need to be justified for the accuracy of taxonomic identity of the species. There was difference between the proportion of TL and SL in the two varieties. Proportion of SL vs. HL and SL vs. CP were also found different between two varieties. However, proportion of HL and ED, TL and SL, HL and postorbital length, HL and 1st dorsal fin base length did not differ (Table 2).

TABLE 1 Average morphometric characteristics of local and Thai *Anabas testudineus* ($n = 25$)

Characteristics	Mean \pm SD (cm)	
	Local variety	Thai variety
Total length	11.98 \pm 0.61	14.94 \pm 1.2
Standard length	9.99 \pm 0.31	12.64 \pm 0.78
Head length	3.5 \pm 0.17	3.2 \pm 0.25
Eye diameter	0.71 \pm 0.09	0.65 \pm 0.05
Snout length	0.60 \pm 0.0	0.70 \pm 0.0
Post orbital length	2.11 \pm 0.22	1.97 \pm 0.16
Pre dorsal length	3.82 \pm 0.17	3.65 \pm 0.18
Caudal peduncle length	1.56 \pm 0.17	1.38 \pm 0.10
Abdominal region length	2.33 \pm 0.17	2.68 \pm 0.12
1st dorsal fin base length	4.56 \pm 0.46	4.98 \pm 0.58
2nd dorsal fin base length	1.16 \pm 0.12	1.55 \pm 0.20
1st anal fin base length	2.28 \pm 0.25	2.56 \pm 0.42
2nd anal fin base length	1.18 \pm 0.18	1.72 \pm 0.36
Height of pectoral fin	2.21 \pm 0.13	2.37 \pm 0.15
Height of ventral fin	2.00 \pm 0.21	2.05 \pm 0.24
Upper jaw length	2.03 \pm 0.24	2.17 \pm 0.19

From the result it is also revealed that the proportion of mean SL with that of mean TL between two varieties were 1.19 for local koi and 1.18 for Thai koi. Results also showed that the proportion of SL with that of HL were 2.85 and 3.95 for local and Thai variety of koi. The proportion of CP with that of mean SL between local and Thai koi were 6.4 and 9.15 accordingly. The proportion of snout length with that of mean HL between two koi were 5.83

for local koi and 4.57 for Thai koi. From the result it was also found that the proportion of post orbital length with that of mean Head length were 1.65 and 1.62 in case of local and Thai koi. The proportion of 1st dorsal fin base with that of head length for local koi was 0.76 and 0.64 for Thai koi. The proportion of eye diameter (ED) and mean HL between two varieties of koi was same and that was 4.92.

TABLE 2 Proportion of different morphometric characters of local and Thai *Anabas testudineus* ($n = 25$)

Proportions between lengths	Mean \pm SD (cm)	
	Local variety	Thai variety
Total : Standard	1.19 \pm 0.03	1.18 \pm 0.02
Standard : Head	2.85 \pm 0.13	3.95 \pm 0.18
Standard : Caudal peduncle	6.4 \pm 0.35	9.15 \pm 0.56
Head : Snout	5.83 \pm 0.26	4.57 \pm 0.22
Head : Post orbital	1.65 \pm 0.07	1.62 \pm 0.05
Head : 1st dorsal fin base	0.76 \pm 0.03	0.64 \pm 0.02
Head : Eye diameter	4.92 \pm 0.38	4.92 \pm 0.29

Among the meristic characteristics, number of dorsal spines, dorsal fin rays, anal spines, anal fin rays, pectoral fin rays and total scales on lateral line were different between two varieties of koi (Table 3). Both the varieties showed the same number of pelvic spine, pelvic fin rays, branchiostegal rays and the numbers were I, 5, and vi respectively. Scales above the lateral line and scales below the lateral line were also noticed the same (3 and 9 respectively) in both varieties. The taxonomic formula of local koi, based on present study is

Br vi, D₁ xv–xvii, D₂ 7–9, A₁ ix–xi, A₂10, P 13–16, V i/5, TLr 30–38

Whereas this formula for Thai koi is as follows:

Br vi, D₁ xvii–xix, D₂ 9–10, A₁ x–xi, A₂ 9–10, P 13–15, V i/5, TLr 26–35.

The local koi had no body spots whereas Thai koi possessed body spots all over the body surface (77%) and in some cases limited spots were found 23% (Figure 4). Spots on the base of caudal fin were found in various patterns and some of the individuals of both varieties had no spot. In majority of the cases, black spot was found on both side of the peduncle (50% for local and 33% for Thai koi; Figure 5). The colour of pelvic fin base region was yellowish (67%) and whitish to yellowish (33%) in the local koi. In contrast, yellowish pelvic fin base was not found in Thai koi in the present investigation but whitish to yellowish (58%) and whitish (42%) was noticed (Figure 6). Among these the body spots and the colour at pelvic fin region were found different between varieties.

TABLE 3 Various meristic characteristics of local and Thai *Anabas testudineus* (n = 25)

Characters	Fish varieties	
	Local koi	Thai koi
Dorsal spine	xv – xvii (xvi)	xvii – xix (xvii)
Anal spine	ix – xi (x)	x – xi (xi)
Dorsal fin ray	7 – 9 (8)	9 – 10 (9)
Anal fin ray	10	9 – 10 (10)
Pectoral fin rays	13 – 16 (15)	13 – 15 (14)
Ventral spine	i	i
Ventral fin ray	5	5
Scale on upper lateral line	18 – 22 (20)	14 – 21 (17)
Scale on lower lateral line	12 – 16 (14)	12 – 14 (12)
Total scale on lateral line	30 – 38 (34)	26 – 35 (30)
Scale above lateral line	3	3
Scale below lateral line	9	9
Brancheostegeals	vi	vi

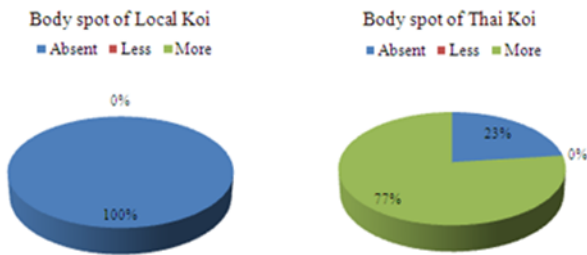


FIGURE 4 Occurrence of body spots in two varieties of *Anabas testudineus*

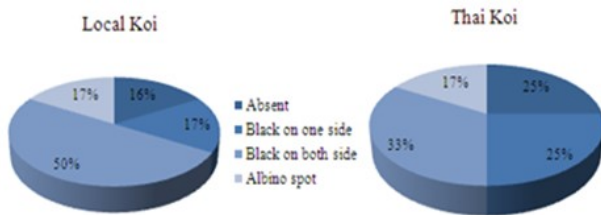


FIGURE 5 Percentages of occurrence of spots on caudal fin base in two varieties of *Anabas testudineus*

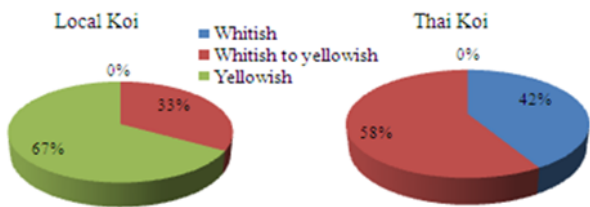


FIGURE 6 Colour pelvic fin base regions in two varieties of *Anabas testudineus*

4 | DISCUSSION

Local and Thai *Anabas testudineus* was found to have a wide range of variation in size. The morphometric and meristic characteristics, the present study establishes the

possible relationship among the different attributes and even the degree of well-being between two varieties of *A. testudineus*. The mean TL of local koi was found 11.98 cm, whereas the TL of Thai koi was found 14.94 cm. The difference in mean SL was 9.99 cm in local and 12.64 cm in Thai koi. Most of the other morphometric characteristics differed between the two varieties having greater value in Thai koi among which head length, eye diameter length, postorbital length, predorsal length, and caudal peduncle length were higher in local variety. Though in rest every case, values were higher in Thai koi than the local koi.

Snout length of local koi was 0.6 cm and 0.7 cm in Thai koi was not that different from each other. Among the morphometric characteristics, SL, HL, body depth and ED were found very similar to the observation of Hassan (2004), however, TL slightly differed from Hassan (2005). As the morphometric variations may come from age, food and physiological conditions of fish, the proportion between morphometric characters need to be justified for the accuracy of taxonomic identity of the species. Between the local and Thai *A. testudineus* the growth rates of different morphometric attributes in relation to increase in TL were not significantly different. In case of both varieties, increment of SL, HL, predorsal length, and CP length showed a positive relation to TL. Again their increment of ED, height of anal fin, height of pelvic fin, height of pectoral fin of each variety were increased with an increase in TL in contrast to that of the every type of koi.

There was difference between the proportion of TL and SL in the two varieties. From the result it is also revealed that the proportion of mean SL with that of mean TL between two varieties were 1.19 for local koi and 1.18 for Thai koi. Results also showed that the proportion of SL with that of HL were 2.85 and 3.95 for local and Thai variety of koi. The proportion of CP with that of mean SL between local and Thai koi were 6.4 and 9.15 accordingly. The proportion of snout length with that of mean HL between two koi were 5.83 local and 4.57 for Thai koi. From the results it was also found that the proportion of post orbital length with that of mean HL were 1.65 and 1.62 in case of local and Thai koi. The proportion of 1st dorsal fin base with that of HL for local Koi was 0.76 and 0.64 for Thai koi. The proportion of ED and mean HL between two types of koi was same and that was 4.92. The results of proportion of some morphometric characteristics of local koi match with the observation of Hassan (2005) whereas no records of Thai koi from Bangladesh were found to compare for this character. Biswas and Shah (2009) reported that morphometric characteristics were higher in Thai koi than local koi; and among them, pre-dorsal length, post-orbital length, least peduncle depth, length of caudal peduncle, length of 2nd dorsal fin base, length

of 1st and 2nd anal fin base, length of chest, length of upper jaw and length of pelvic spine were different. Proportion of TL and SL, SL and body depth, HL and ED, HL and snout length, HL and post-orbital length, SL and 1st dorsal fin base length were different between the two varieties of *A. testudineus*.

Among the meristic characteristics, number of dorsal spines, dorsal fin rays, anal spines, anal fin rays, pectoral fin rays and total scales on lateral line were found significantly different between two varieties of koi. Both the varieties of koi showed the same number of pelvic spine, pelvic fin rays, branchiostegal rays and the numbers were I, 5, vi accordingly. Scales above the lateral line and scales below the lateral line were also noticed same in both cases and the numbers were 3 and 9 respectively. The taxonomic formula of local koi and Thai koi obtained in this study was similar to Hassan (2005) except for the number of dorsal spines as they found 9.56 ± 0.65 and 9.00 ± 0.74 spines whereas it was 16.9 in the present study that is supported by Rahman (2005).

The local koi had no body spots whereas Thai koi possessed body spots- all over the body surface for the majority of the individuals (77%) and limited spots for the rest. Spots on the base of caudal fin were found in various patterns and some had no spots in both the varieties. Black spot was found common on both side of the peduncle. The colour of pelvic fin base region was yellowish in the majority of the specimens and whitish to yellowish in the local koi. In contrast, no yellowish pelvic fin base was found in Thai koi. This result agreed with the study of Hoq (2006). He reported that qualitative characteristics like body spots and the colour at pelvic fin region are different and there is no body spot in local koi, whereas it is present in Thai *A. testudineus*. Meristic and qualitative characters of two varieties are considered more for taxonomic keys than morphometric characters. Though morphometric, meristic and qualitative have been considered in this investigation revealed a complete comparison between different characteristics. Axelrod (1974) identified Thai koi as *A. oligolepis* based on a higher body form and absence of spot at the base of the caudal fin. Rao (1968) with morphological characters and later Ramaseshaiah and Dutt (1984) with protein electrophoresis showed that there are two distinct species of koi and gave the name *A. oligolepis* to the second species. However, Bleeker (1855) described it as a variety of *A. testudineus*. In the present investigation, most of morphometric, meristic and qualitative characteristics showed that the local koi differed from the Thai Koi. However, there is still much scope to study with molecular techniques to distinguish different strains of *A. testudineus* to identify their taxonomic status.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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CONTRIBUTION OF THE AUTHORS

IA PhD researcher; MRN research supervisor