



A morphometric study of species of *Amblypharyngodon* Bleeker, 1860 (Teleostei: cypriniformes: Cyprinidae) from the rivers of Western Ghats, Kerala

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Abstract

Morphological characters of *Amblypharyngodon melettinus* and *Amblypharyngodon microlepis* were analyzed using 48 morphometric characters between populations from three districts (Thrissur, Kottayam and Pathanamthitta) of Kerala, South - West coast of India. A total of 40 specimens from each station (120 individuals) were analyzed. Principal component analysis was performed involving the data on 33 morphometric characters of three population of *Amblypharyngodon*. The PCA yielded, 29 components, the first three of which remained significant and comprised 63.05% of total variance among body characters. The present observations based purely on traditional and truss morphometric characters revealed that the specimens of *Amblypharyngodon* from Pathanamthitta and Thrissur represent two population of *A. melettinus* and those from Vaikom (Kottayam) could be treated as a distinct population of *A. microlepis*.

Keywords: *amblypharyngodon melettinus*, *amblypharyngodon microlepis*, *amblypharyngodon chakaiensis*, morphometrics, PCA

Introduction

The level of endemism is high in the Western Ghats region in Kerala and is considered as one of the Worlds biodiversity hot spots (Menon and Bawa, 1997) [24]. Current taxonomic status of the fishes adapted largely from Eschmeyer (2019) [16], recognize 320 species of fresh water fishes belonging to 11 orders, 35 families and 112 genera in the Western Ghats, of which nearly 65% are endemic. The endemism is also just not restricted to the species level, as there is at least 1 family and 19 genera of fish that are unique to this region (Raghavan, 2019) [27]. Order Cypriniformes includes 6 families over 50 genera, and 194 species with new species being described, the major sub families of the family Cyprinidae are Cyprininae, Xenocyprinae, Rasborinae, Danioninae, Gobioninae, Tincinae, Barbinae, Labeoninae, Leuciscinae, Culturinae and Acheilognathinae (Eschmeyer, 2013) [15]. The subfamily Rasborinae (=Danioninae) is rather numerously represented both by genera and species in the fresh waters of India and adjacent countries. In most of the genera the fishes are too small and bony such as *Amblypharyngodon*, *Aspidoparia*, *Brachydanio*, *Danio*, *Danionella*, *Engraulicypris*, *Rasbora*, *Salmostoma* etc.

The genus *Amblypharyngodon* is represented by not less than five species in India (Jayaram, 1999; Babu, 1981) [20, 1]. A round six species of the genus occur in India, they are *A. atkinsonii* (Blyth, 1860) [11], *A. chakaiensis* (Babu and Nair, 1978) [8], *A. chulabhornae* (Vidthayanon and Kottelat, 1990) [30], *A. Melettinus* (Cuvier & Valenciennes, 1844), *A. microlepis* (Bleeker, 1853) [10], *A. mola* (Hamilton, 1822) [17]. In Kerala the genus *Amblypharyngodon* is represented by three species namely *A. chakaiensis*, *A. melettinus*, and *A. microlepis*.

The first attempt to study a species of *Amblypharyngodon* based on morphometrics, meristics and color pattern was that of Murthy (1977) [25] on *Amblypharyngodon mola* (Hamilton, 1822) [17] the type species of the genus. Earlier studies on this

genus have mainly been concentrated on taxonomy and biology, notable contribution in this regard are those of Chaudhury (1912), Pillai (1929) [26], John (1936) [21], Srivasthava (1967) [28], Murthy (1977) [25], and Babu and Nair (1978) [8]. Babu and Nair (1978, 1981, 1983 a, b, c, d, e, f) [8, 1] studied in detail the taxonomy, anatomy, and fishery biology of one species of *Amblypharyngodon* (*A. chakaiensis*) from chakai canal at Trivandrum, Kerala.

A perusal of literature on *Amblypharyngodon* clearly shows that the distinguishing characters of the different species are rather confusing because of their close resemblance and overlapping morphometric characteristics. The present work, therefore, is aimed at providing some basic information about the taxonomy of the genus based on landmark based morphometrics involving two populations of *Amblypharyngodon melettinus* from Pathanamthitta and Vaikom and one population of *A. microlepis* from Thrissur.

Materials and Methods

Specimens of *Amblypharyngodon* species required for the present study were collected from three different Districts of Kerala, namely, Pathanamthitta, Kottayam (Vaikom) and Thrissur. At present there is a lot of confusion relating to the specific identity of species of *Amblypharyngodon* inhabiting the rivers of Kerala. Therefore, in the present study the species of *Amblypharyngodon* collected from the three localities namely Pathanamthitta, Vaikom and Thrissur are considered as *Amblypharyngodon* species 1, species 2 and species 3 respectively (Fig. 3).

For the present study, fresh specimens of the species were collected from the respective localities and preserved in 10% formalin for morphological analysis. Morphometric measurements were recorded from each specimens (40 numbers of each species) using digital Vernier Caliper with an accuracy of 0.1mm (Mitutoyo, Japan) after fixing certain landmarks on the body as per the methodology adopted by

Hubbs and Lagler (1958) [19]. Altogether 33 morphological characters were taken from each specimen of fish (Table 1). Meristic characters such as number of spine and rays of dorsal fin (D), Anal fin (A), pectoral fin (P), ventral fin (V) and the number of lateral line scales and gill filaments were also counted.

For comparison of all the morphological characters the proportion of each character, body characters in relation to standard length, were calculated and expressed in percentage. To study the variations in morphological characters among the three specimens of *Amblypharyngodon* as well to figure out those characters that probably serve to delineate the three species, Principal Component Analysis was performed. All the analysis were carried out using the statistical package PAST (version 2.17C) (Hammer *et al.*, 2001) [18].

Results

Description of species

Amblypharyngodon Species – 1 (Pathanamthitta)

Distinguishing Character

D ii 7; A iii 5; P i 14; V i 8; L.I. 50 – 57; Gill filaments 79.

Morphometric measurements and proportions are from 10 specimens ranging from 66.86 – 75.24mm standard length. Body is elongate and moderately deep, 24.84–26.09 (25.49 ± 0.592). Preanal length from 68.02 – 69.98 (69.17 ± 0.732). Origin of dorsal fin is behind the insertion of the ventral, its upper edge is concave. Dorsal origin to pelvic insertion is 24.44–26.87 (25.60 ± 0.928) of standard length. Pectoral fin and Pelvic fin length are 16.54 –18.01 (17.18 ± 0.403) and 15.01–16.87 (15.84 ± 0.568) respectively. Dorsal insertion to pelvic insertion ranges from 24.91–26.14 (25.67 ± 0.503). Dorsal origin to anal origin distance is 25.95–27.10 (26.73 ± 0.458) and dorsal insertion to anal origin is 19.45–21.01 (20.52 ± 0.607) and dorsal insertion to anal insertion is 20.37–22.86 (21.55 ± 0.728) and Pelvic insertion to anal origin is 16.20–17.99 (17.26 ± 0.599) of standard length.

Colour: Greenish along back, silvery on flanks and belly; in between a light bluish green iridescent band extending from the operculum to the caudal fin.

Amblypharyngodon species – 2 (Vaikkom)

Distinguishing Character

D ii 7; A iii 5; P i 13; V i 8; L.I 41-49; Gill filaments 77.

Morphometric measurements and the proportions are based on 10 specimens ranging from 67.29–76.91mm standard length. Body of the species is elongate, Barbus-like. Body depth from 27.00–28.37 (27.79 ± 0.531). Fins colourless to yellowish. Dorsal fin is slightly behind the origin of the ventral, origin of dorsal to pelvic insertion is 26.01–27.99 (27.21 ± 0.71) of standard length. Dorsal fin height and pectoral fin length is 22.6–23.41 (22.52 ± 0.49) and 15.48–16.15 (15.74 ± 0.25) respectively. Occiput to pectoral insertion is 21.36–22.96 (22.39 ± 0.512). Dorsal origin to anal origin distance is 28.03–29.97 (29.01 ± 0.662) and dorsal insertion to anal origin distance is 21.47–22.58 (20.00 ± 0.431). Pelvic fin to anal fin distance is 17.39–18.89 (18.11 ± 0.594).

Colour

A broad dull greenish: silver longitudinal band from operculum to base of caudal fin; slightly dark above and

below silvery, belly whitish fins hyaline to yellowish.

Amblypharyngodon species -3 (Thrissur)

Distinguishing characters

D ii 7; A iii 5; P i 17; V i 8; L.I 54-57; Gill filaments 79.

The morphometric measurements and the proportions are based on 10 specimens ranging from 61.09–73.90mm standard length. Body is elongate; its depth at pelvic origin is 23.01–24.66 (23.72 ± 0.486). Preanal length from 67.37–68.02 (67.65 ± 0.253) of standard length. Dorsal fin height and pectoral fin length is 02.14–23.02 (22.59 ± 0.38) and 15.26–16.00 (15.72 ± 0.254) respectively. Dorsal fin to pelvic fin distance is 23.62–25.83 (24.97 ± 0.828) of standard length. Dorsal fin to anal fin origin from 26.47–28.54 (27.35 ± 0.585). Pelvic insertion to anal origin distance is 16.80–18.07 (17.19 ± 0.394).

Colour

Silver on lower, dorsal side dark and in between a light bluish green iridescent band extending from the operculum to the caudal fin.

Morphometric analysis

The complete morphometric data on body characters of the three species of *Amblypharyngodon* were transformed to log and subjected to Principal Component Analysis. The PCA yielded 29 components, the first three of which remained significant so far as variations in morphometric characters were concerned (Table 2, Figs 1&2). They together comprised 63.05% of variance, the first component alone recorded 30.04% of total variance with an Eigen value of 9.3%. Of the total morphometric characters 12 variables showed negative loadings and 19 positive loadings in the first component. Data reduction on this component identified 8 characters which recorded factor loadings higher than 0.7 in the first component. Those characters that can be of some value in discriminating the three species of *Amblypharyngodon* are dorsal origin to pelvic insertion, body depth at pelvic origin, occiput to pectoral insertion, dorsal insertion to pelvic insertion, dorsal origin to anal origin, dorsal insertion to anal insertion and pelvic insertion to anal origin. All these characters had positive component loadings with correlation values ranging from 0.704 to 0.900 (Table 2, Figs 1&2).

For instance, *Amblypharyngodon* sp1 with positive component scores for PC2 and negative component scores for PC1, is plotted on the left upper quarter of the component matrix, whereas *Amblypharyngodon* SP2 with negative scores for both the components 1 and 2 is placed on the left lower quarter of the ordination matrix opposite to *Amblypharyngodon* sp1. The *Amblypharyngodon* species 3 with positive component scores for majority of the characters in PC1 and PC2 occupies the right half portion of the scatter plot (Fig 2).

The detailed analysis of the data on morphometric characters of the three species of *Amblypharyngodon* clearly indicate that species 1 from Pathanamthitta is clearly separated from the other two species on such characters as pre-anal length, dorsal fin height, pectoral fin length and pelvic fin length (Figs. 2). On the other hand, *Amblypharyngodon* sp2, the species from Vaikom, remained distinct from the other two species, with such specific characters as dorsal origin to pelvic insertion, body depth at pelvic origin, occiput to pectoral insertion, dorsal insertion to pelvic insertion, dorsal

insertion to anal origin, dorsal insertion to anal insertion and pelvic insertion to anal origin. Regarding the species from Thrissur, *Amblypharyngodon* 3, the analysis did not reveal any characters specific to this species. However, some characters like pre anal length, dorsal fin height and pelvic fin length were more or less comparable to those of *Amblypharyngodon* 2, whereas it shares characters like dorsal origin to anal origin, dorsal insertion to anal origin and dorsal insertion to anal insertion with *Amblypharyngodon* species from Pathanamthitta. The species from Thrissur stands apart from the other two in recording lowest mean value for characters like dorsal insertion to pelvic insertion, body depth at pelvic origin and dorsal insertion to pelvic insertion (Figs 2).

Discussion

Ever since creation of the genus *Amblypharyngodon* by Bleeker (1860) [9] a number of species of cyprinids have been added to this genus by several workers. Babu and Nair (1978) [8] while describing a new species of *Amblypharyngodon* from Kerala made a comparison of this species with six species of *Amblypharyngodon* described from India, namely, *A. mola* (Hamilton, 1822) [17], *A. atkinsonii* (Blyth, 1860) [11], *A. microlepis* (Bleeker, 1853) [10], *A. melettinus* (Cuvier and Valenciennes, 1844), *A. saranensis* (Chaudhuri, 1912) [12] and *A. gadigarhi* (Malhotra and Dutta, 1975) [22]. Of these the last two species have been synonymised with *A. mola* by Talwar and Jhingran (1991) [29]. Jayaram (1999) [20] recorded five species of *Amblypharyngodon* namely, *A. chakaiensis*, *A. microlepis*, *A. melettinus*, *A. atkinsonii* and *A. mola*, whereas Menon (1999) [23] listed only three species *A. mola*, *A. melettinus* and *A. microlepis* occurring in India, and treated *A. chakaiensis* as a synonym of *A. melettinus*. At present the genus *Amblypharyngodon* is represented in India by four valid species namely, *A. atkinsonii*, *A. mola*, *A. melettinus* and *A. microlepis*. The later three species are represented in the rivers of Western Ghats (Dahunakar and Raghavan, 2013) [14].

In the present study identification based mainly on meristic characters of the species of *Amblypharyngodon* collected from the three location did not yield any conclusive result, because of overlapping of many meristic characters among the three group studied. Nevertheless, the specimens from Thrissur and Pathanamthitta, resembled each other in some of the characters and also shared many characters with *A. chakaiensis* described by Babu and Nair (1978) [8]. The Vaikom specimens of *Amblypharyngodon*, on the other hand, remained separate from the other two groups in several meristic characters. This separation of the three groups of *Amblypharyngodon* studied, treated here tentatively as three species, was more evident in the comparative study of morphological characters including both body and head characters. For instance, the Pathanamthitta specimen of *Amblypharyngodon* seemed to be clearly separated from the other two groups on such morphometric characters as pre anal length, lengths of dorsal, pectoral and pelvic fins and maximum head width. The Vaikom specimens, *Amblypharyngodon* species 2, remained very much separated from the other two groups with distinctness in such morphological traits as dorsal origin to pelvic insertion, body depth at pelvic origin, occiput to pectoral insertion, dorsal insertion to pelvic insertion, dorsal insertion to anal insertion, pelvic insertion to anal origin. (Table 2 & fig. 2).

In the present study the data on truss morphometric characters, in combination with traditional ones, seem to be valid and appropriate in separating the three groups or rather species of *Amblypharyngodon* collected from Pathanamthitta, Thrissur and Vaikom regions. Even though confusions still persist regarding the identity, occurrence and

distribution of different species of *Amblypharyngodon*, the present observations based purely on traditional and truss morphometric characters reveal that the specimens of *Amblypharyngodon* from Thrissur and Pathanamthitta represent two populations of *A. melettinus* and those from Vaikom could be treated as a distinct population of *A. microlepis*. Further studies on the meristics and morphological studies on different populations and/or species of *Amblypharyngodon* along with molecular studies are needed to establish the exact specific identity of the species of *Amblypharyngodon* inhabiting the rivers of Western Ghats.

Tables and Figures

Table I: The Morphometric Characters studied with abbreviations

1	Total length	TL
2	Standard length	SL
3	Preanal length	PAL
4	Preanus length	PAS
5	Predorsal length	PDL
6	Prepelvic length	PPL
7	Prepectoral length	PPT
8	Body width(D)	BWD
9	Body width(A)	BWA
10	Peduncle length	PL
11	Dorsal origin to pelvic insertion	DPL
12	Anal fin height	ANF
13	Body depth at pelvic origin	BDL
14	Peduncle depth	PD
15	Caudal fin length	CFL
16	Dorsal fin height	DFH
17	Pectoral fin length	PFH
18	Pelvic fin length	PLH
19	Occiput to dorsal origin	ODO
20	Occiput to pectoral insertion	OPT
21	Occiput to pelvic insertion	OPL
22	Dorsal insertion to pelvic insertion	DIL
23	Dorsal origin to pectoral insertion	DOT
24	Dorsal origin to anal origin	DAO
25	Dorsal insertion to caudal fin base	DCF
26	Dorsal insertion to anal origin	DAL
27	Dorsal insertion to anal insertion	DAI
28	Dorsal finbase	DFB
29	Anal finbase	AFB
30	Pectoral insertion to pelvic insertion	PIL
31	Pelvic insertion to anal origin	PLA
32	Dorsal origin to caudal fin base	DCB
33	Head length	HL

Table 2: Component matrix of 4 axes from PCA based on 12 selected morphometric measurements of the three species of *Amblypharyngodon* studied

Sl. No.	Selected Body Characters	Components		
		1	2	3
1	Preanal length	-0.2597	0.7356	-0.3212
2	Dorsal origin to pelvic insertion	0.7953	0.5279	-0.0579
3	Body depth at pelvic origin	0.8701	0.4122	-0.1224
4	Dorsal fin height	-0.0740	0.4802	0.8051
5	Pectoral fin length	-0.3919	0.8384	0.0392
6	Pelvic fin length	-0.3848	0.7822	0.0214
7	Occiput to pectoral insertion	0.8193	0.2274	0.1576
8	Dorsal insertion to pelvic insertion	0.8286	0.3528	-0.0942
9	Dorsal origin to anal origin	0.8841	-0.1766	0.0981
10	Dorsal insertion to anal origin	0.8400	-0.2185	0.1477
11	Dorsal insertion to anal insertion	0.8287	-0.1740	0.1802
12	Pelvic insertion to anal origin	0.7283	0.1138	-0.3555
	Eigenvalue	5.83	2.83	1.00
	% Variance	48.55	23.61	8.30

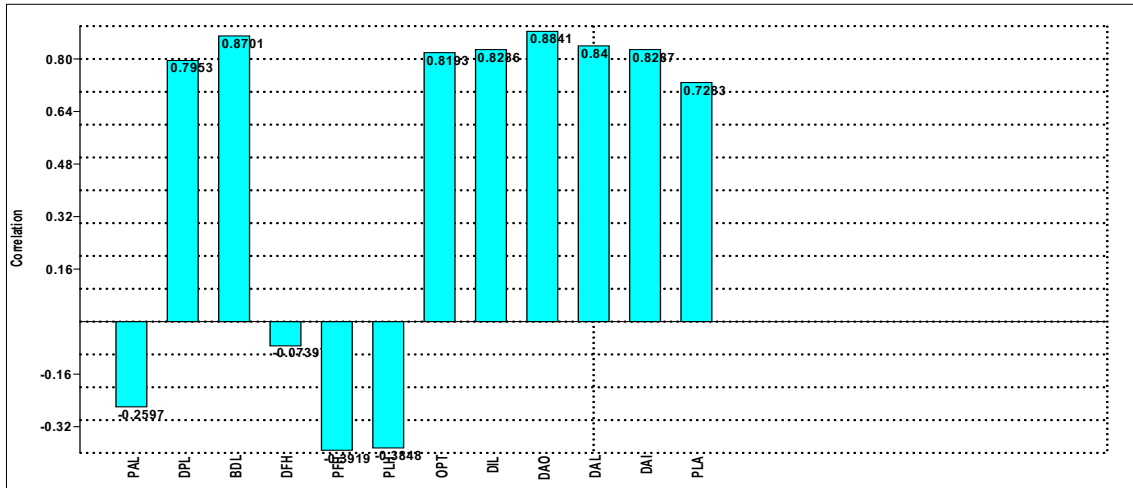


Fig 1: PCA loadings for factors in the first component based on 12 selected Morphometric Measurements of the 3 populations of *Amblypharyngodon* studied.

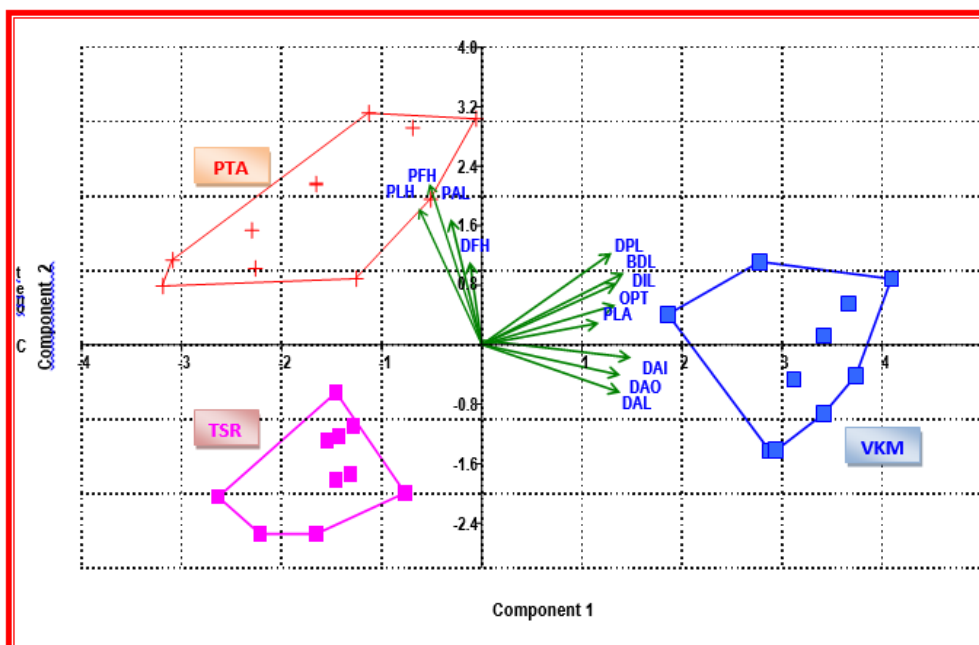


Fig 2: Principal component ordination for three species of *Amblypharyngodon* based on the selected Morphometric Measurements.

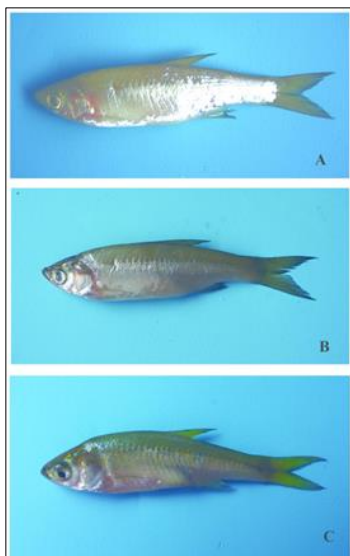


Fig 3: A- *Amblypharyngodon* sp1 from Pathanamthitta; B - *Amblypharyngodon* SPS 2 from Vaikom; C - *Amblypharyngodon* SPS 3 from Thrissur

Conclusions

The present observations based purely on traditional and truss morphometric characters reveals that the specimens of *Amblypharyngodon* from Pathanamthitta and Thrissur Represent 2 populations of *A. melettinus* and those from Vaikom could be treated as a distinct population of *A. microlepis*.

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