Present Status of Morphometric Characteristics and their Correlations with a Fish, *Channa punctatus* from Arrah, Bihar, India

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Abstract
The present study aims to measure the morphometric characteristics and their correlation of a fish, *Channa punctatus* (Bloch, 1793) from Arrah, Bihar, India. The collection of fish specimens took place from September 2022 to August 2023. Nineteen morphometric and nineteen relative metamorphic characters have been measured for each fish specimen. The descriptive statistical parameters and correlation coefficient were analysed with total length and other morphometric characters. It was observed that the relationship between various morphometric characters and total length was linearly positive and significant ($p \leq 0.01$). Significant differences ($p \leq 0.01$) in the slopes of different regression lines for each morphometric measurement were also discovered. The negative allometric growth of these characters relative to total length is indicated by a slope value less than 3.0 with total length and other morphometric characters. Hence, there is a direct relationship between the total length of fish and all morphometric characters, which were found to be the best indicators of allometric pattern growth in fish. The study shows that fish growth is satisfactory and that the aquatic environment is favourable for fish.

Keywords: *Channa punctatus*; Morphometric characters, Arrah.

Introduction

Channa (=*Ophiocephalus*) *punctatus* (Bloch, 1793) belongs to the order Anabantiformes (Labyrinth fishes) and the family Channidae or Ophiolidae (Snakeheads) (Nelosn, 2016). It is a benthopelagic, potamodromous fish commonly distributed in Southeast Asian countries including India, Sri Lanka, Nepal, Bangladesh, Afghanistan, Pakistan and China. In our country, it is usually found in Bihar, West Bengal, Orissa, Maharashtra, Tamil Nadu, Kerala, Punjab, Andhra Pradesh, Karnataka, etc. (Talwar and Jhingran, 1991) in ponds, swamps, brackish water and ditches and prefer stagnant waters with vegetation. It plays a key role in the aquatic food chain/web as it is preyed by large carnivorous fauna including fishes, hence upholds the ecological balance in nature.

The data of morphological measurements are beneficial for their taxonomic status in aquatic environments. Morphological characteristics of fishes are mostly divided into two main categories namely morphometric and meristic characteristics (Ambily, 2017).

Fish are very sensitive to environmental changes and quickly adapt themselves by changing necessary morphometrics (Hosssian *et al.,* 2010). The differences in morphometric characters arise due to changes in the environmental factors rather than genetic distinction (Pinheiro *et al.,* 2005). However, the changes in fish morphometrics due to genetic variations result from natural selection during a long period of geographical isolation. Morphometric characters are useful implements and reliable tools for the identification of fish specimens in their stocks (Costa *et al.,* 2003). The correlation matrix amongst the morphometric characters of fish illustrates the morphological associations between their different body portions. This can be used to determine the possible differences amongst separate stocks of the same fish species and to assess the well-being of its specimens in natural habitats (King, 2007).

Fishes with the same morphometric characters are usually assumed to constitute a stock and variations between the stocks help in stock structure analysis and also for any short-duration environmentally induced variation (Cardin, 2000). Several workers provided morphometric data on several fishes and emphasized their utility in separating stocks of the fishes living in the same or different environments (Doherty and McCarthy, 2004; Najero *et al.,* 2008; Najero, 2010).

Dean *et al.,* (2002) have reported the differences in morphometric parameters to separate physically similar species. Saini *et al.,* (2008) reported the morphometric differentiation of the catfish *Mystus seenghala*. Sharma *et al.,* (2015) have recorded the subtle variations in morphometric characters of Golden Mahseer (*Tor putitora*) for characterizing their stocks.

The morphology of fish, *Channa punctatus* was studied for identification by several workers (Ram, 1975; Sarkar, 1996). However, the study on intraspecific variations of *C. punctatus* using traditional morphometric methods is limited, and notable among them are Samad and Jafri (1996), Najero (2010), Kashyap *et al.,* (2014), etc. The present study is intended to engender data on morphometric characters and their correlations of *Channa punctatus* (Bloch) from aquatic habitats of Arrah, Bihar, India**.**

Material and Methods

The work was conducted in the Department of Zoology, VKS University, Arrah from September 2022 to August 2023. For the study of the morphometric characters, five different aquatic habitats of district Arrah, Bihar, India were selected to procure some 150 specimens of fish *Channa punctatus*. At once samples were instantly chilled in ice and stored in the laboratory with 10 % buffered formalin, where all morphometric characteristics were calculated. Nineteen morphometric and sixteen relative morphometric characters were analyzed in this study with standard procedures as previously followed by Dwivedi and Menezes (1974) and Prasad *et al.,* (2020). Different linear dimensions were taken by measuring board to 0.01 cm accuracy.

The descriptive statistical parameters and correlation coefficient were analysed with total length and other morphometric characters. Linear regression relationship equation was applied to determine the relationships between total length versus morphometric parameters as $y = a + bx$, where x = total length. All the statistical analyses ($p<0.05$) were done by using the GraphPad Prism 8.0 software.

Results and discussion

Morphometric measurements disclose that total length (TL) of *Channa punctatus* were found in a range from 10.1±1.2 to 20.0±2.2cm, standard length (SL) between 8.5±0.9 to 16.6±1.6cm, length of head (HL) varies from 2.9±0.3 to 5.6±0.6cm, height of body (HB) ranged from 1.4±0.2 to 3.4±0.4cm, width of body (WB) from 1.5±0.2 to 3.5±0.5cm, height of head (HH) from 1.7±0.3 to 3.1±0.5cm, length of snout (LS) from 0.6±0.1 to 1.5±0.3cm, diameter of eye (DE) ranged from 0.4±0.0 to 0.6±0.1cm, interorbital width (IW)ranged from 0.65±0.01 to 1.3±0.3cm, gape of mouth (GM) ranged from 0.4±0.0 to 0.7±0.1cm, length of dorsal-fin (LDF) varies from 4.3±0.5 to 9.5±0.9cm, length of pectoral-fin (LPF) varies from 1.8±0.3 to 2.9±0.5cm, length of ventral-fin (LVF) varies from 1.2±0.2 to 2.1±0.4cm, length of anal-fin (LAF) varies from 2.6±0.3 to 6.0±0.6cm, length of caudal-fin (LCF) varies from 1.6±0.2 to 3.4±0.5cm, length of caudal peduncle (LCP) ranged from 0.7±0.1 to 1.2±0.3cm, height of caudal peduncle (HCP) ranged from 1.0±0.2 to 2.0±0.5cm, pre-dorsal length (PrDL) ranged from 3.3±0.4 to 6.3±0.8cm and post-dorsal length (PoDL) ranged from 3.0±0.3 to 5.2±0.6cm (Table 1).

Similar results were also reported by Serajuddin (2004) and Kashyap *et al.,* (2014) in *Labeo rohita, Labeo bata, Labeo calbasu, Mastacembelus armatus, Macrognathus pancalus* and *Channa punctatus* respectively. Above mention results were also found to be similar to those previously described by Al-Faisal *et al.,* (2015) and Roul *et al.,* (2017) which might be because of their exact geographical location and ecological conditions as stated by Fakunmoju *et al.,* (2014). Variations in morphometric characters of fishes are dependent on their body size. Sharma *et al.,* (2015) have recorded the subtle variations in morphometric characters of Golden Mahseer (*Tor putitora*) for characterizing their stocks. Remarkably, Dean *et al.,* (2002) reported the differences in morphometric parameters to separate physically similar species. Saini *et al,* (2008) reported the morphometric differentiation of the catfish *Mystus seenghala*. The variances in the morphology of individuals of many fish species were determined from different parts of Africa (Ikpeme *et al.,* 2017).

Morphometric analysis is considered to be very important in the identification of any stocks of a fish species. The current study on the morphometric characters of *Channa punctatus* revealed that all nineteen morphometric measurements of the fish have a linear association with the total length (TL) as the value of the coefficient of correlation (r) was highly significant ($p<0.001$) which showed that with the increase in total length (TL) of fish, there was a corresponding increase in length of various body measurements (Table 2). However, comparatively low values of coefficient of correlation ($p<0.01$) were found between the diameter of the eye, gape of mouth, length of caudal peduncle, the height of caudal peduncle and post dorsal length. Kashyap *et al.,* (2015) also observed low values of correlation coefficient (r) between total length and eye diameter (ED) in River Gomti and Pond of Malihabad, Kolkata indicating a weak relationship. Singh and Tandon (2009) related the decrease in the eye diameter of fish in River Gomti to the water turbidity of the River. The characteristics like the height of the head, length of the dorsal fin, length of the anal fin, length of the caudal fin and pre-dorsal length about total length illustrate very high correlation coefficients. Similarly, Johal *et al.,* (2003) have reported that most of the characters display a high degree of correlation coefficients.

Fish morphometric characters usually refer to the measuring of the total length of fish with various other body parts; therefore, by Marr (1955), Hoque (1984) and Chaklader *et al.,* (2006), a study of linear regression relationships between the total length of fish and several morphometric characters were found to be the best indicator for detecting the growth pattern of fish.

The values of correlation coefficients are almost comparable in agreement with the conclusions of other researchers (Nahar *et al.,* 2018). The significant correlation among morphometric parameters was described in *S. richardsonii* (Pathak *et al.,* 2013). Additionally, the established correlations can help in the association of different characters during the conducive growth of fish. These findings were correlated with the outcomes of Soni and Ujjania (2017) determined the relationships between the morphological traits of fish specimens of rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*) and catla (*Catla catla*).

The regression analysis and t-test between the different morphometric measurements on the total length of the three populations of *Channa punctatus* indicated that increase in total length (Table 3). Comparison of regression analysis for each morphometric parameter also indicated differential growth rates as many parameters were found to be significant at 0.1%, 1% and 5% levels inthe student t-test. These significant differences in slopes for morphometric characters indicated the variable growth rate for a parameter between the compared populations. These variations in the morphometric characters suggested a relationship between the phenotypic heterogeneity and geographical barrier, showing limited intermingling of *Channa punctatus*.

Relative morphometric measurements disclose that head in total length (HTL) of *Channa punctatus* were found in a range from 3.48±0.03 to 3.70±0.04, head in standard length (HSL) between 2.83±0.03 to 2.96±0.03, height in total length (HtTL) varies from 4.84±0.07 to 5.94±0.09, height in standard length (HtSL) ranged from 4.83±0.307 to 6.07±0.09, height in length of head (HtLH) from 1.38±0.2 to 2.00±0.3, snout in length of head (SLH) from 2.87 ±0.3 to 3.83±0.5, diameter of eye in length of head (DELH) from 7.20±0.7 to 9.64±0.8, diameter of eye in snout (DES) ranged from 2.00±0.2 to 2.54±0.3, diameter of eye in interorbital width (DEIW) ranged from 1.60±0.3 to 2.17±0.4, predorsal length in standard length (PrLSL) ranged from 2.40±0.3 to 2.59±0.3, postdorsal length in standard length (PoLSL) ranged from 2.83±0.4 to 3.29±0.5, length of dorsal fin in standard length (LSFSL) varies from 1.74±0.3 to 1.98±0.3, length of pectoral fin in head (LPFH) varies from 1.61±0.3 to 1.93±0.3, length of ventral fin in head (LVFH) varies from 2.40±0.4 to 2.94±0.4, length of anal fin in standard length (LAFSL) varies from 2.73±0.4 to 3.27±0.5, length of caudal fin in head (LCFH) varies from 1.64±0.3 to 1.87±0.3, height of caudal fin in total length (HCFTL) ranged from 5.88±0.8 to 6.31±0.9, length of caudal peduncle in standard length (LCPSL) ranged from 4.80±0.7 to 5.31±0.8, length of caudal peduncle in height (LCPHt) ranged from 12.00±1.7 to 13.89±1.8 (Table 4).

Less average values of relative morphometric characters except for height in the length of the head, the diameter of the eye in the length of the head, the diameter of the eye in the snout, length of anal fin in standard length, length of caudal fin in head and length of caudal fin total length indicate a relative reduction in the body parts of fish due to spatial climate change.

Observations made by Gupta and Gupta (2006) and Singh (2011) reveal nearly similar averages among the above relative metamorphic characters when compared to the present work. However, a comparison of the present work with the investigation of Bano *et al.,* (2022) reveals maximum differences (Table 5). The reasons for maximum differences seem to be based on differences in feeding regimes and the sensitivity of the fish in the east and north zones of the country (Sardana *et al.,* 2022). The variations based on the head region are considered to be the result of differences in the feeding regimes or it may be due to the availability of food in the region (Rao, 2001).

Table 1 The morphometric characters of *Channa punctatus* collected from five aquatic habitats of Arrah, Bihar, India.

Sl. No.	Character (cm)	Range of number of individuals in each set (n= 25-30)					Average
		1st Set	2nd Set	3rd Set	4th Set	5th Set	
1.	Total Length (TL)	10.1±1.2	12.5±1.7	15.0±1.8	18.0±1.9	20.0±2.2	15.12±3.58
2.	Standard Length (SL)	8.5±0.9	10.2±1.3	12.0±1.4	15.0±1.5	16.6±1.6	12.46±2.99
3.	Length of Head (HL)	2.9±0.3	3.6±0.4	4.1±0.4	5.3±0.6	5.6±0.6	4.31±1.02
4.	Height of Body (HB)	1.4±0.2	1.8±0.2	2.2±0.3	3.1±0.4	3.4±0.4	2.35±0.76
5.	Width of Body (WB)	1.5±0.2	2.0±0.2	2.4±0.3	3.3±0.4	3.5±0.5	2.54±0.76
6.	Height of Head (HH)	1.7±0.3	2.0±0.2	2.3±0.3	2.8±0.4	3.1±0.5	2.38±0.51
7.	Length of Snout LS)	0.6±0.1	1.0±0.2	1.1±0.2	1.4±0.2	1.5±0.3	1.12±0.32
8.	Diameter of Eye (DE)	0.4±0.0	0.5±0.0	0.5±0.0	0.6±0.1	0.6±0.1	0.51±0.07
9.	Interorbital Width (IW)	0.6±0.1	0.8±0.1	0.9±0.2	1.2±0.3	1.3±0.3	0.97±0.24
10.	Gape of Mouth (GM)	0.4±0.0	0.5±0.0	0.5±0.0	0.6±0.1	0.7±0.1	0.54±0.10
11.	Length of Dorsal fin (LDF)	4.3±0.5	5.7±0.8	7.0±0.8	8.1±0.8	9.5±0.9	6.92±1.81
12.	Length of Pectoral fin (LPF)	1.8±0.3	2.2±0.2	2.5±0.4	2.7±0.4	2.9±0.5	2.42±0.39
13.	Length of Ventral fin (LVF)	1.2±0.2	1.5±0.2	1.7±0.3	1.8±0.3	2.1±0.4	1.66±0.30
14.	Length of Anal fin (LAF)	2.6±0.3	3.5±0.4	4.3±0.4	5.5±0.6	6.0±0.6	4.38±1.25
15.	Length of Caudal fin (LCF)	1.6±0.2	2.0±0.2	2.5±0.3	3.0±0.4	3.4±0.5	2.50±0.05
16.	Length of Caudal peduncle (LCP)	0.7±0.1	1.0±0.2	1.0±0.2	1.2±0.2	1.2±0.3	1.02±0.18
17.	Height of Caudal peduncle (HCP)	1.0±0.2	1.5±0.3	1.6±0.3	1.7±0.3	2.0±0.5	1.56±0.33
18.	Pre dorsal length (PrDL)	3.3±0.4	4.2±0.4	5.0±0.6	5.8±0.6	6.3±0.8	4.92±1.08
19.	Post dorsal length (PoDL)	3.0±0.3	3.6±0.4	4.2±0.4	4.2±0.4	5.2±0.6	4.04±0.73

Table 2 The correlation matrix amongst the different morphometric parameters *Channa punctatus*

	TL	SL	HL	HB	WB	HH	LS	DE	IW	GM	LDF	LPF	LVF	LAF	LCF	LCP	HCP	PrDL	PoDL
TL	1.0	0.998***	0.993***	0.992***	0.993***	0.998***	0.978***	0.954**	0.990***	0.967**	0.966**	0.985***	0.979***	0.998***	0.979***	0.931**	0.944**	0.997***	0.953**
SL		1.0	0.996***	0.998***	0.996***	0.999***	0.971***	0.946**	0.997***	0.971**	0.989***	0.972**	0.967**	0.997***	0.997***	0.922**	0.926**	0.989***	0.939**
HL			1.0	0.998***	0.999***	0.995***	0.980***	0.948**	0.998***	0.963**	0.980***	0.970**	0.954**	0.997***	0.989***	0.943**	0.922**	0.988***	0.988***
HB				1.0	0.998***	0.997***	0.968**	0.936**	0.999***	0.965**	0.979***	0.961**	0.950**	0.994***	0.990***	0.922**	0.908*	0.983***	0.983***
WB					1.0	0.994***	0.978***	0.944**	0.997***	0.959**	0.979***	0.969**	0.952**	0.997***	0.989***	0.941**	0.917**	0.988***	0.911*
HH						1.0	0.972***	0.949**	0.996***	0.974***	0.991***	0.972**	0.970**	0.996***	0.997***	0.921**	0.930**	0.989***	0.943*
LS							1.0	0.984***	0.971**	0.960**	0.976***	0.986***	0.968**	0.984***	0.973**	0.986***	0.969**	0.987***	0.923*
DE								1.0	0.945**	0.976***	0.964**	0.967**	0.973**	0.954**	0.949**	0.970**	0.989***	0.961**	0.940*
IW									1.0	0.972**	0.978***	0.959**	0.951**	0.993***	0.988***	0.930**	0.914*	0.981***	0.914*
GM										1.0	0.970**	0.943**	0.965**	0.962**	0.964**	0.920**	0.950**	0.955**	0.944**
LDF											1.0	0.990***	0.993***	0.992***	0.997***	0.926**	0.963**	0.995***	0.970**
LPF												1.0	0.987***	0.984***	0.985***	0.953**	0.973**	0.995***	0.959**
LVF													1.0	0.970**	0.981***	0.922**	0.983***	0.982***	0.990***
LAF														1.0	0.997***	0.943**	0.939**	0.997***	0.937**
LCF															1.0	0.921**	0.942**	0.996***	0.958**
LCP																1.0	0.950**	0.948**	0.859**
HCP																	1.0	0.956**	0.963**
PrDL																		1.0	0.952**
PoDL																			1.0

(***denotes the significant correlation $p < 0.01$; ** = $p < 0.01$ and * = $p < 0.01$; TL = Total length, SL = standard length, HL = Length of head, HB = Height of body, WB = Width of body, HH= Height of head, LS = Length of snout, ED = Diameter of eye, IW = Interorbital width, GM = Gape of mouth, LDF = Length of dorsal fin, LPF = Length of pectoral fin, LVF = Length of ventral fin, LAF = Length of anal fin, LCF = Length of caudal fin, LCP = Length of caudal peduncle, HCP = height of caudal peduncle, PrDL = Pre-dorsal length and PoDL = Post dorsal length)

Table 3 Values of a, b, r and t of the morphometric characters of *Channa punctatus* collected from five aquatic habitats of Arrah, Bihar, India

Sl. No.	Character (cm)	Regression equation	Correlation coefficient	't' value
1.	Total Length (TL)			
2.	Standard Length (SL)	y= -0.112+0.831x	0.997 (p<0.001)	21.16 (p<0.001)
3.	Length of Head (HL)	y=0.084+0.282x	0.994 (p<0.001)	15.78 (p<0.001)
4.	Height of Body (HB)	y= -0.802+0.210x	0.992 (p<0.001)	13.59 (p<0.001)
5.	Width of Body (WB)	y= -0.646+0.210x	0.992 (p<0.001)	13.59 (p<0.001)
6.	Height of Head (HH)	y=0.226+0.142x	0.997 (p<0.001)	21.16 (p<0.001)
7.	Length of Snout LS)	y= -0.196+0.087x	0.978 (p<0.001)	8.15 (p<0.001)
8.	Diameter of Eye (DE)	y=0.242+0.017x	0.954 (p<0.01)	5.61 (p<0.05)
9.	Interorbital Width (IW)	y= -0.050+0.067x	0.990 (p<0.001)	12.07 (p<0.001)
10.	Gape of Mouth (GM)	y=0.124+0.027x	0.966 (p<0.01)	6.44 (p<0.01)
11.	Length of Dorsal fin (LDF)	y=0.695+0.503x	0.996 (p<0.001)	19.15 (p<0.001)
12.	Length of Pectoral fin (LPF)	y=0.811+0.106x	0.985 (p<0.001)	9.85 (p<0.01)
13.	Length of Ventral fin (LVF)	y=0.417+0.082x	0.979 (p<0.001)	8.16 (p<0.01)
14.	Length of Anal fin (LAF)	y= -0.892+0.348x	0.998 (p<0.001)	27.72 (p<0.001)
15.	Length of Caudal fin (LCF)	y= -0.462+0.181x	0.999 (p<0.001)	38.42 (p<0.001)
16.	Length of Caudal peduncle (LCP)	y=0.299+0.047x	0.931 (p<0.01)	4.43 (p<0.05)
17.	Height of Caudal peduncle (HCP)	y=0.261+0.085x	0.943 (p<0.01)	4.96 (p<0.05)
18.	Pre dorsal length (PrDL)	y=0.378+0.300x	0.996 (p<0.001)	19.15 (p<0.001)
19.	Post dorsal length (PoDL)	y=1.101+0.194x	0.951 (p<0.01)	5.28 (p<0.05)

Table 4 Relative Morphometric characters of *Channa punctatus* collected from five aquatic habitats of Arrah, Bihar, India

Sl.No.	Character	Range of number of individuals in each set (n= 25-30)					Average
		1st Set	2nd Set	3rd Set	4th Set	5th Set	
1.	Head in total length (HTL)	3.48±0.3	3.57±0.3	3.66±0.4	3.67±0.4	3.70±0.4	3.62±0.08
2.	Head in standard length (HSL)	2.93±0.3	2.83±0.3	2.26±0.3	2.83±0.3	2.96±0.3	2.88±0.05
3.	Height in total length (HtTL)	5.21±0.8	5.94±0.9	4.84±0.7	5.80±0.9	5.88±0.9	5.53±0.43
4.	Height in standard length (HtSL)	6.07±0.9	5.67±0.9	5.45±0.8	4.83±0.7	4.88±0.7	5.38±0.47
5.	Height in length of head (HtLH)	1.38±0.2	2.00±0.3	1.86±0.3	1.70±0.3	1.64±0.3	1.72±0.21
6.	Snout in length of head (SLH)	2.87±0.3	3.60±0.4	3.73±0.4	3.76±0.4	3.83±0.5	3.56±0.35
7.	Diameter of eye in length of head (DELH)	7.25±0.7	7.20±0.7	8.20±0.7	9.64±0.8	9.33±0.8	8.32±1.01
8.	Diameter of eye in snout (DES)	2.00±0.2	2.00±0.2	2.20±0.2	2.54±0.3	2.50±0.3	2.25±0.23
9.	Diameter of eye in interorbital width (DEIW)	1.63±0.3	1.60±0.3	1.80±0.3	2.18±0.4	2.17±0.4	1.88±0.25
10.	Predorsal length in standard length (PrLSL)	2.56±0.3	2.43±0.3	2.40±0.2	2.59±0.3	2.53±0.3	2.50±0.07
11.	Postdorsal length in standard length (PoLSL)	2.83±0.4	2.83±0.4	2.86±0.4	3.17±0.5	3.29±0.5	3.00±0.19
12.	Length of dorsal fin in standard length (LSFSL)	1.98±0.3	1.79±0.3	1.74±0.3	1.85±0.3	1.75±0.3	1.82±0.09
13.	Length of pectoral fin in head (LPFH)	1.61±0.3	1.64±0.3	1.64±0.3	1.66±0.3	1.93±0.3	1.70±0.12
14.	Length of ventral fin in head (LVFH)	2.42±0.4	2.40±0.4	2.41±0.4	2.94±0.4	2.67±0.5	2.57±0.21
15.	Length of anal fin in standard length (LAFSL)	3.27±0.5	2.91±0.4	2.79±0.4	2.73±0.4	2.77±0.4	2.89±0.20
16.	Length of caudal fin in head (LCFH)	1.87±0.3	1.80±0.3	1.64±0.3	1.77±0.3	1.65±0.3	1.75±0.09
17.	Height of caudal fin in total length (HCFTL)	6.31±0.3	6.25±0.9	6.00±0.9	6.00±0.9	5.88±0.8	6.09±0.16
18.	Length of caudal peduncle in standard length (LCPSL)	5.31±0.8	5.10±0.8	4.80±0.7	5.00±0.7	4.88±0.7	5.02±0.18
19.	Length of caudal peduncle in height (LCPHt)	12.14±1.7	12.20±1.8	12.00±1.7	13.64±1.8	13.83±1.8	12.76±0.8

Table 5 Comparison of values of relative Morphometric characters of *Channa punctatus* collected from five aquatic habitats of Arrah, Bihar, India with earlier works

Sl. No.	Character	Gupta and Gupta (2006) (A)		Singh (2011) (B)		Bano et al, (2022) (C)		Present observation (D)		Difference			
		Range	Average	Range	Average	Range	Average	Range	Average	(A-D)	(B-D)	(C-D)	Average
1.	Head in total length (HTL)	3.0-3.7	3.35	3.40-3.96	3.59	1.86-2.18	2.12	3.48-3.70	3.62	0.27	0.03	-1.50	-0.40
2.	Head in standard length (HSL)	2.4-3.1	2.75	2.26-3.29	2.85	1.57-1.92	1.80	2.83-2.96	2.88	0.13	0.03	-1.08	-0.31
3.	Height in total length (HtTL)	5.1-6.0	5.55	4.84-7.21	5.91	3.82-5.07	4.66	4.84-5.94	5.53	-0.02	-0.38	-0.87	-0.42
4.	Height in standard length (HtSL)	3.6-5.0	4.30	4.83-6.07	5.42	3.23-4.48	3.98	4.83-6.07	5.38	1.08	-0.04	-1.40	-0.36
5.	Height in length of head (HLH)	-	1.50	1.38-2.00	1.72	2.06-2.32	2.00	1.38-2.00	1.72	0.22	0.00	0.28	0.17
6.	Snout in length of head (SLH)	5.4-5.5	5.45	2.87-3.76	3.56	3.88-4.65	4.61	2.87-3.83	3.56	-1.89	0.00	1.05	-0.28
7.	Diameter of eye in length of head (DELH)	6.6-7.3	6.95	7.20-9.64	8.54	14.00-15.45	14.00	7.20-9.64	8.32	1.37	-0.22	5.66	2.26
8.	Diameter of eye in snout (DES)	1.2-1.3	1.25	2.00-2.64	2.31	3.32-3.60	3.014	2.00-2.50	2.25	1.00	-0.06	0.79	0.58
9.	Diameter of eye in inter orbital width (DEIW)	1.6-2.0	1.80	1.60-2.20	1.93	-	-	1.60-2.18	1.88	0.08	-0.05	-	-
10.	Length of dorsal fin in standard length (LDFSL)	-	1.80	1.74-1.98	1.81	1.39-1.43	1.53	1.74-1.98	1.82	0.02	-0.01	-0.29	-0.09
11.	Length of pectoral fin in head (LPFH)	-	1.70	1.61-1.96	1.75	1.75-1.83	1.73	1.61-1.93	1.70	0.00	-0.05	.03	-0.01
12.	Length of ventral fin in head (LVFH)	-	2.50	2.40-2.94	2.56	1.37-1.55	1.44	2.40-2.94	2.57	0.07	0.01	-1.13	-0.35
13.	Length of anal fin in standard length	2.5-2.7	2.60	2.72-3.27	2.87	2.68-3.61	3.17	2.73-3.27	2.89	0.29	0.02	0.28	0.20
14.	Length of caudal fin in head (LCFH)	1.5-1.9	1.57	1.61-1.96	1.70	3.50-2.97	3.18	1.64-1.87	1.75	0.18	0.05	1.43	0.55
15.	Height of caudal fin in total length (HtCFH)	4.1-5.2	4.65	5.88-6.31	6.06	8.13-9.33	10.26	5.88-6.31	6.09	1.44	0.03	4.17	1.88
16.	Length of caudal peduncle in height (LCPH)	11.4-13.8	12.60	10.20-13.64	12.50	-	-	12.00-13.83	12.76	0.98	0.26	-	-

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