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Length-weight relationship, relative condition factor (Kn) and morphometry of *Arius subrostratus* (Valenciennes, 1840) from a coastal wetland in Kerala

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ABSTRACT

The length – weight relationship and relative condition factor of the shovel nose catfish, *Arius subrostratus* (Valenciennes, 1840) from Champakkara backwater were studied by examination of 392 specimens collected during June to September 2008. These fishes ranged from 6 to 29 cm in total length and 5.6 to 218 g in weight. The relation between the total length and weight of *Arius subrostratus* is described as Log W = -1.530+2.6224 log L for males, Log W = - 2.131 + 3.0914 log L for females and Log W = - 1.742 + 2.8067 log L for sexes combined. The mean relative condition factor (Kn) values ranged from 0.75 to 1.07 for males, 0.944 to 1.407 for females and 0.96 to 1.196 for combined sexes. The length-weight relationship and relative condition factor showed that the well-being of *A. subrostratus* is good. The morphometric measurements of various body parts and meristic counts were recorded. The morphometric measurements were found to be non-linear and there is no significant difference observed between the two sexes. From the present investigation, the fin formula can be written as D: I, 7; P: I, 12; A: 17 – 20; C: 26 – 32. There is no change in meristic counts with the increase in body length.

Keywords: *Arius subrostratus*, Condition factor, Length-weight relationship, Morphometry

Introduction

Length – weight relationship studies of any fish species is a pre-requisite for assessing its population characterstics (Le Cren, 1951). The ponderal index or condition factor or the 'fatness' (K) indicates the well- being of the population with the assumption that the growth of fish in ideal conditions maintain an equilibrium in length and weight (Hile, 1936). The data on length–weight relationship and the associated condition factor also enables comparison of the populations of the same species from different environments. The study of morphometric characters in fishes is important because they can be used for the differentiation of taxonomic units. The present study provides comprehensive information on the length-weight relationship, relative condition factor and morphometry of *Arius subrostrstus* (Valenciennes, 1840) from Champakkara backwaters, Kerala.

The importance of the species of the genus *Arius* as food and ornamental fish is significant in the context of its sustainable use of the resource as well as conservation of the endemic fish germplasm. Biology of flat – mouthed cat fish, *Tachysurus platysomus* from the Gulf of Mannar was reported by Menon (1984). Food and feeding habits of *Tachysurus thalassinus* (Menon, 1979); *Tachysurus dussumieri* (Vasudevappa and James, 1992), *Tachysurus caelatus* and *Osteogeneiosus militaris* (Raje, 2006), and *Tachysurus jella* (Raje *et al.*, 2008) have also been reported. A survey on the available literature on *Arius* spp*;* indicated that, there is limited information available on the length-weight relationship and condition factor of *A. subrostratus* from Indian subcontinent. It was in this view that the length-weight relationship, condition factor and morphometry of *A. subrostratus* from a wetland system in Kerala was addressed during the presented study.

Materials and methods

Fresh fish samples were collected at weekly intervals during June 2008 - September 2008 from the fishermen of the Champakkara backwater system (Latitude 9º 57'27" N and Longitude 76º 19' 45" E). A total of 392 specimens of *A. subrostratus* (170 males and 222 females) ranging in size from 6 to 29 cm in total length (TL) and 5.6 to 218 g in weight were used for the length-weight analysis, various morphometric measurements and meristic counts. The relationship between various parameters was determined by the least square method.

Length of fish was measured to the nearest mm and weight up to 0.1 g. The fishes were then sexed by observing

the gonads after dissecting the abdomen. The length – weight relationship of the form $W = aL^b$ was calculated for male, female and sexes pooled, which was transformed in logarithmic form as Log W = Log a + b Log L. Ponderal index (Kn) was observed separately for males and females of different length groups of 3 cm length interval. The smoothed mean weights W, for each length group have been computed from this log formula. Significance of the difference between the regression coefficients of the sexes was tested by ANACOVA (Snedecor and Cochran, 1967). To test whether the regression coefficients depart significantly from 3, t test was conducted. Le Cren's (1951) modified formula, $Kn = W/aL^n$ was used for calculation of the relative condition factor. Twenty two morphometric and six meristic characters were studied following the standard procedures described by Appa Rao (1966), as well as Dwivedi and Menezes (1974). For meristic characters, dorsal fin rays, dorsal spines, pectoral fin rays, pectoral spines and candal fin rays were counted.

Results

Length-weight relationship

Length–weight equations were calculated separately for males, females and sexes combined. When empirical values of lengths were plotted against their respective weight on an arithmetic scale, smooth curves were obtained (Fig. 1, 2 and 3).

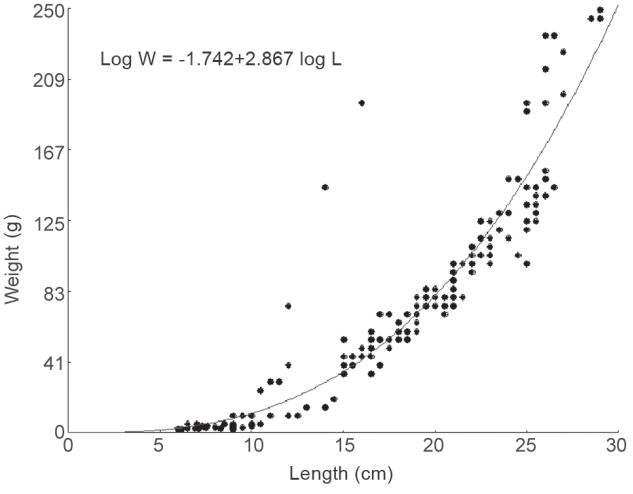

Fig. 1. Length-weight relationship of *Arius subrostratus* (sexes combined)

The regression coefficients calculated using the method of least squares for male and female, *A. subrostratus* in the size range 6 to 29 cm gave the following equations:

Male : $W = 0.0295\ L^{2.6224}$

$\text{Log } W = -1.530 + 2.6224 \text{ log } L \quad r^2 = .94$

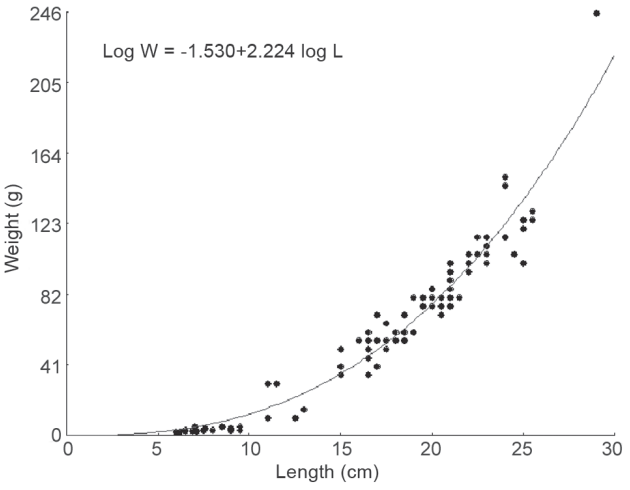

Fig. 2. Length-weight relationship of *A. subrostratus* (Male)

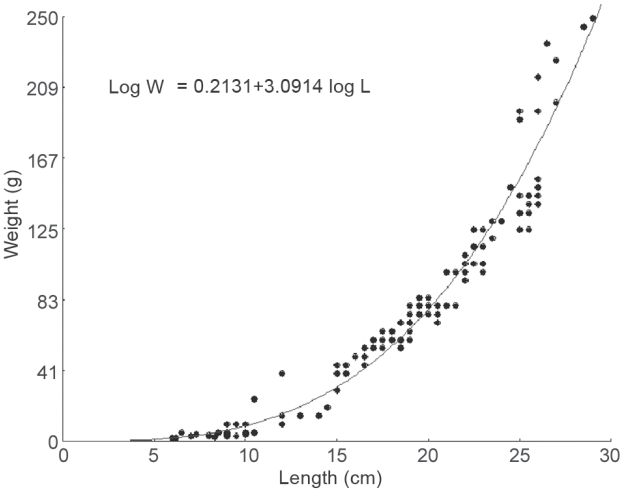

Fig. 3. Length-weight relationship of *A. subrostratus* (Female)

Female : $W = 0.0074\ L^{3.0914}$

$\text{Log } W = -2.131 + 3.0914 \text{ log } L \quad r^2 = 0.95$

Pooled : $W = 0.0181\ L^{2.8067}$

$\text{Log } W = -1.742 + 2.8067 \text{ log } L \quad r^2 = 0.87$

The analysis of covariance indicated no significant difference in the regression coefficients. As may be seen from the equations, the exponential values for males, females and sexes combined were practically identical. The coefficient of correlation, 'r^2' for males, females and sexes combined for the regression of total length and body weight were estimated as 0.94, 0.95 and 0.87 respectively which is highly significant at 1% level.

The relative condition factor (Kn) for all fish samples were determined from the average lengths and weights of 3 cm interval of total length (Table 2). The values of Kn showed fluctuation in all size groups of both males females and sexes combined.

Table 1. Data on length and weight of *Arius subrostratus* from Chambakkara backwaters

Length group (cm)	No. of fishes (combined)	Mean length (cm)	Mean weight (g)	No. of males	Mean length (cm)	Mean weight (g)	No. of females	Mean length (cm)	Mean weight (g)
6-9	25	7.3	5.6	12	7.3	6	13	7.3	5.6
9-12	28	10.3	13.9	14	10.2	13	14	10	14.2
12-15	10	13.2	24	0	0	0	10	13.2	24
15-18	63	16.3	52.5	29	16.4	52.5	34	16.3	48.1
18-21	77	19.3	75	36	19.3	71	41	19.3	70
21-24	119	22.3	105	59	22.5	99	60	22.3	102.5
24-27	61	25.3	147.5	20	25	125	41	25.3	156.7
27-30	9	28.3	218	0	0	0	9	28.3	218

The weekly Kn values were calculated for various length groups. Values of Kn for different sizes groups ranged from 0.75 – 1.07 in males, 0.94 – 1.407 in females and from 0.94 – 1.19 in sexes combined (Table 2 and 3).

Table 2. Relative condition factor (Kn) values of *A. subrostratus* from Champakkara backwaters

Length group (cm)	Male			Female			Sexes combined		
	Observed Weight (g)	Calculated Weight (g)	Kn	Observed Weight (g)	Calculated Weight (g)	Kn	Observed Weight (g)	Calculated Weight (g)	Kn
6 - 9	6	8	0.75	5.6	3.98	1.407	5.6	4.68	1.196
9 - 12	13	16.92	0.768	14.2	10.1	1.405	13.9	12.36	1.124
12 - 15	0	0	0	24	22.98	1.04	24	24.89	0.96
15 - 18	52.5	48.96	1.07	48.1	42.91	1.12	52.5	45.13	1.16
18 - 21	71	70.48	1.007	70	70.77	0.989	75	72.69	1.03
21 - 24	99	99.34	0.996	102.5	108.56	0.944	105	109.27	0.96
24 - 27	125	125.75	0.994	156.7	157.76	0.993	147.5	156.01	0.945
27 - 30	0	0	0	218	215.28	1.012	218	211.89	1.028

Table 3. K and Kn values of *A. subrostratus* for different length groups

Male			Female			Sexes combined		
Length (cm)	K	Kn	Length (cm)	K	Kn	Length (cm)	K	Kn
7.3	1.5423	0.75	7.3	1.4395	1.407	7.3	1.4395	1.196
10.2	1.225	0.768	10	1.42	1.405	10.3	1.272	1.124
16.4	1.1902	1.07	13.2	1.0435	1.04	13.2	1.0435	0.96
19.3	0.9876	1.007	16.3	1.1107	1.12	16.3	1.2123	1.16
22.5	0.8691	0.996	19.3	0.9737	0.989	19.3	1.0433	1.03
25	0.8	0.994	22.3	0.9242	0.944	22.3	0.9468	0.96
-	-	-	25.3	0.9676	0.993	25.3	0.9108	0.945
-	-	-	28.3	0.9825	1.012	28.3	0.9618	1.028

Morphometric and meristic characters

Morphometric measurements of various parts of the body and their percentage ratio in relation to TL for males and females of 392 fishes (170 males and 222 females) ranging from 6 to 29 cm TL are given in Table 4 and 5 respectively. As may be seen from the tables, fork length, standard length, body width, body depth, pre-dorsal length, pre-pectoral, pre-pelvic, base of dorsal, base of pectoral, base of pelvic, base of anal, base of caudal, length of pectoral, length of pelvic, length of anal, length of caudal, least width of caudal peduncle, head length, eye diameter, snout length, post-orbital length, inter-orbital length and gape width are highly correlated with TL and the relationship between body measurements are found to be non-linear. The details of meristic characters, such as counts of dorsal fin rays, dorsal spines, pectoral fin rays, pectoral spine, anal fin rays and caudal fin rays as presented in Table 6.

Discussion

In general, growth of fishes or any other animal increases with the increase in body length. Thus, it can be said that length and growth are interrelated. Length-weight relationship is expressed by the cube formula $W = aL^3$ by

Table 4. Regression values for various morphometric characteristics as function of total length (male)

Parameters	a	b	R	R^2	Y = b X + a
Fork length	4.81	3.696	0.993	0.987	3.696 Tl + 4.81
Body width	2.699	2.074	0.953	0.908	2.074 Tl + 2.699
Body depth	3.582	2.753	0.957	0.915	2.753 Tl + 3.582
Pre-dorsal length	3.685	2.832	0.979	0.959	2.832 Tl + 3.685
Pre-pectoral length	8.636	6.636	0.871	0.759	6.636 Tl + 8.636
Base of dorsal	1.824	1.402	0.801	0.642	1.402 Tl + 1.824
Base of pectoral	1.867	1.435	0.686	0.47	1.435 Tl + 1.867
Base of pelvic	1.163	0.894	0.909	0.827	0.894 Tl +1.163
Base of anal	3.377	2.595	0.853	0.728	2.595 Tl +3.337
Base of caudal	2.856	2.195	0.913	0.834	2.195 Tl + 2.856
Length of pelvic	3.152	2.422	0.93	0.866	2.422 Tl + 3.152
Length of pectoral	4.932	3.789	0.61	0.373	3.789 Tl + 4.932
Length of anal	4.118	3.164	0.749	0.56	3.164 Tl + 4.118
Length of caudal	5.701	4.381	0.826	0.683	4.381 Tl + 5.701
Least width of caudal peduncle	1.495	1.149	0.913	0.834	1.149 Tl + 1.495
Head length	5.127	3.94	0.954	0.911	3.94 Tl + 5.127
Eye diameter	0.964	0.741	0.866	0.75	0.741 Tl + 0.964
Pre-orbital	4.124	3.169	0.917	0.84	3.169 Tl + 4.124
Post-orbital	4.173	3.206	0.793	0.628	3.206 Tl + 4.173
Inter-orbital	2.416	1.856	0.951	0.905	1.856 Tl + 2.416
Gape width	2.123	1.631	0.803	0.644	1.631 Tl +2.123

Table 5. Regression values for various morphometric characteristics as function of total length (female)

Parameters	a	b	R	R^2	Y = b X + a
Fork length	3.892	4.023	0.989	0.978	4.023 Tl+ 3.892
Body depth	2.961	3.06	0.93	0.865	3.060 Tl + 2.961
Pre-dorsal length	6.076	6.281	0.839	0.704	6.281 Tl + 6.076
Pre-pectoral length	6.759	6.987	0.791	0.626	6.987 Tl + 6.759
Base of dorsal	1.623	1.677	0.756	0.572	1.677 Tl + 1.623
Base of pectoral	1.415	1.463	0.714	0.51	1.463 Tl + 1.415
Base of pelvic	1.074	1.11	0.832	0.691	1.110 Tl + 1.074
Base of anal	2.642	2.731	0.79	0.623	2.732 Tl +2.642
Base of caudal	2.476	2.56	0.858	0.736	2.560 Tl + 2.476
Length of pectoral	3.351	3.464	0.854	0.73	3.464 Tl + 3.351
Length ofanal	3.225	3.334	0.743	0.552	3.334 Tl + 3.225
Length of caudal	3.813	3.942	0.836	0.699	3.942 Tl + 3.813
Least width of caudal peduncle	1.603	1.657	0.784	0.614	1.657 Tl + 1.603
Head length	3.752	3.879	0.937	0.878	3.879 Tl + 3.752
Eye diameter	0.71	0.734	0.829	0.688	.734 Tl + .710
Pre-orbital	2.97	3.071	0.887	0.787	3.071 Tl + 2.970
Post-orbital	2.87	2.967	0.747	0.559	2.967 Tl + 2.870
Inter-orbital	1.961	2.027	0.913	0.833	2.027 Tl + 1.961
Gape width	1.891	1.955	0.649	0.421	1.955 TL + 1.891

Table 6. Meristic counts in three length groups of *A. subrostratus*

Length group (cm)	Dorsal fin rays	Pectoral fin rays	Anal fin rays	Caudal fin rays
9 - 15	1,7	1,12	26 - 32	17 - 20
15 – 21	1,7	1,12	26 - 32	17 - 20
21 - 27	1,7	1,12	26 - 32	17 - 20

earlier workers (Brody, 1945; Lagler, 1952; Brown, 1957). In the present study. the value of 'b' in *A. subrostratus* was found to range between 2.6224 to 3.0914. The highest 'b' value was arrived in females followed by sexes combined and then males. The exponential value of 3.0914 implies that the female gain weight at a faster rate in relation to the length than males (2.6224) and sexes combined (2.8067). Le Cren (1951) reported that females are heavier than the males of the same lengths probably because of the difference in fatness and gonadal development.

In the t test, for determining the variation of b from 3, the 't' value in males and females showed that the regression coefficient were not significantly different from 3, indicating an isometric growth in the species. All the earlier reports (Hile, 1936; Tesch, 1968; Krishnamurthy and Kaliyamurthy, 1978; Jayasankar, 1991; Narejo *et al.*, 2000) are in compliance with the present findings on the length-weight relationship in *A. subrostratus* in which the 'b' values were very close to the isometric value of 3. This indicated that *A. subrostratus* in the present study showed an isometric growth.

In the present study, sex-wise analysis of Kn values in females (1.11) was higher than that of males (0.927) (Tables 2, 3 and Fig. 4). In sexes combined, the mean value was 1.04. According to Le Cren (1951), Kn values greater than 1 indicates good general condition of the fish whereas values less than 1 denotes the reverse condition. High Kn values were recorded in *Labeo rohita* (1.0129) and *Catla catla* (0.9967) by Pandey and Sharma (1998) from Uttar pradesh. In the present study also females showed the highest value (1.11) as compared to males and sexes combined. This indicates that females are in better condition compared to males. The values of K showed significant fluctuation in both males and females which may be due to difference in the weight of food contents in the stomach. This result supports the reports of Kader and Rahman (1978); Umesh *et al.* (1996) and Das et *al.* (1997). The values of K showed fluctuations in different length groups of males and females. In females, Kn values remained high in size group up to 15 – 18 cm and then gradually declined by 18 – 21 and 27 – 30. In males, Kn value remained comparatively low in size group up to 12-15 cm but suddenly rose in 15–18 cm size group indicating the length at first maturity as per Hart (1946). This corroborates with the studies by Jhingran (1972); Jayasankar (1991) and Suresh *et al.* (2007).

From the results of the present investigation, it was observed that, the body parameters grew symmetrically when observed in different length groups. Similar observations were reported in Mahseer by Mann (1976), Talwar and Jhingran (1992) and Muhammad Zafar *et al.* (2002). The morphometric measurements were found to be non-linear and there is significant difference observed between the two sexes. From the regression results of morphometric characters, the coefficient of determination (r^2) was noted to have varying strength relationships between the total length against other measurements. As such the relative growth of the morphometric characters in relation to the total length was noted to be the least in the post-orbital length (b=0.107) and the highest in the pre-pectoral length (b=6.987).

It is clear that dorsal fin (1/7), pectoral fin (1/12), anal fin (17 - 20) and caudal fin (26 - 32) remained constant in all groups of fish having different body length. It means that in this study, the meristic counts are independent of body size and there is no change in meristic counts with increase in body length. This corroborates with the studies in other fishes by Vladykov, (1934); Talwar and Jhingran (1992) and Muhammad Zafar *et al*. (2002). Variations in meristic characters were reported in many fishes such as *Nematalosa nasus* (Al-Hassan, 1987), *Pseudobagrus ichikawai* (Watanabe, 1998) and *Pterophyllum scalare* (Bibi *et al.*, 2008). The variations in the number of meristic characters have been documented by many workers (Hart and Raynolds, 2002; Abdul Rahiman *et al.,* 2004), where they agreed that the environmental factors, particularly temperature influences meristic characters in the process of their growth in fishes.

The results of the present investigation on length–weight relationship and relative condition factor of *A. subrostratus* indicated that the wellbeing of the species studied were good.

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