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Preliminary observations on morphometry and length-weight relationship of *Decapterus macrosoma* (Bleeker, 1851) off Cochin coast, Kerala

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ABSTRACT

Short fin scad is a commercially relevant species of the family Carangidae and the current study provides scientific information on some biological aspects, including length- weight relationship, morphometric measurements etc., from Cochin Coast. A total of 200 specimens of *Decapterus macrosoma,* ranging in size from 10.3 to 25 cm in total length (TL) and 10.99gm to 102.7 gm in weight, were collected for various analyses. The relation between the total length and weight of *Decapterus macrosoma* is described as Log W = -1.4248 + 2.5294 log L for males, Log W = -0.9751 + 2.1986 log L for females and Log W = -1.1752 + 2.3428 log L for sexes combined. The values of r^2 were 0.91, 0.84, and 0.88 for males, females, and both sexes combined, respectively.The value of **b** ranged between 2.1986 and 2.5294, and the exponential value indicated negative allometric growth of fish (b<3).The values of Kn showed fluctuation in all size groups of males, females and sexes combined. Values of Kn ranged from 0.58 to 1.07 in males, 0.76 to 1.08 in females and 0.60 to 1.09 in sexes combined. In the present study, sex-wise analysis of Kn values in females (0.925) was higher than that of males (0.865). The morphometric measurements such as pre-dorsal length, body depth, pectoral fin length, ventral fin length, ventral fin base, and post orbital length exhibit linear relationship. From the present investigation, the fin formula can be written as D: I, 13; V: 6-20; C: 26-40; A: 10-17.

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1. Introduction

The short fin scad, *Decapterus macrosoma,* significantly contribution to the pelagic fishery in both tropical and subtropical waters of the world. It is one of the dominant and commercially important species of the family Carangidae, used as food as well as bait in tuna fishery and exported frozen. The cheap source of protein credits its demand in the market and is less expensive than any other pelagic fishery resources. *Decapterus* species are widely distributed in tropical Indo-West Pacific, eastern Pacific Ocean, etc. Because of the increased demand for these species, the scad fishery faces continuous exploitation day by day without proper monitoring, resulting in the decline of fish stocks. Various kinds of purse seines, gill nets, ring nets, mini-trawls etc. are used for the fishery, leading to the degradation of fish resources (Ohshimo *et al.,* 2014; Narido *et al.*, 2016). Moreover, global warming is also responsible for alteration in distribution patterns and other biological characteristics of such species, gradually leading to the decline of these fish resources (Dahlan *et al.,* 2014).

Decapterus macrosoma is slender, elongate and pelagic (in coastal and oceanic waters) schooling fish species occasionally identified in reef slopes (Kuiter and Tonozuka, 2001) and feeds primarily on small invertebrates, plankton, pelagic fish larvae and eggs, pelagic crustacean etc. (Tiews *et al.,* 1975). It is a marine reef-associated species inhabiting waters from 20 to 214m in tropical areas; 39°N - 34°S, 180°W - 180°E (Fishbase, 2020). It exhibits sexual growth dimorphism and the female fish tends to be stronger and larger than the male fish (Shan *et al*., 2021a). The scads fishery contributes to significant growth in the national economy. Based on the annual reports of marine fish landings in India issued by CMFRI, the estimated scads fish landings in Kerala exhibit an increased contribution from preceding years and a catch rate of about 7% compared to the landings in 2020 (CMFRI, 2021). Over the past few years, the decline in the scad fishery has been attributed to overexploitation and a lack of sustainable management. The fishery management measures are inevitable for the improvement of optimal and sustainable production of such relevant fish species and these measures include the minimum usage of fishing gear, wide use of environmentally-friendly fishing gear, net mesh size and seasonal closures of fishing grounds (Asni *et al.,* 2019).

The short fin scads are well-documented in several studies by researchers worldwide. Utilization rate and length-weight relationship (Osman *et al*., 2022; Bintoro *et al.,* 2021), age and growth (Rohit and Shanbhogue, 2005), comparative transcriptome sequencing analysis (Cai *et al.,* 2022), sexual shape dimorphism (Uba, 2019), biological aspects (Asni *et al.*, 2019), length-weight relationship, body condition, and fishing gear selectivity (Ahmadi, 2020, Jamal *et al.*, 2021), spawning period, length at maturity (Rada *et al.,* 2019; Gonzales *et al.*, 2021), morphometric and meristic comparison (Dahlan *et al.,* 2014), physicochemical properties, oxidative stability and sensory acceptance (Halmi *et al.,* 2021), species composition, abundance and catch trends (Jimenez *et al.*, 2020), trace metal accumulation (Khalaf *et al.,* 2012), size distribution, length-weight relationship and age group (Pattikawa *et al.*, 2017).

Length–weight relationship studies of any fish species are a pre-requisite for assessing its population characteristics (Le Cren, 1951). It allows for estimating the average weight of the fish of a given length group by establishing a mathematical relation between them (Sarkar *et al.,* 2008; Mir *et al.,* 2012). The condition factor (K) shows the degree of well-being of the fish (Nehemia, 2012; Weatherly and Gills, 1987). Both the length- weight relationship and its corresponding condition factor provide a comparative

study of the populations of the same species from different environments (Ambili, 2010). Morphometric characters are efficient tools used to identify differences between fish populations and to differentiate between species of similar shapes (Mojekwu and Anumudu, 2015). The available literature indicated that comprehensive information on fishery biology such as length-weight relationship, condition factor and morphometric analysis on *Decapterus macosoma* from the Indian subcontinent, is scarce. Hence, the study addressed the knowledge of length-weight relationship, relative condition factor and morphometry of *Decapterus macrosoma* (Bleeker, 1851) off Cochin Coast, Kerala in the context of sustainable use and conservation of resources.

2. Materials and Methods

Fresh samples were collected weekly from October to November 2016 from the Kalamukku fish landing center in Cochin Coast (Lat: 9 ◦98'48''N and Long: 76◦ 24'22''E), the south-western zone of the Arabian Sea. A total of 200 specimens of *Decapterus macrosoma* ranging in size from 10.3-25 cm in total length (TL) and 10.99gm to 102.7 gm in weight were used for the length-weight analysis. The morphometric traits were measured using a scale while weight was measured using a digital balance. Twenty one morphometric and six meristic characters were studied following the standard procedures described by Appa Rao (1966), as well as Dwivedi and Menezes (1974). Morphometric parameters are divided into body parameters and head parameters. For meristic characters (countable structures), Dorsal fin rays, ventral fin rays, caudal fin rays, anal fin rays were counted. (Give diagram /fig showing different morphomentric measurements of the species.) list the meristic traits also.

The relationship between various parameters was determined by the least square method. Each fish's total length (cm) was taken from the tip of the snout to the extended tip of the caudal fin using a measuring board. Body weight was measured to the nearest gm using a digital balance after removing adhered water and other particles from the body surface.

The length – weight relationship of the form $W = aL^b$ was calculated for male, female and sexes combined, which was transformed in logarithmic form as Log W = Log a + b Log L, where, W is body weight (gm), L is total length (cm), a is a coefficient related to body form and b is an exponent indicating growth pattern (Beverton and Holt, 1996). Relative condition factor (Kn) was calculated separately for males and females of different length groups at 3 cm length interval. Significance of the difference between the regression coefficients of the sexes was tested by ANOVA (Snedecor and Cochran, 1967; Ostertagova and Ostertag, 2013; Neill, 2010). 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 to calculate the relative condition factor.

3. Results

3.1. Length-weight relationship

The equations of length- weight relationship were calculated separately for males, females and sexes combined. The arithmetic scale with smooth curves were obtained from the corresponding length and weight parameters (Fig. 1, 2 and 3).

The L-W relationship for male and female of *Decapterus macrosoma* has been established as follows

Male: $W = 0.0376\ L^{2.5294}$

$\log W = -1.4248 + 2.5294 \log L \qquad r^2 = 0.91$

Female: $W = 0.1059\ L^{2.1986}$

$\log W = -0.9751 + 2.1986 \log L \qquad r^2 = 0.84$

Sex combined: $W = 0.0668\ L^{2.3428}$

$\log W = -1.1752 + 2.3428 \log L \qquad r^2 = 0.88$

The coefficient of correlation, 'r^2' for males, females and sexes combined for the regression of total length and body weight were estimated as 0.91, 0.84 and 0.88, respectively and it is highly significant at 1% level. In the present study, the value of 'b' in *Decapterus macrosoma* as found to range between 2.1986 to 2.5294. The exponential value of 'b' obtained in the present study was less than '3' there by indicating negative allometric growth of fish.

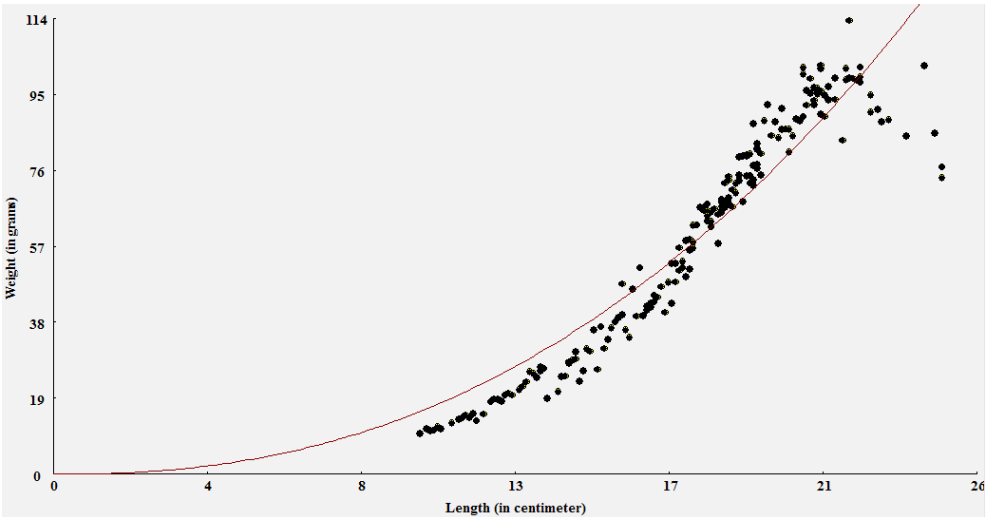

Fig. 1. Length and weight relationship of *Decapterus macrosoma* (Sexes combined)

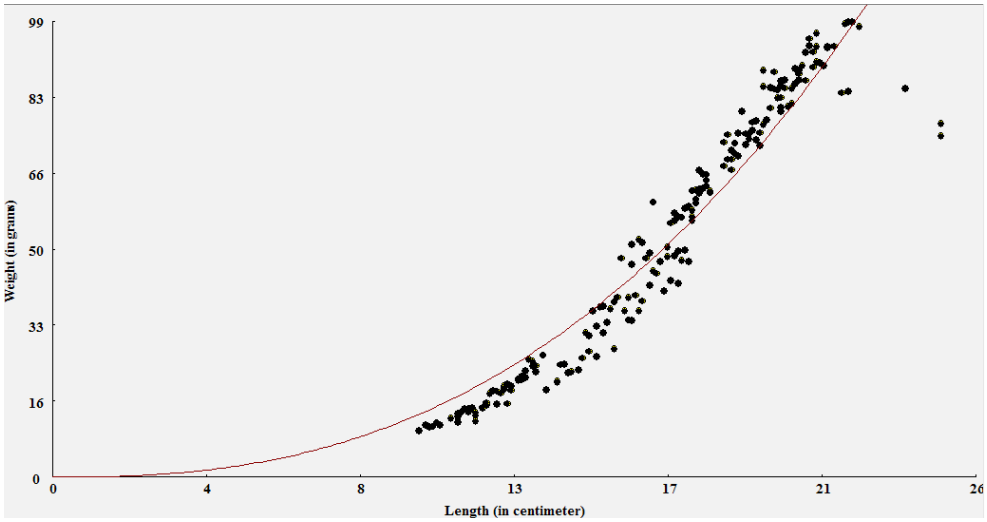

Fig. 2. Length and weight relationship of *Decapterus macrosoma* (Male)

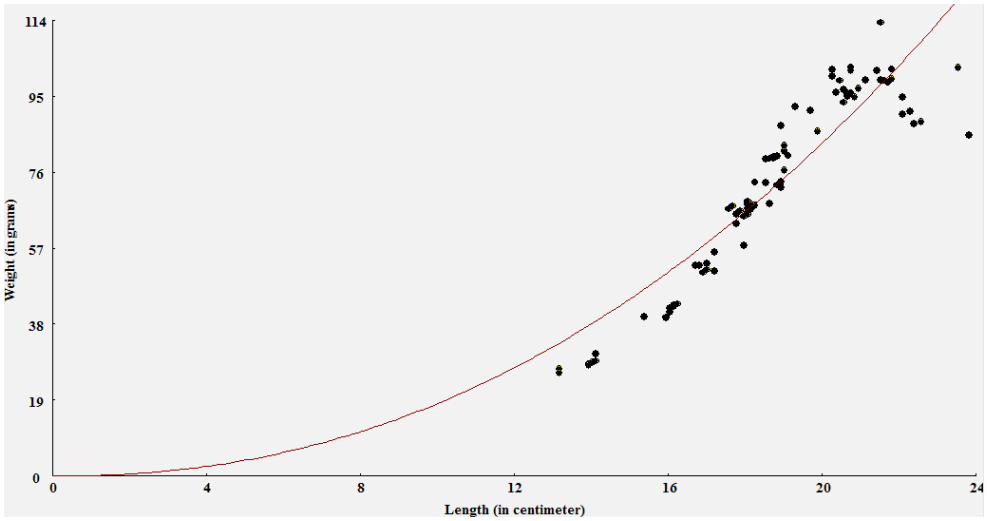

Fig. 3. Length and weight relationship of *Decapterus macrosoma* (Female)

Table 1. Data on length and weight of *Decapterus macrosoma* from Cochin Coast

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)
10-13	57	11.9	15.45	57	11.9	15.45	0	0	0
13-16	65	14.52	27.89	58	14.57	27.84	7	14.34	28.28
16-19	199	17.73	53.21	170	17.71	52.67	29	17.87	56.4
19-22	154	20.22	80.53	118	20.18	78.57	36	20.35	86.95
22-25	23	22.84	96.16	8	22.56	93.32	15	22.99	97.68
25-28	2	25	76.17	2	25	76.17	0	0	0

The relative condition factor (Kn) for all fish samples was determined from the average lengths and weights of 3 cm interval of total length (Table 1). The values of Kn showed fluctuation in all size groups of both males, females and sexes combined. The monthly Kn values were calculated for various length groups. Values of Kn for different size groups ranged from 0.58 to 1.07 in males, 0.76 to 1.08 in females and 0.60 to 1.09 in sexes combined (Tables. 1, 2, 3). In the present study, sex-wise analysis of Kn values in females (0.925) was higher than that of males (0.865). (If the L-W relationship and condition factor values are estimated for different sexes, different maturity stages, in different months the conclusion and comparison becomes easy).

3.2. Morphometric and meristic characters

Morphometric measurements of various body parts and its corresponding percentage ratio with respect to the total length for males and females of 145 ranging in size from 10.6 cm to 25 cm in total length (table 4). The various body measurements of fork length, standard length, dorsal fin height, dorsal fin base, head length etc. show the positive correlation with total length. The body parameters such as pre-dorsal length, body depth, pectoral fin length, ventral fin length, ventral fin base and post orbital length exhibit a linear relationship (table 5). It is observed that the body parameters grew symmetrically when observed in different length groups. The details of meristic characters, such as

Table 2. Relative condition factor (Kn) values of *Decapterus macrosoma* from Cochin Coast

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
10-13	15.34	19.77	0.77	-	-	-	15.06	21.29	0.7
13-16	27.34	32.67	0.83	28.28	37.02	0.76	28.31	35.34	0.8
16-19	53.07	52.31	1.01	56.4	60.18	0.93	54.91	56.06	0.97
19-22	82.89	77.16	1.07	86.95	80.09	1.08	85.22	77.68	1.09
22-25	93.32	99.77	0.93	97.68	104.53	0.93	96.69	102.21	0.94
25-28	76.17	129.17	0.58	-	-	-	76.16	125.79	0.6

Table 3. K and Kn values of *Decapterus macrosoma* for different length groups

	Male			Female			Sexes combined		
Length (cm)	K	Kn	Length (cm)	K	Kn	Length (cm)	K	Kn	
11.9	0.916	0.77	-	-	-	11.9	0.916	0.7	
14.57	0.9	0.83	14.34	0.959	0.76	14.52	0.911	0.8	
17.71	0.948	1.01	17.87	0.988	0.93	17.73	0.954	0.97	
20.18	0.956	1.07	20.35	1.031	1.08	20.22	0.974	1.09	
22.56	0.812	0.93	22.99	0.803	0.93	22.84	0.807	0.94	
25	0.487	0.58	-	-	-	25	0.487	0.6	

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

parameters	**a**	**b**	**R**	**R2**	**Y=bX+a**
Fork length	0.384	0.877	0.981	0.962	0.877 TL+ 0.384
Standard length	0.552	0.805	0.975	0.951	0.805 TL+ 0.552
Pre-dorsal length	0.057	0.319	0.953	0.907	0.319 TL+ 0.057
Anal length	0.205	0.478	0.959	0.919	0.478 TL+ 0.205
Girth length	1.055	0.436	0.891	0.795	0.436 TL+1.055
Body depth	0.003	0.256	0.755	0.567	0.256 TL+ 0.003
Dorsal fin height	0.447	0.093	0.758	0.575	0.093 TL+ 0.447
Dorsal fin base	0.534	0.102	0.774	0.6	0.102 TL+ 0.534
Pectoral fin length	0.201	0.13	0.805	0.647	0.130 TL+ 0.201
Anal fin length	0.423	0.063	0.823	0.678	0.063 TL+ 0.423
Anal fin base	0.535	0.074	0.71	0.504	0.074 TL+ 0.535
Ventral fin length	0.148	0.089	0.889	0.79	0.089 TL+ 0.148
Ventral fin base	0.004	0.023	0.503	0.253	0.023 TL+ 0.004
Length of caudal peduncle	0.062	0.037	0.786	0.618	0.037 TL+ 0.067
Head length	0.27	0.234	0.952	0.906	0.234 TL+ 0.270
Eye diameter	0.209	0.044	0.834	0.695	0.044 TL+ 0.209
Gape width	0.084	0.3	0.354	0.126	0.30 TL+ 0.080
Pre-orbital length	0.015	0.091	0.908	0.824	0.091 TL+ 0.015
Post-orbital length	0.068	0.113	0.892	0.796	0.113 TL+ 0.068
Inter-orbital width	0.227	0.068	0.82	0.672	0.068 TL+ 0.227

counts of dorsal fin rays, ventral fin rays, caudal fin rays and anal fin rays etc. remained constant in all group of fishes having different body length (table. 6). The result exhibits the meristic counts are independent of body size and there is no change in meristic counts with increase in body length.

4. Discussion

In general, the length and growth are interconnected as growth of fishes or any other organism's increases with an increase in body length. It gives information on the condition and growth patterns of fish (Bagenal and Tesch, 1978). The relationship between total length and total weight for nearly all species of fish is expressed by the equation: $W= aL^b$

In the present study the value of **b** was found to range between 2.1986- 2.5294. The highest b value was reached in males, followed by pooled sexes and females. The exponent value of 2.5294 implies that the males gain weight at a faster rate in relation to the length than pooled sexes (2.3428) and females (2.1986) (Faizah and Sadiyah, 2020). The exponential value of *Decapterus macrosoma* off Cochin coast is b <3 and hence, the fishes exhibit negative allometric growth (Agista *et al*., 2019). It implies the fish becomes more slender as it increases in weight (Riedel *et al.,* 2007). The present study also confirms that the body shape of *Decapterus macrosoma* is very elongate, slender and nearly rounded. The negative allometry growth pattern were recorded in the same fish by Syahailatua

(2004), Randongkir *et al.* (2018), Afdhilal *et al.* (2019), Guzman and Rosario (2020), Bintoro *et al.* (2021) from Indonesia. *Decapterus macrosoma* exhibits both positive growth patterns (Pattikawa *et al.,* 2017; Asni *et al*., 2019) and isometric growth patterns (Prihartini *et al*., 2007; Ahmadi, 2020). Various factors like sample size variation, life stages, growth difference, seasonal fluctuations, gonad development, sex, and other environmental factors affect the growth pattern of fish species (Mehanna *et al.,* 2015; Aswini *et al.,* 2016; Kalhoro *et al.,* 2017).

5. Conclusion

In the present study the various important parameters of *Decapterus macrosoma* exhibited positive correlation with total length. The meristic characters are remained constant and also independent of the body size. The females of this species show better life condition than others. The different body parameters such as pre dorsal length, pectoral fin length, ventral fin length etc. follows linear relationship and it indicates symmetrical growth pattern of different length groups of *Decapterus macrosoma.* The fin formula of this species is D: I, 13; V: 6-20; C: 26-40; A: 10-17.

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Table 5. Results of statistical analysis of morphometric characteristics of male and female *Decapterus macrosoma*

Parameters	Male		female	
	R	R^2	R	R^2
Fork length	0.984	0.968	0.952	0.907
Standard length	0.979	0.959	0.937	0.877
Pre-dorsal length	0.949	0.901	0.944	0.891
Anal length	0.964	0.929	0.906	0.821
Girth length	0.903	0.812	0.762	0.581
Body depth	0.716	0.512	0.66	0.649
Dorsal fin height	0.75	0.563	0.677	0.458
Dorsal fin base	0.764	0.584	0.705	0.497
Pectoral fin length	0.813	0.661	0.764	0.584
Anal fin length	0.82	0.672	0.567	0.552
Anal fin base	0.631	0.391	0.574	0.33
Ventral fin length	0.827	0.684	0.837	0.704
Ventral fin base	0.475	0.226	0.083	0.007
Length of caudal peduncle	0.712	0.507	0.572	0.327
Head length	0.951	0.904	0.94	0.883
Eye diameter	0.796	0.634	0.938	0.88
Gape width	0.432	0.186	0.028	0.001
Pre-orbital length	0.892	0.796	0.941	0.885
Post-orbital length	0.902	0.813	0.88	0.774
Inter-orbital width	0.8	0.641	0.831	0.691

Table 6. Meristic counts in four length groups of *Decapterus macrosoma* from the Cochin coast

Length group	Dorsal fin rays	Ventral fin rays	Caudal fin rays	Anal fin rays
10-14	1,13	6-20	26-40	10-17
14-18	1,13	6-20	26-40	10-17
18-22	1,13	6-20	26-40	10-17
22-26	1,13	6-20	26-40	10-17

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