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MORPHOMETRY, LENGTH-WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR OF SHRIMP SCAD *ALEPES DJEDABA* (FORSSKAL, 1775) OFF COCHIN COAST, KERALA

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Abstract: *Alepes djedaba* is a commercially important species found along Indian coast and one of the much demanded table fish among the local people. A total of 605 fishes (315 males and 290 females) were collected from commercial fish landing centres at Cochin (Cochin fisheries harbour, Vypin and Munambam) and Morphometry, length- weight relationship and relative condition factor of species collected is presented in this contribution. Twenty eight morphometric and six meristic characters were analysed. The relationship between total length and weight were estimated by least square method. The growth followed was in isometric pattern and the 'b' values obtained were 2.9763 (male), 2.9491 (female) and 2.9642 (sexes combined). The relative condition factor obtained was close to one which reflects that the species was in a better health condition.

Keywords: *Alepes djedaba*, Morphometry, Length-weight relationship, Relative condition factor.

INTRODUCTION

The family Carangidae includes highly diverse group of fishes such as jacks, scads, trevallies, pompanos, amberjacks and queen fishes. They are one of the important pelagic fishery resources in India, contributing 12% to the total marine fish production of Kerala. An improved pelagic fish landing was reported along Kerala coast during 2016 which was mainly due to the heavy catch of scads (CMFRI, 2016). Though many species sustain scad fishery along Kerala coast, *Alepes djedaba* assumes greater significance. Different workers reported length-weight relationship, morphometry and condition factor of carangids such as *Megalaspis cordyla* (Jaiswar and Acharya, 1991; Reuben *et al,* 1992; Sivakami, 1995; Kasim, 1999; Zafar *et al,* 2000; Saker *et al,* 2004; Panda *et al,* 2011; Ahmed *et al* 2013), *Decapterus russelli* (Murty, 1991; Jawad *et al*, 2010; Panda *et al.*, 2011), *Selar cremunophthalmus* (Roos *et al.*, 2007), *Caranx carangus* (Hamsa and Kasim, 1989), *Caranx kalla* (Kalita and Jayabalan, 1997) and *Scomberoides lysan* (Thulasitha and Sivashandini, 2012). But information on the morphometry, length -weight relationship and condition factor of *Alepes djedaba* are few other than the works of Sivakami (1990) and Raje (1993) from Cochin and Veraval coasts respectively. Shuaib and Ayub (2011) studied some aspects on the biology of the species from Pakistan coastal waters and Barr *et al.* (2014) from Arabian Gulf off Saudi Arabia.

Morphological systematics is considered as one of the easiest and authentic methods for the identification of a species (Nayman, 1965). Fishery biologists widely rely on the technique of measuring the linear dimensions of the whole or part of a fish for describing a species (Jayaprakash, 1989). The length -weight relationship of a fish helps in establishing the mathematical relationship between the two variables (Le Cren, 1951). It is also used in fishery management by estimating body weight from length observations (Das *et al*, 2014), condition indices (Safran, 1992), age structure, growth rate (Kohler *et al*, 1995) and standing stock biomass

(Martin- Smith, 1996). The relative condition factor (Kn) reflects the general well-being of the fish, the growth pattern and the life cycle of the species contributes to its management strategies.

MATERIALS AND METHODS

The samples were collected from the commercial fish landing centres at Cochin during January 2012 to December 2013. A total of 161fresh samples (87 males, 74 females) were collected for analysis of morphometric and meristic characters. Twenty eight morphometric and six meristic characters were analysed by following the standard procedures described by Appa Rao (1966), Dwivedi and Menezes (1974). The relationship between different morphological characters with total length and head length was worked out by linear regression analysis using the formula $y = a + bx$

Length weight relationship was derived based on a total of 605 fishes (315 males and 290 females) and the total length and weight were recorded to the nearest 1 mm and 0.1 g respectively. The significance of the variation in length and weight values between the sexes was determined by Analysis of Covariance (Snedecor and Cochran, 1967). The length-weight relationship was estimated separately for males, females and combined sexes using the formula $W= aL^b$ (Le Cren, 1951; Froese, 2006). This equation was expressed logarithmically as Log W= Log a + b Log L where, W =weight of the fish (g), L = length of the fish (cm), '*a*' is a coefficient related to body form and '*b*' is an exponent indicating growth pattern. The ABee software version 1.0 of ICLARM (International Centre for Living Aquatic Resources Management, 1997) was used to compute the length-weight relationship. In order to confirm whether b values obtained from the cubic relationship were significantly different from the isometric value of b=3, students t-test was applied. The equation was expressed as

$$t_s = (b-3) / SE$$ (Sokal and Rohlf, 1987)

where t_s is the t-test value, b the slope and SE the standard error of the slope (b). The relative condition factor (Kn) can be computed using the formula, Kn = W/W' (Le Cren, 1951) where W is the observed weight and W' is the calculated weight. All statistical analysis was done by analytical software SPSS 16.0 (Statistical Package for Social Sciences) (Biswas, 1993).

RESULTS AND DISCUSSION

Morphometric and meristic characters

Morphometric investigations of an animal species reveal the interrelation between the various body parameters (Carpenter *et al*, 1996). Such measurements of an organism mean, measuring various external body parts and meristic characters that account for anything that can be counted (Talwar and Jhingran, 1992). The statistical analysis of various morphometric characters of *A. djedaba* collected during the study period was presented in table 1. In the present study, different morphometric characters and cephalometric characters of both sexes were compared against total length and head length respectively (Table 2 and 3). Most of the morphometric characters showed strong positive correlation with total length; higher value of correlation was noted for standard length (r^2= 0.995- male; r^2= 0.997 - female) and fork length against total length (r^2 = 0.995- male; r^2= 0.996 - female). The comparison of head length with various characters showed high correlation with pre-pectoral length, post-orbital length and pectoral fin length and least correlated with gap width. Different authors studied various morphological parameters of carangids in order to define the identification characteristics of a particular stock (Saker *et al*, 2004), to compare the morphological differences among males and females, to understand the morphological differences with increase in body length (Jardas *et al*, 2004), to assess the intraspecies variations (Bektas and Belduz, 2009) and to analyse the bilateral asymmetry (Jawad *et al*, 2010)

Among all the characters compared with total length, the regression coefficient was higher for standard length (b=0.833 for males, b=0.837 for females) and fork length (b=0.863 for males, b=0.872 for females); while that compared with head length higher value obtained for post orbital length. The higher coefficient of regression indicates that the rate of growth of these individual characters in length is highest in respect of total length and head length respectively. These regression coefficients and the constant obtained from the analysis were used to formulate the regression equations between each morphological parameter

Table 1. Statistical estimation of various morphometric characters of *A. djedaba*

Morphometric characters	Male		Female	
	Range (cm)	Mean ± SD (cm)	Range (cm)	Mean ± SD (cm)
Total length (TL)	9.8-32.8	20.3 ± 5.9	10.4-32	20.7 ± 6.2
Standard length (SL)	8- 26.2	16.7 ± 5	8.7-26	17.0 ± 5.2
Fork length (FL)	8.2-27.4	17.5 ± 5.1	9.2-27	17.9 ± 5.4
Body width (BW)	0.6-4.4	2.0± 0.9	0.7-4	2.0 ± 0.8
Body depth (BD)	1-9.3	5.5 ± 1.9	1-9	5.6 ± 1.8
Pre-orbital length (POL)	0.6-2.3	1.3 ± 0.4	0.8-2.2	1.3 ± 0.4
Post- orbital length (PoOL)	0.9-3.8	2.0 ± 0.6	1-3.4	2.1 ± 0.7
Eye diameter (ED)	0.6-1.4	0.9 ± 0.2	0.6-1.4	0.9 ± 0.2
Head length (HL)	2.1-6.7	4.3 ± 1.1	2.4-6.9	4.3 ± 1.2
Pre-pectoral length(PPL)	2.2-7	4.4 ± 1.2	2.4-7	4.5 ± 1.3
Pre-pelvic length(PPeL)	2.6-8	5.1 ± 1.5	2.6-8.3	5.2 ± 1.6
Pre-dorsal length(PDL)	2.9-11	5.8 ± 1.8	3-9.3	6 ± 1.7
Pre-anal length(PAL)	2-13	7.9 ± 2.5	2.2-13.1	8.2 ± 2.7
Pectoral fin length(PFL)	2-8.6	5.0 ± 1.7	2-8.7	5.1 ± 1.9
Pelvic fin length(PeFL)	0.6-3.2	2.0 ± 0.6	0.7-3.2	2.0 ± 0.7
I dorsal fin length(IDFL)	0.9-3.4	2.2 ± 0.7	1-3.9	2.2 ± 0.8
II dorsal fin length(IIDFL)	1.2-4.1	2.4 ± 0.7	1.4-4	2.5 ± 0.7
Anal fin length(AFL)	1-3.4	2.2 ± 0.6	1-3.5	2.2 ± 0.6
Caudal fin length(CFL)	2.2-7.6	4.7 ± 1.4	2-7.2	4.8 ± 1.4
Least width of caudal peduncle(LWCP)	0.3-1.1	0.6 ± 0.2	0.3-1.1	0.7 ± 0.2
Base of pectoral fin(BPF)	0.3-1.2	0.7 ± 0.2	0.3-1.3	0.8 ± 0.2
Base of pelvic fin(BPeF)	0.2-0.8	0.5 ± 0.2	0.2-1.1	0.5 ± 0.2
Base of I dorsal Fin(BIDF)	1-3.9	2.2 ± 0.7	0.5-5.2	2.2 ± 0.8
Base of II dorsal fin (BIIDF)	3.2-16.4	7.0 ± 2.4	1.2-11.2	6.9 ± 2.3
Base of anal fin((BAF)	0.4-11.6	6.7 ± 2.2	3.5-11	6.9 ± 2.1
Lower jaw length(LJ)	1-2.9	1.9 ± 0.5	1.2-2.8	1.9 ± 0.4
Gap width(GW)	0.4-2	0.9 ± 0.3	0.4-1.7	0.9 ± 0.3

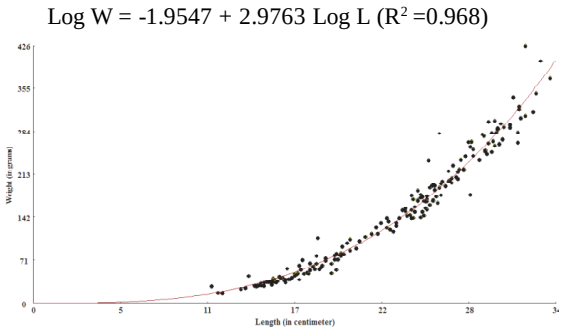

Fig. 1. Length-Weight relationship of *A.djedaba* for male

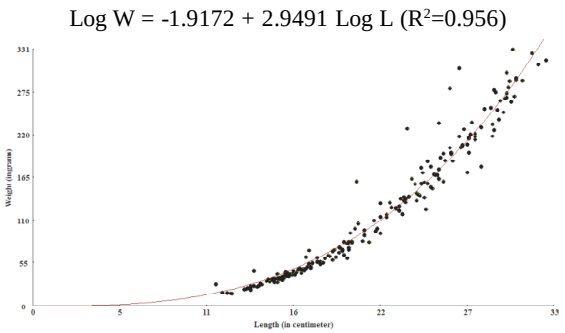

Fig. 2. Length-Weight relationship of *A.djedaba* for female

Table 2. Values of constants 'a' and 'b' in the linear regression of various morphometric characteristics (*y*) of *A. djedaba* (male) as function of total length and head length *(x)*

Characters	Intercept a	Regression b	r square value
TL and SL	-0.234	0.833	0.995
TL and FL	-0.052	0.863	0.995
TL and BW	-0.778	0.134	0.961
TL and BD	-0.404	0.294	0.845
TL and HL	0.434	0.188	0.948
TL and PPeL	0.256	0.237	0.939
TL and PDL	-0.05	0.288	0.874
TL and PAL	-0.421	0.408	0.931
TL and PFL	-0.682	0.28	0.962
TL and PeFL	-0.034	0.098	0.875
TL and IDFL	-0.118	0.112	0.943
TL and IIDFL	0.291	0.106	0.922
TL and AFL	0.199	0.098	0.945
TL and CFL	0.106	0.227	0.957
TL and LWCP	-0.021	0.032	0.882
TL and BPF	0.054	0.033	0.829
TL and BPeF	-0.007	0.022	0.761
TL and BIDF	-0.019	0.109	0.906
TL and BIIDF	0.042	0.34	0.736
TL and BAF	-0.542	0.358	0.918
HL and ED	0.408	0.126	0.729
HL and POL	-0.039	0.314	0.896
HL and PoOL	-0.317	0.551	0.954
HL and PPL	0.165	1.002	0.961
HL and PFL	-1.04	1.423	0.924
HL and LJ	0.285	0.371	0.866
HL and GW	-0.011	0.218	0.517
HL and BD	-1.16	1.558	0.849

Table 3. Values of constants 'a' and 'b' in the linear regression of various morphometric characteristics (*y*) of *A. djedaba* (female) as function of total length and head length *(x)*

Characters	Intercept a	Regression b	r square value
TL and SL	-0.31	0.837	0.997
TL and FL	-0.152	0.872	0.996
TL and BW	-0.465	0.118	0.716
TL and BD	-0.431	0.289	0.954
TL and HL	0.342	0.192	0.963
TL and PPeL	-0.005	0.249	0.981
TL and PDL	0.25	0.272	0.96
TL and PAL	-0.648	0.43	0.972
TL and PFL	-0.93	0.293	0.961
TL and PeFL	-0.203	0.107	0.936
TL and IDFL	-0.216	0.116	0.906
TL and IIDFL	0.359	0.103	0.924
TL and AFL	0.195	0.098	0.926
TL and CFL	0.258	0.218	0.941
TL and LWCP	-0.014	0.032	0.852
TL and BPF	0.056	0.034	0.832
TL and BPeF	-0.053	0.026	0.757
TL and BIDF	-0.221	0.119	0.825
TL and BIIDF	-0.731	0.37	0.957
TL and BAF	-0.184	0.341	0.972
HL and ED	0.434	0.118	0.826
HL and POL	-0.014	0.312	0.948
HL and PoOL	-0.381	0.566	0.969
HL and PPL	0.066	1.029	0.975
HL and PFL	-1.262	1.482	0.942
HL and LJ	0.266	0.371	0.909
HL and GW	0.027	0.201	0.528
HL and BD	-0.762	1.463	0.935

Table 4. Meristic characters in *A. djedaba* for both sexes

Sex	Dorsal Fin	Anal Fin	Pectoral Fin	Pelvic Fin	Girdles	Scute No
Male	VII-I-22-25	II-I-18-20	17-20	I-4	7	44-48
Female	VII-I-22-25	II-I-19-20	16-20	I-4	7	44-48

Table 5. Relative codition factor for different size class of *Alepes djedaba*

Size class (mm)	Male			Female		
	Min	Max	Mean ± SD	Min	Max	Mean ± SD
115-135	_	_	_	0.81	1.6	1.1 ± 0.43
135-155	0.89	0.98	0.94 ± 0.03	0.76	1.5	0.92 ± 0.17
155-175	0.75	1.85	1.02 ± 0.28	0.74	1.68	0.9 ± 0.17
175-195	0.67	1.7	0.98± 0.19	0.76	1.24	0.94 ± 0.12
195-215	0.69	1.08	0.92 ± 0.12	0.85	1.15	0.98 ± 0.09
215-235	1.07	1.14	1.1 ± 0.03	0.85	1.1	0.97 ± 0.08
235-255	0.87	1.09	0.98 ± 0.73	0.83	1.16	1.02 ± 0.09
255-275	0.89	1.09	0.98 ± 0.06	0.92	1.49	1.08 ± 0.15
275-295	0.88	1.2	1.03 ± 0.09	0.77	1.11	1.01 ± 0.08
295-315	0.91	1.13	1.02 ± 0.06	0.9	1.2	0.99 ± 0.08
315-335	0.83	1.27	0.99 ± 0.12	0.83	1.03	0.93 ± 0.08

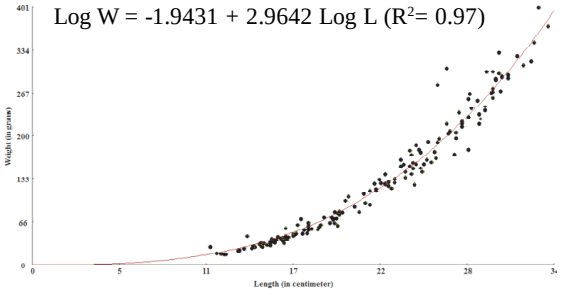

Fig. 3. Length-Weight relationship of *A.djedaba* for combined

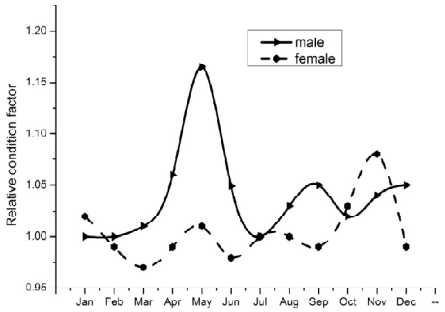

Fig. 4. Relative condition factor during different months

with total length and head length. The meristic counts of the species showed that dorsal fin rays, anal fin rays, pectoral fin rays, pelvic fin rays and lateral line scutes were almost equal in number; girdles remained constant (Table. 4) for both sexes. The meristic counts noted, are comparable with the previous works on the species (Iwatsuki and Kimura, 1996; Lin and Shao, 1999). The morphologic and meristic characters observed in this study were useful for comparison of the stock from other regions.

Length-Weight Relationship

Information on length- weight relationship of any fish species is essential to understand its population (Le Cren, 1951). A total of 605 fishes (315 males and 290 females) were analysed for length weight relationship; the total length and weight obtained for *Alepes djedaba* varied from 13.5 cm to 32.5 cm and 22.8 g to 316 g for male while that for female it varied from 11.6 cm to 30.6 cm and 27.6 g to 293 g. Measuring the weight of a fish from the field itself was a time consuming process. Hence length weight regression has been frequently used to estimate weight from length data (Sinovcic *et al*, 2004). Here the length weight relationship was estimated by the non-linear regression method (Figs. 1 to 3) and the regression equation for male, female and sexes combined were as follows:

Male: Log W = -1.9547 + 2.9763 Log L (R^2=0.968)

Female: Log W = -1.9172 + 2.9491 Log L (R^2=0.956)

Combined: Log W = -1.9431 + 2.9642 Log L (R^2= 0.97)

Analysis of co-variance for the regression of log weight on log length revealed that no significant differences existed between the sexes (F = 1.07, P > 0.01), and hence it can be inferred that male and female fishes exhibited similar growth pattern in relation to length. The correlation coefficient obtained

for male (r = 0.944) and female (r = 0.968) fishes showed that a strong positive correlation exists between the variables length and weight. The values of 'b' will be 3 for an ideal fish having a constant body shape and specific gravity (Allen, 1935, Vivekanandan and James, 1984). From a huge number of length weight data Carlander (1969, 1977) has demonstrated that the value of b lies between 2.5 and 3.5. The present study revealed that, the exponential value 'b' for male (2.9763), female (2.9491) and sexes combined (2.9642) were close to the expected value of regression coefficient for isometric growth i.e.; b=3. So it can be said that the species exhibit isometric growth pattern ('b' value close to 3), when its length doubles its weight will increase 8 times i.e.; the variables length and weight follows the cubic relationship. Student's t test also showed that the 'b' value for both male and female fishes did not significantly deviate from the ideal value of b =3. Similar observations for the species were made by Sivakami (1990) from Cochin waters and Shuhaib and Ayub (2011) from Karachi, Pakistan. Isometric growth pattern was also reported for other carangids like *Megalaspis cordyla* from north west coasts (Jaiswar and Acharya, 1991) and from Mumbai waters (Panda *et al*, 2011); *Caranx kalla* from Mangalore coast (Kalita and Jayabalan, 1997). Ahmed *et al.* (2013) reported that *M. cordyla* collected from Karachi coast showed a shifting of positive and negative allometric growth in accordance with seasons. *Scomberoides lysan* collected from the Northern waters of Sri Lanka exhibited positive allometric growth for male and isometric growth for female (Thulasitha and Sivashanthini, 2012). From the present investigation it can be inferred that in *A. djedaba* the length increases in equal proportions with body weight for constant specific gravity.

Relative Condition Factor

Lecren (1951) introduced the relative condition factor (Kn) which measures the deviation of an individual species from the expected weight obtained from the length weight data. The study of Kn is important for understanding the life cycle of a species and contributes to its adequate management.

The monthly index for the relative condition factor of *A. djedaba* is presented in Fig. 4 and it is suitable for comparing condition within a given sample (Froese, 2006). A species with higher condition factor is generally considered to be a healthier one. Lambert and Dutil (2000) opined that in females lower body condition not only reduces its reproductive investment but also increases its risk of mortality. The present study revealed that both male and female in *A. djedaba* showed fluctuation in the values of Kn during different months and different size groups. Only male fishes showed highly significant variation in the monthly values ($F = 3.437$, $P < 0.01$) while females showed significant variation according to length ($F = 1.628$, $P < 0.05$). Male fishes showed low values during March and high values during May whereas females having length 155-175 mm showed lower values.

Variation in kn values depended on many factors such as changes in gonadal development, food availability and other environmental parameters (Pope and Willis, 1996). Fluctuation in Kn values is in accordance with the spawning seasons, that was reported by earlier workers (Raje, 1994; Dar *et al.*, 2012). Raje (1994) reported three peaks in the relative condition factor of different size groups of *A. djedaba* which was associated with maturation of gonads. No such changes were observed in the present investigation. Fluctuation in Kn values reported in this study may be attributed to various factors such as time of the year, stages of maturity and stomach contents. The overall results indicate a better health condition for the species.

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