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Length-Weight Relationship of *Sphyraena obtusata* Cuvier, 1829 (Pisces: Perciformes) from the Jaffna Lagoon, Sri Lanka

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Abstract: The present study was carried out to gain some knowledge on length-weight relationship parameters, growth pattern and difference between the growth parameters of male and female *Sphyraena obtusata*. The knowledge of length-weight relationship has numerous practical applications in fishery biology. Such a mathematical equation enables conversion of one parameter in to another as is often required during monitoring field measurements. Length-weight regression equations were derived for male and female *Sphyraena obtusata* collected from the Jaffna lagoon, Sri Lanka. Regression coefficients were estimated by using the logarithms of the total lengths and the corresponding weights. The curvilinear relationships of length-weight relationships for male and female were $W = 0.0117*L^{2.898}$ and $W = 0.0138*L^{2.843}$, respectively. Covariance analysis for length-weight relationships of males and females revealed that there is no significant difference ($p>0.05$) between male and female and hence a common formulae of $W = 0.0133*TL^{2.857}$ was derived for *S. obtusata*. The 'b' values 2.898 and 2.843 obtained for male and female, respectively indicate that the fish follows the cube law and its growth is negative allometry.

Key words: Obtuse barracuda, growth, cube law, Jaffna lagoon, regression coefficients

INTRODUCTION

Sphyraena obtusata (Pisces: Perciformes: Sphyraenidae) is commonly referred to as obtuse barracuda and is one of the largest order of fishes recorded along the coastal areas and brackish water bodies of the northern part of Sri Lanka. These are one of the commercially important groups of fishes inhabiting the Jaffna lagoon, Sri Lanka (Munro, 1982). Usually these fishes found in bays and estuaries (Senou, 2001); they also inhabit in schools in sea grass beds and rocky reefs (May and Maxwell, 1986). They feed mainly on fishes and exhibits diurnal behavior. These are commonly caught with set nets (Senou, 2001). These are sold fresh, frozen or dried salted in markets. They grow up to 55 cm total length (May and Maxwell, 1986). These are distributed along the Indo Pacific: Red Sea and East Africa to Samoa, north to the Ryukyu Islands, south to Lord Howe Island. They migrated to eastern Mediterranean from the Red Sea via the Suez Canal (Por, 1978). Various studies on length-weight relationship of *Sphyraena* sp. as well as other fish species have been carried out in different parts of the world, so far (Anastasopoulou *et al*., 2006; Başusta and Çiçek, 2006; Filiz and Bilge, 2004; Filiz *et al*., 2006; Froese, 1998; Karakulak *et al*., 2006; Yeldan and Avsar, 2007).

King (1996) expressed that there is a cubic relationship between Length (L) and weight (W) of fishes which can be represented by the cubic power equation $W = a L^b$. The 'b' values are the indicators of growth pattern in fishes whereas 'a' values represents the condition of the fish. The knowledge of length-weight relationship has numerous practical applications in fishery biology. Such a mathematical equation enables conversion of one parameter in to another as is often required during monitoring field measurements. It also helps in establishing the yield. The present study provides

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information on the size distribution, length-weight relationship parameters and a comparison between male and female length-weight relationship parameters of *Sphyraena obtusata* from the Jaffna lagoon. *Sphyraena obtusata* is perhaps one of the most abundant popular food fishes with high consumer demand. Few studies were performed to estimate the length weight relationship of *S. obtusata* from various parts of the world such as New Caledonia, Indonesia, India and Malaysia (Letourneur *et al*., 1998; Kulbicki *et al*., 2005; Pauly *et al*., 1996; Ahmad *et al*., 2003; Somvanshi, 1989). No studies have been made on length weight relationship of these species in Sri Lanka, so far and therefore the present study was carried out to gain some knowledge on length weight parameters of this species.

MATERIALS AND METHODS

The Jaffna lagoon is a shallow water body located in the northern province of Sri Lanka. It lies between approximately 79° 52'E to 80° 38'E longitude and 9^0 26'N to 9° 46'N latitude and has an area of about 412 km^2 (160 square miles) and the depth does not exceed 4 m.

Weekly random samples of *Sphyraena obtusata* were collected from Kakkaithevu, Navanthurai, Kurunagar and Pashaiyoor landing centres of Jaffna lagoon, Sri Lanka from November 2004 to December 2005 (Fig. 1). Thirteen field visits were made to each landing centers throughout the study period. During the field visits 70 specimens were collected from Kurunagar and Pashaioor landing centers whereas 62 specimens were collected from Kakkaithevu and Navanthurai landing centers of the Jaffna lagoon. Samples were brought to the laboratory and Total length (TL) was measured to the nearest 5 mm with a measuring board. Weight (W) was measured to the nearest 0.1 g by an electronic balance (AND, FY 300) after draining the water from the buccal cavity and wiping the moisture content on the body of fish (King, 1996). The parameters 'a' (proportional constant or intercept) and 'b' (exponent) of the Total length (TL) -Weight (W) relationship of the form $W = aTL^b$ were estimated for males and females separately by using the logarithmic transformation log W = log a+b.log TL. Male and female *S. obtusata* were identified only after dissecting the specimens and this species cannot be differentiated by any special external morphological characters. External morphology of *S. obtusata* is shown in Fig. 2. The regression line was calculated by the method of least square regression analysis. The regression lines of male and female fishes were then analyzed further by covariance analysis using MINITAB software for significant differences.

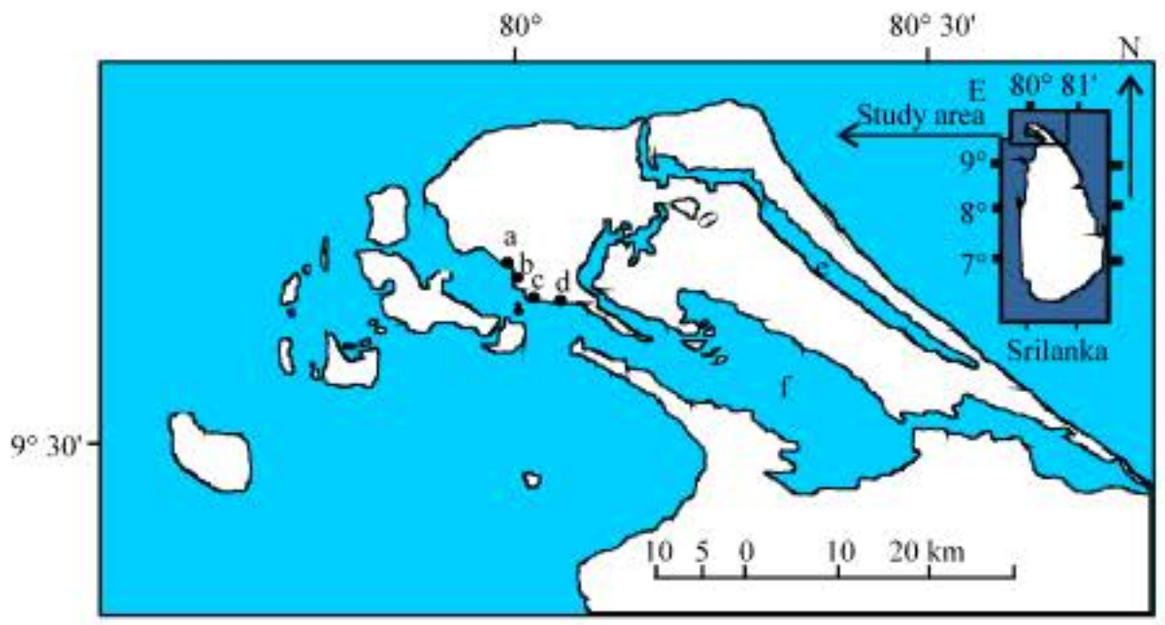

Fig. 1: Map showing the collection sites (a-d) of Jaffna lagoon, Sri Lanka. (a) Kakkaithevu, (b) Navanthurai, (c) Kurunagar, (d) Pasaioor, (e) Thondaimannar lagoon and (f) Jaffna lagoon

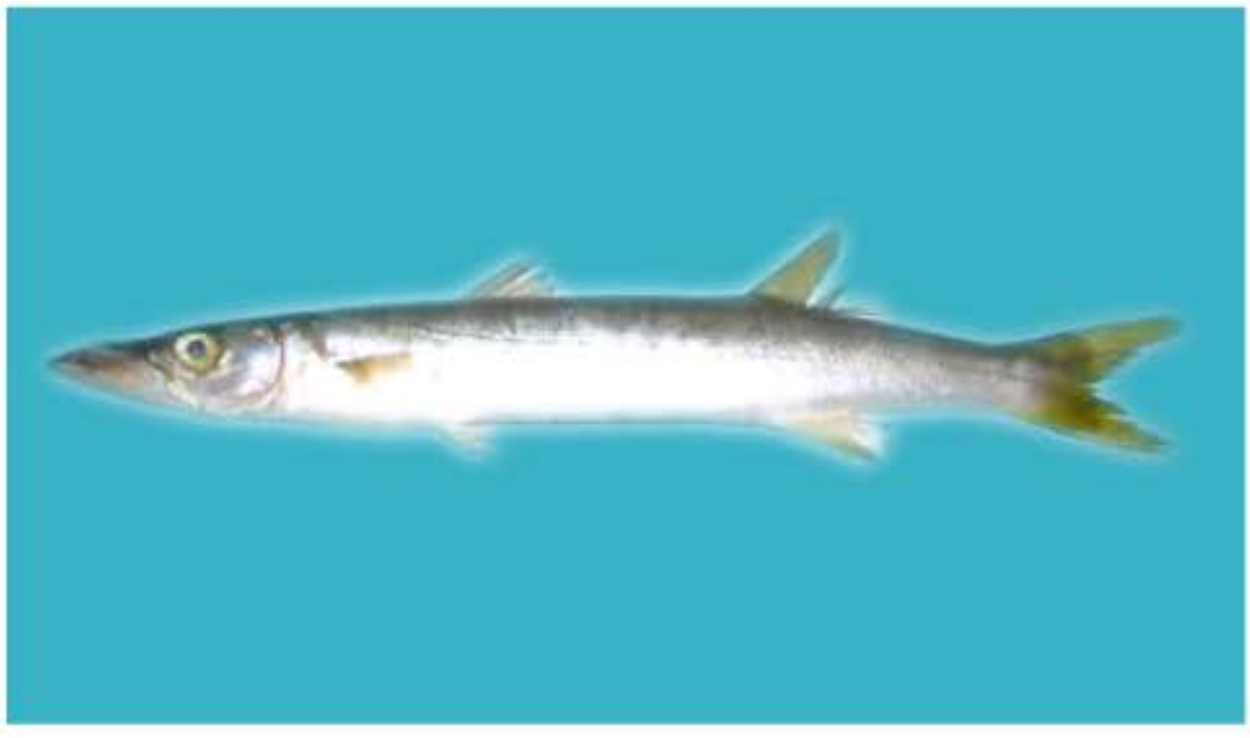

Fig. 2: External morphology of *S. obtusata*

RESULTS

The size (Total length-TL) of *S. obtusata* ranged from 140 to 334 mm (Mean±SD = 219.42±37.00 mm). Males ranged from 149-333 mm TL (Mean±SD = 210.38±31.7 mm) while females ranged from 140 to 334 mm TL (Mean±SD = 228.73±39.7 mm). The values obtained for the mean weight by sex were simply compared by two-sample t-test (Table 1). The results showed that females were significantly ($p<0.05$) larger than males.

The estimates of the regression parameters of length-weight relationship for male and female, obtained by regression analysis are shown in Table 2. The equations of total length-weight relationship and their logarithmic transformation are given in Table 3. The 'b' values 2.898 and 2.843 obtained for male and female respectively indicate that the fish follows the cube law, its growth is proportionally three-dimensional (n = 134, $r^2 = 0.983$, 95% CL a = 0.0143 to 0.00961, 95% CL b = 2.833 - 2.964 and coefficient of variation = 0.00286 for males; n = 130, $r^2 = 0.987$, 95% CL a = 0.0116 - 0.0165, 95% CL b = 2.788 - 2.898 and coefficient of variation = 0.00245 for females). That is, with increasing age, rate of growth in terms of weight in this fish becomes slower than that of its length. Correlation coefficients(r) 0.991 for male and 0.993 for female were found to be significant ($p<0.01$) in both instances indicate good correlation between length and weight.

The significance of variation in the estimates of b for *S. obtusata* from the expected value for the ideal fish (3.0) was tested by Students' t-test (Snedecor, 1963; Jayaprakash, 2001). Students' t test was employed by dividing the difference between 'b' and '3' by standard error of b (Zar, 1996). The results are as follows:

- **Male:** (2.898~3.0)/0.0331 = 3.0816 Significant (computed $t_{\alpha(2),0.05,133}>1.978$)
- **Female:** (2.843-3.0)/0.0279 = 5.627 Significant (computed $t_{\alpha(2),0.05,129}>1.978$)
- **Pooled:** (2.857-3.0)/0.0229 = 6.244 Significant (computed $t_{\alpha(2),0.05,263}>1.969$)

The GLMANCOVA showed the slopes (b) of males and females not to exhibit significant interaction (computed $F_{1,264}<5.07$, $p>0.05$). Further, comparison of regression co-efficient of males and females using GLMANCOVA for the regression of log weight on log total length of males and females showed the 'b' values not to show significant differences ($p>0.05$). The confidence

Table 1: Parameters obtained from two-sample t-test for mean weight of male and female *Sphyraena obtusata* collected from Jaffna lagoon, Sri Lanka

Statistical parameters	Female	Male
Mean	110.21	85.51
Variance	3210.67	1599.19
Observations	130	134
Hypothesized mean difference	0	
df	231	
t-statistic	4.08	
P (T≤t) one-tail	3.09×10^{-5}	
t-critical one-tail	1.65	
P (T≤t) two-tail	6.19×10^{-5}	
t-critical two-tail	1.97	

Table 2: Length-weight relationship parameters of *Sphyraena obtusata* collected from Jaffna lagoon, Sri Lanka

Sex	R	N
Male	0.991	134
Female	0.993	130
Pooled	0.991	264

R: Correlation co-efficient; N: No. of observations/sample size

Table 3: Relationship between total length and weight of male, female and pooled sexes of *Sphyraena obtusata*

Sex	Length-weight relationship	Logarithmic transformation
Male	$W = 0.0117\times L^{2.898}$	Log W = -1.9304+2.898*LogL
Female	$W = 0.0138\times L^{2.843}$	Log W = -1.857+2.843*LogL
Pooled	$W = 0.0133\times L^{2.857}$	Log W = -1.876+2.857*LogL

intervals of 'a' for male and female overlap with each other and therefore there is no significant differences between the intercepts, too. Hence the following common formulae were derived for males and females.

$$\text{Parabolic equation: } W = 0.0133\times TL^{2.857}$$

$$\text{Logarithmic equation: } \log W = -1.876 + 2.857\times \log TL$$

The regression exponent value 2.843 for females indicates a negative allometric growth in *S. obtusata* females while the exponent value 2.898 for males, significant from 3 ($p>0.05$) indicate an almost negative allometric growth in *S. obtusata* males, too.

DISCUSSION

A historical review on length weight relationship and recommendations for users about length weight relationships, condition factors and relative weight is provided by Froese (2006). Allen (1938) pointed out that the exponent coefficient (b) in the length-weight relationship of fishes is usually 3. Later Carlander (1969) pointed out that the b value is very close to 3.0 but varies between 2.5 and 3.5. If the 'b' value for a fish is 3, the fish grows isometrically; if it is greater than 3, the fish exhibits positive allometry and if it is lower than 3 the fish exhibits negative allometry (Bagenal and Tesch, 1978). Fishery biologists also stated that the 'a' and 'b' values not only differ in different species but also differ in the same species depending on sex, stage of maturity, food habits and so on (Qasim, 1973; Bal and Rao, 1984; Froese, 2006). The parameters of length-weight relationship of obtuse barracudas estimated by various authors from different parts of the world are given in Table 4.

One previous study available for length-weight relationship of *S. obtusata* in Bombay waters, west coast of India is that of Jaiswar *et al*. (2004). They reported a 'b' value of 2.7226, a slightly lower

Table 4: The parameters of length-weight relationship of *Sphyraena obtusata* from different regions of the world

Sex	a	b	Range (cm)	Sample size	Region	Source
Unsexed	0.0370	2.472	19-26.5 FL	23	New caledonia	Letourneur *et al*. (1998)
Unsexed	0.0257	2.588	19-26.5 FL	23	New caledonia	Kulbicki *et al*. (2005)
Unsexed	0.0095	2.868	12-50 FL	--	Indonesia --	Pauly *et al*. (1996)
Unsexed	0.0070	2.870	TL	581	Malaysia	Ahmad *et al*. (2003)
Unsexed	0.0041	3.131	16-40 TL	410	India	Somvanshi (1989)

TL: Total length, FL: Fork length, SL: Standard length

value than obtained in the present study. Deviation in the growth rate 'b' observed during the present investigation may be the result of variations in ecology of the geographical locations or due to changes in the environmental conditions (Bagenal and Tesch, 1978). In a long-term basis, further studies on breeding biology, nutritional studies, feeding biology and age and growth will lead to a successful sustainable management of *S. obtusata* in Sri Lankan waters.

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