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STUDY ON THE GROWTH PATTERNS OF HERRING SCAD, *ALEPES VARI* (CUVIER, 1833) COLLECTED FROM THE KARACHI COAST OF PAKISTAN

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ABSTRACT

The current study explains the estimation of growth patterns of Herring scad *Alepes vari* (Cuvier, 1833) collected from Karachi coast, Pakistan. A total of 100 samples (44 males and 56 females) were caught from January to December 2019. The length-weight relationships (LWR) along with correlation coefficients (r) calculated for the combined sexes, males and females of *Alepes vari* had showed Log Wt = - 1.36 + 2.56 Log TL (r = 0.853), Log Wt = -1.84 + 2.90 Log TL (r = 0.965), and Log Wt = - 0.96 + 2.28 Log TL (r = 0.760). In this study, the general growth pattern for combined sexes, males, and females were observed only positive allometric type (A+) with *b*-values ranged between 2.28 to 2.90, respectively. The overall results revealed that all length-weight relationships were strongly correlated with 'r' values ranging from 0.760 to 0.965, which shows a good health condition of this species. Moreover, the average values of Relative condition factor (Kn) ranging from 0.8 to 1.0, which revealed that both abiotic and biotic factors of the Karachi coast were found in acceptable limits for this species. Thus, our present study will provide useful information on growth patterns and management of *Alepes vari* along the Karachi coast of Pakistan.

Keywords: *Alepes vari*, Condition factor, Growth patterns, allometric, isometric, length-weight relationship

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INTRODUCTION

Growth is a distinct character of each living organism. Holihan *et al.* (1995) had observed that the major abiotic factors of the aquatic ecosystem that can influence the growth in fishes include i.e., temperature, pH, salinity, depth, the concentration of dissolved oxygen and ammonia. Therefore, better ecological conditions and availability of food is quite essential for optimal growth pattern in fish. Fish exhibits isometric and allometric growth patterns (Taylor *et al.,* 2005; Zhang *et al.*, 2019; Park and Jeong, 2020). Moreover, allometric growth patterns may be categorized into two types, (i) positive allometric (A+), and (ii) negative allometric (A-). Positive allometric growth patterns can be defined as if anabolism exceeds beyond catabolism than fish becomes relatively deep-bodied with an increase in its total body length. While the negative allometric growth pattern can be defined as if catabolism increases beyond anabolism than fish becomes slightly slender with increases in its total body length (Olopade *et al.,* 2015). All these patterns of growth are sometimes might vary between the several individuals, whichever belong to a single species or diverse group of species found in the same environment (Afzal *et al.,* 2012; Zubia *et al.,* 2014). The estimation growth pattern is a very useful tool in understanding the fish ecology, proper handling, and management of an aquatic ecosystem. Length-weight relationship (LWRs) data as an indicator of growth patterns have been used by several fisheries biologists to describe the specific growth pattern of any fish species (Hossain *et al.,* 2012; Baloch *et al.,* 2020; Putra *et al.,* 2021). As it is much difficult to estimate the fish body weight from its total body length during field surveys or sometimes might be time-consuming as well; therefore, length-weight relationship (LWRs) is a useful technique that can overcome all these issues. Likewise, both condition and relative condition factors have now also being developed through several fisheries biologists for the comparison of growth condition, health fitness or disease of fish, food abundance, and duration of the breeding season (Malik *et al.*, 2019; Khanipour *et al.,* 2020).

Alepes vari is a tropical marine fish species, which is commonly known as 'Herring scad'. World widely distributed fishes occur in the Indo-West Pacific Ocean, which can grow up to 30 cm in total body length (Romero, 2002). These are large pelagic fishes, which are commonly found up to 10 meters of water depth and feed mainly on small-sized crustaceans and fishes (Bogorodsky *et al.,* 2011). Local names of this species are Bangra, Seem, Kakaan, and Pattar (Bianchi (1985). Nevertheless, very limited research work had been done on length-weight relationships (LWRs) of economically important pelagic fishes, particularly during their breeding seasons (Hosseini *et al.,* 2009). Therefore, our

current study is a first attempt to examine the growth patterns of this species at the Pakistan coast that have potential value in fisheries management and exploitation.

MATERIALS AND METHODS

Fish sampling: About 56 males and 44 females of *Alepes vari* were caught from Karachi fish harbor along Karachi coast, which is located at 24° 48 N latitude and 66° 58 E longitudes on North-eastern border of Arabian Sea (see Figure A) from January to December 2019. All these specimens were then brought in the Fisheries and Aquaculture Lab, Department of Zoology, Jinnah University for Women, Karachi, for further examination.

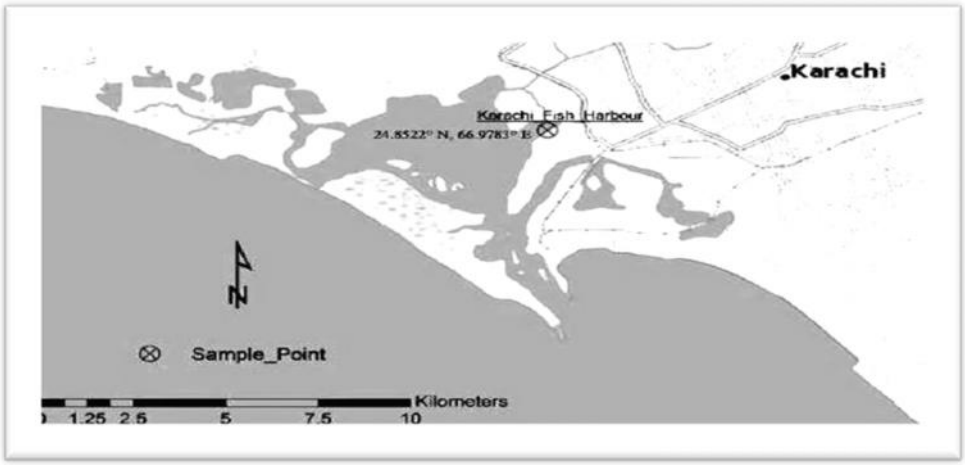

Figure A. Google Map of Karachi Fish Harbor at Karachi Coast of Arabian Sea.

Analysis of Growth patterns: For each fish specimen, total length (TL) was calculated in centimeters, and weight in grams immediately after its capture (Figure B). The growth pattern of fish was measured by using cube law of Le Cren (1951) for obtaining the data on the growth conditions of fish, and also finds the growth pattern, whether isometric (equal increase in length vs. weight) or allometric (positive/negative relationship between body length vs. weight) as follows;

$$W = a\mathrm{TL}^{b}$$

Where, **Wt** = whole weight of the fish body (g), **TL**= total length (cm) of the fish body, while 'a' representing point of intercept, and '***b***' representing the slope of the regression line. Besides, the log-transformed data of this equation was also mentioned as;

$$\text{Log Wt} = \log a \pm \log b^{*} \text{ TL}$$

If *b*-value is 3.0, then it indicates isometric growth pattern, while *b*-value was less than 3.0, then its shows positive allometric growth pattern (when length increases than weight also increase), and if it is less than 0.0 or negative (if length increases than weight decreases), then shows negative allometric growth pattern (Wootton, 1990; Roul *et al.*, 2017). Also, Pearson correlation coefficient 'r' values were estimated at 5% significant ($p<0.05$) for measuring the relationships among fish length and its weight by following the method of Olopade *et al.* (2015). If $r\leq0.50$, then it illustrates the correlation among total length and weight of fish was weak, and if $r\geq0.60$ than moderate correlation occurs, but if $r\geq0.70$ than it indicates a strong correlation.

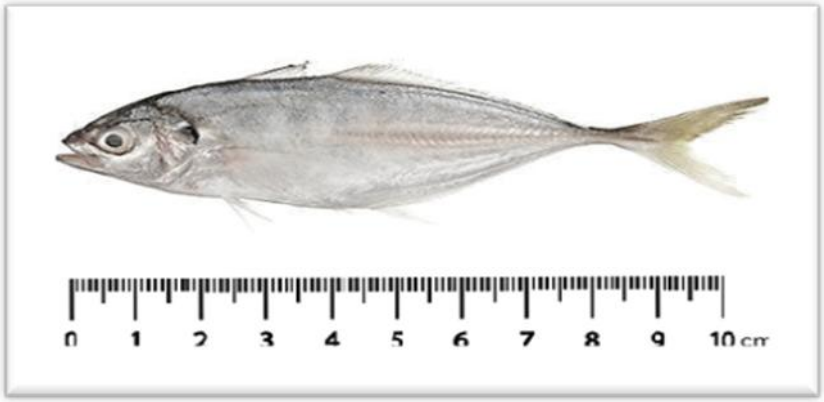

Figure B: total length measurements of fish

Condition factor (K): Also calculated the condition factor (K) value by using Fulton's equation as given below by Fulton (1902) as;

$$\text{Condition Factor (K)} = Wt^{*}100/TL^{3}$$

Whereas, '**K**' is the condition factor, '**Wt**' is the weight of the fish in grams, and '**TL**' is the total length of fish in centimeters (Malik *et al.*, 2019).

Relative condition factor (Kn)*:* The relative condition factor was measured by using the equation as proposed by Le Cren (1951), and Zubia *et al.* (2014) as given below;

$$\text{Relative condition factor (Kn)} = Wt / We$$

Whereas, 'Wt' represents observed-body-weight, while 'We' represents theoretically-estimated-weight as expressed in grams, respectively.

RESULTS AND DISCUSSION

Length-weight Relationships (LWR) of *Alepes vari:* The values of mean, standard error, standard deviation, ranges (minimum & maximum values), regression coefficients of length-weight relationship (LWRs), along with correlation coefficients 'r' for the sex combined, males and females of *Alepes vari* are presented in Table 1. Total length (TL) of combined sexes ranged from 13.5 to 35.2 cm with mean value 25.89 ± 4.24 cm and the log-transformed linear regression equation was Log Wt = -1.36 + 2.56 Log TL (r = 0.853); while male total length ranged from 19.2 to 35.2 cm with mean value 26.29 ± 4.05 cm, and the linear regression equation was Log Wt = -1.84 + 2.90 Log TL (r = 0.965); whereas the females was ranging between 13.5 to 34.1 cm with mean value 25.39±4.46 cm and the regression equation for female was Log Wt = - 0.96 + 2.28 Log TL (r = 0.760), respectively. Furthermore, the bodyweight of this species was found in ranged between 63.0 to 448 g for combined sexes, 79.0 to 440 g for males, and 63.0 to 448 g for females, as shown in Tables 1-2 and Figures 1 - 2. The generalized LWRs for males, females, and combined sexes indicating only strong correlation occurs with correlation coefficient (r) values ranging from 0.760 to 0.965 that indicates the favorable ecological conditions on Karachi coast required for the appropriate growth of *Alepes vari*, which was consonant with Roul *et al.* (2017), who found the significantly strong correlation for this species from Kerala waters in the southwest of Indian coast. Furthermore, *b*-values were found in the range between 2.28 to 2.90 for male, females, and combined sexes of *Alepes vari*, which indicated that the generalized growth pattern was only positive allometric, which was following the Siddik *et al.* (2019), who also detected the same outcomes for this species along the Bay of Bengal coast of Bangladesh. However, the analysis of growth patterns of fishes belongs to same species or populations might vary due to the availability of food, sex, breeding seasons, fishing methodology, conditions of habitats or their occurrence in different locations of the world as previously explained by Hossain *et al.* (2009), Olopade *et al.* (2015), and Malik *et al.* (2019).

Condition factor (K): Condition factor can describe as a quantitative parameter, which had been widely used for the estimation of water quality, growth in a fish population, and the accessibility of food for fish. Fishes with large body size and weight would indicate the satisfactory conditions of their habitat. In this study, the mean K-values were found ranged from 1.04 to 1.16, as shown in Tables 3. According to the Roul *et al.* (2017), if condition factor (K) values found in a range from 0.2 to 1.2, which consider as an indicator of the good condition of fish, therefore our present study was also indicating the suitable condition of environment for the growth in males and females of *Alepes vari* along Karachi coast of Pakistan. However, such growth condition of fishes might to varies because of its reproductive cycle, an abundance of food, sample size, age, sexual maturity and conditions of the environment, adaptation, water temperature, and salinity, rates of metabolism and fishing activities in habitat (Josef, 2016; Farooq *et al.* 2017).

Relative condition factor (Kn): It might be considered as a valuable index for observing the age, growth rates, fish feeding intensity, and management of fishes (Farooq *et al.,* 2017). The mean Kn value observed for males, females and combined sexes of *Alepes vari* was ranged from 0.8 to 1.0, which shows good health condition of *Alepes vari* on Karachi coast of Pakistan, as following Roul *et al.* (2017), who also showed the similar results for *Alepes vari* found in Kerala waters at south-west Indian coast. Furthermore, the Kn value was also found high (Kn=1.0) for males as compared to females (Kn=0.8) in the present study, which indicates that the males were found in good health condition than females *Alepes vari* along Karachi coast, which was in accord with Kudtarkar *et al.* (2018), who also found the similar results along Goa Mumbai coasts of India. However, such Kn values for same species or population might vary because of variation in their spawning season, sexual maturity stage, spent condition, feeding intensity, stomach fullness, management techniques, health status and sex of fish as previously described by Weatherly (1972) and Olopade *et al.* (2015).

Table 1. Regression coefficients of length-weight relationship (LWR) of males, females and combined sexes of *Alepes vari*.

Sex	N	TL in cm		Wt in grams		TL Range		Wt Range		Regression Coefficients			t-test	p-value
		Mean±S.D	S.E	Mean±S.D	S.E	Min.	Max.	Min.	Max.	A	b	r		
Combined sex	100	25.89±4.24	0.42	196.6±92.9	9.29	13.5	35.2	63.0	448.0	- 336	20.6	0.93	26.86	0.00*
Male	56	26.29±4.05	0.54	201.2±93.0	12.4	19.2	35.2	79.0	440.0	-382	22.2	0.96	27.66	0.00*
Female	44	25.39±4.46	0.67	190.0±93.6	14.1	13.5	34.1	63.0	448.0	- 294	19.1	0.91	14.18	0.00*

Note: N=number of samples; S. D=standard deviation; S.E= standard Error; a=intercept; b=regression slope; r = correlation coefficient. TL is taken in cm while weight is in gram; * represents t-test significant at p<0.05.

Table 2. Log transformed data of cube law for males, females and combined sexes of *Alepes vari*.

Sex	Log TL		Log W		Regression coefficients				
	Mean±S.D	S.E Mean	Mean±S.D	S.E Mean	Log a	Log b	R	t-test	p-value
Combined sex	1.407±0.073	0.007	2.246±0.204	0.020	-1.37	2.56☼	0.85***	60.3	0.00*
Male	1.414±0.067	0.009	2.258±0.199	0.026	- 1.85	2.90☼	0.96***	-47.0	0.00*
Female	1.397±0.081	0.012	2.230±0.211	0.032	- 0.96	2.28☼	0.76***	-37.7	0.00*

Note: * shows t-test is significant when p<0.05; *** shows strong correlation when r>0.70; ☼ shows positive allometric growth when b<3.0, r = correlation coefficient.

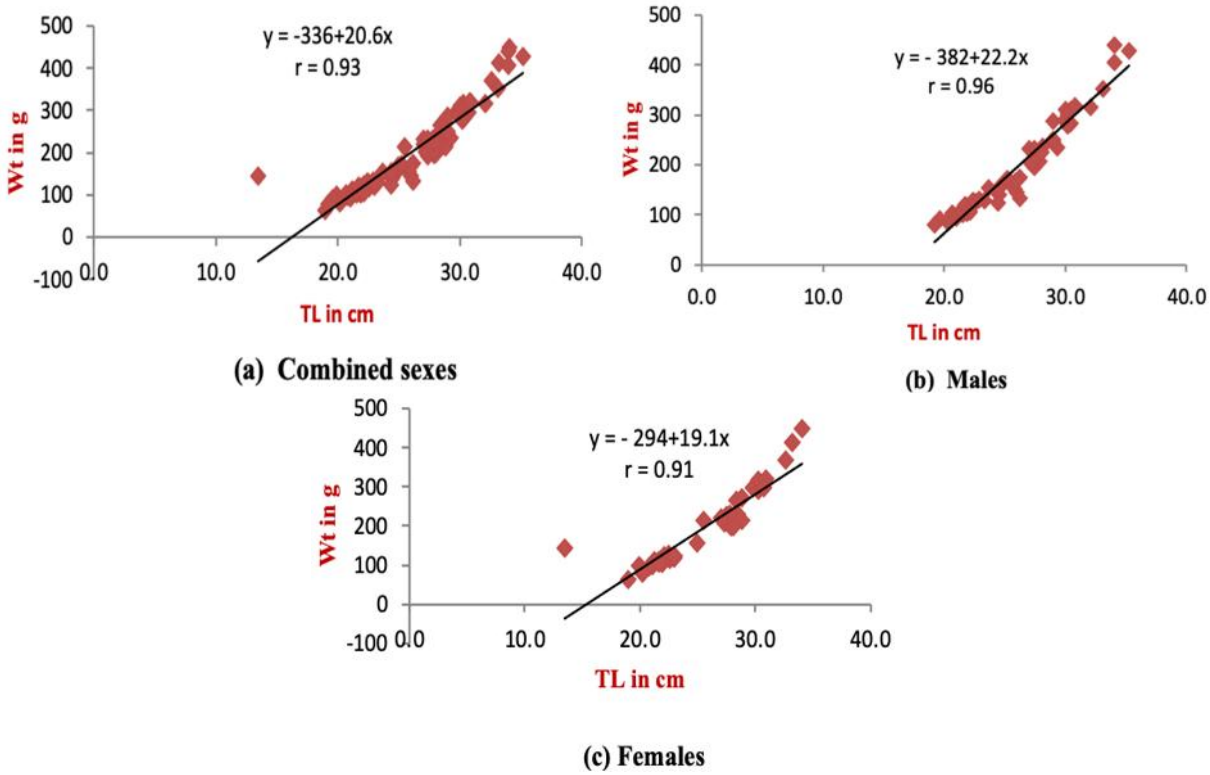

Figure 1. Length-weight relationship (LWR) data for combined sexes, males, and females of *Alepes vari* from Karachi coast.

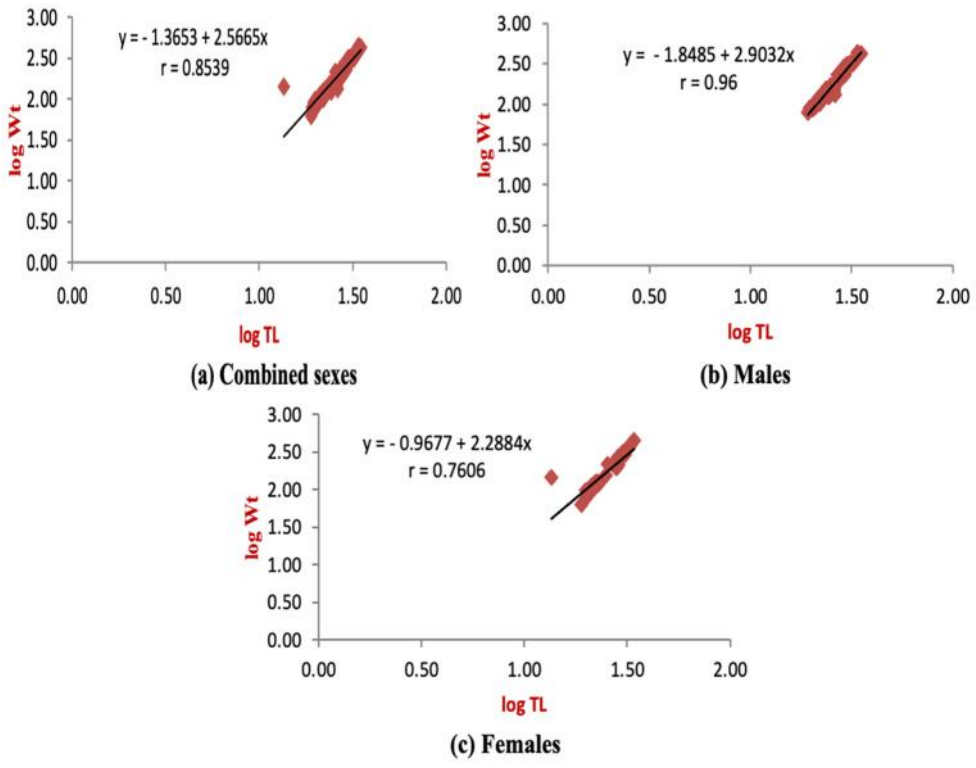

Figure 2. Log transformed length-weight relationship (LWR) data for combined sexes, males, and females *Alepes vari* at Karachi coast.

Table 3. Condition factor (K) values for combined, male, and female sexes of *Alepes vari* at Karachi coast.

		Range (K-values)	
Sex	**Mean±S.D**	**Max.**	**Min.**
Combined	*1.09±0.49	5.85	0.73
Male	*1.04±0.09	1.21	0.73
Female	*1.16±0.73	5.85	0.89

Note: * shows the mean K values > 1.0. S. D= Standard deviation.

Table 4. Relative Condition factor (K) values for combined, male, and female sexes of *Alepes vari* at Karachi coast.

		Range (Kn-values)	
Sex	**Mean±S.D**	**Max.**	**Min.**
Combined	*1.0±0.4	1.4	-2.5
Male	*1.0±0.2	1.8	0.7
Female	0.8±0.1	1.3	-4.0

Note: * shows the mean Kn values = 1.0. S. D= Standard deviation.

Conclusions: As the natural environmental condition of various aquatic ecosystems in the various regions of the world have now been constantly modifying with the abundance of non-native species and certain other factors like species composition, overfishing, illegal fishing practices, over populations, changes in feeding or reproduction behaviors, habitat degradation, climatic variations, fish diseases, use of pesticides in agriculture fields, wastewater dumping that can destroy spawning grounds of various aquatic species; therefore, our present work on length-weight relationships of *Alepes vari* is a useful parameter for fisheries biologists and fish farmers for the analysis of growth pattern and factors can impact on the culturing and stocking of this fish species.

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Conflict of Interest: The authors declared that they have no conflict of interest.

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