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Length-Age Relationshipsof theFour Mullet Species; Family Mugilidae from Karachi Coast of Pakistan

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Abstract: A study was conducted to observe the linear regression relationships between total length (L) and age (A) for the four mullet species (*Liza melinoptera, Liza macrolepis, Valamugil speigleri* and *Mugil cephalus*) from Karachi coast, Pakistan. The basic objective of the present investigation was to assess the strength of relationship between whole body growth and the addition of new annual rings on the edges of fish scale. The results of length-age relationship revealed that highly significant relationship($r > 0.90$; t-test; $p \leq 0.05$) was noted for all four selected mullet species, Hence, it has been proved that significantly strong correlation has exists between whole body growth and ages of these mullet species.

Key words: Mullets · Length-Age Relationship · Linear Regression · Correlations

INTRODUCTION

Mullets have been distributed throughout the world and dwell primarily temperate and tropical oceans. In general, Mugilidae family comprise of 17 genera along with 80 species in the biosphere [1]. Mullet that belongs to the genus *Mugil* are commonly found fish in artisanal type of fishing in the tropical and temperate areas and mostly apprehended from tidelands, reef areas as well as along the beaches shallow region by using gillnets and seines of diverse size of mess [2]. The growth of individual belongs to themullet species of Mugilidae family is fast, because they have great capability to flourish and reach in mediocre 17 to 23 cm in total length as well as sexual maturity throughout the initial year of their life [3-6]. Bermejo [7] studied that age of a fish is extremely interrelated to the fish length as well as with the sex of fish. This factdoesn't mean that all of the fish that possess identical size are having similar age. Actually this thing has been previously observed in bygone studies [8], which stated that location determines the growth rate. Mullet fish as well as the products that are made by utilizing mullet subsidize the economics of fisheries in several parts of world particularly in the Mediterranean countries [9]. The researches on the age as well as growth cannot be unkempt when the researcher wants to deal with the dynamics of population, fishery forecasts, fishery scouting and fisherysurveys along with cultural studies [10]. One of the researchers pointed that erroneous determination of age can have influence on the precision of population dynamics [11]. It has been found through reliable research that enhanced consideration of size/ age and growth relationship is vital for those who are applying the models of equilibrium yield in the administration of fishery [12].

MATERIALS AND METHODS

Fish Sampling: A total of 1006 samples of the four species of family Mugilidae were collected on monthly basis from the landings sites at Karachi fish harbor, throughout the time period of January 2012 to December 2012. Total catch of four species of Mugilidae includes *Liza melinoptera, Liza macrolepis, Valamugil cephalus* and *Mugil cephalus* encompassing total of 307 samples of *Liza melinoptera* (including 166 males and 141 females), 244 samples of *Liza macrolepis* (including 85 males and 159 females), 293 samples of *Valamugil cephalus* (including 170 males and 123 females), 162 samples of *Mugil cephalus* (including 84 males and

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78 females), which were recognizedup to species level in field and in laboratoryby means of thedifferent field guides [13, 14].

Statistical Analysis of Length-Age Relationship: In the present investigation, Length-age relationship was calculated separately for male, female and combined sexes for each mullet species. The length-age relationship was calculated from the following Pearson linear regression equation of [15];

$$L = a \pm bA \quad (1)$$

Where 'L' is the total body length (TL) in centimeters and 'A' is the age in years; 'a' is the intercept and 'b' is the exponent or regression slope. In order to confirm that whether length and ages of fish are linearly related with each other, t-test at 5% significant level ($p<0.05$) was applied by using following model 2 as follows;

$$t=b1/(Se/vSxx) \quad (2)$$

Where 'b1' is the slope of regression line, 'Sxx' is the notation used in regression, 'Se' is the standard error of estimate, which can be calculated by following model 3 as follows;

$$Se= v[SSE/(n-2)] \quad (3)$$

Whereas 'SSE' is the sum of square error. The values of SSE can be calculated by model 4 as follows;

$$SSE = \sum(y-y)^2 \quad (4)$$

Where the values of 'Sxx'was calculated by using model 5 as follows;

$$Sxx = \Sigma x^2 -(\Sigma(x)^2)n \quad (5)$$

Where x is the independent variablemeans total length of fish (L).

RESULTS

In the present investigation, the linear regression relationship between total length (TL) versus age (A) for the combined, male and female sexes of the four mullet species was also determined. Regression equations representing the relationship between the total length of fish and its ages for combined, female and male sexes of each selected mullet species were given in the Table 1. The results of length-age relationship revealed that strong correlations ($r > 0.90$) were observed for males, females and sex combined of all four selected mullet species i.e., *L. melinoptera, L. macrolepis, V. speigleri and M. cephalus,* which was found to be highly significant at 5% level ($p<0.05$). Hence, it had been proved that significantly strong correlation existsbetween these two variables. The values for regression constant "a" (Y-intercept) were so greater that the regression lines did not pass through the origin (0.0). As it was expected thatlength and ages of fish are linearly correlated with each other, therefore, the strong correlations or the higher values of correlation

Table 1: Regression parameters of length-age relationship of the four mullet species of the family Mugilidae

			Length (L) in cm.			Age(A) in years			Regressioncoefficients					
Species	Sex	N	Max.	Min.	Mean±S.D	Max.	Min.	Mean±S.D	a	b	r	Standard Error S.E (b)	t-test	Significant
Liza melinoptera	Combined sexes	307	18.0	14.5	16.48±0.95	4	1	2.28±0.94	14.30	0.96	0.955*	0.04	26.2	+
	Female	141	18.0	14.5	16.84±0..76	4	1	2.28±0.74	14.35	0.95	0.925*	0.07	13.6	+
	Male	166	18.0	14.5	16.15±0.99	4	1	1.97±0.99	14.30	0.95	0.96*	0.05	19.9	+
Liza macrolepis	Combined sexes	244	29.0	12.5	17.49±3.23	6	1	2.67±1.33	11.30	2.23	0.954*	0.09	24.6	+
	Female	159	25.5	12.5	17.74±3.32	5	1	2.81±1.44	11.50	2.23	0.964*	0.10	22.5	+
	Male	85	29.0	13.0	17.0±3.07	6	1	2.43±1.08	10.50	2.68	0.939*	0.22	11.9	+
Valamugil speigleri	Combined sexes	293	19.4	13.1	15.83±2.01	4	1	1.79±1.03	12.50	1.83	0.938*	0.08	23.8	+
	Female	123	19.4	13.1	16.07±2.17	4	1	1.94±1.11	12.50	1.84	0.932*	0.13	14.0	+
	Male	170	19.0	13.5	15.65±1.89	4	1	1.70±0.97	12.50	1.83	0.943*	0.10	19.0	+
Mugil cephalus	Combined sexes	162	37.8	20.0	26.38±4.73	6	1	2.77±1.29	16.60	3.52	0.958*	0.18	19.5	+
	Female	78	36.6	20.0	26.11±5.22	5	1	2.68±1.30	15.80	3.86	0.962*	0.21	16.4	+
	Male	84	37.8	21.7	26.61±4.43	6	2	2.85±1.31	17.30	3.25	0.961*	0.22	14.8	+

N = sample size; SD = Standard deviation; * shows the strong correlation; + shows t-test significant at 5% level (when $p \leq 0.05$)

coefficients "r" between these two variables for all selected mullet species was indicating that present studies was useful to detect this expected relationship. Thus, the results of present study revealed that the growth of the body in fish was always in proportional to the annual increment in its age.

DISCUSSION

In the present study, highly significant correlation (t-test; $p<0.05$) was exists between the total length and ages of the four mullet species, which was demonstrating the validity of using scales for age estimation in mullets. The result of the present study was in agreement withPillay [16], Kagwade [17], Wijeyaratne and Costa [18], Wassef [19], Koutralis and Sinis [20], Aleleye-Wokoma *et al*. [21], Diaz and Turner [22], Abowei and Davies [23] who observed the relationship between body length and ages of mullets and in some other fish species. The results of length-age relationship for males, females and sex combined of all four mullet species of this study revealed the highest correlation coefficient values ($r > 0.90$) that proved the strong correlation exists between total length and ages of mullets. This was in accord with Aleleye-Wokoma *et al*. [21] and McDonough and Wenner[24] who observed the strong relationship between total length and ages of *Mugil cephalus* and found high correlation coefficient values ($r = 0.99$). Chang *et al*. [25] had also been observed the linear regression relationship between total body length and age of the juveniles of *Mugil cephalus* and found highest coefficient of correlation values ($r = 0.84$). In general, no significant differences were observed between the coefficient correlation values (r) for male and female sexes of all four mullet species of this study. Furthermore, the values of the regression constants (regression coefficient/slope 'b' and intercept 'a') of the length-age relationships for males, females and sex combined of each selected mullet species were also found to be identical, which was in agreement with Hotos[26] who observed similar results for *M. cephalus*. This may be because growth in length was same for both male and female sexes of all these mullet species, though females were more dominated in older age groups as observed byKoutrakis and Sinis[20]. However, some slight variations occurred in the values for slope 'b' and intercept 'a' for the two mullet species such as *M. cephalus and L. macrolepis* might be due the differences in the total length and ages recorded for the male, female and combined sexes. However, the values of regression constants of length-age relationships among the four mullet species of this study were found to be different. These differences in the values of linear regression relationships between the age and length of fish depends on the intensity of fishing that can decrease the sizes and ages of commercial fishes or may be due to the differences in the conditions of their habitat in which they lived as observed by Gallardo-Cabello *et al*. [27]. Pillay[16] has observed the similar results for *Mugil trade*. The differences in the size range of male and female sexes of *Mugil cephalus* indicating the variations in their growth rates during juvenile and adult stages as described by Kuo *et al*. [28]. Thesedifferences in the growth rates of mullets may be due to the wide range of environmental (including temperature and photoperiod) and biological factors (differential metabolic rates of the individuals of the same species or intraspecific competition between larvae) as observed by McDonough and Wenner[24]. Koutralis and Sinis[20] observed that the growth rate of mullets was found to be different from species to species.

In the present investigation, length-age relationships for combined, male and female sexes of *L. melinoptera*, *L. macrolepis*, *V. speigleri* and *M. cephalus* revealed that growth in size or length of these mullet species was highest during the first the first years (1-2 years) of life. However, later growth in fish become progressively decreases with further increasing the ages of fish and finally becomes stop at the age of 4+ or 6+ years, which was in agreement with Koutrakis and Sinis[20] and Mehanna[29] who also observed similar results for mullet species. According to McDonough and Wenner[24], during the first year of life, juvenile of *Mugil cephalus* grows more rapidly, but later its growth rate subsequently decreases with increasing the age of fish. Hence, in general, it has been observed that fish mostly shows faster grow rate during the early stages oflife,which later seem to be decreasing with increase in age of fish[19, 30]. Therefore, in small-sized fish, marginal increment or growth of scales was very rapid than in larger fish as reported byWassef[19]. Similarly, Gallardo-Cabello *et al*. [27] also observed that the marginal increment of scale was fast during the first year of life, later the scale marginal increment progressively decreases with increasing age of fish. The distance between first and second growth rings was large, while the distance between other growth rings or annuli was progressively increases with increasing the fish age. Furthermore, Quignard and Farrugio[9] suggested that the length or size of mullets at each age was also found to be varies according to the different locations. Growth of *Mugil cephalus* during the first year of life was also varies, as its

highest growth rate was obtained from Italy, Mexico, France and Tunisia. Such variations may be due to the differences in the seawater temperature, food and geographical location of each habitat that can effect on the growth of fish [19, 31].

CONCLUSION

From the results of the present study, it was concluded that the growth of the fish body was always in proportional to the yearly raise in fish age. Therefore, mullet species in the present study can be considered as fast growing and moderately long-living species, because during the early life stages (3+ to 4+ years), they attained approximately 75% of their maximum size [20]. Thus, the measurement of length-age data of the present study has great importance in fisheries management and can utilized for sustainable exploitation of fish stocks.

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