Length-Weight Relationship, Condition and Relative Condition parameters of *Mugilincilus* (Mugilidae: Mugiliformes) collected from the River Indus of district Sukkur, Pakistan

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ABSTRACT: Length-weight relationship, condition (K) and relative condition factor (Kn) for male, female and combined sexes of a mugilid species, *Mugil incilis* were analyzed during the period from January 2014 to December 2014. During the study, a total of 80 fish samples were collected from the landing sites on Indus River at district Sukkur that included 48 males and 32 females. All specimens were ranging from 12.0cm to 14.5cm in total length (TL) and 23.2g to 38.5g in body weight (BW). While total length of males ranged from 12.4cm to 14.4cm and body weight 23.2g to 38.1g and female's total length ranged from 12.0cm to14.4cm and body weight 25.1g to 38.5g. The result of the present study revealed that a moderate correlation ($r \geq 0.60$, t-test; $p \leq 0.05$) occurred between the length and weight of this species which was found to be significant. The negative allometric growth pattern (b<3.0) was observed and was found to be highly significant (t-test; $p \leq 0.05$) for male, female and for combined sexes. The values of condition factor (K) showed the difference with increase in size or weight of fish. The Relative condition factor Kn value was found to be one (1.0), which showed that conditions of the environment of river Indus was suitable for the growth of this species.

Keywords: Length-weight relationship, Condition factor, Relative condition factor, Mullet species *(Mugil incilis)*.

INTRODUCTION

Fishes of the family Mugilidae are commonly named as "mullets" or "grey mullets". There are 18 genera and 81 species included in this family according to Nelson (2006) and Froese and Pauly (2011). This family is commonly found in marine water but few species live in fresh water as well. In Pakistan, about 3 genera and 12 species were described by Bianchi (1985), while Fehmida (2002) had reported 8 species of this family from Karachicoast. A mugilid species, *Mugil incilis* of the family Mugilidae is commonly known as "parassi mullet". Zubia and Rehana (2010 & 2011) studied length-weight relationships (LWRs) and condition factor (K) of different species of the families *i.e.* Lutjanidae and Gobidae on Karachi coast. Hadi *et al.* (2011) worked on length-weight relationships (LWRs), condition factor (K) and relative weight of different species such as *Argyrops spinifer, Epinephelus coioides, Pomadasys kaakan, Lethrinus nebulosus,*

Lutjanus malabaricus at Northern Persian Gulf, and their work also provided primary information on LWRs and K for these species from Persian Gulf that later proved to be helpful for the fisheries managers in the management of other factors in ocean. Obasohan *et al* (2012) worked on length-weight relationships (LWRs) and condition factor (K) of five different species from Ibiekuma stream at Edo state of Nigeria. Atama *et al.* (2013) studied length-weight relationship and condition factor of six cichlid species of family Cichilidae from Anambra River, Nigeria.

Lagler (1952) described that the growth pattern in fish follow cube law and such relationship will be authentic when fish grow isometrically. In this case, the regression coefficient (b) value must be equal to 3.0. But under natural condition, the values of regression coefficient (b) may fluctuate from 3.0 due to several factors such as, growth, environmental conditions and condition of fish (Le-Cren, 1951).

If the b-value is greater, the growth will be positive allometric, while, on the other hand, if b-value is less than 3.0, than growth is negative allometric (Wootton, 1998). Recently, Zubia *et al.* (2014) also observed that the condition of Karachi Coast was found to be suitable for the growth of mugilid species. It is for the first time in this study, that *Mugil incilus* was identified and studied from this point of view.

MATERIAL AND METHODS

A. Sample collection

Total 80 samples of the mugilid species, *Mugil incilus* of the family Mugilidae were collected from the landing sites in Indus River at district Sukkur, Sindh, Pakistan. The study was conducted in the year 2014 (from January 2014 to December 2014). During the study, about 48 males and 32 females were collected and identified. All specimens were identified by FAO field guide to species level (Bianchi, 1985; Harrison and Senou, 1999). Total length was measured in centimeters from tip of the snout to the end of the caudal fin by using measuring scale, while whole body weight of each sample was calculated in grams through the digital balance. In order to confirm whether length and weight were linearly correlated to each other, Regression coefficient (b = 3.0), coefficient of correlation (r-value) and t-test at 5% significant level (0.05) were used to test the null and alternate hypothesis by using formula followed by Zubia *et al.* (2014) as follows;

Log *Wt* = log *a* + log *b* TL

Where *Wt* is Weight in grams; TL is total body length in cm; *b* is regression coefficient; *a* is intercept/constant. All statistical analysis was carried out by using Minitab Software version 17.0.

RESULTS

The results of Length-weight relationship (LWRs), condition and relative condition factors for the male, female and combined sexes of *Mugil incilus* were presented in Tables 1-3 and figures 1-6.

Table 1: Regression parameters of the length-weight relationship (W=a. TL^b) of the *Mugil incilus*.

Sex	N	Length range (cm)		Mean± S.D	Weight range (g)		mean± S.D	Regression parameter			t-test	p-value
		Max	Min		Max	Min		a	b	r		
Combined sexes	80	14.5	12.0	13.4± 0.53	38.5	23.2	31.87± 4.235	-42.3	5.46	0.68**	-40.7	0.00
Male	48	14.4	12.4	13.4± 0.49	38.1	23.2	30.37± 4.40	-51.5	6.11	0.69**	-28.8	0.00
Female	32	14.5	12.0	13.5± 0.57	38.5	25.1	32.4± 3.71	-26.9	4.38	0.67**	-31.7	0.00

Note: Length (TL) in cm; Weight (Wt) in g; N = sample size; S.D = Standard deviation. *** shows the strong correlation (r>0.70); ** shows moderate correlation (r>0.60); * represent weak correlation (r>0.50); **NS** = not significant (when p>0.05); ^{a}: shows significant at 5% level (when p<0.05).

Table 2: Regression parameters of the length-weight relationship (log W=log a+log b L) of the *Mugil incilus*.

Sex	N	Log TL (cm)		Mean± S.D	S.E (b)	Log Wt range (g)		mean± S.D	Regression parameter			t-test	p-value	GT
		Max	Min			Max	Min		Log a	Logb	r-values			
Combined sexes	80	1.16	1.07	1.13± 0.02	0.004	1.58	1.36	1.48± 0.06	-1.19	2.38	0.67**	-329.9	0.00	-
Male	48	1.15	1.09	1.12± 0.02	0.006	1.58	1.36	1.47± 0.06	-1.58	2.71	0.69**	-239.5	0.00	-
Female	32	1.16	1.07	1.13± 0.02	0.006	1.58	1.39	1.51± 0.05	-0.57	1.84	0.67**	-247.0	0.00	-

Length (TL) in cm; Weight (Wt) in g; N = sample size; S.D. = Standard deviation.
*** shows the strong correlation (r>0.70); ** shows moderate correlation (r>0.60); * represent weak correlation (r>0.50); **NS** = not significant (when p>0.05); : significant at 5% level (when p≤0.05); **s** represent positive allometric pattern of growth (b>3.0);
⁻ shows negative allometric pattern of growth (b<3.0); GT = growth type.

Table 3: Condition factor (K) and Relative condition factor (Kn) values of the *Mugil incilus*.

Sex	N	TL range (cm)		Wt range (g)		Condition factor (K)		Mean (K)	Relative condition factor (Kn)		Mean (Kn)
		Max	Min	Max	Min	Max	Min		Max	Min	
Combined sex	80	14.5	12.0	38.5	23.2	1.516	0.837	1.27	1.1	0.7	1.0*
Male	48	14.4	12.4	38.1	23.2	1.516	0.837	1.26	1.2	0.7	1.0*
Female	32	14.5	12.0	38.5	25.1	1.479	0.862	1.31	1.1	0.7	1.0*

Length (L) in centimeters; Weight (Wt) in grams; N = sample size; *shows the good condition factor Kn.

Fig. 1. Linear regression relationship between TL vs Wt (Combined sexes) of *Mugil incilus*.
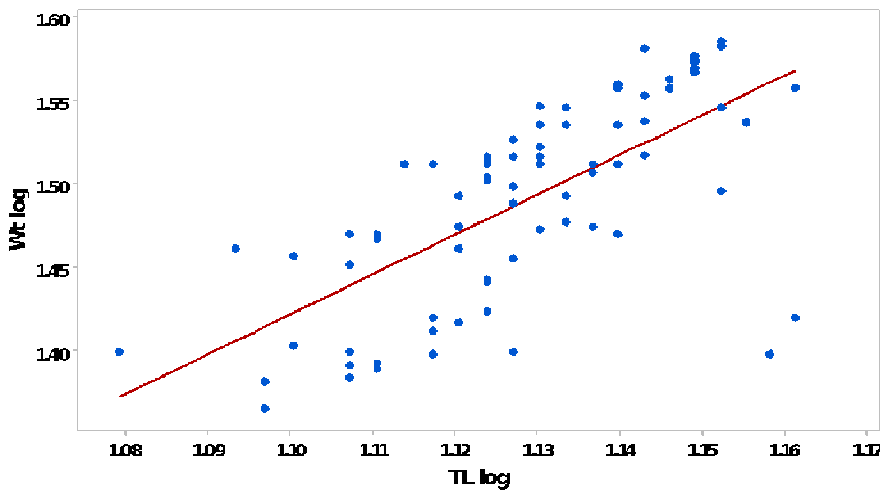(Wt = -4231 + 5.462TL).

Fig. 2. Linear regression relationship between log TL vs log Wt (Combined sexes) of *Mugil incilus*.
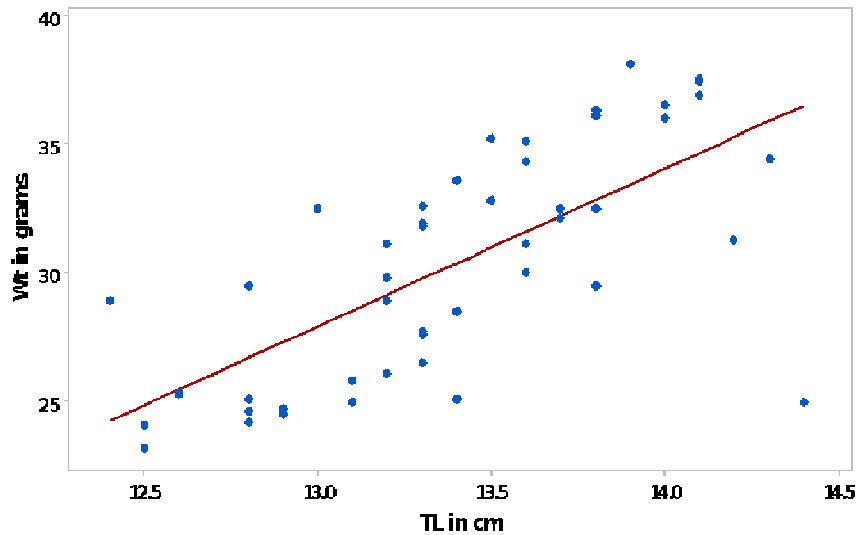(Wt log = -1198 + 2.382TL log).

Fig. 3. Linear regression relationship between log TL vs Wt of Male of *Mugil incilus*.
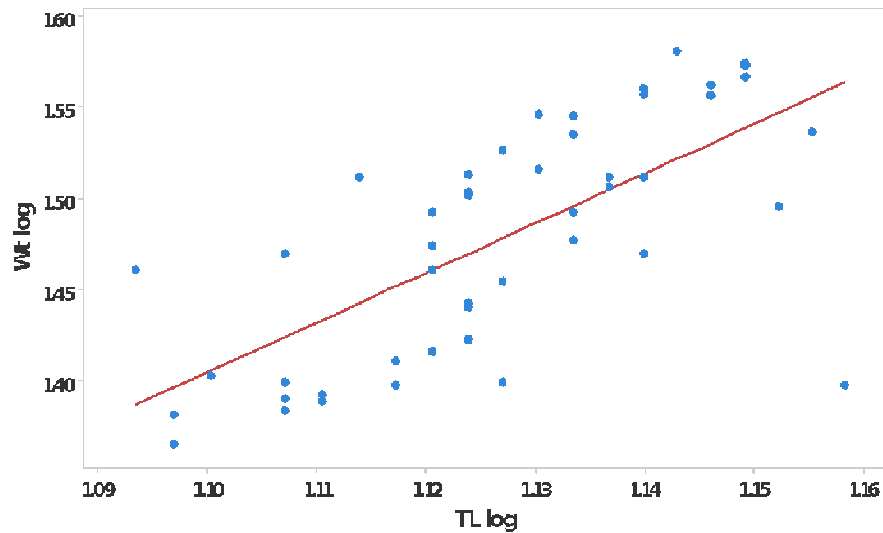(Wt = -5154 + 6.112TL).

Fig. 4. Linear regression relationship between log TL vs log Wt of Male of *Mugil incilus*.
(Wt log = -1.586 + 2.719TL log).

The results of the present study revealed that the relationship between length and weight (LWRs) for the male, female and combined sexes was moderate ($r{\leq}0.60$) but highly significant (t-test; $p<0.05$). The values of regression coefficient (b-values) of LWRs calculated by cube law revealed that negative allometric pattern of growth ($b<3.0$; $p<0.05$) was present for the male, female and combined sexes of *Mugil incilus* as shown in Table 2.

The values of condition (K) and Relative condition factors (Kn) for male, female and combined sexes were separately calculated as shown in Table 3. The average value of Relative condition factors (Kn) was equal to 1.0, which revealed that these fishes were in good condition.
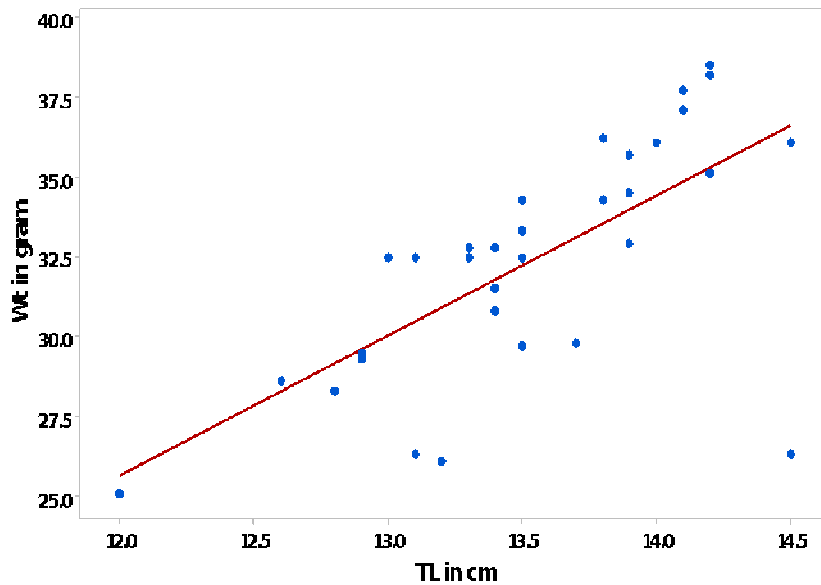
Fig. 5. Linear regression relationship between TL vs Wt of Female of *Mugil incilus*.
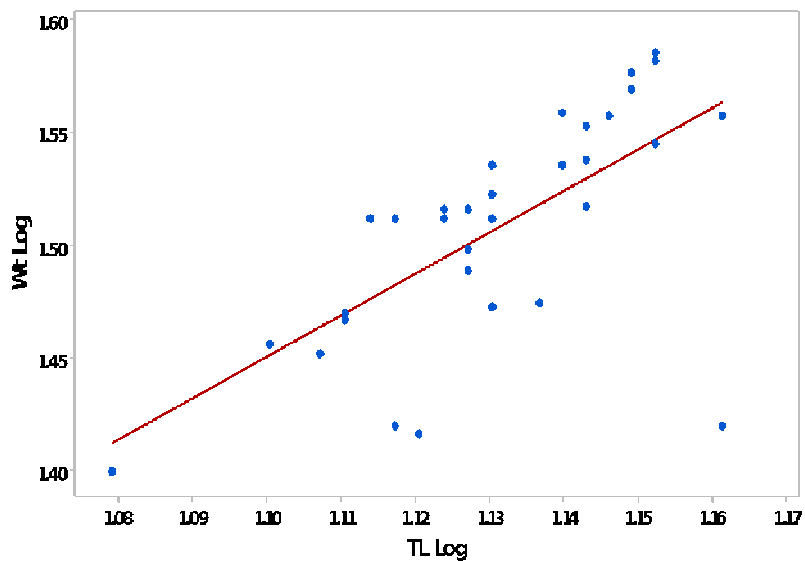

Fig. 6. Linear regression relationship between TL vs log Wt of Female of *Mugil incilus*.

DISCUSSION

In the present study, the length-weight relationship was found to be moderate ($r \geq 0.60$) but highly significant (t-test; $p < 0.05$) for the male, female and combined sexes of *Mugil incilus* which was in agreement with Zubia *et al.* (2014) who also reported highly significant correlation between length-weight relationship for male, female and combined sexes of four different mullet species on Karachi Coast, it means that if the length increases then the body weight will also increase accordingly. Similar positively correlation was found between the length and weight of gold spot mullet, *Liza Persia* by Renjini and Nandan (2011) from Cochin estuary. Present work indicates that *Mugil incilus* did not fulfill the condition of cube law ($b < 3.0$) and the same result was reported by Torres (1991), Raizada *et al.* (2005) and shafi and Yousuf (2012).

Furthermore, present study also revealed the significant differences in the values of regression exponent (b) for the male, female and combined sexes of *Mugil incilus*. For instance, males of *Mugil incilus* had high value of regression exponent (b = 2.71) as compared to female (b = 1.84), which was in accordance with Yousuf and Firdous (2001) and Zubia *et al.* (2014) who also reported similar results for male. While in contrast, Hatikaktoa and Biswas (2004) reported the high value of regression exponent for female than male for the specie *Oreochromis mossambicus* from a domestic pond in Nazira, Upper Assam. Renjini and Nandan (2011) showed that the value of regression exponent (b) for mullet species, *Liza persia* was close to isometric value (b = 3.0) and indicated that this species show isometric growth. The ideal state of regression exponent (b) was 3.0, which shows isometric growth but it get fluctuated due to different reasons e.g. availability of food, age of fish, maturity stages, suitable temperature, growth rate, sampling procedure, time of sampling (Weatherley and Gills, 1987; Ama-Abasi 2007). The Condition factor(K) will also be constant when the length and weight is directly proportion to each other (Salam *et al.,* 2015), but the b-values for male, female and combined sexes of *Mugil incilus* in this study were less than ideal value that is 3.0, so the growth was negatively allometric. The K-values were also influenced by sexual maturity stages and seasonal change (Renjini and Nandan, 2011).

The relative condition factor (Kn) indicates the condition of fish (Lr-Cren, 1951; George *et al*, 1985). When Kn is greater or equal to 1.0, then it indicates that the condition of fish environment is good. On the other hand, if the Kn value is less than one it depicts that environmental conditions are not good. As the average value of Kn for *Mugil incilus* in this study was found to be 1.0 for male, female and combined sexes, it showed that conditions of River Indus were good for the growth and survival of this species which was in agreement with Zubia *et al.* (2014) who also reported the similar conditions (Kn =1.0) for four mullet species on Karachi coast.

CONCLUSIONS

The study of length-weight relationships for the male, female and for both sexes combinly of the species *Mugil incilus* revealed negative allometric pattern of growth (b < 3.0). While the Kn value was equal to the expected or standard value (Kn = 1) which shows this species was in good environmental conditions in River Indus.

Hence, the analysis of length-weight relationship (LWRs), condition and relative conditions factors proved to be very helpful tools in the research of fisheries that later could be used in fisheries biology, fisheries management, estimation of heath condition and growth pattern of fish and assessment of fish stock (Gomiero and Braga, 2003; Froese, 2006; Gomiero *et al.,* 2008; Zubia *et al.,* 2014). The relative condition factor (Kn) gives idea about fish's physiological status and is also useful to compare feeding, climate and other condition of a fish (Le-Cren, 1951; Lizama and Ambrosio, 2002).

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