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Morphometrics and Length Weight Relationship of Tilapia Species, *Oreochromis aureus* Collected from Fish Market of Quetta City, Pakistan

[1]*Nima Nazeer,* [1]*Nighat Din,* [1]*Farhat Iqbal,* [2]*Zubia Masood,* [3]*Nelofer Jamil,*
[1]*Wajeeha Razzaq,* [4]*Muhammad Iqbal Yasinzai and* [1]*Masooma Khawar*

[1]Department of Zoology, Sardar Bahadur Khan Women's University, Quetta, Balochistan, Pakistan
[2]Department of Zoology, University of Karachi, Karachi-75270, Pakistan
[3]Department of Chemistry, Sardar Bahadur Khan Women's University, Quetta, Balochistan, Pakistan
[4]Department of Zoology, University of Balochistan, Quetta, Pakistan

Abstract: A study was conducted on length-weight relationship (LWRs) and fourteen morphometric characteristics for male, female and combined sexes of a tilapia species, *Oreochromis aureus* belong to family Cichlidae were examined during the period from February 2015 to August 2015. A total of 86 samples were collected from the local fish markets of Quetta city that includes 62 males and 24 females. The obtained results of the LWRs for male, females and combined sexes revealed that correlations between length and weight was found to be strong (when $r \geq 0.70$) and highly significant (t-test; $p \leq 0.05$). In the present study, as *b* values were found to be less than ideal value 3.0, so positive allometric growth pattern were observed male, female and combined sexes of this species. Furthermore, the obtained results of two sample t-test at $p \leq 0.05$ for the male and female fishes of the *Oreochromis aureus* revealed that significant variations were found between all fourteen selected morphometric parameters except the length of dorsal fin and height of the pelvic fin that shows insignificant variations between these two characters. Hence, all the selected morphometric characters analyzed in the present study are useful for observing the sexual dimorphism between male and female sexes of *Oreochromis aureus*.

Key words: *Oreochromis aureus* · Growth patterns · Morphometric variations

INTRODUCTION

Fish is a source of valuable animal protein and makes a major contribution to the economy of Pakistan by earning foreign exchange [1]. Tilapia is both a genus of fishes belongs to the Cichlidae family and the common name for nearly a hundred species of freshwater and some brackish water cichlid fishes. Tilapia is a vital food fish in many tropical and sub-tropical countries. It provides one of the most essential sources of animal protein and income throughout the world [2]. They are reflected suitable for culture because of their high acceptance to adverse environmental conditions; comparatively fast growth and the ease with which they can be breed [3]. Pakistan has massive areas of salt waters which can be best exploited for culturing tilapia, as this fish is very hardy, more tolerant than most commonly farmed freshwater fish. Tilapia fish has become one of the more commercially important groups and furthermore, it is also an indigenous African fish that is widely cultivated especially in Asia and the Middle East [4]. Morphometric variation between stocks can provide a basis for stock structure and may be applicable for studying short-term, environmentally induced variation geared towards successful fisheries management [5, 6]. Tilapia grows and imitates in a wide range of environmental conditions and tolerates stress prompted by handling [7]. Major problem in tilapia culture is that females grow slower than males because of early sexual maturation that distracts energy from growth to reproduction, therefore, such problem can be resolve by the production of male fishes only [7]. Morphometric measurements are widely used to identify differences between fish populations and length weight relationship data (LWRs) can also be used to determine possible differences between separate unit stocks of the same species by several workers throughout the world [1,

Corresponding Author: Dr. Zubia Masood, Department of Zoology, University of Karachi, Karachi-75270, Pakistan.

8]. All these previous works has shown that both natural and human impacts can change the morphology or growth rates of populations of same species found in the different regions of world [9, 10]. Therefore, a present study was conducted for determining the length weight relationship data and different morphological characteristics of a tilapia (*Oreochromis aureus*), which was sampled from Quetta city of Balochistan in order to observed the variations in the growth patterns and variations in some external morphological characteristics that could be valuable in determining the taxonomic status of this species as well as in observing sexual dimorphism.

MATERIALS AND METHODS

Samples Collection: A total of 86 samples including 24 females and 62 males of *Oreochromis aureus* were collected from the Quetta fish market during the period from February 2015 to August 2015. Fish were transported immediately to the laboratory of Zoology department of SardarBahadur Khan Women's University, Quetta, where they were measured and weighed and macroscopically sexed for calculating the length weight data by using cubic law followed by Zubia *et al*. [11]. All the statistical work was done on the Minitab version 17.1 statistical software.

Analysis of Morphometric Characteristics: Morphometric characters were studied by following the methods of Zubia *et al.* [12] and Wajeeha *et al.* [13]. Morphometric measurements were made using dial or digital calipers. In Laboratory, about 14 selected morphometric characters of each fish sample were made in the present study as shown in Tables 1. Total length (TL) and all other measurements were taken in millimeters.

Table 1: The morphometric characters and their acronyms.

Variable	Acronyms
Total length	TL
Weight	Wt
Standard length	SL
Body depth	BD
Dorsal fin height	DFH
Dorsal fin length	DFL
Pelvic fin height	PeFH
Pelvic fin length	PeFL
Pectoral fin height	PFH
Pectoral fin length	PFL
Anal fin height	AFH
Anal fin length	AFL
Head length	HL
Pre orbit length	PreOL
Post orbit length	PostOL
Eye diameter	ED

RESULTS AND DISCUSSION

All fourteen morphological characters along with their acronyms are given in the Table 1. The obtained results of length and weight data for the male, female and sex combined of *Oreochromis aureus* were calculated and presented in Tables 2-3, respectively. While analysis of linear relationship between whole body growth versus various morphometric characters for male, female and sex combined was calculated and analyzed separately and recorded in Tables 4-6, respectively. Two sample t-test at5% significant (when $p \leq 0.05$) was also calculated for observing the sexual differentiation between male and female individuals of the *Oreochromis aureus* and noted in Table 7.

Length Weight Relationship (LWRs): Regression coefficient for length weight relationship of the *Oreochromis aureus* was calculated and recorded in Tables 2 and 3. The obtained results of the linear regression relationship (LWRs) between length and weight revealed that male, female and sex combined data showed only strong correlations that is $r \geq 0.70$, as shown in Table 2. On the other hand, the analysis of grown patterns by using cube law revealed that as the values of regression coefficient '*b'* values for male, female and sex combined were less than the ideal value that is $b=3.0$, therefore shows only positive allometric growth pattern and not follow the cubic law which was in agreement with Zubia and Rehana [14] as shown in Table 2.

Morphometric Characters: About fourteen morphological characteristics were observed and calculated in the present study for male, female and sex combined of the *Oreochromis aureus* as shown in Table 1. The obtained results of the linear regression relationship between total length and all selected morphometric characters (except pelvic fin length) for combined sexes revealed mostly highly significant (when $p>0.05$) and strong or moderate type of correlations as shown Table 4. On the other hand, in case of males, most morphometric characters showed in relation to total length showed strong or moderate correlation, except the height and length of dorsal fin, head length, pre-orbital length and eye diameter that shows weak correlations as shown in Table 5. While in contrast, post-orbital length of male shows negative and insignificant type of correlation when $p>0.05$.Similarly, in female fishes, mostly highly significant and stronger moderate type of correlations was found to be occur except the length and height of pelvic fin and

Table 2: Regression coefficients of Length weight relationship of the *Oreochromis aureus*

		Total length (TL) in mm.				Weight (Wt) in grams				Regression coefficient					
Sex	N	Mean±S.D	S.E	Min.	Max.	Mean±S.D	S.E	Min.	Max.	a	b	r	t-test	p-value	C.T
Combined sexes	86	161.1±24.4	2.63	124.6	219.1	52.1±31.0	3.35	24.6	148.9	-136.9	1.17	0.92	-15.7	0.0[a]	*
Male	62	153.9±17.9	15.2	124.6	216.0	44.1±24.6	3.13	24.6	148.9	-131.6	1.14	0.83	-8.63	0.0[a]	*
Female	24	180.0±28.9	5.91	219.1	152.4	72.6±36.6	7.47	124.7	34.0	-152.9	1.25	0.99	36.5	0.0[a]	***

Note: TL= total length; Wt= weight; t= test statistics; CT= Correlation type; [a]t-test is significant When p≤0.05; N=sample size; S.E=standard error.

Table 3: Regression coefficients of Log TL *vs.* Log Wt of the *Oreochromis aureus*

		Total length (TL) in mm.			Weight (Wt) in grams				Regression coefficient					
Sex	N	Mean±S.D	Min.	Max.	Mean±S.D	Min.	Max.	S.E (b)	a	b	r	t-test	p-value	GT
Combined sexes	86	2.20±0.06	2.09	2.34	0.34±0.01	0.32	0.36	0.0003	-0.08	0.19	1.00	-123.2	0.0[a]	*
Male	62	2.18±0.04	2.33	2.09	0.33±0.01	0.32	0.36	0.001	-0.08	1.19	1.00	-93.4	0.0[a]	*
Female	24	2.25±0.06	0.01	2.34	0.35±0.01	0.003	0.36	0.001	-0.08	0.19	1.00	830.0	0.0[a]	*

Note: TL= total length; Wt= weight; t= test statistics; GT= Growth type; [a]t-test is significant When p≤0.05; * shows positive allometric growth pattern when b<3.0.

Table 4: Linear regression relationship between total body length (TL) and various morphometric characteristics for the combined sexes of the *Oreochromis aureus*. Total length and all other measurements are in mm

		Combined Sex (N=86)									
Total length	Morphometric Characters					Regression coefficients					
X	Y	Mean±S.D	S.E	Min.	Max.	a	b	r	t-test	p-value	C.T
TL	SL	122.3±19.8	2.14	104.4	172.7	-0.57	0.76	0.94	24.6	0.0[a]	***
TL	BD	48.0±10.3	1.12	40.0	80.0	-11.4	0.36	0.87	15.9	0.0[a]	***
TL	DFH	27.9±7.1	0.77	17.7	45.7	0.52	0.17	0.58	6.53	0.0[a]	**
TL	DFL	27.1±4.86	0.52	22.0	40.0	8.53	0.11	0.57	6.40	0.0[a]	**
TL	PelFH	31.8±5.27	0.56	18.0	44.0	12.8	0.12	0.54	5.97	0.0[a]	**
TL	PelFL	11.1±5.21	0.56	8.0	43.0	-4.24	0.09	0.44	4.56	0.0[a]	*
TL	PFH	42.6±8.31	0.89	34.0	65.0	-6.01	0.30	0.88	17.6	0.0[a]	***
TL	PFL	6.54±1.79	0.19	4.0	12.0	-3.39	0.06	0.84	14.2	0.0[a]	***
TL	AFH	32.4±8.14	0.87	23.0	55.0	-10.7	0.26	0.80	12.4	0.0[a]	***
TL	AFL	24.7±5.61	0.61	18.0	42.0	-4.43	0.18	0.78	11.7	0.0[a]	***
TL	PreOL	13.9±2.87	0.31	10.0	23.0	-1.59	0.26	0.58	6.66	0.0[a]	**
TL	PostOL	20.2±2.73	0.29	18.0	30.0	1.79	0.07	0.64	7.69	0.0[a]	**
TL	HL	40.3±10.7	1.16	14.0	60.1	10.1	0.06	0.56	6.26	0.0[a]	**
TL	ED	11.4±1.49	0.16	10.0	16.0	5.18	0.04	0.63	7.42	0.0[a]	**

Note: *** shows strong correlations when r>0.70; ** shows correlation moderate when r>0.50; * shows correlation weak when r<0.50; S.D = standard deviation; N=sample size; [a] shows relationship was significant when p<0.05.

Table 5: Linear regression relationship between total body length (TL) and various morphometric measurements for the Male of the *Oreochromis aureus*

Total length	Morphometric Characters	Male (N=62)									
X	Y	Mean±S.D	S.E	Max.	Min.	a	b	r	t-test	p-value	CT
TL	SL	116.3±14.3	1.82	172.7	104.4	12.9	0.67	0.84	11.9	0.0[a]	***
TL	BD	46.2±8.51	1.08	80.0	40.0	-9.91	0.36	0.77	9.31	0.0[a]	***
TL	DFH	26.9±7.07	0.89	45.7	17.7	5.29	0.14	0.36	2.96	0.0[a]	*
TL	DFL	26.6±4.66	0.59	40.0	22.0	10.6	1.10	0.40	3.39	0.0[a]	*
TL	PeFH	31.3±4.15	0.52	44.0	25.0	7.47	0.15	0.67	7.01	0.0[a]	**
TL	PeFL	9.93±1.36	0.17	15.0	8.0	0.91	0.06	0.77	9.35	0.0[a]	***
TL	PFH	41.1±6.05	0.76	65.0	35.0	-1.73	0.27	0.82	11.3	0.0[a]	***
TL	PFL	6.24±1.39	0.17	11.0	4.0	-2.42	0.05	0.72	8.06	0.0[a]	***
TL	AFH	30.4±5.59	0.71	50.0	23.0	1.30	0.18	0.87	5.90	0.0[a]	***
TL	AFL	23.7±4.93	0.62	42.0	18.0	-3.21	0.17	0.60	6.41	0.0[a]	**
TL	HL	37.4±10.1	1.29	60.0	4.0	14.8	0.15	0.26	2.09	0.04[a]	*
TL	PreOL	12.8±1.32	0.16	15.0	10.0	8.07	0.03	0.43	3.64	0.00[a]	*
TL	PostOL	18.9±0.91	0.11	20.0	18.0	20.2	-0.01	-0.16	-1.24	0.22[NS]	*
TL	ED	10.8±0.78	0.09	13.0	10.0	8.25	0.02	0.38	3.16	0.0[a]	*

*NS=not significant when p>0.05. Total length and all other measurements are in mm.

Table 6: Linear regression relationship between total body length (TL) and various morphometric measurements for the females of the *Oreochromis aureus*

Total length	Morphometric Characters	Female (N=24)									
X	Y	Mean±S.D	S.E	Max.	Min.	a	b	r	t-test	p-value	CT
TL	SL	137.6±23.8	4.88	170.2	111.7	-10.3	0.82	0.99	56.9	0.0[a]	***
TL	BD	52.6±13.2	2.70	71.0	40.0	-27.7	0.45	0.98	22.9	0.0[a]	***
TL	DFH	30.4±6.92	1.41	40.6	25.0	-10.1	0.22	0.94	12.9	0.0[a]	***
TL	DFL	28.2±5.27	1.08	37.0	24.0	-0.35	0.16	0.87	8.30	0.0[a]	***
TL	PeFH	32.9±7.44	1.52	43.0	18.0	11.9	0.12	0.45	2.38	0.0[a]	*
TL	PeFL	14.0±9.11	1.86	43.0	10.0	-3.1	0.09	0.30	1.48	0.2[NS]	*
TL	PFH	46.6±11.6	2.38	63.0	34.0	-22.1	0.38	0.95	14.3	0.0[a]	***
TL	PFL	7.33±2.41	0.49	12.0	5.0	-6.94	0.08	0.95	14.9	0.0[a]	***
TL	AFH	37.5±11.1	2.27	55.0	25.0	-24.7	0.35	0.89	9.62	0.0[a]	***
TL	AFL	27.3±6.49	1.33	35.0	20.0	-11.3	0.21	0.95	15.4	0.0[a]	***
TL	HL	47.4±9.13	1.86	60.1	33.0	-6.54	0.29	0.95	14.5	0.0[a]	***
TL	PreOL	16.8±3.77	0.77	23.0	13.0	3.38	0.07	0.57	3.29	0.0[a]	**
TL	PostOL	23.4±3.24	0.66	30.0	20.0	10.8	0.07	0.63	3.76	0.0[a]	**
TL	ED	12.9±1.78	0.36	16.0	10.0	6.80	0.03	0.52	3.14	0.0[a]	*

Total length and all other measurements are in mm.

Table 7: Analysis of variances (ANOVA)

Morphometric Characters	Female		Male		2 sample t-test and CI (95%)			
Morphometric characters	Mean	S.E	Mean	S.E	Confidence interval (Cl at 95%)	t-test	p-value	Sig.
SL	137.6	4.9	116.4	1.8	10.6±31.9	4.08	0.0	S
BD	52.7	2.7	46.2	1.1	0.49±12.4	2.21	0.04	S
DFH	30.3	1.4	26.9	0.9	-0.01±6.75	2.01	0.05	S
DFL	28.2	1.1	26.7	0.59	-1.0±3.98	1.21	0.23	NS
PeFH	32.9	1.5	31.4	0.53	-1.76±4.82	0.95	0.35	NS
PeFL	14.0	1.9	9.94	0.17	0.20±7.93	2.18	0.04	S
PFH	46.6	2.4	41.1	0.77	0.36±10.6	2.20	0.04	S
PFL	7.33	0.49	6.24	0.18	0.02±2.16	2.09	0.05	S
AFH	37.5	2.3	30.4	0.71	2.20±11.9	2.97	0.01	S
AFL	27.3	1.3	23.7	0.63	0.58±6.54	2.43	0.02	S
HL	47.4	1.9	37.5	1.3	5.38±14.5	4.39	0.0	S
PreOL	16.8	0.77	12.8	0.17	2.32±5.57	5.01	0.0	S
PostOL	23.4	0.66	18.9	0.12	3.04±5.82	6.60	0.0	S
ED	12.9	0.36	10.8	0.10	1.37±2.93	5.71	0.0	S

Two Sample t-Test at á=5% (when p≤0.05) of *Oreochromis aureus*

Note: S.E is the standard error; S= t-test is significant when p≤0.05; NS= t-test is not significant when p≥0.05.

diameter of eye that showed weak type of correlations with whole body growth. Furthermore, all these characters showed highly significant correlation except pelvic fin length that showed insignificant correlation when p>0.05 as shown in Table 6. Thus, the tilapia species selected for the present study revealed that most external body parts tend to increase as the total body length of fish increases. Similar results have also been observed by Naeem *et al.* [15] for Mahseer species, *Tor putitora*. Likewise, a strong positive correlation was also observed for pectoral fin height and dorsal fin height in relation to the whole body growth in females of *Liza parsia* by Renjini and Nandan [16].

Furthermore, during the analysis of variations by 2-sample t-test at 5% significant (p<0.05) between selected morphometric characters of male and female fishes of *Oreochromis aureus* revealed that except the length of dorsal fin and pelvic fin, most morphometric characters between male and female fishes of *Oreochromis aureus* were found to be significantly varied hence consider as useful tools in observing sexual dimorphism (Table 7).

CONCLUSION

The present study would be useful for providing information regarding to the growth pattern of tilapia species found in Pakistan. Furthermore, our study will also highlight some important morphometric characteristics that are helpful in observing the sexual dimorphism of the tilapia species examined in the present study. Such study will also be valuable in systematics as well as fisheries management and conservation in the future.

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