Morphometry, Length-Weight Relationship and Condition Factor of *Rita rita* from the Indus River, Punjab, Pakistan

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ABSTRACT
This study aimed to investigate the morphometry, length-weight relationship, and condition factor of the riverine catfish (*Rita rita*) collected from the Indus River, Punjab, Pakistan. Compared morphometric characters revealed a positive allometric growth pattern (b=3.17) and high correlation (r=0.941**) between each other. The length-weight relationship was calculated as W= -435.40L$^{24.15}$. The coefficient of correlation for the length-weight relationship was estimated at 0.941, indicating a high degree of correlation between these two parameters. The Condition factor varied from 0.69 to 1.28. This study will be useful for taxonomists and fisheries biologists to correctly identify *R. rita* and manage this species.

INTRODUCTION

Fish make up more than a quarter of all vertebrate species, with 32,000 different species in every aquatic region on the planet **(Froeser, 2011)**. The freshwater bodies of Pakistan have diverse fauna and flora. Freshwater Ichthyofauna of Pakistan consists of 193 fish species, among which 31 species are commercially high valued species. Fish are one of the most significant vertebrate groups, providing benefits to humans in various ways. Human nutrition relies heavily on fish as a source of dietary animal protein **(De Grandchamp *et al.*, 2007)**.

Fish have been extensively adopted as a high-quality origin of protein that maintains health, and they are one of the major sources of animal protein **(Andrew, 2001)**.The Siluriformes is one major group of 412 genera and 34 families comprising around 2405 species. Catfish from the families of Bagaridae, Clariidae, Pangasiidae and Siluridae are worldwide spread, and

culturing them is traditional in various parts of southeast and south Asia (**Salam** ***et al.,*** **1994**). *R. rita* is a type of fish used as a food source in Pakistan, Afghanistan, India, Bangladesh, Nepal and Myanmar. Its common name is ''khagga'', ''tarkanda'' in Pakistan and RITA/ RITHA in India and Bangladesh (**Mirza, 2003**).

Freshwater fish, *R. rita*, can be found in ponds, lakes, rivers, canals and streams. *R. rita* is an important catfish with a good fishery in the major rivers. It is a well-favored fish due to its delicious taste and high proteins. It has recently been evaluated as an ornamental fish, with evidence of it being sold as an indigenous ornamental fish from India (**Gupta, 2015**). *R. rita* feeds primarily from the bottom and from the column on occasion. *R. rita* is a carnivore that eats everything from microscopic copepods to macroscopic spawn and fry of fishes. They eat mostly insects, mollusks, shrimps and decaying organic matter. Bottom feeding adults are carnivores; they eat fish and larvae, crustaceans & mollusks (**Jayaram, 2009**).

From Pakistan's freshwater bodies, around 186 freshwater fish species have been identified. The identification of a species is crucial for behavioral research. Different methods are employed for species identification, but morphometry and meristic counts are considered to be the primitive and most reliable (**Kohinoor** ***et al.***, **1995; Narejo** ***et al.***, **2000**). Morphometric differences across stocks of different species are widely acknowledged as crucial for identifying stocks and assessing population structure. For *R. rita*, it is possible to determine the differences between sexes. Pectoral spines in females have both serrated inner and posterior margins from their tip to their base, whereas males have serrated anterior margins with a smooth posterior edge. During the breeding season, a male's muscular genital papilla grows more pronounced and conspicuous (**Mojekwu & Anumudu, 2015**).

Both fishery biology and taxonomy research require morphometric measurements and statistical correlations of fishes (**Tandon** ***et al.***, **1993**). These connections also reveal information on the health and growth trends of fish (**Bagenal & Tesch., 1978**). Furthermore, condition factors can be used to detect seasonal fluctuations in fish growth, which can vary depending on food availability and the stock's average reproductive stage. Condition factor analyzes the individual health and habitat condition. The fish better condition is marked when the value of K is more than 1 and in worse condition of fish and habitat when the value of K is less than 1.

MATERIALS AND METHODS

Fish sampling and study site

A total of 36 fresh specimens of *Rita rita* with a length range of 15.80- 39cm and weight range of 37.00- 542g were collected from the Indus River near Dera Ghazi khan, Punjab, Pakistan for the study of morphometry, length-weight relationship and condition factors. The collected samples were transported to the Fisheries Research Lab, Department of Zoology, Ghazi University Dera Ghazi Khan.

Morphometric characters

Twenty six external and four internal morphometric characters were measured using a digital slide calipurse, while weight was measured using a digital balance Model: KD 300KC, with 0.01g accuracy according to **Simon and Mazlan (2008)**.

Wet body weight (Ww), anal fin base (AFB), anal fin length (AFL), caudal fin depth (CFD), caudal fin length (CFL), body depth (BD), dorsal fin length(DFH), dorsal fin base (DFB), Pre dorsal length (PDF), fork length (FL), pectoral fin base (PtFB), pectoral fin length (PtFL), eye diameter(ED), pelvic fin base (PvFB), pelvic fin length (PvFL), head length (HL), standard length (SL), gap of mouth (GM), total length (TL), interorbital length(IOL), snout length(SNL), pre-orbital length (PrOL) and post orbital length (POL), lower jaw length (LJL), upper jaw length (UJL), mandibular barble length (MBL) were determined in the current study. Four internal morphometric characters were analyzed. For the study of internal morphometry, the fishes were dissected and different characters, viz. gut length, stomach weight, liver weight and heart weight were measured (Fig. 1).

Length-weight relationship

The body weight (wet) relation with its total length was found by using the following formula of **Le Cren (1951):** $W = aL^b$

Where, W is the wet weight of the fish in grams; L is the length of fish in millimeters, and a and b are constants.

The data on total length and weight were statistically treated by the method of least squares, using the equation of **Le Cren (1951)** given as: **Log W= log a + b log L**

In this formula, the log a and b are constants estimated by the linear regression of the log transformed verities.

Coeffcient of correlation

The relationship between all the morphological characters was determined using the method of least square to fit a linear regression as: **Y= a + b X**

Where, **Y** = dependent variable (various body parameters)

 X = an independent variable (Total length, body weight), **a** = proportionality constant

b = regression coefficient (slope)

Range, mean, median, standard deviation and correlation of coefficient (r) were estimated for the characters under study. The significance of regression was assessed by using ANOVA at 5% significance level (*P*< 0.05). The *P*- value indicates that the relationship between two variables was statistically significant. The statistical analysis was performed by the SPSS software.

Condition factor

Condition factor K was measured for every sample by using the strategy of **Weatherly and Gill (1990)** as a condition variable.

$$\text{Condition factor} = 100 \times \frac{W}{L3}$$

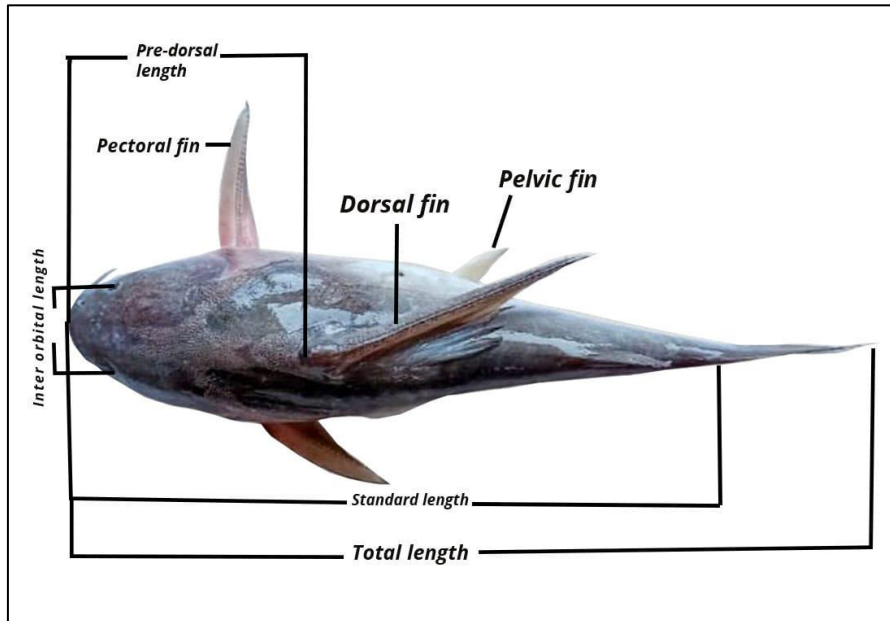Where, L is the length in centimeters (cm), and W is the weight in grams (g).

Fig. 1. Morphometric characters of *R. rita*

RESULTS AND DISCUSSION

During the present investigation on the morphometery of *Rita rita*, the co-efficient of correlation (r) for various morphometric characters compared against ranges of wet weight and total length were 37.00- 542g and 15.80- 39cm, respectively. Their mean weight and mean total length values with standard deviation were 215.50±107.65 and 26.95±4.19452, respectively (Table 4). Observations showed that this fish had a large head as compared to other fishes. The length of the head ranged from 3.00- 8.50cm and 5.50cm as an average size. Fork length range fluctuated between 14.50 & 33.00cm, with an average of 23.9222±3.57332cm. The standard length range was 13.00- 32.00cm, with an average of 22.0583±3.55225cm. Snout length ranged from 1.00- 3.00, with an average of 2.0056±0.40634cm. Pre-orbital length was between 1.00 & 3.00cm, with an average of 1.9556±0.47595cm. Post-orbital ranged from 2.00- 7.00cm and averaged a value of 3.7717±1.07613cm. Pre-dorsal length with range was 5.20- 13.50cm, with an average value of 9.2556±1.60097cm. The diameter of eyes was 1.40- 0.30cm with an average size of 0.4694 ± 0.23154cm, and distance between eyes was between 1.50 & 4.50cm, with an average size of 2.9000 ± 0.56112cm.The length of mandibles was from 1.40- 4.50cm, with an average size

of 2.9806±0.89819cm. The length of the maxilla ranged from 1.7- 6.00cm, with an average size of 3.8361 ± 1.00801cm (Table 1).

The fishes have several fins with variable shapes and lengths. The length of the dorsal fin was in an average size of 7.227 ± 1.77049cm; the dorsal fin base ranged from 2.00-7.40cm, with an average size of 3.40±0.935cm, (Table 4.1). The length of the pectoral fin was in the range from 3.00- 8.50cm, with an average size of 5.53±1.203cm. Moreover, the pectoral fin base fluctuated from 0.70- 2.00cm, with an average size of 1.38±0.33. Pelvic fin length was in the range of 1.50- 4.50cm, with an average size of 2.66`±0.56cm. while, the pelvic fin base was in the range of 0.40- 1.70, with an average size of 0.9583±0.24068cm. Anal fin length ranged from 1.90- 5.00cm, with an average of 3.333±0.65115cm. Caudal fin length was observed in the range from 3.00- 8.00cm, with an average of 5.4722±1.12697. Whereas, the caudal fin base ranged from 1.30- 4.00cm, with an average of 2.45±0.60cm. the mouth gap ranged from 0.40- 1.80, with an average of 0.8778±0.2977cm.

In addition, the internal morphometry was observed in the present study where the heart weight was in the range from 0.09- 2.74g, with an average of 1.2375±0.65438g. While, the stomach weight fluctuated from 0.69- 29.62g, with an average of 7.1331±5.81284g. On the other hand, the liver weight ranged from 0.08- 8.82g, and the average was 2.7178±1.58049g, while the gut length ranged from 3.32- 35.00cm, with an average of 16.167±5.66339cm.

The correlation coefficient value of 0.974 was highly significant ($P<0.001$) between weight and total length between untransformed and log-transformed data. The b value (regression coefficient) was 3.17, which matches with an ideal slope value that shows the positive allometric growth.

Relationship of total length with standard length, fork length, head length, snout length, pre-dorsal length, dorsal fin length and base, pectoral fin length, pectoral-fin base, pelvic fin length, pelvic fin base, anal fin length , anal fin base, caudal fin length and base, body depth, inter-orbital length, lower jaw length, pre-orbital and mandibular barbel heart weight, stomach weight, liver weight, gut length is highly significant ($P<0.001$). The total length correlation with eye diameter and pre-orbital length is significant ($P<0.01$). Total length relationship with a gap of mouth and upper jaw length is non-significant ($P>0.05$). Their respective correlation coefficient (r) values and b values are shown in Table (2).

Relationship of log total length with the log of all morphological characters show strong correlation and highly significant relation ($P<0.001$), excluding the gap of mouth and upper jaw length that show non-significant relation ($P>0.05$). The correlation coefficient (r) values and b values are presented in Table (3).

Wet body weight showed highly significant relationship with all studied morphometric characters ($P<0.001$), except for the pelvic fin base that shows significant relationship ($P<0.01$) and post-orbital length showing least significant relation ($P<0.05$). Mouth gap and upper jaw length shows non-significant relation ($P>0.05$). The values of r with regression coefficient are displayed in the Table (4).

Log of wet body weight was found to be the highly significant relationship with the log of other morphological characters, excluding the gap of mouth and upper jaw length that show non-significant relation with wet body weight (p> 0.05). The respective correlation coefficient (r) values and b values are shown in Table (5).

Regression coefficient of K against W and TL was expressed as:

$$K = 0.859 + 0.006 \text{ TL} \qquad (r = 0.207)^{ns}$$

$$K = 0.933 + 0.000 \text{ W} \qquad (r = 0.361)^{*}$$

The calculated mean value of K was 1.0196 ± 0.12048 and the range was from 0.69- 1.28 as shown in the Table (1). Condition factor (K) shows non-significant relationship with the total length ($P>0.05$); while with total weight, it shows the least significant relationship ($P< 0.05$).

Condition factor (K) shows significant relation with pre-orbital length ($P>0.01$). The correlation coefficient (r) value shows the least significant relation among wet body weight, fork length, pelvic fin base, body depth & lower jaw length ($P<0.05$). Condition factor (K) shows non-significant relation with all other morphological characters ($P>0.05$). Their respective correlation coefficient (r) values and b values are shown in Table (6).

Log condition factor shows significant relation with the log of wet body weight and head length ($P<0.01$), while the least significant relationship was detected with snout length, pre-dorsal length, pelvic fin base, caudal fin base, body depth, lower jaw length, pre-orbital length, post-orbital length & length of mandibular barbel ($P<0.05$). On the other hand, condition factor displays non-significant relation with total length, standard length, fork length, dorsal fin base, pectoral fin base, pectoral fin length, pelvic fin length, anal fin base, anal fin length, caudal fin length, eye diameter, inter-orbital length, the gap of mouth, upper jaw length, post-orbital length, heart weight, stomach weight, liver weight and gut length ($P<0.05$). Their respective correlation coefficient (r) values and b values are shown in Table (7).

The obtained values of Fulton's condition factors were found >1, which indicate the good growth performance of *Rita rita* from the Indus River near DG khan. The fluctuation may occur due to age and stage of maturity of the species as well as the environmental conditions of habitat such as temperature, salinity and seasonality. The outcomes of the present study would play an important role in the management and conservation of these species as well as other small indigenous fish species of Pakistan.

Table 1. Mean values, ranges, standard deviations and variance of various morphological characteristics of *R. rita* (n=36)

Parameter	Average	Range Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
WW	505.00	37.00	542.00	215.5000	17.94204	107.65222	11589.0
TL	23.20	15.80	39.00	26.9528	69909	4.1945	17.594
CF	0.58	0.69	1.28	1.0196	0.02008	0.12048	0.015
SL	19.00	13.00	32.00	22.0583	.59204	3.55225	12.619
FL	18.50	14.50	33.00	23.9222	.59555	3.57332	12.769
HL	5.50	3.00	8.50	5.8139	.18937	1.13620	1.291
SL	2.00	1.00	3.00	2.0056	.06772	.40634	.165
PrOL	2.50	1.00	3.50	1.9556	.07933	.47596	.227
POL	5.00	2.00	7.00	3.7717	.17936	1.07613	1.158
PDL	8.30	5.20	13.50	9.2556	.26683	1.60097	2.563
DFB	5.40	2.00	7.40	3.4083	.15591	.93545	.875
DFL	9.60	3.40	13.00	7.2278	.29508	1.77049	3.135
PtFB	1.30	.70	2.00	1.3889	.05517	.33104	.110
PtFL	5.50	3.00	8.50	5.5333	.20055	1.20333	1.448
PvFB	1.30	.40	1.70	.9583	.04011	.24068	.058
PvFL	3.00	1.50	4.50	2.6639	.09446	.56677	.321
AFB	3.20	.80	4.00	2.3000	.09587	.57520	.331
AFL	3.10	1.90	5.00	3.3333	.10853	.65115	.424
CFB	2.70	1.30	4.00	2.4500	.10075	.60451	.365
CFL	5.00	3.00	8.00	5.4722	.18783	1.12697	1.270
ED	1.40	.30	1.70	.4694	.03859	.23154	.054
IOL	3.00	1.50	4.50	2.9000	.09352	.56112	.315
BD	13.00	8.50	21.50	15.2333	.41339	2.48032	6.152
GM	1.40	.40	1.80	.8778	.04962	.29772	.089
UJL	4.30	1.70	6.00	3.8361	.16800	1.00801	1.016
LJL	3.10	1.40	4.50	2.9806	.14970	.89819	.807
MBL	3.50	2.00	5.50	3.1139	.13640	.81841	.670
HW	2.65	.09	2.74	1.2375	.10906	.65438	.428
SW	28.93	.69	29.62	7.1331	.96881	5.81284	33.789
LW	8.74	.08	8.82	2.7178	.26342	1.58049	2.498
GL	31.68	3.32	35.00	16.1617	.94390	5.66339	32.074

S.D = Standard deviation, Y = a+bx

Table 2. Descriptive statistics and regression analysis of *R. rita*: Total length against various morphological characters

Formula Y=a+bX	Relation parameters a	b	CI of a	CI of b	R	r²
W	-435.402	24.150	-571.97-352.83	21.122-27.178	0.941***	0.885
K	0.859	0.006	0.592-1.126	-0.004-0.016	0.207***	0.043
SL	-0.444	0.835	-1.794-0.905	0.785-0.884	0.986***	0.972
FL	1.266	0.841	-0.49-2.580	0.792-0.889	0.987***	0.974
HL	-0.700	0.242	-1.863-0.462	0.199-0.284	0.982***	0.796
SNL	0.561	0.54	-0.206-1.328	0.025-0.082	0.553***	0.306
PDL	-0.558	0.364	-1.646- -0.31	0.342-0.404	0.954***	0.910
DFL	-2.831	0.373	-4.705- -0.957	0.304-0.442	0.884***	0.782
DFB	0.135	0.121	-1.643-1.912	0.056-0.187	0.545***	0.297
PtFL	-0.706	0.232	-2.317-0.904	0.172-0.291	0.807***	0.651
PtFB	-0.233	0.060	-7.18-0.253	0.042-0.078	0.762***	0.581
PvFL	-0.372	0.113	-1.081-0.337	0.087-0.139	0.834***	0.695
PvFB	0.159	0.030	-0.308-0.626	0.13-0.047	0.517***	0.267
AFL	-0.299	0.13	-1.031-0.433	0.108-0.162	0.868***	0.754
AFB	-0.672	0.110	-1.447-0.103	0.082-0.139	0.804***	0.647
CFL	-0.657	0.227	-2.017-0.702	0.178-0.277	0.846***	0.716
CFB	-0.839	0.122	-1.568-0.111	0.095-0.149	0.847***	0.717
ED	-0.264	0.027	-0.720-0.193	0.010-0.044	0.493**	0.243
BD	0.901	0.532	-1.557-3.359	0.442-0.622	0.899***	0.809
IOL	-0.365	0.121	-0.904-0.175	0.101-0.141	0.905***	0.820
GM	0.345	0.020	-0.303-0.992	-0.004-0.044	0.279	0.078
UJL	2.713	0.042	0.464-4.962	-0.41-0.124	0.173	0.030
LJL	-0.901	0.144	-2.407- -0.605	0.089-0.199	0.673***	0.452
PrOL	0.040	0.071	-0.801-0.880	0.040-0.102	0.626***	0.392
POl	0.901	0.107	-1.317-3.119	0.25-0.188	0.415**	0.172
MBL	-0.625	0.139	-1.929-0.680	0.091-0.187	0.711***	0.50
HW	-1.904	0.117	-2.889- -0.918	0.080-0.153	0.747***	0.558
SW	-17.884	0.928	-27.664- -8.105	-0.507-1.287	0.670***	0.449
LW	-6.143	0.329	-7.893- -4.394	0.265-0.393	0.873***	0.761
GL	-10.653	0.995	-19.328- -1.978	0.677-1.313	0.737***	0.543

Table 3. Descriptive statistics and regression analysis of *R. rita*: Log total length against log of various morphological characters

Parameter	Relation Parameters		CI of a	CI of b	r	r²
	a	b				
Log WW	-2.246	3.176	-2.615- -1.877	2.918-3.435	0.974***	0.948
Log K	-0.246	0.176	-0.615-0.123	-0.082-0.435	0.231***	0.054
Log SL	-0.118	1.022	-1.99- -0.037	0.965-1.078	0.987***	0.975
Log FL	0.016	0.952	-0.055-0.088	0.902-1.003	0.989***	0.977
Log HL	-0.872	1.142	-1.146- -598	0.950-1.334	0.901***	0.811
Log SNL	-0.710	0.704	-1.237--0.183	0.335-1.073	0.553***	0.306
Log PDL	-0.591	1.088	-0.749--0.433	0.977-1.199	0.960***	0.921
Log DFL	-1.150	1.400	-1.485- -0.814	1.165-1.636	0.901***	0.812
Log DFB	0.886	0.987	-1.408- -0.365	0.621-1.352	0.685***	0.469
Log PtFL	-0.799	1.075	-1.224- -0.375	0.777-1.373	0.783***	0.613
Log PtFB	-1.562	1.187	-2.045- -1.078	0.848-1.526	0.774***	0.599
Log PvFL	-1.071	1.044	-1.414- -0.729	0.804-1.284	0.835***	0.696
Log PvFB	-1.562	1.073	-2.156- -0.967	0.657-1.490	0.668***	0.446
Log AFL	-1.047	1.095	-1.361- -0.732	0.875-1.315	0.853***	0.750
Log AFB	-1.627	1.385	-2.157- -1.097	1.014-1.756	0.793***	0.628
Log CFL	-0.884	1.131	-1.217- -0.550	0.897-1.365	0.860***	0.740
Log CFB	-1.399	1.246	-1.792- -1.006	0.970-1.521	0.845***	0.713
Log ED	-2.042	1.183	-2.823- -1.260	0.635-1.730	0.602***	0.362
Log BD	-0.201	0.966	-0.418-0.016	0.814-1.118	0.911***	0.831
Log IOL	-1.132	1.113	-1.392- -0.871	0.930-1.295	0.905***	0.819
Log GM	-0.939	0.601	-1.981-0.103	-0.129-1.332	0.276	0.076
Log UJL	0.101	0.326	-0.809-1.1012	-0.312-0.964	0.176	0.031
Log LJL	-1.448	1.334	-2.207- -0.690	0.802-1.865	0.658***	0.433
Log PrOL	-1.204	1.041	-1.741- -0.668	0.665-1.417	0.694***	0.482
Log Pol	-0.739	0.913	-1.395- -0.084	0.453-1.372	0.569***	0.324
Log MBL	-0.998	1.037	-1.576- -4.20	0.631-1.442	0.665***	0.443
Log HW	-4.599	3.240	-5.873- -3.325	2.347-4.133	0.784***	0.615
Log SW	-4.165	3.443	-5.582- -2.747	2.450-4.436	0.770***	0.593
Log LW	-5.6774	4.227	-6.799- -4.554	3.441-5.014	0.882***	0.778

Table 4. Descriptive statistics and regression analysis of *R. rita*: Wet body weight against various morphological characters

| Formula Y=a+bX | Relation parameters | | CI of a | CI of b | R | r² |
	a	b				
TL	19.052	0.037	17.948-20.156	0.032-0.041	0.941***	0.885
K	0.933	0.000	0.845-1.020	0.000-0.001	0.361***	0.130
SL	15.392	0.031	14.430-16.353	0.027-0.035	0.937***	0.879
FL	17.177	0.031	16.252-18.102	0.027-0.035	0.943***	0.889
HL	3.804	0.009	3.390-4.218	0.008-0.011	0.884***	0.781
SNL	1.526	0.002	1.271-1.782	0.001-0.003	0.589***	0.347
PDL	6.315	0.014	5.820-6.810	0.012-0.016	0.917***	0.842
DFL	4.223	0.014	3.493-4.953	0.011-0.017	0.848***	0.719
DFB	2.416	0.005	1.799-3.033	0.002-0.007	0.530***	0.281
PtFL	3.662	0.009	3.073-4.252	0.006-0.011	0.777***	0.603
PtFB	0.913	0.002	0.734-1.093	0.001-0.003	0.717***	0.515
PvFL	1.749	0.004	1.488-2.010	0.003-0.005	0.806***	0.650
PvFB	0.716	0.001	0.554-0.878	0.000-0.002	0.502**	0.252
AFL	2.253	0.005	1.970-2.536	0.004-0.006	0.829***	0.687
AFB	1.420	0.004	1.131-1.708	0.003-0.005	0.765***	0.585
CFL	3.641	0.008	3.129-4.153	0.006-0.011	0.812***	0.659
CFB	1.398	0.005	1.166-1.631	0.004-0.006	0.869***	0.755
ED	0.231	0.001	0.076-0.385	0.000-0.002	0.515***	0.265
BD	10.9151	0.020	9.975-11.928	0.016-0.024	0.862***	0.744
IOL	1.911	0.005	1.704-2.117	0.004-0.005	0.881***	0.776
GM	0.738	0.001	0.513-0.963	0.000-0.002	0.235	0.055
UJL	3.427	0.002	2.660-4.195	-0.001-0.005	0.203	0.041
LJL	1.736	0.006	1.232-2.240	0.004-0.008	0.692***	0.479
PrOL	1.335	0.003	1.054-1.616	0.002-0.004	0.651***	0.424
Pol	2.980	0.004	2.202-3.758	0.000-0.007	0.368*	0.135
MBL	1.853	0.006	1.446-2.259	0.004-0.008	0.770***	0.593
HW	0.261	0.005	-0.078-0.600	0.003-0.006	0.746***	0.556
SW	-1.366	0.039	-4.454-1.721	0.027-0.052	0.730***	0.534
LW	-0.011	0.013	-0.633-0.611	0.010-0.015	0.863***	0.744
GL	7.406	0.041	4.608-10.205	0.029-0.052	0.772***	0.596

Table 5. Descriptive statistics and regression analysis of _R. rita_: Log wet body weight against log of various morphological characters

Formula	Relation Parameters		CI of a	CI of b	R	r²
	a	b				
Log TL	0.744	0.299	0.689-0.800	0.274-0.323	0.974**	0.948
Log K	-0.233	0.104	-0.400--0.066	0.032-0.177	0.447**	0.199
Log SL	0.635	0.308	0.575-0.696	0.282-0.334	0.971**	0.943
Log FL	0.714	0.289	0.666-0.763	0.268-0.310	0.979**	0.958
Log HL	-0.061	0.358	-0.182-0.060	0.305-0.411	0.921**	0.849
Log SNL	-0.227	0.228	-0.479-0.026	0.118-0.338	0.584**	0.342
Log PDL	0.200	0.333	0.121-0.279	0.298-0.368	0.958**	0.918
Log DFL	-0.128	0.427	-0.297-0.041	0.353-0.501	0.896**	0.803
Log DFB	-0.152	0.295	-0.415-0.111	0.180-0.409	0.667**	0.445
Log PtFL	0.012	0.316	-0.210-0.235	0.219-0.413	0.750**	0.563
Log PtFB	-0.663	0.348	-0.916- -0.410	0.237-0.458	0.739**	0.546
Log PvFL	-0.278	0.304	-0.464- -0.091	0.223-0.386	0.794**	0.630
Log PvFB	-0.822	0.346	-1.102- -0.543	0.224-0.468	0.704**	0.495
Log AFL	-0.240	0.331	-0.401- -0.078	0.260-0.401	0.853**	0.728
Log AFB	-0.626	0.426	-0.885- -0.367	0.313-0.539	0.796**	0.634
Log CFL	-0.050	0.341	-0.221-0.122	0.267-0.416	0.847**	0.717
Log CFB	-0.505	0.387	-0.692- -0.318	0.305-0.468	0.855**	0.731
Log ED	-1.193	0.367	-1.575- -0.811	0.200-0.534	0.6098**	0.370
Log BD	0.499	0.297	0.394-0.604	0.251-0.343	0.914**	0.836
Log IOL	-0.310	0.335	-0.448- -0.172	0.275-0.395	0.889**	0.790
Log GM	-0.499	0.183	-1.013-0.014	-0.041-0.407	0.274	0.075
Log UJL	0.282	0.125	-0.162-0.727	-0.069-0.318	0.219	0.048
Log LJL	-0.543	0.437	-0.896- -0.191	0.283-0.591	0.703**	0.494
Log PrOL	-0.493	0.338	-0.741- -0.244	0.230-0.447	0.736**	0.542
Log Pol	-0.082	0.282	-0.403-0.240	0.142-0.422	0.574**	0.329
Log MBL	-0.269	0.328	-0.547-0.008	0.207-0.449	0.687**	0.473
Log HW	-2.271	1.004	-2.888- -1.655	0.735-1.273	0.793**	0.629
Log SW	-1.652	1.050	-2.356- -0.949	0.743-1.357	0.766**	0.587
Log LW	-2.581	1.284	-3.151- -2.011	1.035-1.533	0.874**	0.764
Log GL	0.313	0.381	-0.170-0.796	0.170-0.591	0.533**	0.284

Table 6. Descriptive statistics and regression analysis of *Rita rita*: Condition factor (K) against various morphological characters

Formula	Relation Parameters		CI of a	CI of b	r	r²
Y=a+b K	a	B				
TL	19.601	7.211	7.415-31.786	-4.660-19.082	0.207	0.043
W	-113.286	322.466	-411.40-184.83	32.037-612.89	0.361*	0.130
SL	14.548	7.366	4.334-24.761	-2.584-17.316	0.250	0.062
FL	15.495	8.266	5.304-25.685	-1.662-18.193	0.279	0.078
HL	2.224	3.521	-0.906-5.354	0.472-6.570	0.373*	0.139
SNL	0.989	0.997	-0.164-2.142	-0.126-2.120	0.296	0.087
PDL	5.035	4.139	0.518-9.553	-0.262-8.540	0.311	0.097
DFL	3.596	3.562	-1.505-8.696	-1.406-8.531	0.242	0.059
DFB	2.556	0.836	-0.205-5.318	-1.855-3.526	0.108	0.012
PtFL	4.218	1.290	0.675-7.762	-2.162-4.742	0.129	0.017
PtFB	1.042	0.340	0.067-2.018	-0.611-1.290	0.124	0.015
PvFL	2.203	0.452	0.528-3.878	-1.180-2.084	0.096	0.009
PvFB	0.191	0.753	-0.471-0.853	0.108-1.398	0.377*	0.142
AFL	2.106	1.203	0.221-3.991	-0.633-3.040	0.223	0.050
AFB	1.219	1.060	-0.446-2.885	-0.562-2.682	0.222	0.049
CFL	3.354	2.078	0.091-6.617	-1.101-5.256	0.222	0.049
CFB	0.898	1.522	-0.812-2.608	-0.144-3.188	0.303	0.092
ED	0.140	0.323	-0.538-0.818	-0.337-0.983	0.168	0.028
BD	8.493	6.611	1.518-15.468	-0.184-13.406	0.321*	0.103
IOL	1.754	1.124	0.137-3.371	-0.452-2.699	0.241	0.058
GM	0.719	0.156	-0.164-1.601	-0.703-1.016	0.063	0.004
UJL	1.809	1.989	-1.099-4.716	-0.844-4.821	0.238	0.056
LJL	0.335	2.595	-2.165-2.835	0.159-5.031	0.348*	0.121
PrOL	0.249	1.674	-1.032-1.529	0.427-2.921	0.424**	0.180
POl	2.256	1.487	-0.895-5.407	-1.583-4.556	0.166	0.028
MBL	1.014	2.060	-1.302-3.330	-0.196-4.316	0.303	0.092
HW	-0.030	1.243	-1.922-1.861	-0.599-3.086	0.229	0.052
SW	-4.269	11.183	-21.060-12.521	-5.174-27.541	0.232	0.054
LW	1.285	1.405	-3.381-5.951	-3.141-5.951	0.107	0.011
GL	12.006	4.076	-4.748-28.760	-12.245-20.397	0.087	0.008

***$P<0.001$ (Highly significant values); **$P<0.01$ (Significant values); *$P< 0.05$ (least Significant values); $P>0.05$ (Non-significant values).

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Table 7. Descriptive statistics and regression analysis of *R. rita*: Log condition factor (log K) against log of various morphological characters

Formula logY=a=b logK	Relation Parameters		CI of a	CI of b	R	r²
	a	b				
LogT	1.424	0.303	1.400-1.447	-1.41-0.748	0.231	0.054
LogW	2.271	1.910	2.200-2.342	0.576-3.243	0.447**	0.199
LogSL	1.336	0.365	1.312-1.360	-0.090-0.820	0.269	0.072
LogF	1.372	0.377	1.349-1.394	-0.044-0.797	0.2988	0.089
LogHL	0.752	0.661	0.742-0.781	0.130-1.193	0.398**	0.158
LogSNL	0.291	0.539	0.261-0.320	-0.012-1.089	0.323*	0.104
LogPDL	0.957	0.481	0.931-0.983	-0.010-0.971	0.323*	0.105
LogDFL	0.843	0.587	0.807-0.879	-0.093-1.267	0.288	0.083
LogDFB	0.518	0.300	0.484-0.553	-0.350-0.950	0.159	0.025
LogPtFL	0.732	0.233	0.698-0.765	-0.390-0.855	0.129	0.017
LogPtFB=	0.129	0.236	0.092-0.166	-0.460-0.933	0.118	0.014
LogPvFL	0.416	0.184	0.385-0.446	-0.384-0.752	0.129	0.013
LogPvFB	-0.036	0.802	-0.073-0.000	0.124-1.481	0.381*	0.145
LogAFL	0.512	0.399	0.482-0.542	-0.161-0.960	0.241	0.058
LogAFB	0.343	0.657	0.302-0.384	-0.107-1.422	0.287	0.082
LogCFL	0.727	0.410	0.696-0.758	-0.174-0.993	0.238	0.056
LogCFB	0.373	0.649	0.340-0.407	0.014-1.284	0.335*	0.113
LogED	-0.359	0.611	-0.40--0.313	-0.261-1.484	0.237	0.056
LogBD	1.174	0.452	1.150-1.199	-0.006-0.910	0.325*	0.106
LogIOL	0.452	0.393	0.423-0.481	-0.152-0.938	0.244	0.059
LogGM	-0.083	0.244	-0.13- -0.030	-0.749-1.236	0.085	0.007
LogUJL	0.563	0.596	0.519-0.607	-0.227-1.420	0.245	0.060
LogLJL	0.447	1.109	0.402-0.492	0.268-1.950	0.418*	0.174
LogPrOL	0.275	0.820	0.241-0.308	0.197-1.442	0.417*	0.174
LogPOl	0.559	0.450	-0.521-0.597	-0.265-1.166	0.214*	0.046
LogMBL	0.476	0.659	0.440-0.512	-0.015-1.333	0.323*	0.104
LogHW	0.010	1.652	-0.086-0.106	-0.145-3.449	0.305	0.093
LogSW	0.735	1.448	0.629-0.841	-0.531-3.426	0.247	0.061
LogLW	0.339	1.686	0.227-0.452	-0.423-3.795	0.268	0.072
LogGL	1.181	0.189	1.124-1.237	-0.873-1.252	0.062	0.004

K = Condition Factor, (K) = $W/L^3 * 100$

CONCLUSION

The present study addressed the relationship of various morphometric parameters and condition factors of *Rita rita* in the Indus River, Dera Ghazi Khan, Punjab, Pakistan. Various external and internal morphometric characters were studied to comprehend their correlation with total length and wet body weight. The correlation coefficient (r) value of 0.974 was

highly significant ($P<0.001$) as a correlation between weight and total length. The relationship of total length with various morphometric parameters were determined by regression analysis which show that correlation of total length with all morphometric parameters was highly significant ($P<0.001$), except correlation with eye diameter and pre orbital length which is significant ($P<0.01$). Total length relationship with a gap of mouth and upper jaw length is non-significant ($P>0.05$). Wet body weight showed highly significant correlation with all studied morphometric characters ($P<0.001$), except for the pelvic fin base that shows significant relationship ($P<0.01$) and the post-orbital length showing the least significant relation ($P<0.05$). On the other hand, mouth gap and upper jaw length show non-significant relation ($P>0.05$).

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