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THE MORPHOMETRICS, GROWTH AND LENGTH-WEIGHT RELATIONSHIP OF HILSA SHAD (*TENUALOSA ILISHA*) IN THE DOWN STREAM KOTRI BARRAGE INDUS RIVER, PAKISTAN

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ABSTRACT

Morphological characteristics and Length-Weight relationship of Hilsa Shad (*Tenualosa ilisha)* from the Down Stream Kotri Barrage Indus River, Pakistan are examined. A total of 25 specimens (*T. ilisha)* were collected from August 2019 to September 2020 and found multiple dots in their bodies. These dots were varying to some extent; few specimens have no dots while others had 12 dots. The dots consist of black color that appeared very first time in Pakistan and has no history in the past. The merits are similar but morphometric characters, body length and weight were found to be different. The maximum and minimum weight and length were noted as 254±0.7g and 31±0.6g, 21.1±0.9cm and 15.5±0.8cm, respectively. Only three specimens were found without dots present in their body followed by four dots and nine dots, however, only two specimens categorized as two dots and twelve dots, five specimens with eight dots and seven specimens with single dot. The growth of fish was found higher in one dot specimens followed by four, eight and twelve dot specimens. Results also revealed that almost all specimens exhibited an isometric growth and the Length-weight relationship was significant with $r^2 \geq 0.910$ while no statistical ($P>0.05$) difference was found between female (A) and male fish (B). The Hilsa (*T.ilisha)* is a migratory fish from sea to river for breeding and spawning purpose but, unfortunately illegal fishing, local demand, environmental change and habitat destruction cause Hilsa fish to decline continuously in the Indus river of Pakistan. Therefore, it is recommended that stock assessment with genomic studies of Hilsa Shad will be taken to distinguish the actual number of species present in the Indus River of Pakistan.

1. INTRODUCTION

The tropical Hilsa shad (*Tenualosa ilisha*; Hamilton-Buchanan, 1822) belonging to the family Clupeidae is an anadromous, planktivore and euryhaline species and lives in pelagic and neritic waters (Riede 2004; Hossain et al. 2019, 2021). They are commonly found in many countries of Asia such as Bangladesh, Nepal, Sri Lanka, India, Pakistan, China, UAE, Myanmar, Iraq, Iran, Malaysia, Oman, Kuwait, Qatar, Saudi Arabia, Thailand and Vietnam (Freyhof, 2014; Hossain et al. 2021). This species is characterized as least concern in Asia countries mentioned in IUCN red list (Freyhof 2014) because they are the most commercially targeted species in freshwater bodies.

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The starting 1900s, Palla has been of great socio-economic interest, and was generally harvested in the river Indus, Shatt Al-Arab (southeastern Iraq), Meghna, Irrawaddy, Ganges, Brahmaputra, Mahananda, Godavari, Krishna, Cauvery, and Euphrate river (Jafri, 1988; Hamilton-Buchanan, 1822; BoBP, 1985, Date, 1878, BoBLME, 2012). In Pakistan, Hilsa is a well-known traditional native species of Sindh region. In 1984 the annual catch of hilsa (T. ilisha) was recorded high 5469 tons but it is gradually decrease from the last two decades about 146 tons recorded in 2004 (Department of Fisheries, Karachi). The biggest threat to the fishery is the low run of fresh water during migration to the Indus River (Jafri, et al., 1988). Adult shads reach 57 to 61 cm (Al-Baz & Grove 1995; Amin *et al*. 2004) and fully mature at 19-30 cm within 7 to 12 months reported in

Bangladesh, India and Kuwait (Jhingran & Natarajan 1969; Ramakrishnaiah, 1972; Halder, 2002; Mome & Arnason, 2008). Hilsa shad usually migrate to rivers from marine habitats for spawning and breeding purpose. They spend all their life in the sea except for breeding (Tint et al., 2019; Arai & Amalina, 2014; Blaber, 2000 AL-Baz & Grove, 1995; Pillay and Rosa, 1963). The period of hilsa migration for spawning is recorded differently in many countries such as February to March in Southeastern Iraq, May to June in Kuwait, October to November in Bangladesh, and February to July in Indus River (Hossain 1985, Al-Baz & Grove, 1995, Narejo et al. 2008, Bhaumik et. al, 2011; Al-Dubakel 2011; Hossain et al., 2021). Growth and morphological studies are very helpful to classify the particular type of species and bring attention to its meristic trait in the field of fisheries sciences (Bagenal & Tesch 1978; Hossain 2010, Hossen et al. 2018; Santic et al. 2018; Rahman et al. 2019, Islam et al. 2020; Hossain et al., 2021). In addition to its economic significance, there is incomplete information on stock testing of palla fish in Indus River, while significant research work has recently been available on the migration pattern (Jafri, 1988, Bhuiyan and Talbot, 1968), annual development of small gonads, natural reproduction, height, weight, age, feeding and growth (Panhwar et al., 2011). However, no studies have been covered the meristic features and length-weight relationships of this species found in the Indus River of Pakistan. Therefore, purpose of this study was to determine the morphological characteristics with length and weight measurements of Hilsa shad in the Down Stream Kotri Barrage Indus River, Pakistan.

2. MATERIALS AND METHODS

The Indus River in Sindh range with the major landing areas were selected for collection of fish samples (Figure 1).

Figure 1 Study site is the Kotri Barrage on the Indus River, Sindh, Pakistan.

Sampled were collected from Ghulam Muhammad Barrage /Kotri Barrage and Ketti Bunder of river Indus from August 2019 to September 2020 one-year period. Sampled were preserved in ice box and formalin and taken in laboratory for further identification. A total of six morphometric, determine (normal length, head length, fork length, total length, girth and eye width) and seven combined letters (precy pelvic scutes, anal fin radiation, rays of the dorsal fin, pectoral fin radiation, total number of scutes, pelvic fin radiation and post pelvic scircs) were selected for assessment. Although, TL (Total Length), FL (Fork Length), SL (Standard Length), HL (Head Length); SNL (Snout Length), ED (Eye diameter), DFL (Dorsal Fin Length), PFL (Pectoral Fin Length), VFL (Ventral Fin Length), AFL (Anal Fin Length), UCFL (Upper part of Caudal Fin Length), DCFL (Down part of Caudal Peduncle Length) and GR (Girth) were also measured showing figure 2.

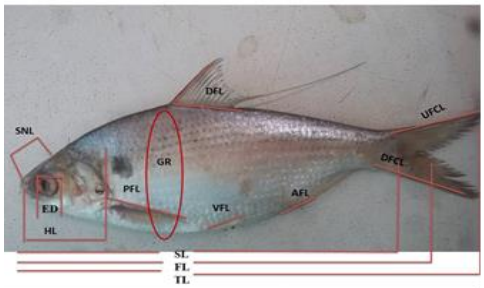

Figure 2 Shows thirteen morphometric measurements of Hilsa (*T. ilisha*) found *in Indus River, Sindh-Pakistan.*

All compliance calculations for morphometric measurements were performed by way of directed (Pillay et al., 1957). All grains were measured in millimeters nearby and measured in electric balance up to the nearest gram. The weight-bearing relationship with the condition of the related factor Kn is determined by the least square approaches as provided by Le Cren in 1951. The formula of length-weight relationship is $W = a\ L^b$. Generally, morphological characters that appear on the outside of the body of fish are used to identify the particular type of species (Figure 2). Countless numbers of fish are collectively referred to as morphometric characters and morphometric. These characters are superficial and very versatile and should be used with caution. Character letters have been widely used in fisheries biology to measure understanding and the relationship between the various tax categories. (Avsar, 1994, Corti et al., 1988; Villaluz et al., 1988).

3. RESULTS

The morphometric, length-weight relationship and meristic characteristic of Hilsa (*T.ilisha)* found in different areas of Indus River and specimen collected from August 2019 to September 2020. The body shape

of Hilsa Shad is fusiform and dorsoventrally compressed and the body colour is silver to light purple. The mouth is terminal in position and upper jaw with a distinct median notch is present (Figure 2). A total of 25 specimens of Hilsa (*T.ilisha)* were collected and found multiple dots in their bodies. These dots were varying to some extent; few of specimens have no dots while others had 12 dots in their bodies (Figure 3). The dots consist of black color that appeared very first time in Pakistan and has no history in past. The merits are similar but morphometric character, body length and weight found different. The maximum weight was 254 g and maximum length was 21 cm, minimum weight was 31 g and length were 15.5 cm respectively. Only three specimens were found whereas no dots were spotted in the body; the seven specimens were found which have single dot present. Two dots' specimens were found; three specimens presented four dots in sample. The five specimens were viewed eight dots whereas three specimens illustrated nine dots in body. The two specimens and twelve dots are present in the body. The high rate of weight was found in dots one, eight, four and twelve respectively.

During the year-round sampling, it was noticed that two separate populations of Hilsa, *T. ilisha* exist. To identify two different morphometric characters, one is spotted *T.ilisha* and the second without spotted *T .ilisha* we found. Table 2 described equation log (W) = log a + b log (L) (a: intercept and b: slope of the equation). N (sample size), Length (L) in cm- weight (W) in g. Minimum: (Min) and Maximum (Max) of L & W; SE is Standard error; CI (b): confidence intervals of b; r2: coefficient of determination, P is significance of regression with P significant at ≤ 0.05 relative condition factors (Kn) of the selected fish species with its range (Min-Max) and SE. t-test significance was conducted to verify if b is significantly different from the consensus b = 3. The growth behavior was deduced based on b. No statistical (P>0.05) difference was found between female and male fish, mentioned in Figure 5 & 6.

4. DISCUSSION

Hilsa (*Tenualosa ilisha)* was found in different areas of Indus River and specimen collected from August 2019 to September 2020. A total of 25 specimens of Hilsa (*T.ilisha)* were collected and found multiple dots in their bodies. These dots were varying to some extent; few of specimens have no dots while others had 12 dots in their bodies. The dots consist of black color that appeared very first time in Pakistan and has no history in past. The merits are similar but morphometric character, body length and weight found different. The maximum weight was 254g, maximum length was 21 cm, minimum weight was 31g and length was 15.5 cm respectively.

Figure 3. Photographs of Hilsa (*T. ilisha*) collected from Indus River, Sindh-Pakistan.

Only three specimens were found whereas no dots were spotted in the body; the seven specimens were found which have single dot present. Two dots' specimens were found; three specimens presented four dots in sample. The five specimens were viewed eight dots whereas three specimens illustrated nine dots in body. The two specimens and twelve dots are present in the body. The high rate of weight was found in dots one, eight, four and twelve respectively. On the basis of dots the further investigation in genome or chemical/ environmental effect on species (*T.ilisha)* or new species that found in genus *Tenualosa*. The previous research was a comparative study of two types of Hilsa (*T.ilisha)* in Kotri Barrage and Ketti Bunderat Indus River. Belong to type A and B intertype differences in six morphometric measurements (total length, standard length, fork length, head length, eye diameter and girth) and seven meristic characters (total number of scutes, pre pelvic scutes, post pelvic scutes, dorsal fin rays, pectoral fin rays, pelvic fin rays and anal fin rays). Length-weight relationship, condition factor values and GSI values were also different in summer and winter types of *T. ilisha* (N.T. Narejo, et al., 2008). The present research is initially in progress to further investigate different kinds of palla (*T.ilisha)* different kinds as well as other species in Indus River. Ongoing new species of genus *Tenualosa* is discovery or environment factor affecting Hilsa (*T.ilisha)* body as well as its growth.

Similarly, this research also illustrates low growth rate as compared to previous data was (57 cm) of Rahman et al., (1999) and Amin et al., (2002) in Bangladesh and Al-Baz & Grove (1995) in Kuwait (61 cm) of Amin et al., (2004), though Fish Base (Froese and Pauly, 2020) showed a maximum length of 60 cm. All other studies (Flura et al., 2015; Sarkar et al., 2017; Roomiani and Jamili, 2011; Bhakta et al., 2019; Mohanty and Nayak, 2017; Bhaumik et al., 2011) found the body length were greater than the current study. McConnel, et al., 1978 details on morphometric observation of fish and the learning of mathematical relationships between them are important for text work. In addition, to see the source of the stock, the classification of stocks or the identification of important commercial fish species, morphometric characters are regularly used (Godsil, et al., 1948; Schaffer, et al., 1948; Pillay, et al., 1957; Royce, et al., 1963; Kramholz and Cavanah, 1968). During the year sampling of the current research, it is known that the different people of the Hilsa, *T.ilisha* new were present in one.

On the basis of our findings, we suggest that it is necessary to take serious consideration to provide proper hilsa access to the Indus River during the breeding season, and to impose restrictions on fishing during the migration of the river and restrictions on sub-fishing for this traditional fishery. Due to the excessive exploitation and indiscriminate killing of Hilsa from inland waters especially from breeding areas (river harbor), the fishing area was severely depleted from previous years. The number of items responsible for this decrease includes:

- An obstacle to the migration of natural habitats due to the topography of the river
- Excessive fishing pressure at different stages of life
- River water pollution alters the natural boundaries of rivers
- Destruction of a dwelling.
- As a result, in order to preserve the Hilsa fishery it was necessary to develop a Hilsa Fishery Management Action Plan (HFMAP).

5. CONCLUSION

The Hilsa (*T.ilisha)* is a migratory fish from sea to river and its very tasty important fish in fisheries but due to environmental, over fishing and coastal or breeding ground destruction the Hilsa (*T.ilisha)* is decline our Indus River. This research supporting to identification differences in morphometric character and length-weight relationship all effect on species environmental as well as overfishing and also observing number of dots present in bodies and it varies. Further to investigate genomic studies to distinguish that Hilsa (*T.ilisha)* has two or more species or single species present in our Indus river.

6. CONFLICT OF INTEREST

All authors have declared that there is no conflict of interests regarding the publication of this article.

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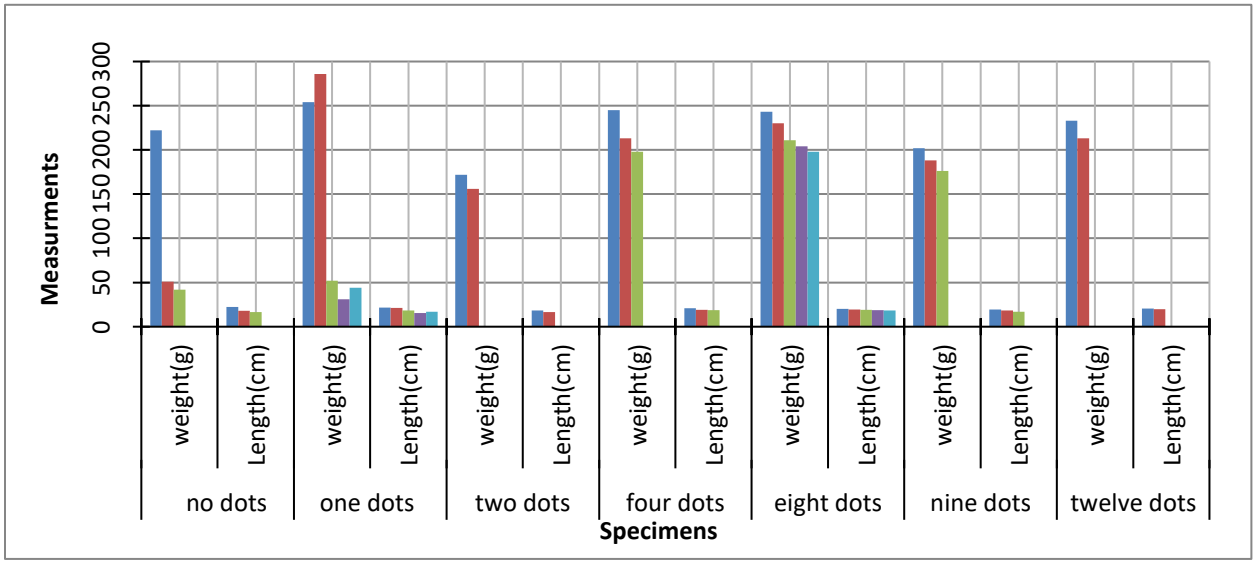

Figure 4. Graph showing the Length weight measurement of specimens *T. ilisha* collected from Indus River, Sindh, Pakistan

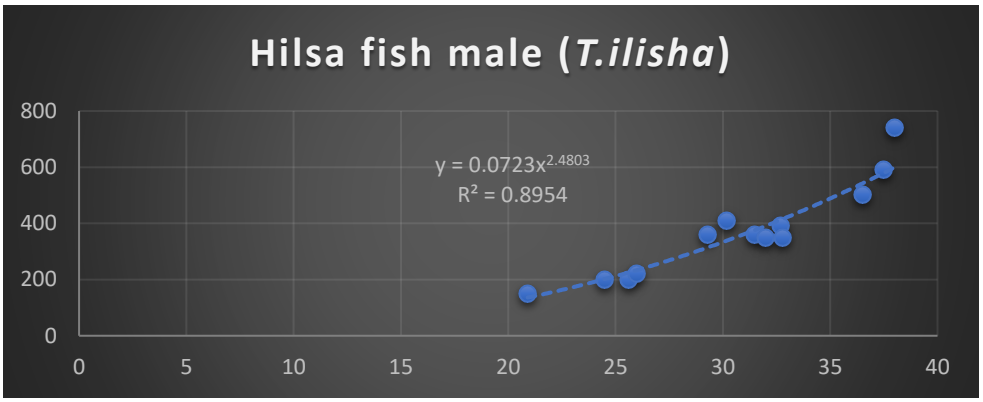

Figure 5. Regression analysis of Hilsa fish female.

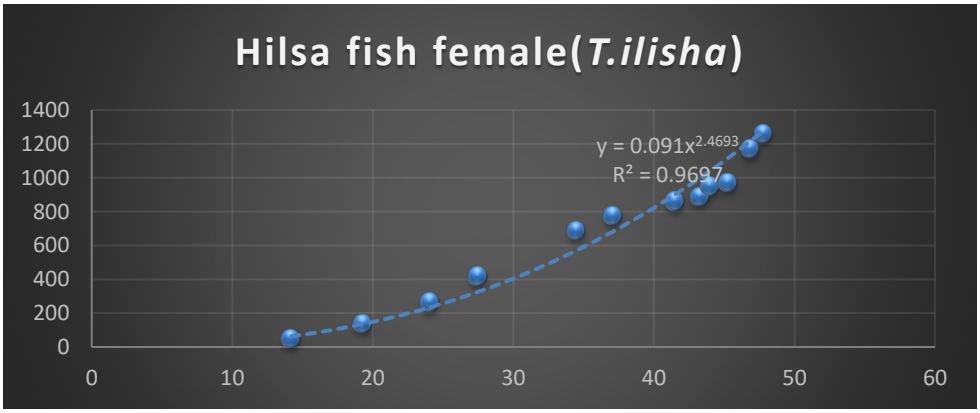

Figure 6. Regression analysis of Hilsa fish female.

Table 1. Morphometric analysis of Hilsa fish (*T. ilisha*).

S.N	WT(g)	TL(cm)	FL(cm)	SL(cm)	HL(cm)	HH(cm)	SnL(cm)	ED(cm)
One dot specimens								
1	150	20.9	18.4	17.5	4.9	3.5	0.9	1.1
2	200	24.5	18.2	16.9	4.2	4.5	0.9	1.2
3	200	25.6	16	15.1	4.3	4.2	0.9	0.9
4	220	26	13.2	12.6	3.7	3.1	0.7	0.8
5	360	29.3	14.5	13.9	4.2	3.8	0.8	0.8
6	410	30.2	13.3	12.9	3.9	3.7	0.7	0.9
7	360	31.5	14.3	13.6	4	3.8	0.9	0.8
Mean	271.4285714	26.85714286	15.41428571	14.64285714	4.171428571	3.8	0.828571429	0.928571429
Two dot specimens								
8	350	32	15.2	14.8	4.5	3.6	1	1.1
9	390	32.7	14.3	13.2	3.9	3.1	0.8	0.8
Mean	370	32.35	14.75	14	4.2	3.35	0.9	0.95
Four dot specimens								
10	500	36.5	17.3	16.3	5	5.3	1.2	1.1
11	590	37.5	16.8	15.1	4.5	4.8	1	1
12	50	36.5	16.4	14.9	4.1	4.2	1	1
Mean	380	36.83333333	16.83333	15.43333	4.533333	4.766667	1.066667	1.033333
Eight dot specimens								
13	243	20.2	16.9	14.9	5.2	5.3	1	1.1
14	230	19.4	16.6	14.7	5	5.1	1	1.1
15	139.2	19.3	16.4	14.4	4.8	4.9	1	1
16	265	24.1	16.1	14.2	4.4	4.6	1	0.9
17	416.3	27.5	15.8	14	4.1	4.5	1	0.8
Mean	258.7	22.1	16.36	14.44	4.7	4.88	1	0.98
Nine dot specimens								
18	686	34.5	16.5	15.7	5.1	5.1	1.2	1
19	775.5	37.1	16.2	15.3	5	5	1	1
20	860	41.5	15.9	15.1	4.9	4.7	0.9	0.8
Mean	773.8333333	37.7	16.2	15.36667	5	4.933333	1.033333	0.933333
Twelve dot specimens								
21	887	43.3	17.6	16.7	5	4.9	1.4	1.1
22	950	44	17.1	16.3	4.9	4.8	1.2	1
Mean	918.5	43.65	17.35	16.5	4.95	4.85	1.3	1.05
No dot specimens								
23	970	45.3	16.8	15.6	5.1	4.8	1.1	1
24	1170.2	46.9	15.6	15	4.1	4	0.8	1
25	1260	47.8	13.9	13.4	4	3.7	0.6	0.8
Mean	1133.4	46.66666667	15.43333	14.66667	4.4	4.166667	0.833333	0.933333

**WT represents weight gain; TL (total length); FL (fork length); SL (standard length); HL (Head Length); HH (head height); SnL (Snout Length); ED (Eye diameter).*

Table 2. Length-Weight relationship of Hilsa shad (*T. ilisha*).

Sex (Male &female)	Male	Female
N	13	12
L min-max (cm)	20.9-38	14.2-47.8
W min-max (g)	740-150	1260-50
a	0.07230942	0.109462
b	2.480301413	2.46932
SE (b)	0.391599728	0.391599728
Cl (b)	0.26216903	0.26216903
r^2	0.891903205	0.910437854
p	0.005326472	0.005326472
t-test sig	-3.543401943 Negative	-3.543401943 Negative
K (fulton's condition factor)	1.245334342	1.459104178