



Short Communication

Length-weight relationships of five migratory fish species from the Narmada estuary, Gujarat, India

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The present study estimated the Length-Weight Relationships (LWRs) of *Boleophthalmus dussumieri*, *Ilisha megaloptera*, *Aulopareia ocellata*, *Tenualosa ilisha*, and *Thryssa stenosoma*. The fish samples were collected from the estuarine stretch (72 km) of the river Narmada from November 2018 to December 2020 seasonally, using bag nets (10 mm cod-end mesh size), stake nets (5 – 10 mm mesh size), and stick traps (locally known as fanda). The value of exponent b for LWRs ranged from 2.641 to 3.546. This study presents the first reference on LWR for *T. stenosoma* and the first LWRs for three other species (*viz.*, *B. dussumieri*, *I. megaloptera*, and *A. ocellata*) in the Narmada estuary. Additionally, the study established a new maximum length record for *T. stenosoma*. The LWRs, along with other biological parameters of the respective species, serve as baseline information for the management and conservation of both migratory and local fishes.

[Keywords: Estuarine migrants, India, Length-weight relationships, Narmada estuary]

Introduction

River Narmada is one of the largest west-flowing rivers of India (1312 km), originating from Amarkantak under Shahdol District, Madhya Pradesh, and culminating in the Arabian Sea through the Gulf of Cambay in Gujarat¹. Construction of the dam adversely affected the fish diversity, along with overfishing, habitat degradation, pollution, etc., along the river Narmada²⁻⁵. For instance, a decline in the Indian shad, *Tenualosa ilisha*, has been reported from the Narmada estuary due to the construction of the Sardar Sarovar Dam⁵.

The Length-Weight Relationships (LWRs) for any fish species are very useful for conservation and management of the respective fisheries resources, along with environmental and fish biology and

population parameters⁶⁻¹⁶. The LWRs in fish serve many essential purposes, like estimating the weight corresponding to a given length as well as providing useful information on fish condition and stock structure, condition of a fish⁶, estimations of standing crop biomass when the length-frequency distribution is known, and use in stock assessment models^{17,18}. While LWRs are a significant aspect to examine in the context of fish and fisheries, this relationship has not been explored for many fish species within the Narmada estuarine system. The present study provided LWRs of five important migratory fishes from the Narmada estuary. For two of these species, such as *A. ocellata* and *T. stenosoma*, no corresponding data had yet been available in the FishBase database²⁰.

Materials and Methods

The fish specimens were collected on eight occasions, spanning the seasons from November 2018 to December 2020. Table 1 provides details on the collected fishes, the collection sites, the fishing gear used, and the Red List Status of the International Union for Conservation of Nature (IUCN). Local fishers primarily harvested the collected fish specimens using bag nets (10 mm cod-end mesh size), stake nets (5 – 10 mm), and stick traps (locally known as fanda). The collected fish samples from selected landing centres were transported in a plastic-insulated box after being preserved in ice, then brought to the laboratory. The fish specimens were identified with the standard taxonomic keys²¹⁻²³. The species identification characters, along with their fin formulas, are provided in Table S1. Taxonomic names of the species were assigned as per Fricke *et al.*²³ and Froese and Pauly¹⁹.

For the LWRs estimation, the Total Length (TL) of each individual was measured to the nearest 0.1 cm by using a digital slide calliper, and Body Weight (BW) was measured (accuracy: 0.01 g) by a digital balance. The LWRs were calculated separately for each specimen using the following equation: $W = aL^b$; where, W is the weight of the fish in g, L is the total length of the fish in cm, and a and b are the intercept and regression coefficient, respectively^{6,24}. The equation $W = aL^b$ was converted to a natural

Table 1 — Details of the studied species along with their families, site of collection, fishing gear used, IUCN red list status and habitat

Species	Family	Collection sites	Coordinates	Fishing gear	IUCN status	Habitat
<i>Boleophthalmus dussumieri</i>	Gobiidae	Bhadbhut/ Jageshwar	21°40'52" N, 72°50'42" E/ 21°40'19.63" N, 72°34'40.12" E	Bag net, stake net, stick-traps	LC (IUCN, 2017)	B+M
<i>Ilisha megaloptera</i>	Pristigasteridae	Bhadbhut,	21°40'52" N, 72°50'42" E	Bag net	LC (IUCN, 2017)	F+B+M
<i>Aulopareia ocellata</i>	Gobiidae	Bhadbhut,	21°40'52" N, 72°50'42" E	Bag net	LC (IUCN, 2018)	M
<i>Tenualosa ilisha</i>	Clupeidae	Bhadbhut,	21°40'52" N, 72°50'42" E	Bag net	LC (IUCN, 2013)	F+B+M
<i>Thryssa stenosoma</i>	Engraulidae	Bhadbhut,	21°40'52" N, 72°50'42" E	Bag net	DD (IUCN, 2017)	B+M

Abbreviations: F - Freshwater; B - Brackish; M - Marine; IUCN - International Union for Conservation of Nature; LC - Least Concern; and DD - Data Deficient

Table 2 — Descriptive statistics and estimated LWRs of five estuarine migrants collected from Narmada estuary, Gujarat, India

Species	N	TL (cm)			BW (g)		Regression parameters		95 % CL of <i>a</i>	95 % CL of <i>b</i>	<i>r</i> ²
		Min	Max	Max*	Min	Max	<i>a</i>	<i>b</i>			
<i>Boleophthalmus dussumieri</i> Valenciennes, 1837	77	6.9	18.3	18.7	1.71	22.03	0.0110	2.641	0.0080- 0.0150	2.518- 2.764	0.96
<i>Ilisha megaloptera</i> (Swainson 1839)	29	10.7	29.5	36.5 (SL)	8.5	178.12	0.0048	3.119	0.0037- 0.0063	3.029- 3.209	0.99
<i>Aulopareia ocellata</i> (Day 1873)	34	8.2	12.6	-	4.4	19.8	0.0038	3.373	0.0024- 0.0061	3.169- 3.576	0.97
<i>Tenualosa ilisha</i> (Hamilton 1822)	43	7.5	22.1	60 (SL)	2.03	106.25	0.0021	3.546	0.0016 0.0026	3.452- 3.641	0.99
<i>Thryssa stenosoma</i> Wongratana 1983	83	4.0	22.2	15 (SL)	0.31	59.13	0.0054	2.995	0.0046- 0.0062	2.926- 3.064	0.99

Abbreviations: N - Sample size; TL - Total Length; BW - Body Weight; *a* - Intercept; *b* - Slope; CL - Confidence Interval; *r*² - Coefficient of determination; Min - Minimum; Max - Maximum; Max* - Maximum reported length as per FishBase

logarithmic form as $\ln W = \ln a + b \ln SL$, and the parameters, *a* and *b* were calculated using regression analysis²⁵. The extreme outliers were excluded during the linear regression analysis. The statistical significance and 95 % Confidence Intervals (CLs) were estimated for the parameters of *a* and *b*, along with the coefficient of determination (*r*²).

Results and Discussion

Five species of estuarine migrants, namely, *Boleophthalmus dussumieri* Valenciennes, 1837; *Ilisha megaloptera* (Swainson 1839); *Aulopareia ocellata* (Day 1873); *Tenualosa ilisha* (Hamilton 1822); and *Thryssa stenosoma* Wongratana 1983, were studied for LWRs. These species belong to four different families. Table 2 provides detailed descriptive statistics on the sample size, length, and weight range; the 95 % Confidence Interval (CL) of *a* and *b* for LWR parameters; and the coefficient of

determination (*r*²). The value of exponent *b* ranged from 2.641 to 3.546, and the *r*² values ranged from 0.97 to 0.99, which was found highly significant ($p < 0.005$) (Fig. 1a – e).

The exponent value *b* usually lies between 2.5 and 3.5^(ref. 6), and the LWRs of four out of five studied species are within the expected range of *b*. The LWRs of *B. dussumieri*, *A. ocellata*, and *I. megaloptera* are newly reported from the study area, *i.e.*, the Narmada estuary, and for *T. stenosoma*, LWR is reported for the first time as per the record of FishBase²⁶ and any water bodies. While considering the growth pattern, three species (*I. megaloptera*, *A. ocellata* and *T. ilisha*) followed positive allometry ($b > 3$), one species (*B. dussumieri*) followed negative allometry ($b < 3$), and one species (*T. stenosoma*) had isometric growth ($b = 3$) (Table 2). In the present study, *b* value for *T. ilisha* was a little higher when

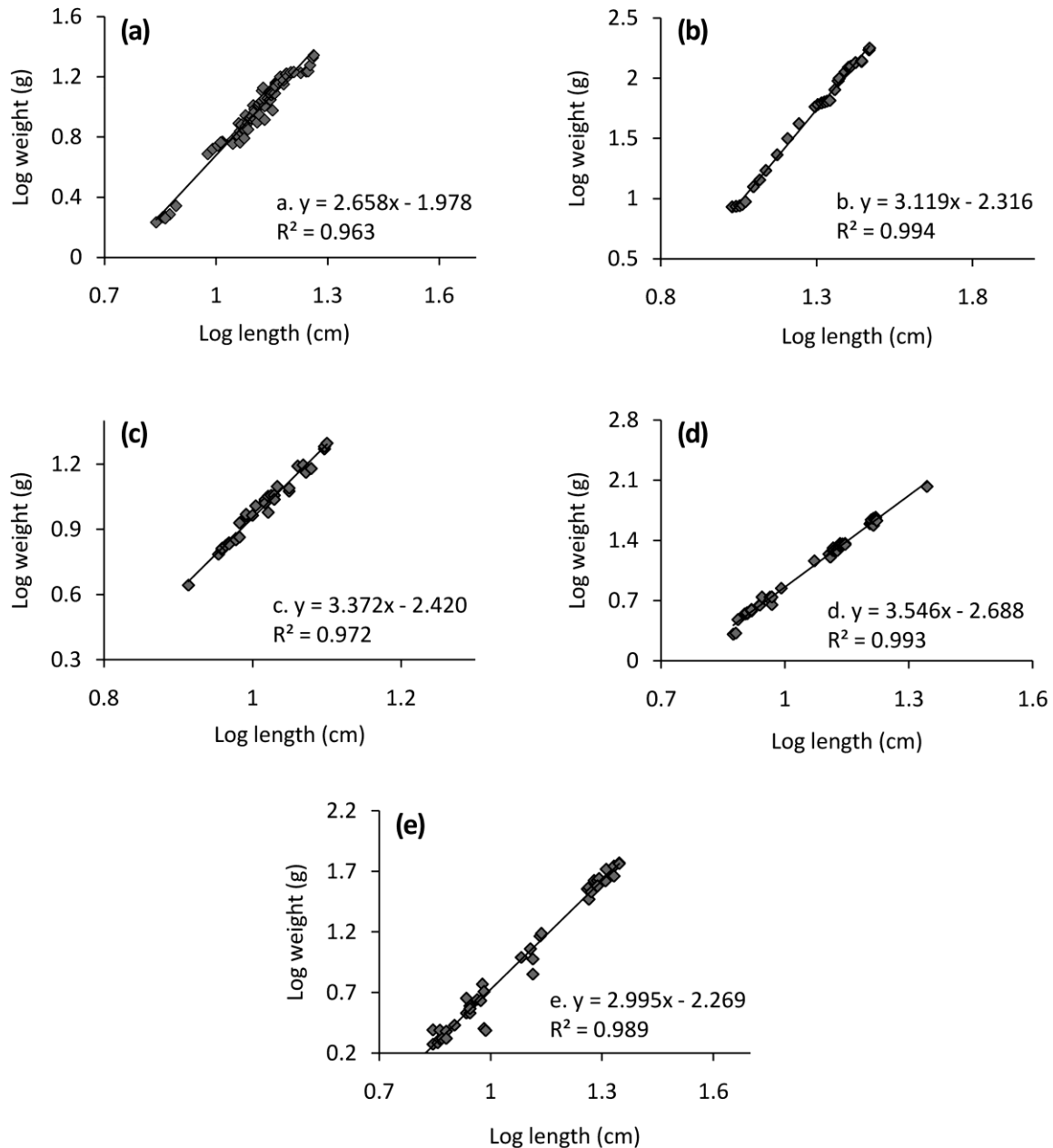


Fig. 1 — Logarithmic length-weight relationships (combined sexes) of a) *B. dussumieri*, b) *I. megaloptera*, c) *A. ocellata*, d) *T. ilisha*, and e) *T. stenosoma* collected from the Narmada estuary

compared with the study of Bhakta *et al.*¹⁶ in the same environment and Froese & Pauly²⁶, which may be due to the collection of smaller-sized specimens, fishing methods, seasonal changes, etc.²⁷. Table 3 provides a comparative study of those same species, recently conducted in different water bodies. The b value for *B. dussumieri* was within the range reported from previous studies, but the values for *I. megaloptera*, *A. ocellata*, and *T. ilisha* were slightly higher. This

variation might be due to a smaller sized sample, as the bag net (10 mm cod-end mesh size) used for sample collection is mostly used to catch small fishes. The present findings could serve as useful reference points for other closely related migratory fishes, for which information on LWRs is currently unavailable¹⁹. The study could further be advantageous for the overall management of fisheries in the respective estuarine ecosystems.

Table 3 — Comparison of length-weight relationships of *B. dussumieri*, *I. megaloptera*, *A. ocellata* and *T. ilisha* from different water bodies

Species	Sample size	Sex	Intercept (a)	Slope (b)	Correlation coefficient (r^2)	Location	Reference
<i>Boleophthalmus dussumieri</i>	59	Pooled	0.0002	2.34	0.93	Persian Gulf, Iran	Abdoli <i>et al.</i> ²⁸
<i>B. dussumieri</i>	86	Pooled	0.0373	2.330	0.93	Helleh, Persian Gulf	Ghanbarifardi <i>et al.</i> ²⁹
<i>B. dussumieri</i>	572	Pooled	0.027	2.40	0.87	Bay of Hormozgan province, Persian Gulf	Sharifian <i>et al.</i> ³⁰
<i>B. dussumieri</i>	268	Pooled	0.012	2.734	0.97	Parangipettai and Mumbai coast	Mahadevan <i>et al.</i> ³¹
<i>Ilisha megaloptera</i>	25	Pooled	0.0113	2.779	0.94	Indus delta, northern Arabian Sea	Hussain <i>et al.</i> ³²
<i>I. megaloptera</i>	708	Pooled	0.0219	2.68	0.96	Karachi Fish Harbour, Pakistan	Mahmood <i>et al.</i> ³³
<i>I. megaloptera</i>	38	Pooled	0.0063	3.04	0.94	Persian Gulf, Iran	Zare <i>et al.</i> ³⁴
<i>I. megaloptera</i>	172	Pooled	0.012	2.83	0.99	Northeastern Persian Gulf	Daliri <i>et al.</i> ³⁵
<i>I. megaloptera</i>	354	Pooled	0.031	2.546	0.87	Diamond Harbour, West Bengal	Mondal <i>et al.</i> ³⁶
<i>I. megaloptera</i>	30	Pooled	0.0205	2.85	0.98	Persian Gulf and Oman Sea	Mousavi-Sabet <i>et al.</i> ³⁷
<i>Aulopareis ocellata</i>	82	Male	0.000014	2.88	0.93	Malad creek, Mumbai	Panicker <i>et al.</i> ³⁸
	63	Female	0.00041	2.18	0.55		
<i>Tenualosa ilisha</i>				2.80		Hooghly estuary	Gupta ³⁹
<i>T. ilisha</i>	813	Pooled	0.00002	2.961	0.98	Hooghly Matlah estuary	De & Datta ⁴⁰
<i>T. ilisha</i>	1079	Pooled	0.0000064	3.11	0.93	Hooghly estuary	Bhaumik <i>et al.</i> ⁴¹
<i>T. ilisha</i>	550	Pooled	0.000006	3.109	0.99	Northern Bay of Bengal	Dutta <i>et al.</i> ⁴²
<i>T. ilisha</i>	245	Pooled	0.000021	2.817	0.89	Hooghly estuary	Sarkar <i>et al.</i> ⁹
<i>T. ilisha</i>	270		0.0000006	3.07	0.99	Narmada estuary	Bhakta <i>et al.</i> ¹⁶

Supplementary Data

Supplementary data associated with this article is available in the electronic form at [https://nopr.niscpr.res.in/jinfo/ijms/IJMS_54\(04\)207-212_SupplData.pdf](https://nopr.niscpr.res.in/jinfo/ijms/IJMS_54(04)207-212_SupplData.pdf)

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Conflict of Interest

The authors declare no conflicts of interest.

Ethical Statement

All applicable national and institutional guidelines for the care and use of animals were followed during this study. Fish specimens were collected from the

Narmada estuary with due permission from local authorities. No endangered or protected species were targeted or harmed. The study involved only non-invasive measurements (length and weight), and all efforts were made to ensure ethical sampling and handling of the organisms.

Author Contributions

DB: Specimen collection, manuscript writing; BKD: Conceptualization, editing; SPK: Data entry and analysis; SS: Data collections; GC, AP & SS: Review & editing.

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