Indian Journal of Geo Marine Sciences
Vol. 50 (03), March 2021, pp. 253-257

Short Communication

Estimation of morphometric relationships for flathead sillago, *Sillaginopsis panijus* (Hamilton, 1822) in the Bay of Bengal (Bangladesh) using multi-linear dimensions

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Received 29 November 2019; revised 16 October 2020

This study on flathead sillago, *Sillaginopsis panijus* (Hamilton 1822) estimates the first morphometric relationships from the marine ecosystem, Bay of Bengal, Bangladesh using multi-linear dimensions. Additionally, meristic counts for different fin-rays were done. Alltogether, 204 specimens were captured during July 2018 to June 2019 by several gears including seine net and long lines. Morphometric measurements as well as body weight (BW) were recorded for each individual. The LWRs (length-weight relationships) were assessed as: $W = a \times L^b$. Lateral line scales and fin rays were observed by magnifying glass. The LWRs and LLRs (length-length relationships) were found significant ($p < 0.0001$), with the r^2 values being ≥ 0.913 and ≥ 0.952, respectively. Based on r^2 values, LWRs by BW *vs.* SL and for LLRs, TL *vs.* FL were found as the best model. Fin formula observed for *S. panijus* is D_1 IX; D_2 I/24-28; P 17-20; P_v 1/5; A I-II/24-27; C 2/16-18. Scales on lateral line were ~82-86. This investigation should be helpful for resource management in the marine ecosystems of Bangladesh and other subtropical countries.

[**Keywords**: Length-length relationship, Length-weight relationship, Marine ecosystem, Meristics, *Sillaginopsis panijus*]

Introduction

The marine ecosystems of Bangladesh have major commercial fishery resources that play an important role in Bangladesh's economy[1-4]. The flathead sillago, *Sillaginopsis panijus* (Hamilton 1822), one of the most common fish species in its coastal and marine waters, belongs to the family Sillaginidae and order Perciformes[5,6]. It is properly known as *Hundra* or *Tular Dandi* in Bangladesh, *Tool-mach* or *Tool-danti* in India; and *Nga-palwe* in Myanmar. *S. panijus* is plentiful in the coastal rivers, estuaries, muddy bays, and marine habitats of Bangladesh[5,7,8]. This species has great survivability in adverse conditions and habitually migrates between the sea and freshwater (amphidromous). *S. panijus* is piscivorous but also forage on some algae[6]. It has great demand in native markets, and the juveniles are often used as ornamental fish. Consequently, a complete study is necessary to understand the population dynamics of the above mentioned species[9].

Morphometric study and meristic counts are considered the easiest and genuine approaches for taxonomic identification. Morphometrics is a term which describes body shape for measuring the length or distance among physical structures[10]. In contrast, meristics involves counting of fish body parts. Both traits play an important role for ecology, conservation, evolution, behavior, and stock assessment, including fish condition[11-13]. Morphometric and meristic investigation provides enhanced recognition of marine fish populations and labeling of spatial distributions[14].

There is some available literature on multivariate, morphometric relationships and fishery biology[9,15] of *S. panijus* (Table S1). But, there is no profound investigation covering various ("multi") linear dimensions for this species along the marine shore of Bangladesh. Information on morphometric characteristics of *S. panijus* is essential to manage this commercially important species. So, this investigation provides the informative and complete examination of morphometric traits, *i.e.*, LLRs, LWRs and meristic traits of *S. panijus* from the Bay of Bengal Sea.

Material and Methods

The study was carried out in marine waters, *i.e.*, the Bay of Bengal, Bangladesh from July 2018 to June 2019. Altogether, 204 individuals of *S. panijus* were captured using multiple gears including seine net and long lines. The morphometric and meristic traits were computed in the laboratory. Body weight (BW) was measured with electric balance to the nearest 0.01 g. Furthermore, several linear dimensions *i.e.*, total length (TL); fork length (FL); standard length (SL); head length (HL); etc. (Fig. S1) were measured to the nearest 0.01 cm. Besides fin rays, lateral line scales were also counted with the help of magnifying glass.

Length and body weight relationships were determined as $W = a \times L^b$, where, W is the BW and L designates several lengths (e.g., TL, FL, HL, etc.). Moreover, 95 % confidence limits (CLs) of a and b and the co-efficient of determination (r^2) were calculated from these analyses. Also, t-tests were implemented for verifying if b values are significantly different from the isometric value ($b = 3$)[16]. For both LWR and LLR analyses, the best model had the highest r^2 value.

Results

Body shape of *S. panijus* was elongated with a depressed head and snout. Two dorsal fins were present and the second spine of the first dorsal fin was very elongated and filamentous. Eyes were small and almost covered by fleshy orbits. The caudal fin is forked. Body colour is greenish yellow on the dorsum and pale to whitish below. Fins are pale brownish with light dustings of black spots (Fig. 1).

TL varied from 8.5-37.2 cm (19.75±6.25 cm) and BW ranged from 6.46-285 g (56.58±59.24 g) (Table 1). Regression parameters with 95 % confidence intervals and r^2 values for LWRs of *S. panijus* are presented in Table 2. Based on r^2 values, BW *vs.* SL was found as the best-fitting model among 14 equations. The LLRs are shown in Table 3, and all relationships analyses are found to be highly correlated ($p < 0.0001$). Based on r^2 values, TL *vs.* FL was observed as the best-fitting model among 13 equations.

Both spiny and soft fin rays characterized this species (Fig. 1). The fin formulas observed is First Dorsal, D_1 IX; Second Dorsal, D_2 I/24-28; Pectoral, P 17-20; Pelvic P_v 1/5; Anal, A I-II/24-27, and Caudal, C 2/16-18. The lateral line contained 82-86 scales.

Discussion

Until this study, description of the morphometric and meristic traits using multi-linear dimensions was

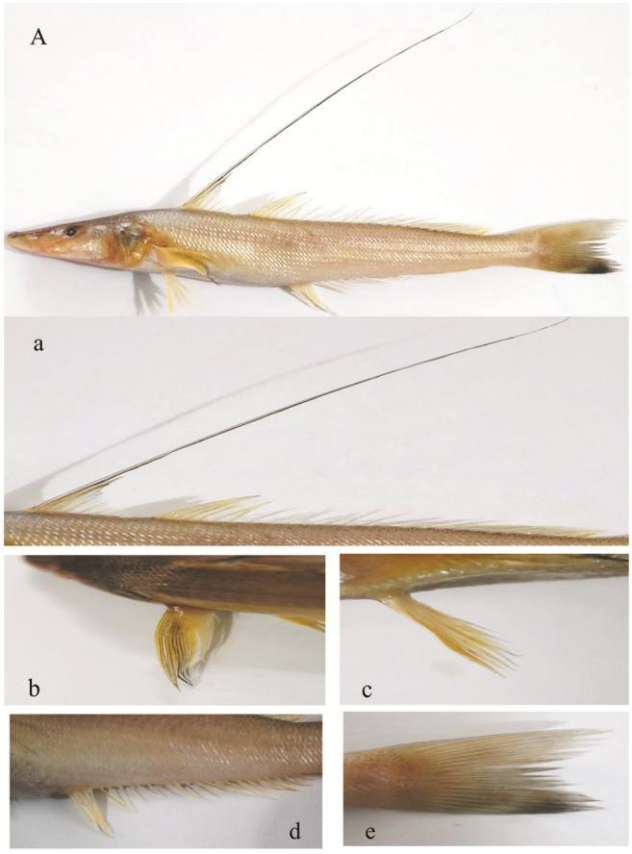

Fig. 1 — *Sillaginopsis panijus* from the Bay of Bengal, Bangladesh: A) complete specimen; a) dorsal, b) pectoral, c) pelvic, d) anal, and e) caudal fin

Table 1 — Morphometric measurements of *Sillaginopsis panijus* (n = 204) captured from the Bay of Bengal, Bangladesh

Measurements	Min (cm)	Max (cm)	Mode (cm)	Mean ± SD	95% CL	% TL
TL (Total length)	8.5	37.2	16.3	19.75 ± 6.25	18.88 - 20.61	-
FL (Fork length)	8.3	35.5	13.2	18.99 ± 5.89	18.17 - 19.80	95.43
SL (Standard length)	8.0	32.8	13.7	16.87 ± 5.39	16.12 - 17.61	88.17
HL (Head length)	2.2	9.0	3.4	4.84 ± 1.48	4.63 - 5.04	24.19
$PrDL_1$ (Pre-dorsal length)	2.5	11.0	3.7	5.44 ± 1.86	5.70 - 5.18	29.56
$PrDL_2$ (Pre-dorsal length)	3.2	14.2	4.3	7.44 ± 2.50	7.09 - 7.78	38.17
$PoDL_1$ (Post-dorsal length)	3.6	14.7	6.0	7.63 ± 2.56	7.27 - 7.98	39.51
$PoDL_2$ (Post-dorsal length)	7.0	28.8	12.1	14.99 ± 4.83	14.33 - 15.66	77.41
PcL (Pectoral length)	2.3	10.1	4.2	5.13 ± 1.68	4.89 - 5.36	27.15
PvL (Pelvic length)	2.4	10.5	4.5	5.45 ± 1.72	5.21 - 5.69	28.22
AnsL (Anus length)	3.4	15.7	7.0	8.65 ± 2.93	8.24 - 9.05	42.20
PrAnL (Pre-anal length)	4.4	18.5	7.2	9.14 ± 3.07	8.72 - 9.571	4973.
PoAnL (Post-anal length)	7.2	29.6	12.5	14.89 ± 4.55	14.27 - 15.52	79.56
GrL (Girth length)	3.1	14.0	5.8	7.12 ± 2.34	6.80 - 7.45	37.84
BW (Body weight)*	6.46	285.0	8.49	56.58 ± 59.24	48.39 - 64.75	-

Table 2 — Descriptive statistics and estimated parameters of the length-weight relationships for *Sillaginopsis panijus* captured from the Bay of Bengal, Bangladesh

Equation	Regression parameter		95% CL of *a*	95% CL of *b*	r^2
	a	*b*			
$BW = a \times TL^b$	0.0062	2.96	0.0048 to 0.0079	2.87 to 3.04	0.957
$BW = a \times FL^b$	0.0056	3.03	0.0043 to 0 .0073	2.93 to 3.12	0.956
$BW = a \times SL^b$	0.0103	2.94	0.0080 to 0.0132	2.85 to 3.03	0.976
$BW = a \times HL^b$	0.3396	3.05	0.2843 to 0 .4056	2.93 to 3.16	0.932
$BW = a \times PrDL_1^b$	0.3911	2.76	0.3361 to 0.4551	2.67 to 2.85	0.947
$BW = a \times PrDL_2^b$	0.1702	2.74	0.1387 to 0.2088	2.64 to 3.84	0.931
$BW = a \times PoDL_1^b$	0.1345	2.83	0.1109 to 0.1631	2.73 to 2.92	0.943
$BW = a \times PoDL_2^b$	0.0150	2.93	0.0119 to 0.0191	2.84 to 3.02	0.955
$BW = a \times PcL^b$	0.4058	2.84	0.3442 to 0.4785	2.73 to 2.94	0.937
$BW = a \times PvL^b$	0.3152	2.88	0.2565 to 0.3874	2.76 to 3.00	0.913
$BW = a \times AnsL^b$	0.1202	2.72	0.0981 to 0.1471	2.62 to 2.81	0.940
$BW = a \times PrAnL^b$	0.0775	2.85	0.0646 to 0.0929	2.76 to 2.93	0.957
$BW = a \times PoAnL^b$	0.0140	2.96	0.0103 to 0.0189	2.85 to 3.07	0.928
$BW = a \times GrL^b$	0.1309	2.93	0.1065 to 0.1609	2.82 to 3.03	0.936

a and *b* are LWR parameters; CL - confidence limit; and r^2 - coefficient of determination

Table 3 — The estimated parameters of the length-length relationships ($y = a+b \times x$) for *Sillaginopsis panijus* captured from the Bay of Bengal, Bangladesh

Equation	Regression parameters		95% CL of *a*	95% CL of *b*	r^2
	a	*b*			
$TL = a+b \times FL$	-0.3915	1.06	-0.5217 to -0.2614	1.05 to 1.07	0.998
$TL = a+b \times SL$	0.2610	1.15	0. 0273 to 0.4947	1.14 to 1.17	0.993
$TL = a+b \times HL$	-0.4202	4.16	-0.8583 to 0.0179	4.08 to 4.25	0.978
$TL = a+b \times PrDL_1$	1.6774	3.32	1.2822 to 2.0726	3.25 to 3.39	0.978
$TL = a+b \times PrDL_2$	1.3730	2.46	0.9457 to 1.8003	2.41 to 2.52	0.975
$TL = a+b \times PoDL_1$	1.3080	2.41	0.9326 to 1.6834	2.37 to 2.46	0.981
$TL = a+b \times PoDL_2$	0.3932	1.29	0.1639 to 0.6225	1.28 to 1.31	0.993
$TL = a+b \times PcL$	0.9646	3.66	0.5438 to 1.3854	3.58 to 3.74	0.977
$TL = a+b \times PvL$	0.2071	3.58	-0.2281 to 0.6423	3.51 to 3.66	0.977
$TL = a+b \times AnsL$	1.5072	2.10	1.1311 to 1.8833	2.07 to 2.15	0.980
$TL = a+b \times PrAnL$	1.2261	2.02	0.9285 to 1.5237	1.99 to 2.06	0.988
$TL = a+b \times PoAnL$	-0.2219	1.34	-0.8697 to 0.4258	1.30 to 1.38	0.952
$TL = a+b \times GrL$	1.0663	2.60	0.5407 to 1.5920	2.54 to 2.67	0.964

a - intercept; *b* - slope; CL - confidence limit; and r^2 - co-efficient of determination

absent for *S. panijus* in the Bay of Bengal, Bangladesh, though some research works are available on fishery biology, stock structure, and length-weight relationships from the Tentulia, Meghna, and Baleswar rivers of Bangladesh[9,15]. So this is the first detailed and informative morphologic study of *S. panijus* from the marine waters of Bangladesh.

Our study on *S. panijus* assessed several body sizes. But the absence of fish smaller than 8.5 cm TL may reflect choice of fishing gear or location. The maximum length (TL) recorded was 37.2 cm, which is noticeably larger than from our past Tentulia river study (34.0 cm TL)[17] and that of Siddik *et al*.[9] in the Tentulia, Meghna, and Baleswar rivers (29.30, 28.7, and 27.7 cm TL, respectively)[9,15]. Information about maximum length is crucial to anticipate growth parameters and is also important for unit stock to estimate sexual maturity and resource management for fisheries[17,18].

The *b* values of LWRs typically range between 2.5 to 3.5 for fish studies in south Asia[18,19], as found in the current study. Generally, *b* values near 3 indicate that fish growth is isometric, else growth is allometric (> 3 indicates positive allometry and < 3 indicates negative allometry)[20]. Here, *S. panijus* showed

negative allometric growth as *b* values were generally less than 3, except for BW *vs.* FL and BW *vs.* SL. A previous study found positive allometric growth (b = 3.3) in the Tentulia river of Bangladesh[17]. However, *b* values may vary for a fish species based on preservation method, habitat, physiology, growth variations in body parts, gonadal maturation, stomach fullness, feeding habit, gender and season[17,20-23], which were not assessed in the present study. In our study, LLRs were extremely significant ($p < 0.0001$).

The observed fin formula in the present study (D_1 IX; D_2 I/24-28; $P_.$17-20; $P_{v.}$1/5; A I-II/24-27; C 2/16-18), is quite similar to the results of Rahman[5] except for caudal fin (D_1 IX; D_2 1/26-27; $P_.$23-24; $P_{v.}$1/5; A I-II/25-26; C II/25-26) and Habib *et al*.[24] (D_1 X; D_2 I/28; $P_.$23; $P_{v.}$1/5; A II/26), but dissimilar to the findings of Talwar & Jingran[25] (D X+I 26-27; A II 24-26; P 24; $P_{v.}$ I 5). The lateral-line scale counts (82-86) were somewhat similar to those of Talwar & Jingran[25] (84-88), but dissimilar to the results of McKay[26] (84-90) and Rahman[5] (90-93).

The current study focused on the standard ichthyological studies, *i.e.*, morphometric features and meristic counts, which may help improve the management of *S. panijus* populations in marine ecosystems, including the Bay of Bengal and in other subtropical countries.

Supplementary Data

Supplementary data associated with this article is available in the electronic form at http://nopr.niscair.res.in/jinfo/ijms/IJMS_50(03)253-257_SupplData.pdf

Acknowledgements

The authors would like to express their faithful gratitude to PIU-BARC, NATP-2, Sub-Project ID: 156 for funding. R. L. Vadas Jr. critically reviewed the draft manuscript.

Conflict of Interest

The authors declare that they have no conflict of interest for this study.

Author Contributions

WS & MYH: Conceived the concept. MAI & MNK: Collected and analyzed the data. MRH & ZM: Software analysis. FAR, ST & MAR: Wrote and edited the manuscript.

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