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Length-weight relationships of ten tropical finfish species from north eastern Arabian Sea, India

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Summary

The length weight relationships (LWRs) of ten tropical finfish species from north eastern Arabian Sea, India were studied. Specimens were caught using a wide range of fishing gear mainly trawl nets (20–25 mm), *dol* nets or bag nets (20–40 mm) and gill nets (80–270 mm) operated in Maharashtra maritime waters during 2012–2016. The specimens were measured for total length, and weight, then dissected and the sex confirmed. Previously unavailable in FishBase, the detailed LWR of *Polydactylus mullani* is reported for the first time. Maximum total lengths presented for six species in this study are new records. The existence of a differential growth between male and female was confirmed for five species, which was not known earlier. The LWR data will be useful for deriving future sustainable management and conservation strategies.

1 | INTRODUCTION

Maharashtra state in India along north eastern Arabian Sea has 720 km long coastline stretched across six maritime districts viz., Palghar, Thane, Greater Mumbai, Raigad, Ratnagiri and Sindhudurg. With an average annual marine fish landings of 3.16 lakh t during 2012–16, Maharashtra is one of the major marine fish producing states ranking 6th in the country after Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and Gujarat (CMFRI, 2016). The annual marine fishery potential of the State in the Exclusive Economic Zone (EEZ) is estimated at 6.5 lakh t while the long term potential yield (LTPY) based on the maximum annual landings up to 90 m depth during 2001–2010 is estimated at 5.2 lakh t (CMFRI, 2010a). There are 17,362 crafts in the fishery of which 13,016 were mechanized, 1,563 motorized and non-motorized (2,783). This maritime State with 456 marine fishing villages and 152 fish landing centres supports the livelihood of more than 0.38 million fisher folk (CMFRI, 2010b). The fisheries sector share is 0.3% of the Gross domestic product (GDP) of State. India has exported 9,45,892 MT of seafood worth US$ 4.7 billion during 2015–16, compared to previous year 10.02% quantity of seafood was less (MPEDA, 2016). Hence, updated information on the fish stocks is of utmost importance to manage fishery resources in a manner that is ecologically sustainable and yet economically viable and socially acceptable.

The fishery of Sciaenids, Threadfin breams, Catfishes, Pomfrets, Carangids, Groupers, Lizard fishes, Threadfins, Flat fishes, False trevally, and Goat fishes are mainstay in the total fish production of the State, invariably contributing 9.0%, 4.4%, 4.1%, 2.3%, 0.95%, 0.9%, 0.83%, 0.5%, 0.26%, and 0.35% respectively (CMFRI, 2016). These groups have been and continue to be exploited by a wide range of traditional and mechanized fishing gears in the State.

Length-weight relationships (LWRs) parameters (*a*, *b*) are important for fishery stock assessments and populations (Ricker, 1968), allows the conversion of length into weight and vice versa (Le Cren, 1951), indicators to ascertain the status of fish, such as their nutrition, reproduction and health (Park et al., 2016) and also LWRs allows biometric

TABLE 1 Length- weight relationships for ten tropical finfish species sampled during 2012 –2016 from north eastern Arabian Sea, India

Family/Species	Sex	*N*	TL range (cm)	BW range (g)	Regression parameters					
					a	95% CL of *a*	*b*	95% CL of *b*	SE (*b*)	r^2
Scieanidae										
Protonibea diacanthus	M	391	20.3–40.2	75.0–629	0.008049	0.0066–0.0099	3.1	3.00–3.12	0.031	.987
	F	493	19.8–165	71.0–22,900	0.008808	0.0058–0.0134	3.0	2.92–3.15	0.056	.991
	C	884	19.8 –165	71.0–22,900	0.008049	0.0066–0.0099	3.1	3.00–3.12	0.031	.991
Otolithoides biauritus	M	289	17.9–143.5	35.0–14,180	0.005969	0.0051–0.0070	3.0	2.98–3.07	0.023	.991
	F	273	12.5–117.0	66.0–8,500	0.008416	0.0076–0.0093	2.9	2.89–2.95	0.013	.996
	C	562	12.5–143.5	35.0–14,180	0.009158	0.0085–0.0099	2.9	2.88–2.92	0.010	.994
Cynoglossidae										
Cynoglossus arel	M	570	16.3–31.8	14.0–169	0.000618	0.0005–0.0008	3.6	3.54–3.70	0.040	.974
	F	555	17.9–36.3	21.0–192.6	0.001933	0.0016–0.0024	3.3	3.19–3.31	0.033	.963
	C	1,125	16.3–36.3	14.0–192.6	0.001270	0.0011– 0.0015	3.4	3.33–3.44	0.026	.966
Serranidae										
Epinephelus diacanthus	M	208	16.6–39.5	69.0–832	0.032377	0.0246–0.0426	2.7	2.64–2.81	0.044	.949
	F	1,002	12.0–41.9	21.0–957	0.014946	0.0135–0.0166	3.0	2.94–3.13	0.017	.969
	C	1,210	16.6–41.9	21.0–957	0.016172	0.0147–0.0178	2.9	2.92–2.98	0.016	.967
Ariidae										
Osteogeneiosus militaris	**M**	**582**	**16.6–43.0**	**36.0–695**	**0.010550**	**0.0087–0.0128**	**2.9**	**2.89–3.00**	**0.029**	**.950**
	F	**478**	**17.7–48.5**	**45.0–825**	**0.010570**	**0.0087–0.0128**	**2.9**	**2.89–3.00**	**0.028**	**.959**
	C	**1,060**	**16.6–48.5**	**36.0–825**	**0.010115**	**0.0089–0.0115**	**3.0**	**2.92–3.16**	**0.019**	**.961**
Nemapteryx caelata	M	236	28.3–48.3	227–1,258	0.001769	0.0008–0.0040	3.5	3.28–3.73	0.110	.967
	F	225	18.0–48.5	475–1,500	0.000724	0.0002–0.0034	3.8	3.34–4.17	0.199	.942
	C	461	18.0–48.5	227–1,500	0.001413	0.0007–0.0028	3.6	3.39–3.75	0.091	.964
Plicofollis tenuispinis	**M**	**203**	**21.0–49.2**	**111–1,300**	**0.017820**	**0.0140–0.0227**	**2.9**	**2.79–2.93**	**0.035**	**.974**
	F	**271**	**21.6–51.0**	**99.0–1,586**	**0.016667**	**0.0131–0.0212**	**2.9**	**2.81–2.95**	**0.034**	**.969**
	C	**474**	**21.0–51.0**	**99.0–1,586**	**0.017226**	**0.0146–0.0204**	**2.9**	**2.83–2.92**	**0.024**	**.972**
Nemipteridae										
Nemipterus randalli	**M**	**1,123**	**8.4–23.5**	**9.0–168**	**0.020414**	**0.0187–0.0223**	**2.9**	**2.82–2.88**	**0.016**	**.970**
	F	**410**	**10.4–24.1**	**18.0–173**	**0.019135**	**0.0164–0.0223**	**2.9**	**2.82–2.93**	**0.028**	**.964**
	C	**1,533**	**8.4–24.1**	**9.0–173**	**0.020086**	**0.0186–0.0217**	**2.9**	**2.80–2.86**	**0.014**	**.968**
Polynemidae										
Polydactylus mullani	**M**	**609**	**11.3–22.2**	**24.0–135**	**0.009556**	**0.0075–0.0122**	**3.0**	**2.96–3.14**	**0.044**	**.926**
	F	**279**	**12.1–28.5**	**26.0–248**	**0.013849**	**0.0104–0.0184**	**2.9**	**2.83–3.02**	**0.048**	**.960**
	C	**888**	**11.3–28.5**	**24.0–248**	**0.010723**	**0.0091–0.0126**	**3.0**	**2.95–3.07**	**0.029**	**.951**
Synodontidae										
Saurida tumbil	**M**	**548**	**11.3–45.5**	**21.0–761**	**0.008894**	**0.0072–0.0110**	**2.9**	**2.87–3.00**	**0.033**	**.944**
	F	**424**	**19.4–54.0**	**49.0–1,113**	**0.005789**	**0.0047–0.0072**	**3.1**	**3.13–3.23**	**0.032**	**.958**
	C	**972**	**11.3–54.0**	**21.0–1,113**	**0.007040**	**0.0061–0.0081**	**3.0**	**2.97–3.05**	**0.022**	**.955**

N, sample size; M, male; F, female; C, combined sex; TL, total lengths in cm; BW, body weight in g; *a* and *b*, parameters of length weight relationship; CL, confidence limit; SE (*b*), standard error of slope *b*; r^2, coefficient determination. Bold, maximum total lengths exceeding those in FISHBASE.

and morphological comparisons between different fish species in the same taxonomic group, or between fish populations from different regions or periods (Zhang et al., 2016), however, many fish species are still not available in FishBase (Froese & Pauly, 2017). Therefore, the present study presents the LWR of ten demersal finfish species from the north eastern Arabian Sea, India.

2 | MATERIAL AND METHODS

2.1 | Study area and sampling

Length and weight data for 5 years, weekly fish sampling was from the commercial catch at fish landing centres located around Mumbai, Maharashtra, India (Sassoon dock [18-54-42.43°N, 72-49-33.16°E], New Ferry Wharf [18-57-28.85°N, 72-51-02.73°E], Pachu bunder [19-21-2.88°N, 72-48-24.12°E], Satpati [19-43-30.75°N, 72-42-08.30°E]) during 2012–2016. Lengths and weights (whole wet body weight) were measured to the nearest 0.1 cm and 0.01 g, respectively using an electronic balance (Axpert, India). Measurement of total body length (TL) was used for fishes with different body shapes. Fishes were identified to species level and validated following FishBase (Froese & Pauly, 2016). Immediately thereafter labelled the plastic boxes containing different fishes in the ice at the ratio of 1:2 was transported to the laboratory where the specimens were dissected and the sex confirmed.

2.2 | Data analysis

The length-weight relationships of male, female and combined sex were established using linear regression analysis (least squares method). Parameters *a* and *b* of the length-weight relationships were estimated using the equation proposed by Le Cren (1951): $W = a \times L^b$. After logarithmic transformation of length and weight data, this equation may be expressed as: log W = log a + b log L.where, W is the weight of the fish in grams and L is the total length of the fish in cm, where a is the intercept of the regression curve (coefficient related to body form) and b is the regression coefficient (exponent indicating isometric growth; Froese, 2006).

3 | RESULTS

We sampled a total of 9,169 fish specimens representing ten species, ten genera and seven families and estimated LWR parameters along with the descriptive statistics are given in Table 1. Sample sizes ranged from 461 *N. caelata* individuals to 1,533 *N. randalli*. Coefficient of determination R^2 ranged from .951 for *P. mullani* to .994 for *P. diacanthus*. The *b* values ranged from 2.9 for *P. diacanthus*, *E. diacanthus*, *P. tenuispinis*, *N. randalli* to 3.6 for *N. caelata* and the mean value of *b* was 3.1 (Table 1). Values of parameter *b* remained within the expected range of $2.5 < b < 3.5$ (Froese, 2006), however, for *N. caelata* *b* was >3.5 and these parameters varied among species. Three species were following allometric growth $b > 3$ (the fish grows faster in weight than in length), four were $b < 3$ (the fish grows faster in length than in weight) and three were $b = 3$ (growth is isometric).

4 | DISCUSSION

Maximum total lengths of six of the species (*O. militaris*, *P. tenuispinis*, *N. caelata*, *N. randalli*, *P. mullani*, and *S. tumbil*) exceeded the FishBase data. The length range of *P. diacanthus*, *O. militaris*, *P. tenuispinis*, *E. diacanthus*, *P. mullani*, and *C. arel* had no previous record in FishBase. The *b* values for LWR estimates in the present study for *O. militaris*, *N. caelata*, *C. arel*, and *S. tumbil* are 3.0, 3.6, 3.4, and 3.0 and did not fall within the 95% confidence intervals of Bayesian predictions made for these four species, however, *N. randalli* (2.9) was within the range of Bayesian predictions made for this species following the method identified in FishBase (Froese & Pauly, 2017; Froese, Thorson, & Reyes, 2013) and for remaining five species (*P. diacanthus*, *O. militaris*, *P. tenuispinis*, *E. diacanthus*, *P. mullani*) Bayesian predictions not available. LWRs of *P. mullani* was not yet available in FishBase (Froese & Pauly, 2017) and present study represents the first reference on LWR of this species. The differential growth pattern between male and female for *P. diacanthus*, *C. arel*, *E. diacanthus*, *O. biauritus*, and *P. tenuispinis* was confirmed with separate LWR estimates, which were not known earlier. The new TLmax have been included in this study and thus the LWRs for *O. biauritus*, *O. militaris*, *N. caelata*, *P. tenuispinis*, *N. randalli*, and *S. tumbil* are reported in the paper. This study provides basic information on the LWRs of these commercial important demersal finfishes, which could be useful for sustainable management and for further biological research in the region.

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