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Length–weight relationships of six tropical fish species from Chilika Lagoon, India

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Summary

The length weight relationships (LWRs) of six tropical fish species from Chilika Lagoon, India were studied. Specimens were caught using a wide range of fishing gear operated in the lagoon from January to December 2014. The fresh specimens were measured for total length and weight, then dissected and the sex confirmed. Previously unavailable in FishBase, the detailed LWRs of *Daysciaena albida*, *Eleutheronema tetradactylum*, *Etroplus suratensis* and *Mystus gulio* are reported for the first time. Maximum total lengths reported for *Nematalosa nasus* and *Osteogeneiosus militaris* in this study are new records for these species. The existence of a differential growth between male and female *O. militaris* was confirmed, which was not known earlier.

1 | INTRODUCTION

Chilika, the largest brackishwater lagoon of Asia and a designated Ramsar site is located in the eastern part of India with a connection to the Bay of Bengal. The shallow lagoon harbours more than 317 finfish species, to claim the lagoon as one of the biodiversity hotspots in the tropics (Mohanty et al., 2015). This ecosystem supports the livelihood of more than 0.2 million rural poor (Mohapatra, Mohanty, Mohanty, Bhatta, & Das, 2007). The fisheries share is more than 71% of the economic value of the Chilika ecosystem (Kumar, 2003). The lake also supports the economy with earnings of about half a million US$ in foreign exchange through the export of fishes (Mohanty et al., 2008). Hence, updated information on the fish stocks is of utmost importance for the sustainable management of this ecosystem.

The fishery of *Daysciaena albida* (Cuvier, 1830), *Eleutheronema tetradactylum* (Shaw, 1804), *Etroplus suratensis* (Bloch, 1790), *Mystus gulio* (Hamilton, 1822), *Nematalosa nasus* (Bloch, 1795) and *Osteogeneiosus militaris* (Linnaeus, 1758) is a mainstay in the total fish production of the lagoon. These aforementioned species have been and continue to be exploited by a wide range of fishing gear in the Chilika Lagoon.

The length–weight relationship (LWR; Le Cren, 1951) allows the conversion of length into weight and vice versa, having many vital applications in fisheries management (Goncalves et al., 1996; Moutopoulos & Stergiou, 2002; Pauly, 1993). The present study establishes the LWRs of six tropical fish species for which either no or little information is available, e.g. *D. albida*, *E. tetradactylum*, *E. suratensis*, and *M. gulio* (Froese & Pauly, 2015), although there is some information on LWRs for *N. nasus* and *O. militaris* in FishBase. The species-specific LWRs with the recorded maximum lengths have not been reported elsewhere.

2 | MATERIALS AND METHODS

2.1 | Study area and sampling

Monthly fish sampling was from the commercial catch at fish landing centres located around Chilika (lat. 19°28′–19°54′ North; long. 85°05′–85°38′ East) from January to December 2014. Species identification was done immediately following Day (1986), Talwar and Jhingran (1991), and Rao (2009). The total length (TL) and body weight of randomly selected specimens were measured to the nearest 0.1 cm and to 0.01 g accuracy, respectively. Immediately thereafter fishes were preserved in 10% buffered formalin, labelled and packed in plastic boxes and 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 unsexed populations were established using linear regression analysis (least squares method). Parameters of the length–weight relationship were estimated using the equation proposed by Le Cren (1951):

$$W = aL^b$$

TABLE 1 Length–weight relationships for six tropical fish species from Chilika lagoon

					Regression parameters						Student's *t*-test		ANCOVA	
Species	Sex	*N*	TL range (cm)	BW range (g)	*a*	95% CL of *a*	*b*	95% CL of *b*	*SE* (*b*)	r^2	*t*-stat (*b*)	*p*-value	*F*-stat (*b*)	*p*-value
Daysciaena albida (Cuvier, 1830)	M	103	12.3–58	19–1,647	0.0118	0.0079–0.0176	2.95	2.823–3.067	0.061	.96	47.95	2.67E−71**		
	F	236	13.3–63	25–2,045	0.0099	0.0082–0.0119	3.01	2.954–3.063	0.027	.98	109.35	7.10E−203**	1.23	.27
	U	5,737	3.7–68.5	1–3,190	0.0078	0.0076–0.0079	3.06	3.051–3.067	0.004	.99	716.35	0**		
Eleutheronema tetradactylum (Shaw, 1804)	M	88	21.8–44.4	80–600.5	0.0072	0.0049–0.0106	3.02	2.908–3.134	0.057	.97	53.13	1.53261E−67**		
	F	69	22.5–53.6	86–1,405.2	0.006	0.0037–0.0097	3.08	2.941–3.217	0.069	.97	44.57	1.58098E−51**	0.42	.52
	U	1,662	7.1–61.3	2–1,719	0.007	0.0069–0.0077	3.01	2.987–3.025	0.009	.98	311.99	0**		
Etroplus suratensis (Bloch, 1790)	M	49	10.4–22.3	31–397	0.0278	0.0183–0.0422	2.98	2.833–3.129	0.073	.97	40.46	3.49E−38**		
	F	125	8.3–22	13–277	0.0241	0.0174–0.0334	3.03	2.911–3.144	0.059	.95	51.21	8.24E−85**	0.19	.67
	U	2,370	4.2–25.3	1–404	0.0229	0.0220–0.0239	3.05	3.036–3.068	0.008	.98	372.83	0**		
Mystus gulio (Hamilton, 1822)	M	66	9.4–17.7	6–65.09	0.0059	0.0033–0.0109	3.18	2.947–3.415	0.117	.92	27.18	7.33E−37**		
	F	212	9.2–21.5	8.31–108	0.0106	0.0074–0.0153	3.00	2.864–3.137	0.069	.90	43.24	1.60E−106**	1.47	.23
	U	341	8.5–21.5	6–108	0.0077	0.0059–0.0099	3.11	3.017–3.207	0.048	.92	64.44	2.80E−192**		
Nematalosa nasus (Bloch, 1795)	M	82	11.4–23.0	16–126	0.0145	0.0095–0.0223	2.87	2.711–3.023	0.078	.94	36.58	1.04E−51**		
	F	178	9.4–25.2	8–190	0.0106	0.0078–0.0144	2.99	2.875–3.096	0.056	.94	53.26	1.80E−110**	1.20	.27
	U	648	5.1–25.2	1–190	0.007	0.0066–0.0075	3.13	3.099–3.150	0.013	.99	241.09	0**		
Osteogeneiosus militaris (Linnaeus, 1758)	M	56	12.6–38.9	31–500	0.0202	0.0118–0.0347	2.73	2.569–2.897	0.082	.95	33.47	8.65E−38**		
	F	75	16.2–39.9	32–524	0.0073	0.0049–0.0107	3.04	2.927–3.157	0.058	.97	52.72	7.39E−60**	9.35	.003*
	U	183	12.6–39.9	16–524	0.0089	0.0070–0.0114	2.98	2.905–3.052	0.037	.97	79.78	5.70E−143**		

N, sample size; M, male; F, female; U, unsexed; TL, total lengths in cm; BW, body weight in g; *a* and *b*, parameters of length weight relationship; CL, confidence limits; *SE* (*b*), standard error of slope *b*; r^2, coefficient determination; *t*-stat (*b*), *t*-statistic of *b*; ANCOVA, analysis of covariance; *F*-stat (*b*), *F*-statistic of *b*; *p*-value, probability level.

*$p < .05$.

**$p < .001$.

After logarithmic transformation of length–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). To test the b value against the value of 3, Student's t-test was employed to predict any significant deviation (Snedecor & Cochran, 1967). The t-statistic was calculated as:

$$t = \frac{(b-3)}{\mathrm{Sb}}$$

where, Sb = Standard error of b = $\mathrm{Sb} = \sqrt{(1/(n-2)) \times [(\mathrm{Sy}/\mathrm{Sx})^2 - b^2]}$; Sx and Sy are the standard deviations of x and y, respectively. The t-value was compared with t-table value for (n−2) degrees of freedom. Analysis of covariance (ANCOVA) was performed to determine the difference between the b slopes of LWRs of males and females (Snedecor & Cochran, 1967).

3 | RESULTS

The number of samples measured, range of length and weight and length–weight parameters for each species are given in Table 1. Length–weight relationships were significant with coefficients of determination greater than .90. Estimated growth coefficients (b) for unsexed population for *D. albida*, *E. tetradactylum*, *E. suratensis*, *M. gulio*, *N. nasus* and *O. militaris* were 3.06, 3.01, 3.05, 3.11, 3.013 and 2.98, respectively. The t-statistics estimated for the coefficients (b) were highly significant ($p < .001$), indicating the existence of allometric growth in all species irrespective of their sexes. Differential growth in length–weights between males and females were significant ($p < .05$) only in *O. militaris*, with a higher slope (b) value for females (3.04) than for males (2.73).

4 | DISCUSSION

The maximum TL reported for *N. nasus* (25.2 cm) and *O. militaris* (39.9 cm) at present constitutes a new record, where the previous TL was reported in FishBase as 22.0 and 35.0 cm, respectively (Froese & Pauly, 2015). The b values reported for males, females and the total population of *N. nasus* were 2.61, 2.88 and 2.95 from Pakistan waters (Hussain, Paperno, & Khatoon, 2010), which appeared to be somewhat lower than the present estimates of 2.87, 2.99 and 3.13, respectively. However, the present b value (3.13) for the unsexed population was close to the Bayesian LWR prediction (3.04) made by Froese and Pauly (2015). LWRs of *D. albida*, *E. suratensis*, *E. tetradactylum* and *M. gulio* were not yet available in FishBase (Froese & Pauly, 2015). Hence, the present study represents the first reference on LWRs for these four species. The b values for LWR estimates in the present study for *D. albida*, *E. suratensis*, *E. tetradactylum* and *M. gulio* are 3.06, 3.05, 3.01 and 3.11, and within the range of Bayesian predictions made for these four species following the method identified in FishBase (Froese & Pauly, 2015; Froese, Thorson, & Reyes, 2013). The b value (2.94) for *O. militaris* reported from India (Froese & Pauly, 2015) was very close to the present estimate (2.98). However, the differential growth pattern between male and female for *O. militaris* was confirmed with separate LWR estimates, which were not known earlier. As there is no significant difference in growth between sexes among all five species (except *O. militaris*), the LWR parameters of the combined sample should be useful for further studies.

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