Length-weight relationships of three reef-associated fishes *Lutjanus gibbus, Pinjalo lewisi* and *Pristipomoides filamentosus* off Kochi, southwest coast of India

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Original Article

Abstract

Length-weight relationships (LWRs) of three reef-associated fishes belonging to the family Lutjanidae viz., *Lutjanus gibbus* (Forsskal, 1775), *Pinjalo lewisi* Randall, Allen & Anderson, 1987 and *Pristipomoides filamentosus* (Valenciennes, 1830), were estimated based on 548 samples collected from trawl net and hook and line fishery off Kochi, southwest coast of India. Sampling was done at Kochi (Lat. 09°56′327″N, Long. 76°15′764″E) and Munambam (Lat. 10°10′965″N, Long. 76°10′258″E) landing centers from May 2017 to November 2019. The estimated coefficient (b value) ranged from 2.597 (*P. lewisi*, N = 89) to 2.902 (*P. filamentosus*, N = 240). Coefficient of determination (r^2) ranged from 0.906 (*L. gibbus*) to 0.952 (*P. filamentosus*), indicating a strong functional LWRs that were highly significant (p <0.001). The study reports the new maximum total length (TL_{max}) for *P. lewisi* and also records first estimates of length-weight relationships for three major species of snappers from the region. The generated LWR parameters will be of great importance in evaluating the biological changes in fish stocks and for developing sustainable management measures for snappers in the southeastern Arabian Sea.

Keywords: length-weight relationships, snapper, reef-associated fishes, Southeastern Arabian Sea

Introduction

Snappers are one among the economically important groups of fishes along the southwest coast of India caught mainly by multiday trawlers and hook and lines operating in the rocky outgrowths and coral reef grounds having a wide depth range varying from 5-300 m. During 2018, the estimated landings of snappers in India were 11,668 t which constituted 3.17% to the total perch landing. Along Kerala coast, the estimated landing of snappers in 2018 was 9,75.9 t (CMFRI, 2019). Fifteen species of snappers were landed along the Kerala coast, of which, the crimson jobfish *Pristipomoides filamentosus* (Valenciennes, 1830) formed the dominant species. *P. filamentosus* along with the humpback red snapper *Lutjanus gibbus* (Forsskal, 1775) and slender pinjalo *Pinjalo lewisi* Randall, Allen and Anderson, 1987 together contributed 24.1% to the snapper landings of the region. They fetch good price owing to high demand in both the local and export markets.

The mathematical relationship between length and weight of fishes (LWR) is one of the practical reliable key for understanding their growth, maturity, reproduction, metamorphosis, survival, and the health status (Le Cren,

1951). Also, the LWRs of fishes is an important fishery management tool to understand fish population dynamics and growth patterns on fish stocks (Froese, 2006). They also play a significant role in comparing the morphological variations between different populations of the same species in different geographical regions (Goncalves *et al.*, 1997). The notable works in this direction on snappers along the Indian coast are by Rangarajan (1973), Oomen (1976), Premalatha (1989), Hamsa *et al.* (1994), Abdurahiman *et al.* (2004), Ramachandran *et al.* (2013), Pradeep (2018) and Velamala *et al.* (2019). The length-weight relationships of snappers are not well documented in the southeastern Arabian Sea except for a few reports (Oomen, 1976; Premalatha, 1989; Abdurahiman *et al.*, 2004 and Ramachandran *et al.*, 2013). However, there is little information on the LWRs of *L. gibbus*, *P. lewisi* and *P. filamentosus* off Kochi, southwest coast of India. The present study aims to provide information on LWRs of three species of snappers for the first time from the coast of Kerala along southwest coast of India.

Material and methods

L. gibbus (N = 219), *P. lewisi* (N = 89), and *P. filamentosus* (N =240) were sampled on a fortnightly basis from the commercial catch (trawl net and hook and line) during May 2017 to November 2019 at the two major landing centers (Cochin-Lat. 09°56′327′′N, Long. 76°15′764′′E) and Munambam-Lat. 10°10′965′′N, Long. 76°10′258′′E), of southwest coast of India. All the specimens (548) were sexed, length measured to the nearest 1 mm (total length, TL) and weighed to the nearest 0.1 g (weight, W). The LWRs were calculated using the equation: $W = aL^b$ where W is the total weight (g), L is the total length (cm) and; 'a' and 'b' are the regression coefficients (Froese, 2006). Prior to regression analysis, length and weight data of individual specimens were logarithmically transformed into log W = log a + b log L. To this modified LWR expression, the least-square fitting method was applied to generate regression coefficients and coefficient of determination (Garcia, 2010). Analysis of covariance (ANCOVA; Goldberg and Scheiner, 1993) was employed to test the statistical significance of differences between sexes. The Student's t-test (Zar, 1999) was used to predict any significant deviation in the isometric condition (b = 3 for LWR).

Results and discussion

The length range of *L. gibbus*, *P. lewisi*, and *P. filamentosus* in the samples collected from off Kochi, southwest coast of India were 17.5-48.5, 34-79.5 and 27.5-83.0 cm respectively and their size distribution is presented in Fig. 1-3. The estimated length-weight relationship parameters are presented in Table

1. In the present study, the value of LWR parameter 'b' for all the three species of snapper was found to be consistent and were within the expected range of 2.5 to 3.5 (Froese, 2006) which refers that their present growth status is quite well (Fig. 1). The study also reports the new maximum total
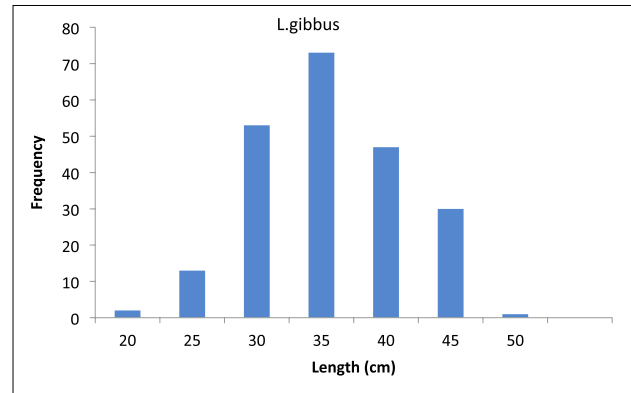

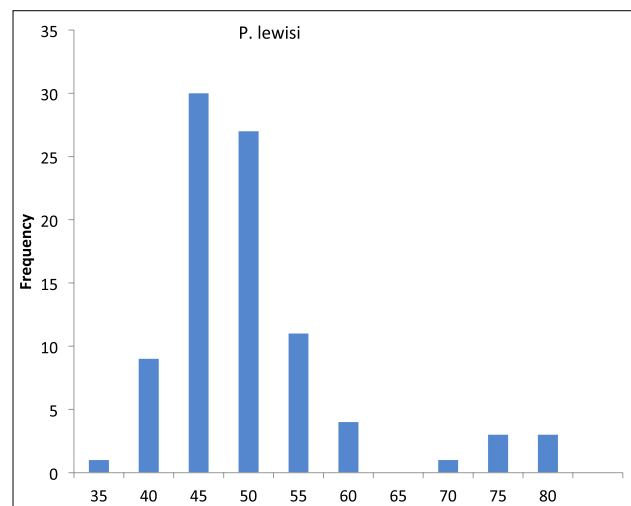Fig.1. Length frequency histogram for *L. gibbus* in the samples collected off Kochi, India

Fig. 2. Length frequency histogram for *P. lewisi* in the samples collected off Kochi, India
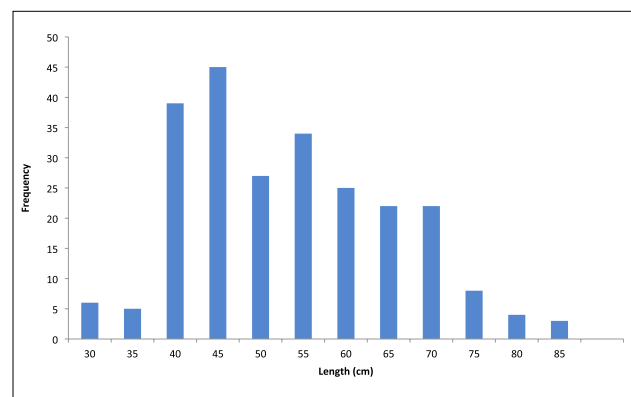

Fig. 3. Length frequency histogram for *P. filamentosus* in the samples collected off Kochi, India

Table 1. Descriptive statistics and estimated length-weight relationship parameters of three species of snappers sampled off Kochi, southwest coast of India from May 2017-November 2019

Species	Sex	N	Total length range (cm)	a	95% CI a	b	95% CI b	r^2	Relationship
Lutjanus gibbus	M	128	25.3-48.5	0.04496	0.02479-0.08154	2.68679	2.51804-2.85555	0.92972	Allometric
	F	91	17.5-42.2	0.03973	0.02223-0.07100	2.71616	2.54621-2.88611	0.95465	Allometric
	P	219	17.5-48.5	0.02878	0.01889-0.04384	2.79203	2.67152-2.91253	0.90575	Allometric
Pinjalo lewisi	M	46	34-79.5	0.07090	0.03799-0.13232	2.58313	2.42178-2.74448	0.958514	Allometric
	F	43	34.7-71	0.03841	0.01426-0.10345	2.73277	2.47345-2.99210	0.915025	Allometric
	P	89	34-79.5	0.06528	0.03791-0.11242	2.59738	2.45645-2.73831	0.939114	Allometric
Pristipomoides filamentosus	M	129	35.3-83	0.02593	0.01537-0.04377	2.78254	2.64369-2.92140	0.968235	Allometric
	F	111	27.5-55.7	0.01087	0.00731-0.01617	3.01338	2.90727-3.11949	0.987689	Isometric
	P	240	27.5-83	0.01517	0.01094-0.02105	2.90289	2.81927-2.98650	0.951583	Allometric

M: male; F; Females; P: male and female pooled; N: number of specimen studied; a: intercept of relationship; b: slope of relationship; CI: confidence interval; r^2: coefficient of determination.

length (TL_{max}) for *P. lewisi* (Table 1) than that reported in FishBase (Froese and Pauly, 2019). Linear regression was highly significant (p < 0.001) with r^2 values ranging from 0.906 (*L. gibbus*, both sexes pooled) to 0.988 (*P. filamentosus*, female). The estimated allometric coefficient 'b' ranged from 2.583 (*P. lewisi,* male) to 3.013 (*P. filamentosus*, female). The analysis of covariance indicated that there was no significant difference in the length-weight relationships between the sexes of all the species analysed except *P. filamentosus*. All the three species exhibited negative allometric growth for pooled sexes, *i.e.*, b < 3 (the fish grows faster in length than in weight) (Table 1). Females of *P. filamentosus* were the only ones that exhibited isometric growth (b = 3) which indicates that the fish increases in length and weight proportionately or at the same rate. The unchanging body form and the specific gravity of a fish would yield a regression coefficient value b=3, which describes isometric growth (Ricker, 1975).

The length of *L. gibbus* in the samples ranged from 17.5-48.5 cm with a maximum size distribution in the class interval of 30-35 cm (Fig. 1). The LWRs of Humpback red snapper (*L. gibbus*) were as follows (Fig. 4):

Male: Log W= -3.10+2.68 log L (r^2 =0.929)
Female: Log W =-3.22 +2.71 log L (r^2 =0.954)

The corresponding parabolic equation can be expressed as follows:

Male: W=0.0449 $L^{2.68}$
Female: W= 0.0397 $L^{2.71}$

The Analysis of covariance (ANCOVA) showed that there is no significant difference in LWRs between males and females (P< 0.01) and hence a common equation was derived by pooling the sexes.

LWRs of pooled sexes: Log W= -3.548 + 2.792 log L (r^2 =0.905)

W= 0.0287 $L^{2.792}$

In the present study, the growth exponential values obtained for males (2.687), females (2.716), and for the sexes pooled (2.792) of *L. gibbus* indicated a negative allometric growth pattern. This finding agrees with Ali (2016) and Ontomwa *et al.* (2018) for *L. gibbus* who reported negative allometric growth for this species along the Socotra Island, Yemen and the Shimoni artisanal fishery, Kenya respectively. However, on the contrary, Martin *et al.* (1991) reported an isometric growth in *L. gibbus* with 'b' value 3.074 from samples collected off Maldives coast. There are often clear variances between
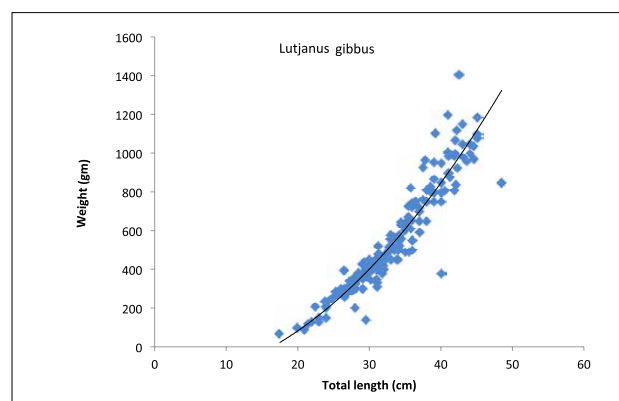

Fig. 4. Scatter diagram showing length-weight relationships of *L. gibbus* (sexes pooled)

different populations of the same species, or between different years in the same population, linked with their nutritional condition (Ricker, 1975).

The length of *P. lewisi* in the samples ranged from 34.0-79.5 cm with the mode in the range of 40.0-45.0 cm (Fig. 2). The LWRs of Slender pinjalo (*P. lewisi*) were as follows (Fig. 5):

Male: Log W= -2.646+2.58 log L (r^2 =0.958)
Female: Log W =-3.25 +2.73 log L (r^2 =0.915)

The corresponding parabolic equation can be expressed as follows:

Male: W=0.0709 $L^{2.58}$
Female: W= 0.038 $L^{2.73}$

The Analysis of covariance (ANCOVA) exhibited no significant difference in LWR between males and females (P< 0.01), hence a common equation was derived by pooling the sexes.

Pooled sexes: Log W= -2.728 + 2.597 log L (r^2 =0.939)

W= 0.065 $L^{2.597}$

LWR for *P. lewisi* is not reported in FishBase (Froese and Pauly, 2019) or elsewhere and hence the present study represents the first report of LWR for the species.

The length of *P. filamentosus* in the samples ranged from 27.5-83.0 cm with a maximum size distribution in the range of 40.0-45.0 cm (Fig. 3). The LWRs of *P. filamentosus* were as follows (Fig. 6):

Male: Log W= -3.652+2.78 log L (r^2 =0.968)
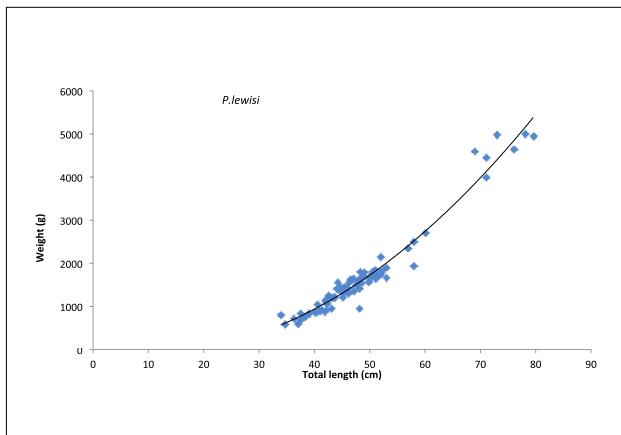Female: Log W =-4.521 +3.01 log L (r^2 =0.987)

The corresponding parabolic equation can be expressed as follows:

Male: W=0.0259 $L^{2.78}$

Female: W= 0.0108 $L^{3.013}$

LWRs of pooled sexes: Log W= -4.187 + 2.902 log L (r^2 =0.951)

W= 0.0151 $L^{2.902}$

The Analysis of covariance (ANCOVA) showed that there is a significant difference in LWR between males and females (P< 0.01). In the current study, the calculated allometric coefficient 'b' values obtained for males (2.783), females (3.0134), and sexes pooled (2.903) of *P. filamentosus* indicated negative allometric growth pattern for males and the combined sexes; and isometric pattern for the females. The growth pattern observed in this study for males as well as combined sexes corroborated with the opinions of Abdurahiman *et al.* (2004) and Mees (2005) for *P. filamentosus* documented from the south Karnataka coast of India and Mahe Plateau, Seychelles respectively. The isometric growth pattern obtained for females of *P. filamentosus* in this study was contrary to that reported by Abdurahiman *et al.* (2004). The growth exponential value 'b'may vary with sex, feeding, state of maturity, metabolic activity and genetic nature (Wootton, 1990).

The study provides the first documented report on the LWRs of three commercially important species of snappers *viz. L. gibbus*, *P. lewisi* and *P. filamentosus* along the Kerala coast. This study is relevant to fill the knowledge gap and to provide baseline information for the effective management and conservation of these species in the Arabian Sea along the southwest coast of India and it would also serve as a reference point for future research.
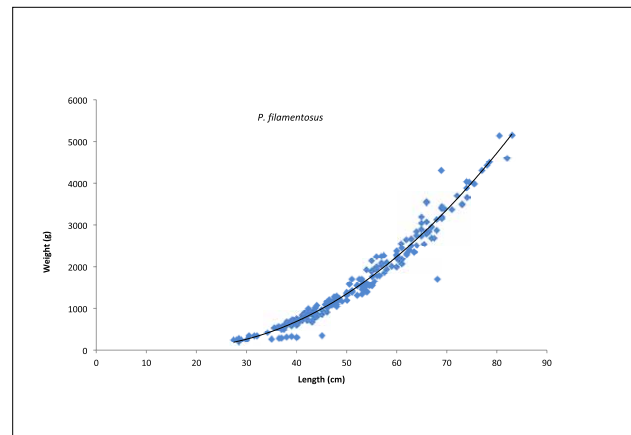

Fig. 5 Scatter diagram showing length-weight relationships of *P. lewisi* (sexes pooled)

Fig.6. Scatter diagram showing length-weight relationships of *P. filamentosus* (sexes pooled)

Acknowledgements

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