



Estimation of length at first maturity and sex ratio of three Gempylidae (Snake mackerels) species dwelling the south coast of India

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Short communication

Abstract

Length at maturity and sex ratio of three fishes belonging to the family Gempylidae, *Promethichthys prometheus* (Cuvier, 1832) *Thyrsitoides marleyi* (Fowler, 1929) and *Neoepinnula orientalis* (Gilchrist and von Bonde, 1924) from Indian waters are presented. Information on the length at maturity of these fishes is either nil or scanty. These fishes mature within the range of 17.53 to 62.03 cm.

Keywords: Deep sea fishes, size at maturity, sex ratio, Gempylidae, by-catch

Introduction

The fishes of the family Gempylidae (Gill, 1862) are commonly called Snake mackerels. They are distributed in tropical, subtropical and temperate waters, representing the deep water fishes, in a depth range of upto 2000 meters (Nakumurai and Parin, 1993). A total of 26 species are included in the family Gempylidae. Among the Gempylids, species like *Leionura atun*, *Rexea solandri*, *Neoepinnula orientalis* and *Lepidocybium flavobrunneum* were recognized as commercially important (Dudley, 1987; Punt and Smith, 1999; Abdusammad *et al.*, 2011). In India *N. orientalis* and *L. flavobrunneum* were considered edible (Balasubramanian and Abdusammad, 2007; Vijayan *et al.*, 2016). The utilization of these deep-sea fishes will reduce fishing pressure in coastal waters (Sajeevan and Nair, 2006). Fishes like threadfin breams, bull's eye, squids, cuttlefishes and octopus were considered non-conventional resources in the past. Now, these species have high demand in the fishery industry. Like this other species of Gempylidae may also become a conventional resource in future.

For the sustainable utilization and conservation of fish stocks, knowledge about their reproductive aspects is important (Cochrane, 2002; Hossain *et al.*, 2017; Khatun *et al.*, 2019). Length at maturity (L_{50}) is the length at which 50% of a fish population enters their spawning stage (Vazzoler, 1996). The sexual maturity of fish is affected by various factors like genetic, physical and environmental variations (Cartes, 1994; Nikolskii, 1969). Studies on gempylid fishes in India are limited to their taxonomy, distribution and feeding biology (Balasubrahmanyam, 1976; Silas and Regunathan, 1974; Venu and Kurup, 2002; Balasubramanian *et al.*, 2007; Sreedhar *et al.*, 2007; Karuppasamy *et al.*, 2008; Naomi *et al.*, 2009; Sajeevan *et al.*, 2009; Mohan *et al.*, 2011; Suresh *et al.*, 2013; Bineesh *et al.*, 2014; Viji *et al.*, 2017). Information on the size at maturity of gempylids was limited to Lorenzo and Paujelo (1999), Viana *et al.* (2012), Beni *et al.* (2017), Varghese *et al.* (2019) and Sileesh *et al.* (2020). Lorenzo and Paujelo (1999) provided information on the size at maturity and sex ratio of roudi escolar, *Promethichthys prometheus* (Cuvier, 1832) occurring from the Canary Islands (Central-east Atlantic). However, no such information is available for roudi escolar occurring in Indian water. Varghese *et al.* (2019) provided information on the sex ratio and length at first maturity of black snoek, *Thyrsitoides marleyi* (Fowler, 1929) occurring in Andaman waters. Beni *et al.* (2017) and Sileesh *et al.* (2020) provided information on the sex ratio and length at first maturity of sack fish *Neoepinnula orientalis* (Gilchrist and von Bonde, 1924) occurring in the southwest coast of India and Andaman waters. Considering the paucity of knowledge on the information on the sex ratio and length at first maturity of three fishes, roudi escolar, black snoek and sack fish occurring in south coast of India. The present study attempted to examine

the sex ratio and length at first maturity of these three fishes belonging to the family Gempylidae.

Material and methods

The samples for the study were collected from the deep sea trawl fish catches of Shakthikulagara (Kerala) and Tuticorin (Tamil Nadu) landing centres. A total of 198 samples were analysed for the study. The specimens were identified using standard references (Smith and Heemstra, 1986; Nakamura and Parin, 1993). Specimens collected were brought to the laboratory and measured the total length to the nearest one millimetre (mm) and the total weight to the nearest gram (g). By dissecting the samples along the body cavity, the sex was noted and we macroscopically examined the gonad maturity. The maturity of gonads was recorded as immature (I), maturing (II), ripening (III), ripe (IV) and spent (V) following (Qasim, 1973). The first two stages were considered immature and marked as '0'. Similarly stages three and above are considered as mature and marked as '1' for doing the regression analysis. Total length in cm and sex of specimens recorded for finding the size at maturity. The logistic regression model was fitted and the parameters of logistic regression and the sigmoid curve of the model were estimated following Mollet *et al.* (2000) and Neer and Cailliet (2001). The sigmoid curves of the logistic regression model were given as a proportion of mature fish by total length. The logistic regression model is as $p(x) = \frac{e^{b_0 + b_1x}}{1 + e^{b_0 + b_1x}}$, where, $p(x)$ is the probability that a fish is mature at a given length x . b_0 and b_1 are the parameters which determine the shape and position of the sigmoid curve. L_{50} was found from the corresponding points of the X and Y axis. The total length that corresponds to any required proportion can find out, once the parameters were estimated, using the expression $x = \frac{(\ln(p/(1-p)) - b_0)}{b_1}$ (except for 0 and 100%). Where b_0 and b_1 are the estimates of the parameters in the logistic regression model. The sex ratio (M: F) was calculated for *N. orientalis*, *P. prometheus* and *T. marleyi* following Philip (1994). Chi-square (χ^2) analysis was performed to test the significance of the sex ratio from the expected value of 1:1. (Snedecor, 1961;

Snedecor and Cochran, 1967). The analyses were done using R software (R core team, 2020).

Results and discussion

The length at maturity of the fish was estimated separately for males and females and is shown in Table 1. The present study estimated the length at maturity of roudi escolar as 35.07 cm for males and 37.97 cm for females (Table 1). The L_{50} value of roudi escolar, for male was statistically not significant ($P > 0.05$) and for females it was significant ($P < 0.05$). The sigmoid curve of both sexes was depicted in Fig. 1. Lorenzo and Paujelo (1999) estimated the length at maturity of roudi escolar from the Canary Islands as 47.41 cm for males and females. These values were higher than the values obtained by the present study. Differences in the geographical region may be the reason for this variance. The sex ratio of male to female was 1:0.94, which was statistically not significant (Table 2). The sex ratio presented by Lorenzo and Paujelo was 1:1.74, whereas the present study recorded a sex ratio of 1:1.

Results of L_{50} values of black snoek for males and females estimated by the present study were 61.52 cm and 62.03 cm respectively (Table 1). Statistically, both values were not significant. The sigmoid curve of male and female black snoek is presented in Fig. 2. Varghese *et al.* (2019) reported the

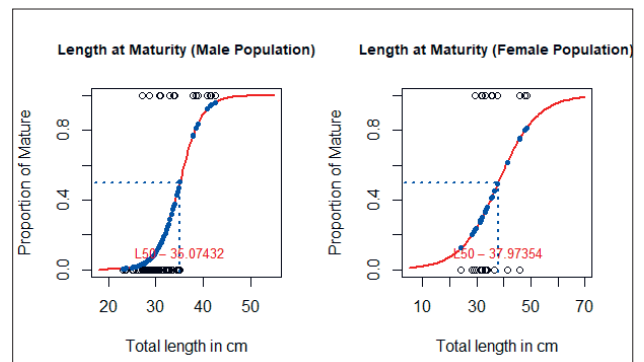


Fig. 1. Length at maturity (L_{50}) curve of roudi escolar from the south coast of India

Table 1. Size at first maturity (L_{50}) of roudi escolar, black snoek and sack fish from the South coast of India

Species name	b_0	b_1	L_{50}	SE(L_{50})	Pr(> z)
Roudi escolar -Male	-15.21	0.433	35.07	0.11	0.00019
Roudi escolar- Female	-5.38	0.141	37.97	0.07	0.059*
Black snoek-Male	-20.39	0.331	61.52	0.18	0.0659*
Black snoek -Female	-54.4	0.877	62.03	0.53	0.098*
Sack fish -Male	-17.65	1	17.53	0.54	0.065*
Sack fish -Female	-14.68	0.7791	18.84	0.23	0.00071

b_0 and b_1 are the estimates of the parameters in the logistic regression model, L_{50} , length at first maturity; SE, standard error; Pr(> |z|), corresponding critical value, *Significant at $P < 0.05$

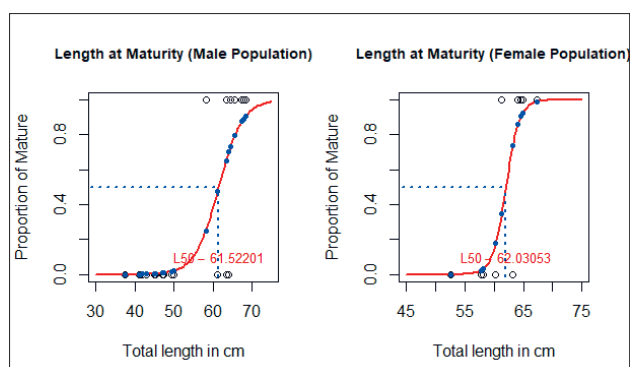
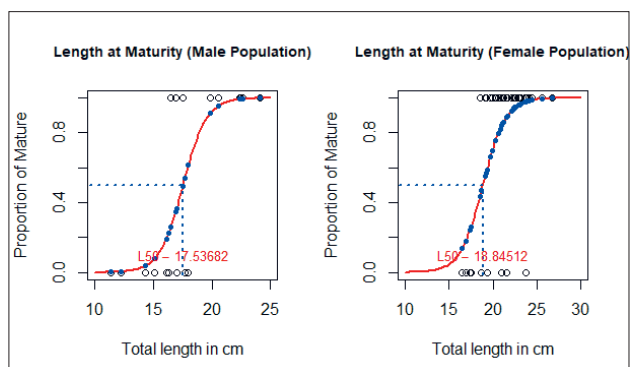
Table 2. Male-to-female sex ratio and chi-square value of *P. prometheus*, *T. marleyi* and *N. orientalis* from the South coast of India

Species name	Sex ratio	Chi-square	P value
Roudi escolar	1:0.92	2.96*	0.85
Black snoek	1:0.69	0.037*	0.39
Sack fish	1:0.62	0.72*	0.84

*Not significant at $P > 0.05$

length at first maturity of black snoek from Andaman waters as 101.1 cm for males and 106.7 cm for females. Results of both studies reported that males mature at a smaller length than females. However L_{50} values of black snoek reported by Varghese *et al.* (2019) did not come in line with the results of the present study. Cartes (1994) opined that differences in the length at maturity of the same species may differ because of regional differences. Hence it can be inferred that the variance in L_{50} may be due to geographical differences. The estimated sex ratio was 1:0.69 (Table 2). Varghese *et al.* (2019) also reported a sex ratio skewed towards male. Hence, it can be inferred that males are dominant in the population.

The L_{50} values of sack fish were estimated as 17.53 cm and 18.83 cm (Table 1). The values obtained were not significant for male and was significant for female. The maturity curve of

Fig. 2. Length at maturity (L_{50}) curve of black snoek from the south coast of IndiaFig. 3. Length at maturity (L_{50}) curve of sack fish from the south coast of India

male and female sack fish were shown in Fig. 3. Study by Beni *et al.* (2017) estimated the length at first maturity of sack fish as 19.2 cm for males and 19.5 cm for females from the southeast coast of India and Sileesh *et al.* (2020) estimated 20.76 cm and 16.76 cm for males and females respectively from Andaman waters. As per the results of the present study male sack fish mature at smaller lengths than females. Beni *et al.* (2017) and Sileesh *et al.* (2020) also recorded similar phenomena in the case of sack fishes. Geographical differences and differences in the study period can be attributed as the reason for slight changes in the length of maturity with earlier findings. The sex ratio in the present study is 1: 0.62 and was statistically significant (Table 2). Venu and Kurup (2006) evaluated the sex ratio skewed to males during post monsoon season and females during the pre-monsoon and monsoon seasons.

Fishes belonging to the family Gempylidae were caught as by-catches of seasonal deep-sea shrimp fishery. As they were not considered commercially important, all of them were thrown overboard at the fishing ground. Hence getting a sufficient number of specimens of these fishes is difficult. Due to this reason only very less study was carried out on this fish. Considering the changes in consumption patterns, availability and demand for non-conventional resources become conventional at some point of time very soon (Sajeevan *et al.*, 2009). Hence information on the biology of Gempylidae fishes will serve as important information for understanding the dynamics of their fishery.

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