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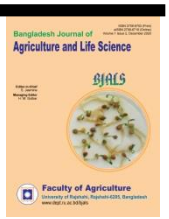

Seasonal variation in length-weight relationships and condition factor of *Rastrelliger kanagurta* (Cuvier, 1816) (Scombridae) from Ibrahim Hyderi fish harbor (commercial fishers' catch), Karachi coast, Pakistan

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ABSTRACT

The length-weight relationship and condition factor of *Rastrelliger kanagurta* (Cuvier, 1816) were estimated using a total of 631 specimens with various sizes (36.00 – 101.00 g body weight; 9.50 – 20.30 cm in total length) from commercial fishers' catch of the Arabian Sea, Karachi Coast, Pakistan. Samples were collected in different seasons from commercial catch landed at Ibrahim Hyderi Fish Harbor, Karachi, Pakistan. Total length (TL) and body weight for each individual were noted. The highest TL (20.30 cm) and BW (101.00 g) values for *R. kanagurta* were obtained in monsoon season. The lowest TL (9.50 cm) and weight (36 g) were found in post-monsoon. The highest condition factor and the lowest condition factor of *R. kanagurta* were determined as 2.766 (pre-monsoon) and 1.733 (monsoon), respectively. The allometric co-efficient (b) values of the LWRs for *R. kanagurta* were calculated as 1.79 in pre-monsoon, 1.07 in monsoon and 1.13 in post-monsoon. These results would be effective for stock assessment and management of this Indian mackerel fishery in the Arabian Sea and surrounding waters.

Introduction

The fish, Rastrelliger kanagurta (Cuvier, 1816) is commonly called the Indian mackerel belongs to the family Scombridae, which is distributed in Indo-West Pacific, Red Sea and East Africa to Indonesia, north to the Ryukyu Islands and China, south. It is mainly found in the Indian and Western Pacific oceans and the seas surrounding them. It is an important food source and widely used in South and Southeast Asian cuisine. *R. kanagurta* is generally found in shallow and coastal waters, adult individuals are found in coastal bays, harbors and deep lagoons. It is of particular importance in the economies of countries in the tropical region, where the species is considered an important cheap protein source and is also widely used as feed (Ahamed et al., 2012; Froese and Pauly, 2014).

Length and body weight values of fish are two important factors in stock assessment and

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general population ecology, community and ecosystem ecology assessments (Giarrizzo et al. 2015; Baitha et al. 2018; Hossain et al. 2021; Khatun et al. 2021). Length-weight relationships (LWR), an important calculation method in fisheries science, enables estimation of the biomass of a species from the length information of fish and determination of the life history and morphological differences of the same species living in different places (Binohlan and Pauly, 2000; Hossain et al. 2013a; 2013b; Sabbir et al. 2021). The LWR, used to demonstrate the status of the fish population, reveals that a fish is heavier or deviates from the average at the same length than a fish with a lower condition factor (Freitas et al. 2017; Rahman et al. 2021).

Many researchers published their work on length-weight relationships of *R. kanagurta* by a number of researchers including Sousa & Gislason (1985); Abdussamad et al. (2006); Jawad et al. (2011); Jayabalan et al. (2014); Amin et al. (2014); Amin et al. (2015); Arrafi et al. (2016); Koolkalya et al. (2017); Pawase et al. (2017); Faizah et al. (2018); Kunzmann and Braitmaier (2018); Asif et al. (2019) and Ahmad et al. (2019). To the best of the author's knowledge, there is no sound and detail studies on LWR and condition factor on *R. kanagurta* from the Arabian Sea. Thus, the aim of this study was to estimate the LWRs and condition factor in *R. kanagurta* during pre-monsoon, monsoon and post-monsoon season from Arabian Sea, Karachi Coast, Pakistan using the samples from Ibrahim Hyderi Fish Harbor, Karachi, Pakistan.

Materials and Methods

A total of 631 *R. kanagurta* (Fig.1) fish individuals were collected seasonally such as during pre-monsoon (January to May 2019), monsoon (June to September 2019) and post-monsoon (October to December-2019) from Ibrahim Hyderi Fish Harbor, Karachi.

Fig. 1. Photo of *Rastrelliger kanagurta* (Cuvier, 1816), collected from Ibrahim Hyderi fish Harbor (commercial fishers' catch), Karachi coast, Pakistan

In pre-monsoon (227), monsoon (196) and post-monsoon (208) specimens were collected. All these fishes were harvested from Arabian Sea, Karachi Coast, Pakistan. Specimens were stored in ice box and transported to laboratory for further analysis. The total length (TL) in cm of the fish, *R. kanagurta* was measured from the tip of the anterior part of mouth to caudal fin using measuring tape. Fish body weight (BW) in g was taken after blot drying with a piece of clean hand towel. The weight to the nearest 0.1 g and total length (TL) to the nearest 0.1 cm were measured for each fish collected.

The length-weight relationships (LWRs) were estimated using the equation W = a×Lb, where L is length (cm), W is the weight (g) of fish. The intercept 'ln(a)' and growth coefficient 'b' were analyzed after transforming data on natural log (ln) equation: ln (W) = ln (a) + b × ln (L) and calculating 95% confidence limits (Le Cren, 1951; Froese, 2006). Additionally, the coefficient of determination (r2) was estimated. Condition factor (CF) was calculated using the following formula by Fulton (2004): CF= (W/L3) × l00; where, W is the weight of fish body in gram; L is the length of fish in centimeters.

Results

The marine fish, *R. kanagurta* (Cuvier, 1817) samples (pre-monsoon - 277, monsoon - 196 and post-monsoon - 208) were collected from the Ibrahim Hyderi Fish Harbor, Pakistan between January to December 2019. The length (TL) and weight (W) (min-max) of the fish specimens were 9.50 – 20.30 cm and 36-101 g respectively. The maximum length (20.30 cm) and weight (101 g) of were obtained in monsoon. The lowest length (9.50 cm) and weight (36 g) were measured in post-monsoon.

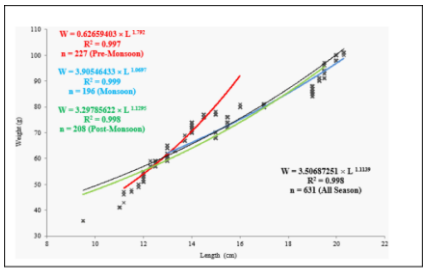

Fig. 2. Length-weight relationship of *Rastrelliger kanagurta* (Cuvier, 1816) from Ibrahim Hyderi fish harbor (commercial fishers' catch), Karachi coast, Pakistan (red color: pre-monsoon, blue color: monsoon; green color: post-monsoon, black color: all season)

The overall length–weight relationship, LWRs according to seasons (pre-monsoon, monsoon and post-monsoon) and coefficient of determination (r^2) are presented in table 2 and illustrated in fig. 2. The b value for overall LWR was 1.1139 and coefficient of determination (r^2) was 0.998. The overall growth pattern and seasonal growth pattern obtained from all the 3 seasons were negative allometric (b<3) with r2 values >0.996 (Table 2).

Table 1. Total length (TL, cm), weight (W, g) and condition factor (CF) of *Rastrelliger kanagurta* (Cuvier, 1816) from Ibrahim Hyderi fish harbor (commercial fishers' catch), Karachi coast, Pakistan.

		Parameters		
Seasons	N	TL ± SE (min.-max. cm)	W±SE (min.-max. g)	CF±SE (min.-max.)
Pre-Monsoon	227	13.36 ± 1.168	65.57 ± 10.089	2.766 ± 0.296
		11.20 – 16.00	43.00 – 81.00	1.953 – 3.345
Monsoon	196	17.00 ± 2.260	80.96 ± 11.770	1.733 ± 0.458
		13.00 – 20.30	59.00 – 101.00	1.195 – 2.776
Post-Monsoon	208	14.70 ± 2.761	68.96 ± 14.276	2.357 ± 0.717
		9.50 – 19.50	36.00 – 97.00	1.224 – 4.198
All season	631	14.93 ± 2.61	71.47 ± 0.55	2.310 ± 0.666
		9.50 – 20.30	36.00 – 101.00	1.195 – 4.198

Table 2. Length and weight relationships of *Rastrelliger kanagurta* (Cuvier, 1816) from Ibrahim Hyderi fish Harbor (Commercial Fishers' Catch), Karachi Coast, Pakistan.

Seasons	WLRs	r^2
Pre-Monsoon	$W = 0.62659403 \times L^{1.792}$	0.997
	$\log W = -0.203 + 1.792 \log L$	
Monsoon	$W = 3.90546433 \times L^{1.0697}$	0.999
	$\log W = 0.5917 + 1.0697 \log L$	
Post-Monsoon	$W = 3.29785622 \times L^{1.1295}$	0.998
	$\log W = 0.5182 + 1.1295 \log L$	
General	$W = 3.50687251 \times L^{1.1139}$	0.998
	$\log W = 0.5449 + 1.1139 \log L$	

Fulton condition factor for overall data was 2.310. The highest and the lowest condition factor were 2.766 (in pre-monsoon) and 1.733 (in monsoon), respectively (Table 1).

Discussion

A total of 631 individuals of *R. kanagurta* were collected during the sampling period. Collection of individual less than 9.5 cm in size in TL (BW = 36 g) was not possible during the sampling period in this water body, which can be attributed to the fact of the fishing gear selectivity (Hossain et al. 2012) and fishermen not catching fishes where smaller sizes were present (Hossen et al. 2016), or more possibly the area where this study was conducted was not containing smaller sizes during this study period (Hossain et al. 2010). The observed maximum length was recorded as 20.3 cm (BW=101 g), which was smaller than the values recorded by Ahmad et al. 2019 (31 cm), Asif et al. 2019 (29 cm), Faizah et al. 2018 (25.75 cm), Koolkalya et al. 2017 (23.5 cm) and Amin et al. 2015 (32.5 cm). These differences in TL might be attributed to the variation of geographical location as well as environmental factors, most importantly water temperature and availability of food (Hossain and Ohtomi, 2010). Maximum body weight of R. kanagurta was 101 g which was smaller than the values recorded by Ahmad et al. (2019) (340 g) and Amin et al. (2015) (339 g). Measuring the change in weight may reveal a more accurate measure of growth over shorter periods. However, the resulting change in weight can be a very temporary indicator of growth, as there is a possibility of both gaining and losing weight. Therefore, while the fish are well fed and growing, it may happen that an individual weighs more than normal for a given length (Hart and Reynolds, 2004).

LWR parameter b may vary between 2 and 4 (Bagenal and Tesch, 1978). When the value of b is close to 3 (b≈3.0) indicates isometric growth, but any significant difference from 3 indicates

allometric growth, where, > 3 indicates positive allometric and < 3 negative allometric (Tesch et al. 1971). But, the b values calculated in this study (pre-monsoon, 1.79; monsoon, 1.07; post-monsoon, 1.13; overall, 1.11) were outside the reported general phenomenon. LWRs curves for all *R. kanagurta* individual are drawn according to pre-monsoon, monsoon, post-monsoon season (Fig. 2). Remarkable growth difference was found in pre-monsoon season. The slope (b) value of the LWRs of *R. kanagurta* is found as 1.1139 from Ibrahim Hyderi Fish Harbor. This variation may be affected by gender, gonad maturity, health, season, habitat, nutrition, environmental conditions (such as temperature and salinity), area, degree of fullness of the stomach, differences in the lengths of the caught specimen and fishing gear (Tesch, 1968). Environmental or habitat factors were not addressed in this study. However, further study is needed for analyzing environmental or habitat factors, to understand the reason for the low b value in Ibrahim Hyderi Fish Harbor. Ahmad et al. 2019 reported the b value for this species to be 2.838 and Amin et al. 2015 recorded 3.2135.

Condition factor is a quantitative parameter that indicates the state of the fish (fatness, maturity and spawning gonadal development and general well-being of the fish) and determine present and future population success by influencing growth, reproduction and survival (Wootton, 1990). Condition factor of *R. kanagurta* varied from 1.195 to 4.198 in all individual (Table 1). However, the Fulton condition factor of fish can be affected by a number of factors such as stress, sex, season, availability of feeds and other water quality parameters (Khallaf et al. 2003).

In conclusion, this study is presenting the biological features of *R. kanagurta* population in Ibrahim Hyderi Fish Harbor such as growth, length-weight relationship and condition factor. It is important to carry out more studies on the composition of the LWRs of the captured species in terms of revealing the ecological balance. According to (Bilgin and Solak, 2020), fish can be exhibited positive allometric growth in the lower fishing pressure condition, isometric growth when fishing pressure is close to extreme/overfishing and has exhibited negative allometric growth and tended to be thinner when there is excessive fishing pressure. Many factors mentioned above can cause the b value to change and the growth to differ. These factors should be examined in detail in future studies in the study area as well. Thus, a contribution can be made to the sustainable management of the studied fish species in the study area.

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Authors' Contribution

Conceptualization: KM; organized field trips and Data collection, FY; supervised the whole research work, supported to laboratory facilities and organized manuscript: SK, helped in data analysis and manuscript submission to journal. All authors have read and agreed to the published version of the manuscript.

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