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LENGTH-WEIGHT RELATIONSHIP OF THREE COMMERCIALLY IMPORTANT FISH SPECIES FROM BALOCHISTAN COAST, PAKISTAN

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ABSTRACT

Length-weight relationship is an important component for the stock analysis for better fishery management. The length-weight relationship of three commercially important fish species was studied from Balochistan coast, Pakistan during present study. A total of 372 individuals of lesser tigertooth croaker (*Otolithes cuvieri*, Trewavas, 1974), Indian mackerel (*Rastalliger kanagurta*, Cuvier, 1816), and Indian oil sardine (*Sardinella longiceps*, Valenciennes, 1847) were collected from Pasni, Gwadar and Ganz areas. The estimated length-weight relationship are, $W = 0.013L^{2.905}$ ($R^2 = 0.964$) for *O. cuvieri*, $W = 0.0025L^{2.725}$ ($R^2 = 0.798$) for *R. kanagurta* and $W= 0.009L^{3.015}$ ($R^2 = 0.756$) for *S. longiceps*. The present findings revealed that the exponent "*b*" values are ranged from 2.725 to 3.015, indicating an isometric growth pattern for all three species with strong correlation coefficients. The R^2 value shows the strong relation between length and weight of the species. The regression content '*a*' is a scaling coefficient for the weight at the length of the fish. According to present findings, the environmental conditions for the growth of these species are favorable along the Balochistan coast, Pakistan.

Keywords: Length-weight relationship, *Otolithes cuvieri*, *Rastalliger kanagurta*, *Sardinella longiceps*, Pakistan

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INTRODUCTION

Pakistan coastline covers 1001 km from Indian borders to the Iranian borders with 350 nautical miles (n.m) an exclusive economic zone (EEZ). The continental shelf limits extended from 200 to 350 n.m, and EEZ from 250, 000 km^2 to 299, 000 km^2 (UN commission March 2015) where from Pakistan can explore and exploit its marine resources. Pakistan coastline is divided in to two provinces i.e. Sindh and Balochistan (Figure 1). The Sindh coast stretches to approximately 266.5 km (Pakistan Navy, 2016) from the Indian border to the Hub River, Balochistan. Bottom of the Sindh coastal waters is generally sandy and muddy. Freshwater inflow from the Indus River creates this region more fertile and rich in mangrove ecosystem which acts as breeding and nursery ground for various fishery resources (FAO, 2009; Laghari, 2018).

Balochistan coast is about 734.5 km (Pakistan Navy, 2016) long with rocky bottom and uneven continental shelf. The continental slop is more than 200 m depth start from 10 to 30 nm from the coast. Most of the Balochistan coast area is productive such as, Sonmiani Bay, Kundmalir, Ormara, Kalmat, Pasni, Gwadar and Ganz, Jiwani. Pakistan marine fisheries industry contributes approximately 57 percent of fish and fishery products. Most of fish catch exported to other parts of the world, and the gross domestic product (GDP) from this sector was about USD 160.9 million during 2006 (FAO, 2009).

Length-weight relationship is significant since they: (a) allow the change of growth-in-length reckonings to growth- in-weight, for use in stock assessment models; (b) allow the approximation of biomass from length explanations; (c) allows to estimate the illness of fish. Length-weight relationship data is a basic unit in fish biology, and for fisheries management (Kalhoro *et al*., 2014a, b). Number of studies is available on length-weight relationship and population dynamics of these species from different areas especially from India (Chakraborty, 1992; Rohit and Uma, 2003; Parashant *et al*., 2006; ManojKumar, 2007; Gondhalli *et al*., 2013; Remya and Vivekanandan, 2013; Bhendarkar *et al*., 2013, 2014). Numerous research have been conducted on various aspects on length-weight relationship, population dynamics and maximum sustainable yield on different fish species and suggest some management steps to maintain the stock of those fisheries based on findings from Pakistani waters (Afzaal *et al*., 2016, 2018; Kalhoro *et al*., 2013; 2015a, b; 2017, 2018; Nadeem *et al*., 2017; Razzaq *et al*., 2019; Baloch *et al*., 2020; Majeed *et al*., 2021). The current study on the length-weight relationship of three commercial fish species along the Balochistan coast was conducted. These species have high economic demand, and a significant portion of the

catch of these species exported to different countries worldwide.

However, limited research has been conducted on the Lesser tighertooth croaker (*Otolithes cuvieri*, Trewavas, 1974), Indian mackerel (*Rastalliger kanagurta*, Cuvier, 1816) and Indian oil sardine (*Sardinella longiceps*, Valenciennes, 1847). The present study will provide the basic biological information on growth for those species along the Balochistan coast, Pakistan. Current study will also help the fisheries managers to formulate effective management strategies for the sustainable exploitation of those species and betterment of marine environment.

MATERIALS AND METHODS

Samples were collected from Pasni, Gwadar and Ganz fish landing sites along the Balochistan coast, Pakistan (Figure 1). The fish samples were collected during research survey project and also from the fish landing sites from August to December, 2020. Samples brought to the Faculty of Marine Sciences, Lasbela University of Agriculture, Water and Marine Sciences laboratory for further analysis. Samples were measured in centimeter (cm) and weights were taken in grams (g). The total length (TL) was measured for *O. cuvieri* and fork length (FL) was measured for *R. kanagurta* and *S. longiceps*.

To estimate the length-weight data, 200 specimens of Lesser tighertooth croaker (*Otolithes cuvieri*, Trewavas, 1974) were collected, with 50 samples from Pasni, 50 from Gwadar, and 100 from Ganz. During the current analysis, 74 pairs of length-weight of Indian mackerel (*Rastalliger kanagurta*, Cuvier, 1816) were obtained, 52 from Pasni and 22 from Ganz. However, 100 pair of Indian oil sardine (*Sardinella longiceps*, Valenciennes, 1847) samples was collected from the Balochistan coast, with 50 pairs from Ganz and 50 from Gwadar.

The length-weight relationship data of these commercially important fish species were calculated by the formula $W=aL^b$. (Le-Cren, 1951; Froese, 2006), where "*a*" is the coefficient, and the exponent "*b*" is the relationship with the rate or slope '*b*'. The statistical analysis using Le-Cren (1951) and Froese (2006) method was made by Microsoft excel 2003.

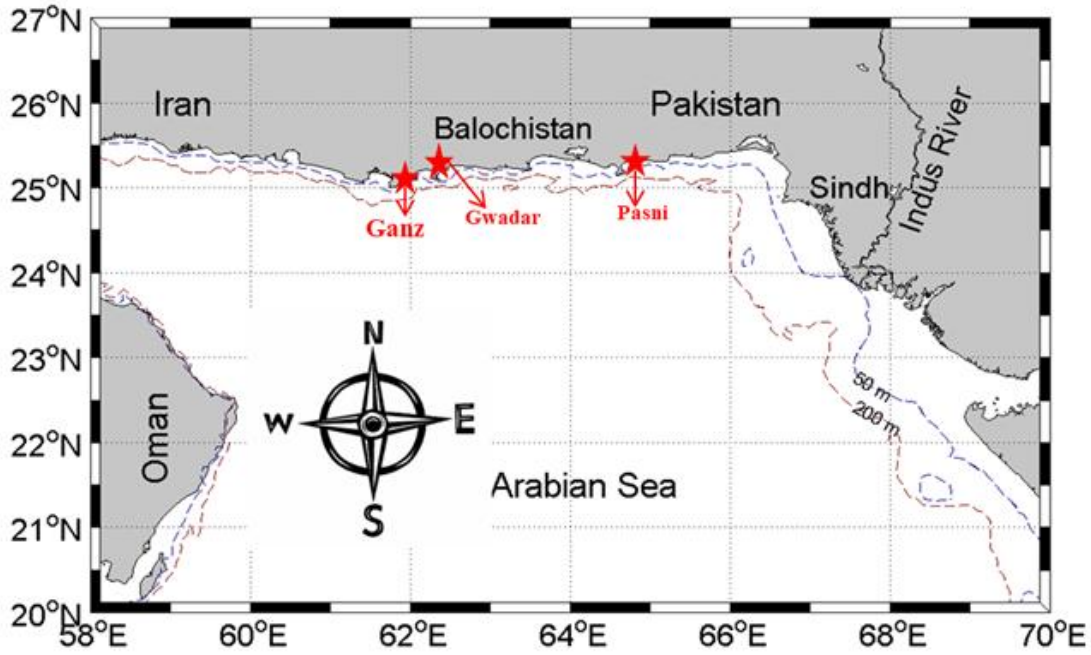

Figure 1. Pakistan coast (Sindh and Balochistan) indicating (★) sample collection sites during present study 2020.

RESULTS

***Otolithes cuvieri* (Trewavas, 1974):** A total of 200 length-weight pairs of *O. cuvieri* were studied, with 50 specimens from Pasni ranging in length from 33-55 cm (TL) and weight from 345-1545 grams. Pasni's length-weight relationship was estimated at '*a*' =0.0085 and '*b*' =3.018 (R^2=0.946) (Figure. 2A). A total of 50 specimens from Gwadar were collected, with minimum and maximum size and weight was 22-55 cm (TL) and 100-1545 g, respectively. The length-weight relation from Gwadar was found at '*a*' =0.0012 and '*b*' =2.938 (R^2=0.980) (Figure 2B). 100 samples were collected from Ganz with minimum and maximum size and weight was

22-39 cm (TL) and 100-620 g respectively. Ganz's size-weight relation was determined at '*a'* =0.004 and '*b'* =3.262 (R^2=0.828) (Figure 2C). The combined length-weight pair was determined to be '*a*' =0.013 and '*b'* =2.905 (R^2=0.964) (Figure 2D).

***Rastalliger kanagurta* (Cuvier, 1816):** A total of 74 pairs of Indian Mackeral (*R. kanagurta*) size and weight relationship were collected from Pasni and Ganz fish harbor. 52 pairs were examined from Pasni with smallest and largest size in cm (FL) and weights being 19-29 cm (FL) and 78-278 g, respectively. The relationship between size and weight was found at, '*a*'=0.0269 and '*b'*=2.7 (R^2=0.786) (Figure 2A). However, 22 pairs of specimen were collected from Ganz with length and weight ranging from 19-21 cm (FL) and 78-120 g, respectively, while, length and weight relation was determined at '*a*'=0.0038 and '*b'*=3.36 (R^2=0.658) (Figure 2B). However, '*a*'=0.0025 and '*b'*=2.725 (R^2=0.798) were calculated for the combined length-weight results (Figure 2C).

***Sardinella longiceps* (Valenciennes, 1847):** A total of 100 pairs of length-weight of Indian oil sardine were measured from Ganz and Gwadar fish landing sites along Balochistan coast. 50 length-weight pairs were measured from Ganz with length-weight range from 16-23 cm (FL) and 30-100 g, respectively. The length-weight relationship from Ganz was found at '*a*'= 0.0023 and '*b'* =3.472 (R^2=0.789) (Figure 4A). 50 pairs of size with weight from Gwadar was gathered with a range of 19-25 cm (FL) and 70-135 g, respectively, whereas, length-weight was found at '*a*'= 0.0215 and '*b'* = 2.728 (R^2=0.712) (Figure 4B). However, length-weight relations of combined data of Indian oil sardine were found at '*a*'= 0.0146 and '*b'*= 2.862 (R^2=0.613) (Figure 4C).

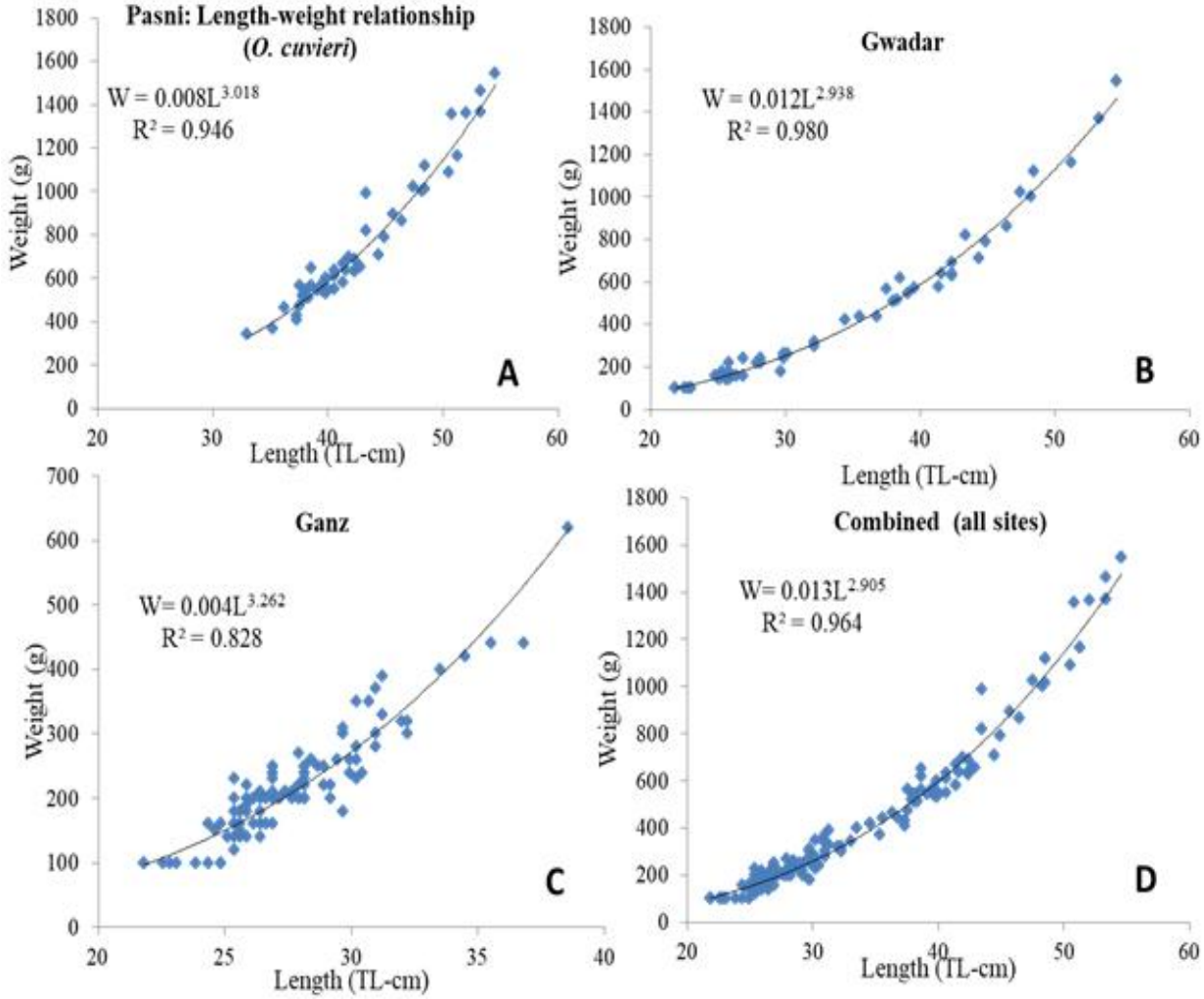

Figure 2. Length-weight relationship of *O. cuvieri* from Pasni (A), Gawadar (B), Ganz (C) and Combine from all sites (D), Balochistan coast

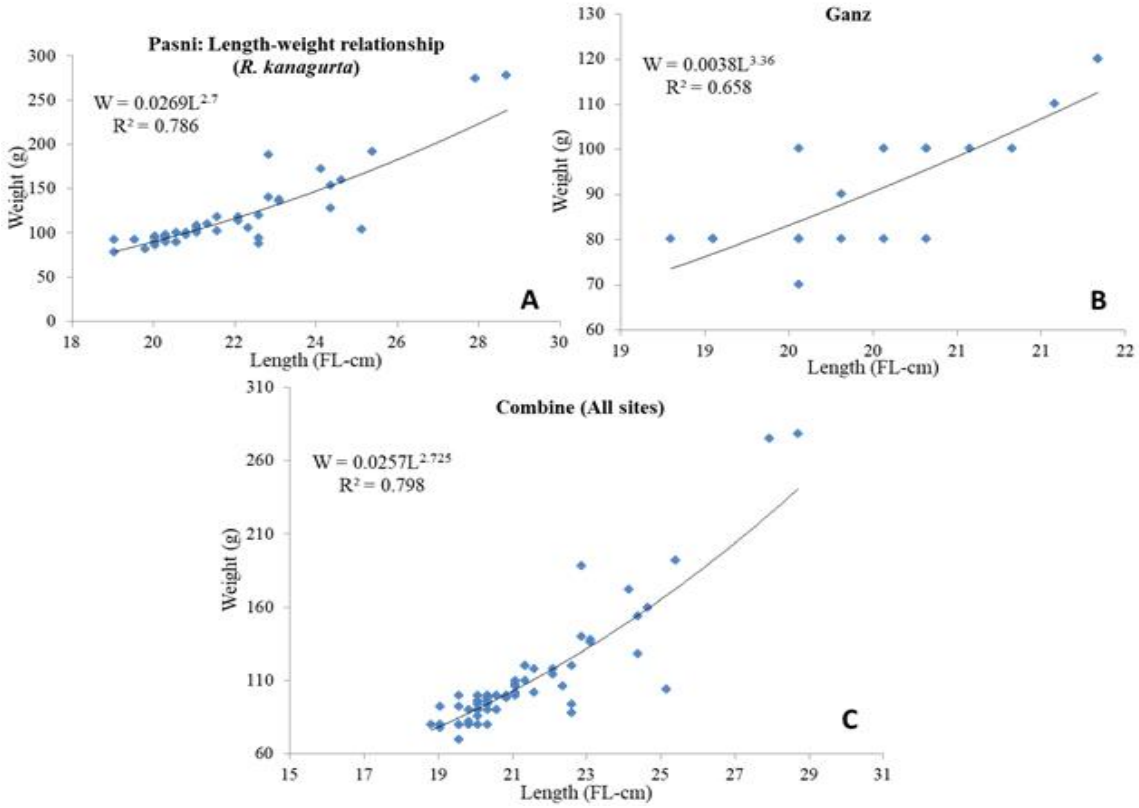

Figure 3. Length-weight relationship of *R. kanagurta* from Pasni (A), Ganz (B), and Combine from all sites (C), Balochistan coast.

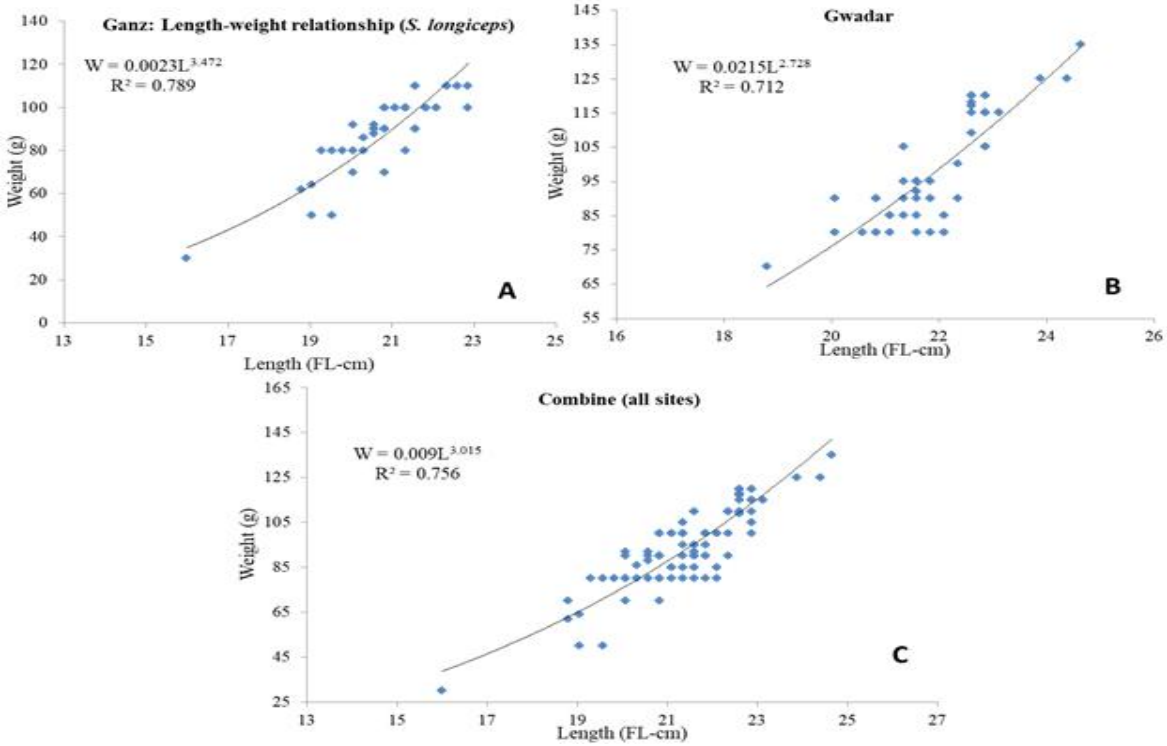

Figure 4. Length-weight relationship of *S. longiceps* from Ganz (A), Gwadar (B), and Combine from all sites (C), Balochistan coast.

DISCUSSION

The length-weight relationship is frequently used to measure species growth and stock assessment. It is also an important element in stock valuation to know the increase in size and weight of species such as isometric or allometric (Abdurahiman *et al.,* 2004; Prasad and Ali, 2007). Again, the length-weight relationship helps to gather information on body transformation, gonadal growth, and feeding rate of fish (Wootton, 1998). The general concept of length-weight relationship of fish denotes when values vary from 2.5 to 3.5, however, the slope '*b'* values greater than 3, indicate fish has positive allometric growth, the slope '*b'* values less than 3, shows the fish has negative allometric growth (Gayanilo *et al.,* 1997, 2003; Froese, 2006). The regression content '*a*' is a scaling coefficient for the weight at the length of the fish, and when '*b*' is within the range of 2.5 to 3.5, then it can be regarded as a condition factor that shows the condition of a fish at the temporal and spatial level (Froese, 2006). Generally, length-weight relationship values are compared with standard values (2.5 to 3.5) given by Le-Cren (1951) and Froese (2006) to better understand the transformation and growth rate of fish species.

The estimated slop '*b'* of *O. cuvieri* of combined data from the Balochistan coast was at '*b'*= 2.905 (R^2=0.964) indicating the isometric growth. The R^2 value shows the strong relation between the length and weight of species indicating model goodness-of-fit which is range from 0-1 indicating 0-100% fitting of data. The finding of this study are within the range of exponent '*b*' values reported from different regions of the world, mainly from Indian and Pakistani waters (Parashant *et al.,* 2006; ManojKumar, 2007; Memon *et al.,* 2015).

The calculated slope '*b*' values of *R. kanagurta* was at '*b'*=2.725 (R^2=0.798), which indicates the isometric growth of Indian Mackerel from Balochistan coast. Similar kind of results were also reported from Pakistan and different parts of the world (Pauly *et al.,* 1996; Moazzam *et al.,* 2005; Al-Mahdawi, 2010; Gondhalli *et al.,* 2013; Bhendarkar *et al.,* 2014; Amin *et al*., 2014; Amin *et al.,* 2015; Ahmad *et al*., 2019). Most of the previous values are close or similar to present findings. Little difference in values may be because of sample collection strategies, time of sample and environmental factors affect on growth.

The combined *S. longiceps* estimated value was '*b'*=3.015 (R^2=0.756), indicating the Indian oil sardine growth is isometric. The current findings of slop '*b*' values was also compared to previous studies such as; 2.54, 2.2, 2.8 from India (Tasaduq *et al.,* 2014), 3.00 from Oman (Abdussamad *et al.,* 2010) and 2.858 from Pakistan (Nadeem *et al.,* 2017), and found within the range of present findings.

It was observed that the previous study slope '*b*' was alike or close to the present findings conducted from the Balochistan coast. Most of the values from different fish landing sites like Pasni, Gwadar and Ganz are similar to previous studies and found isometric growth. Overall, present values from different areas are within the standard values (2.5-3.5) suggested by Le-Cren (1951) and Froese (2006) indicating the positive growth rate signifying that environmental conditions from Pakistani waters are suitable for growth of these species. The estimated values of '*a*' for three species also indicated good environmental condition for the growth of this species in this area. The little difference of slope '*b'* values may be because as of biotic and abiotic factors impact on fish growth (Biswas, 1993; Froese, 2006).

Conclusion: This study provide the basic information of the length-weight relationship of three commercially important fish species (*O. cuvieri*, *R. kanagurta* and *S. longiceps*), from Balochistan, Pakistan, northern Arabian Sea. Present sample data was gathered during research survey project and from three fish landing sites of Balochistan coast. Purpose of the selection of these species is because these species have high economic demand in local as well as international markets and contribute in Pakistan economy. Present findings of slope '*b*' are close / similar to previous studies from worldwide. Little difference in values may be because of change of localities and different environmental factors affect on growth. Since, there are the input parameters for the estimation of stock assessment. The findings of this study will help the scientists to evaluate the stock status of these species and formulate management strategies that will ensure the sustainable exploitation of this species in this region. It is further recommended that additional research may be conducted to understand impact of other factors on the growth rate of fish species for better fisheries management.

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Conflict of interest: The authors declare that there is no conflict of interests regarding the publication of this article.

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