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## POPULATION PARAMETERS OF GOLDEN PONYFISH, *Photopectoralis aureus* AND GOLDSTRIPE PONYFISH, *Karalla daura* FROM SAINT MARTIN ISLAND, BAY OF BENGAL

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### ABSTRACT

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Golden ponyfish *Photopectoralis aureus* and Goldstripe ponyfish *Karalla daura* are small fish with less economic value. Many marine fish population parameters were not investigated because of their low commercial value. Therefore, the primary goals of this study were to determine the size frequency, length-weight relationship (LWR), length-length relationship (LLR) and Fulton's condition factor (Kn) of two tropical ponyfishes from Saint Martin's Island. During March to April 2022, specimens were caught using fixed purse nets. A total of 409 specimens of *P. aureus* and *K. daura* were measured to determine size frequency, LWRs, LLRs, and Fulton's condition factor. For *P. aureus*, the maximum total length (TL) of 12.9 cm sets a new record. The LWRs for *P. aureus* and *K. daura* were highly significant ( $p < 0.001$ ), where coefficient of determination ( $r^2$ ) was 0.985 and 0.869 for *P. aureus* and *K. daura*, respectively. The estimated slope (b) for *P. aureus* and *K. daura* were 3.147 and 2.986, respectively. The LLR equations were  $TL = 1.1089 SL + 0.2689$  for *P. aureus* and  $TL = 0.6792 SL + 3.3309$  for *K. daura*. The Kn value had no significant difference between the species of different length classes for *P. aureus* (0.97-1.40) and *K. daura* (1.19-1.26). There has never been any prior reporting of LWRs or length-length relationships (LLRs) for *P. aureus* in literature or FishBase. The study's findings may benefit the management and conservation of these ponyfishes.

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## INTRODUCTION

Saint Martin's Island is located 9 km south of Cox's Bazar-Teknaf Peninsula in the northeast of the Bay of Bengal, Bangladesh. The biodiversity of Saint Martin's Island is extremely abundant. Saint Martin's Island has a very rich biodiversity comprising seaweeds (153 species), corals (66 species), oysters (187 species), fishes (240 species), birds (120 species), reptiles (29 species) and mammals (29 species) (Froese & Pauly, 2023). Golden ponyfish, *Photopectoralis aureas* (Abe & Haneda, 1972) and Goldstripe ponyfish, *Karalla daura* (Cuvier, 1829), are small ponyfish with low economic worth. Though they have ecological significance, many marine fish population parameters have not been done yet due to their low commercial importance (Abu Hena et al., 2017; Siddique et al., 2020). *P. aureus* and *K. daura* are bycatch species available at the local fish market at a low price (60 to 70 BDT/Kg) (Personal market visit). *P. aureus* and *K. daura* are two common species of the family *Leiognathidae*. *P. aureus* is distributed from Taiwan to Indonesia, the Timor and the Arafura Sea. *K. daura* is widely distributed in India, Sri Lanka, Pakistan, and the Philippines. *P. aureus* are marine, brackish, and demersal fish, mostly found in tropical areas at 70-140 m depth range and found explicitly in offshore coastal areas (Woodland et al., 2002). *P. aureus* is characterized by its long elongated shaped body; mouth projecting forward; teeth are small; skin between jaws and cheeks is heavily pigmented; incomplete lateral line, terminating below the base of 12<sup>th</sup> to 16<sup>th</sup> dorsal fin; dorsal fins are soft; a nearly slim body; maxilla in the posterior limb is short; the upper half is silvery with sporadic marbling and patches of grey-brown color (Woodland et al., 2002). *K. daura* is distributed in the Indo-West Pacific: The Gulf of Aden, India, Sri Lanka, Pakistan and the Philippines (Robins et al., 1991). They are commonly found in Sri Lanka, and Karalla is Sri Lanka's local name for this fish. This fish is demersal and commonly found in the sea at depths of 1 to 40 m (James & Badrudeen, 1981). *K. daura* is characterised by a lateral short body shape and compressed in crossed section; the dorsal head is straight; eyes are less normal; the mouth is protractible, and mouth position is terminal; scales are cycloid; silvery body; dorsal greenish grey with pale vermiculation; a broad yellow stripe in lateral line. Head bears with an elongated mouth pointing downward (Froese and Pauly, 2023).

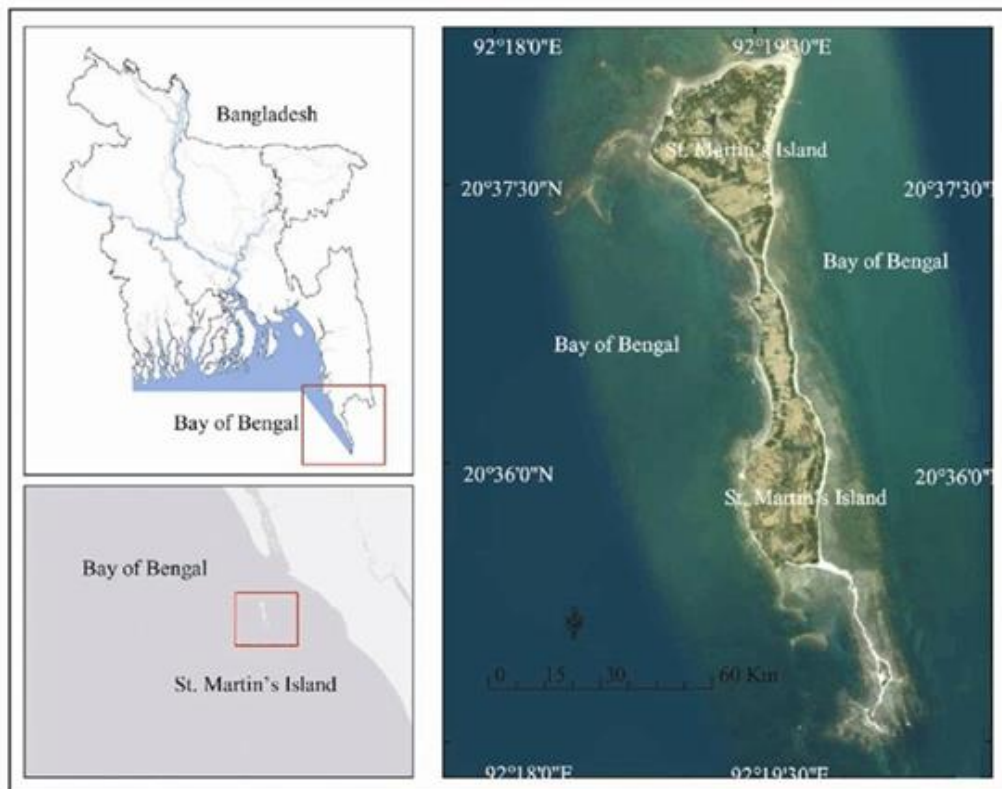
In fisheries science, length-weight relationships (LWRs) are useful to determine the total weight of fish based on length data observations (Baek et al., 2015; Siddique et al., 2015a). The total biomass of an ecosystem can be estimated using LWRs as input parameters (Froese, 1998; Moutopoulos & Stergiou, 2002; Siddique et al., 2015b). Additionally, this information is useful for several biological studies, such as those that examine fish health (fatness, feeding, and breeding state), age structure, growth rates across regions, regional comparisons of fish life-history features, and the suitability of particular environments for a given species (Froese et al., 2011; Jenlyman et al., 2013). LWRs can be used to compare regional and interregional, morphological and life history in species and populations (Kara & Bayhan, 2008; Khan et al., 2012).

Size-frequency studies in fishes strongly correlate with ecological factors and life history characteristics, such as breeding location, aquatic fitness, and stock conditions (Beyer, 1987). Size structure of any fish population represents the interactions of the dynamic rates of recruitment, growth, and mortality (Beyer, 1987). Standing stock, yield and biomass can be estimated using the LWRs, and it is the basis for standardization of length-type data (Froese, 1998). LWR can be used to determine the condition factor of fish or other aquatic animals (Froese, 2006). LWR is related to survival, growth, and reproduction, and specific physical, biological, or environmental changes may impact an aquatic species' condition factor (Le Cren, 1951). The condition factor is also a quantitative indicator of the health and 'well-being' of fish or any aquatic species (Richter, 2007; Siddique et al., 2014; Siddique et al., 2021). To the author's knowledge, there is no previous information on LWR and  $K_n$  of *P. aureus* and *K. daura* from Saint Martin's Island. The main objective of this investigation was to determine the size frequency, LWRs, length-length relationships (LLRs) and  $K_n$  of *P. aureus* and *K. daura* and to compare the selected population parameters of *P. aureus* and *K. daura*. For populations of *P. aureus* and *K. daura*, data on length-weight relationships, length-length relationships, and  $K_n$  are crucial for comprehending their population dynamics, evaluating their health and condition, and developing management and conservation plans meant to secure the long-term sustainability of these species. Through the incorporation of this data into decision-making procedures, involved parties can more effectively tackle the risks facing these populations and encourage their preservation and prudent utilization.

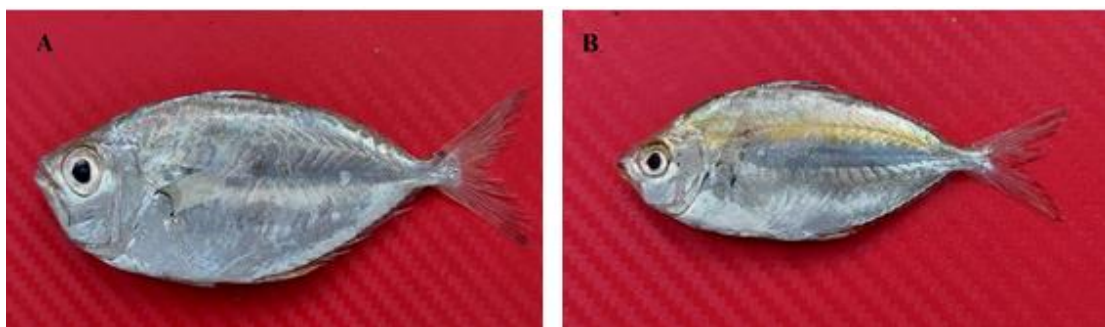
## MATERIALS AND METHODS

### Study area and fish collection

All the samples were collected from Saint Martin's Island (20°36'36" and 92°19'36") of the Bay of Bengal (Fig. 1). Fishermen provided samples that were obtained by using a seine net (last week of March 2022). A Seine net was used to catch fish and the mesh size of the net was 10 to 20 mm. After collecting the fish, samples were cleaned with water and species identification was done. Photographs of *P. aureus* and *K. daura* are shown in Fig. 2. The total length (TL), standard length (SL) and body weight (W) of each fish specimen were measured with a digital balance to the closest 0.1 cm and 0.01 gm, respectively.



**Figure 1.** Sampling locations and study area map.



**Figure 2.** Photograph of (A) Golden pony fish, *Photopectoralis aureus* and (B) Goldstripe pony fish, *Karalla daura*

### Data analysis

PAST 4.17 software was used to analyze all the data. Early juveniles, extremely old, or aberrant specimens were excluded during sample measurement (Siddique et al., 2020). According to Froese (2006), extreme length and weight values were eliminated by visual inspection of outliers before statistical analysis.

The LWRs of *P. aureus* and *K. daura* have been determined using linear regression model (least-squares method). The equation proposed by Le Cren (1951) was used to estimate the LWRs:  $W = a \cdot TL^b$ .

After the logarithmic transformation of length-weight data, this equation was expressed as:  $\log W = \log a + b \log TL$ .

Where  $W$  = wet body weight (g),  $TL$  = total length (cm),  $a$  = intercept of the regression curve and  $b$  = regression coefficient.

For hyper (+) or hypo (-) allometric growth, the allometric coefficient  $b > 3$  or  $b < 3$  was applied, respectively. The coefficient of determination ( $r^2$ ) expresses the quality of linear regression (Scherrer, 1984). The hypothetical value of isometry (3) was tested to see if it fell between these limitations by computing the 95% confidence interval (CI) of  $b$  (Froese, 2006). Using a linear regression analysis, the correlations between  $TL$  and  $SL$  were determined:

$$TL = a + b SL.$$

The  $Kn$  was calculated from the following equation:

$$Kn = 100 \cdot W / TL^3$$

Where  $W$  = wet body weight (g) and  $TL$  = total length of *P. aureus* and *K. daura*.

## RESULTS AND DISCUSSION

### Size frequency

The maximum  $TL$  and  $W$  were recorded 12.9 cm and 28 g for *P. aureus* and 9.8 cm and 11 g for *K. daura*, respectively. The maximum  $TL$  of *P. aureus* (12.9 cm) sets a new record for this species. *P. aureus* individuals from the 6.1 to 7.0 cm length classes (Fig. 3) and *K. daura* individuals from the 7.1 to 8.0 cm length classes dominated 40.54 and 61.30% of collected samples, respectively (Fig 4). Previous studies examined other species, such as *P. bindus*, *P. hataii*, and *P. panayensis*, and *K. dussumieri* (Froese & Pauly, 2023). The size range and weight of the studied fish also varied among different studies. For instance, the present study found that *K. daura* had a  $TL$  range of 6.5-9.8 cm and a weight range of 3-11 g, while James & Badrudeen (1981) reported a larger size range of 5.5-12.5 cm for *K. dussumieri*.

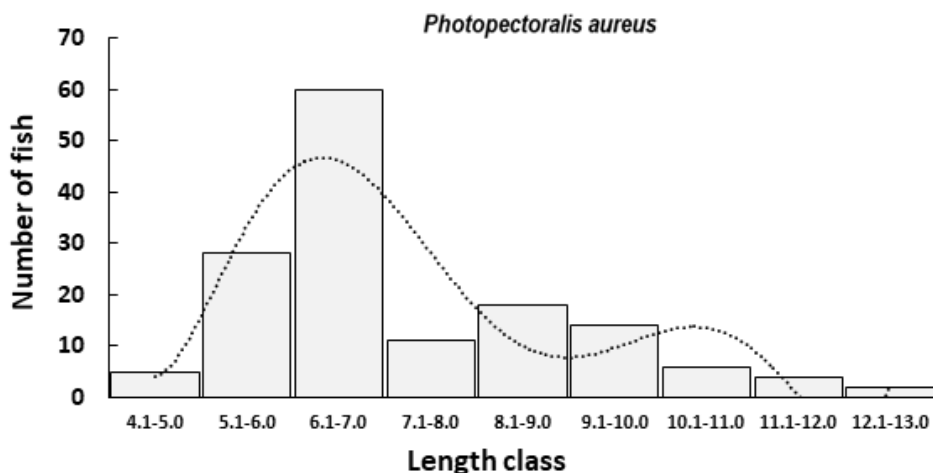


Figure 3. Length frequency of *P. aureus*

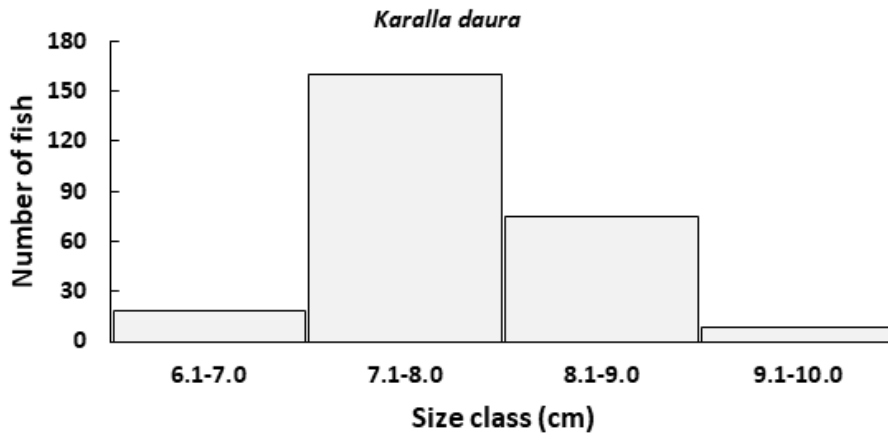


Figure 4. Length frequency of *K. daura*

#### Length-weight relationships

The LWRs for *P. aureus* and *K. daura* were highly significant ( $p < 0.001$ ), and  $r^2$  values were 0.952 and 0.869 for *P. aureus* and *K. daura*, respectively (Table 1). The estimated  $b$  value for *P. aureus* and *K. daura* were 3.147 and 2.986, respectively (Table 1; Fig. 5 and Fig. 6). The calculative growth coefficients ( $b$ ) were indicated a hyperallometric and hypoallometric growth for *P. aureus* and *K. daura*, respectively.

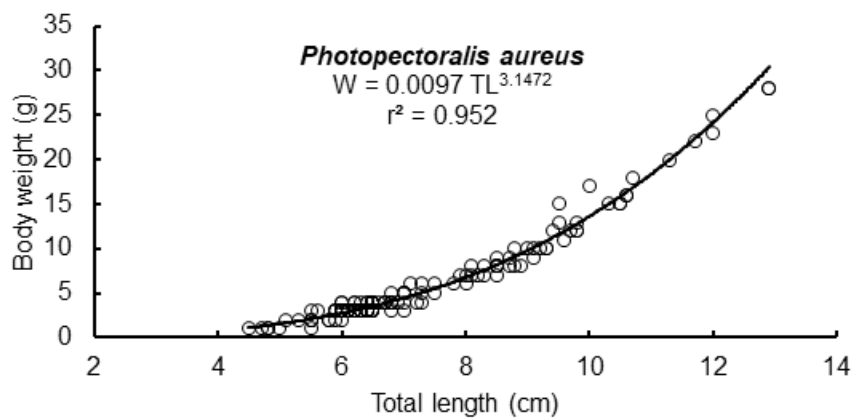
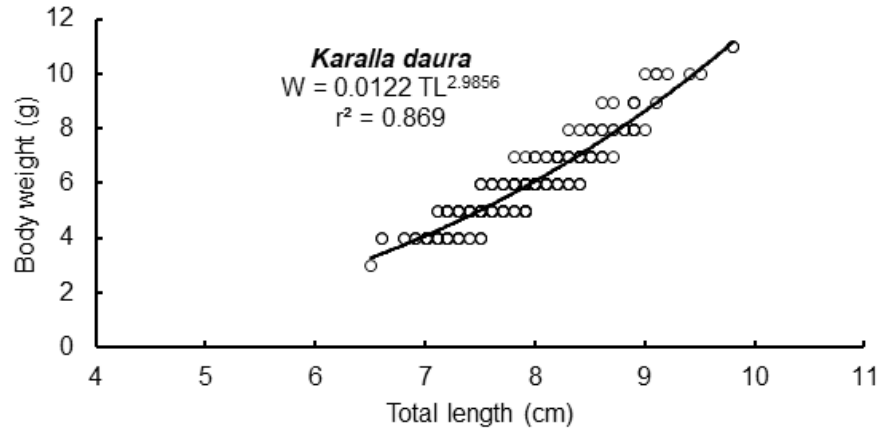
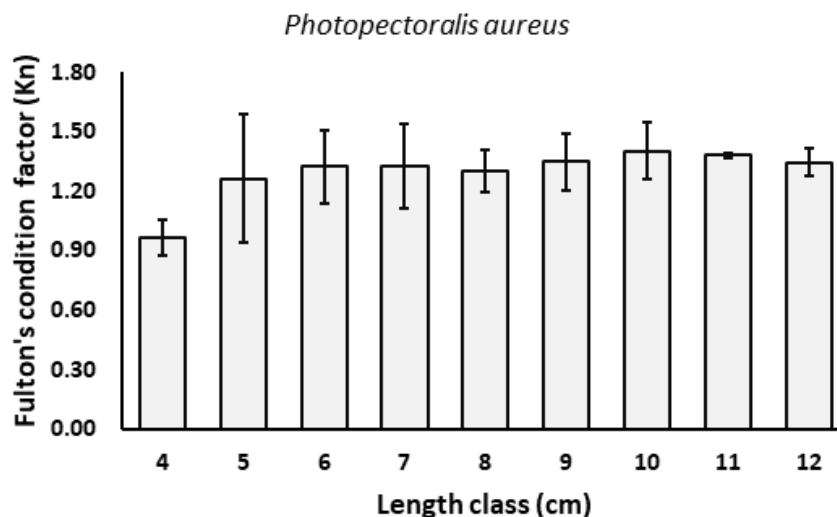


Figure 5. The LWRs of *P. aureus* (arithmetic scale)



**Figure 6.** The LWRs of *K. daura* (arithmetic scale)

The  $b$  value for *P. aureus* and *K. daura* fell within the hypothesized range of  $2.5 < b < 3.5$  (Froese, 2006). The parameters  $a$  and  $b$  for these two species fall within the range of Bayesian LWR predictions (Froese and Pauly, 2023). The  $b$  values for *K. daura* at 95% of confidence limits (2.854 – 3.118) and *P. aureus* (3.035 – 3.266) were very close to the prediction of Bayesian LWRs (Froese, 2006). The current investigation provides valuable insights into the LWRs of *P. aureus* and *K. daura*. While some differences were observed compared to previous research (Table 2), the findings are generally consistent with the positive relationship between length and weight and the use of power function to describe this relationship. Another difference was observed in the regression analysis. The present study found that the LWRs for *Karalla daura* was best described by the equation  $W = 0.0122TL^{2.986}$  with an  $r^2$  value of 0.869, while Corrêa et al. (2015) reported a different equation for *Photopectoralis bindus* with an  $r^2$  value of 0.993. These differences in the regression equations could be due to variations in sample size, environmental conditions, and genetic factors.



**Figure 7.** Variation of Fulton's condition factor (Kn) in different size classes of *P. aureus* from Saint Martin Island, Bay of Bengal.

### Length-length relationships

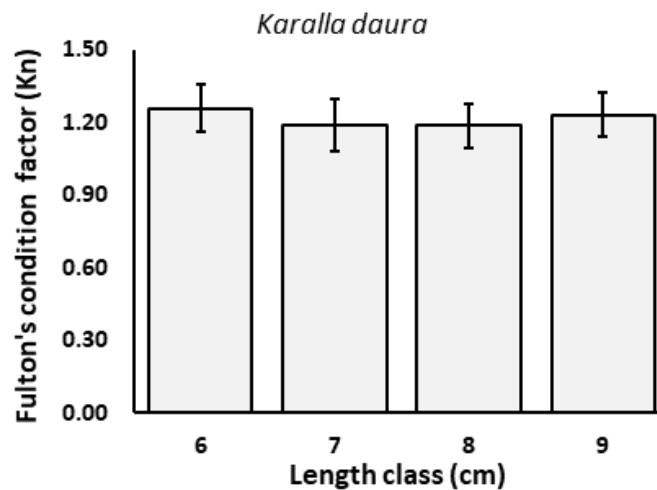
The LLRs for these two species are presented below:

$$Photopectoralis\ aureas\ TL = 1.1089\ SL + 0.2689\ (r^2 = 0.985)$$

$$Karalla\ daura\ TL = 0.6792\ SL + 3.3309\ (r^2 = 0.4023).$$

### Fulton's condition factor

Kn for *P. aureus* (0.97-1.40) and *K. daura* (1.19-1.26) did not significantly differ between specimens of different length classes (Figs. 7 & 8). To our knowledge, no prior reports regarding LWRs or LLRs for *P. aureus* were reported either in the literature or FishBase. The outcomes of this study can be beneficial for the management and conservation of these species.



**Figure 8.** Variation of Fulton's condition factor (Kn) in different size classes of *K. daura* from Saint Martin Island, Bay of Bengal

**Table 1.** Descriptive statistics and LWRs parameters for *P. aureus* and *K. daura* from Saint Martin's Island

Species	N	Total body length (cm)		Total body weight (g)		Regression parameters					
		Min	Max	Min	Max	a	95% CL of a	b	95% CL of b	SE (b)	r <sup>2</sup>
Golden pony fish, <i>Photopectoralis aureus</i> (Abe & Haneda, 1972)	148	4.5	12.9	1	28	0.0097	0.0077-0.0123	3.147	3.035-3.266	0.059	0.952
Goldstripe pony fish, <i>Karalla daura</i> (Cuvier, 1829)	261	6.5	9.8	3	11	0.0122	0.0093-0.0161	2.986	2.854-3.118	0.064	0.869

N = sample size, Min = minimum, Max = maximum, a and b parameters of LWRs, CL = confidence limits, SE (b) = standard error of slope, r<sup>2</sup> = coefficient determination

**Table 2.** Descriptive statistics and LWRs for the genus *Photopectoralis* and *Karalla* from different world locations

Species	N	TL range (min-max)	a	b	r <sup>2</sup>	Location	References
<i>Photopectoralis aureas</i>	148	4.5 - 12.9	0.0097	3.147	0.952	Saint Martin's Island	Present study
<i>Photopectoralis bindus</i>	239	4.4 - 10.8	0.01750	2.934	0.993	Strait of Hormuz, Iran	Corrêa et al., 2015
	365	5.4 - 12.2	0.01670	2.962		Kakinada, India	Murty, S.V., 1983
	141	7.6 - 10.7	0.12600	2.054	0.670	Southern coast of Karnatak, India	Abdurahimet al., 2004
<i>Photopectoralis hataii</i>		4.8 cm SL	0.01862	2.97		Western Pacific Ocean (Taiwan, Philippines, Thailand, Singapore, Indonesia, and northern Australia)	Kimura et al., 2003
<i>Photopectoralis panayensis</i>		8.3 cm SL	0.01862	2.97		Western Pacific Ocean (Taiwan, Philippines, Thailand, Singapore, Indonesia, and northern Australia)	Kimura et al., 2003
<i>Karalla daura</i>	261	6.5 - 9.8	0.0122	2.986	0.869	Saint Martin's Island, Bangladesh	Present study
<i>Karalla dussumieri</i>	105	5.5-12.5	0.01640	2.959		India	James et al., 1981

N = sample size, Min = minimum, Max = maximum, a and b parameters of LWRs, r<sup>2</sup> = coefficient determination

## CONCLUSION

This study reveals new information on the LWRs, growth coefficients, and LLRs of two marine species, *P. aureus* and *K. daura*, from Saint Martin's Island. For *P. aureus*, the highest TL ever reported sets a new record. From this study, the LLRs, LWRs can be used for the management and conservation purposes of these two species in their respective habitats. Additionally, the absence of significant variations in Kn among different length classes for both species suggests that they were in good condition in the study area. Overall, this study adds to the knowledge of the biology as well as ecology of these marine species and emphasizes the importance of further research in this field to better understand and conserve these unique and important organisms.

## Credit authorship contribution statement

Fahmida Akter: Conceptualization, Methodology, Investigation, and Writing – original draft, Reviewing and editing and supervision; Tanzim Akter: Methodology, investigation and writing; Mohammad Abdul Momin Siddique: Conceptualization, Methodology, Investigation, writing original draft, Reviewing and editing.



## DECLARATION OF COMPETING INTEREST

The authors certify that none of their known financial conflicts or interpersonal connections influenced the work presented in this publication.

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