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Growth Performance of Layang (Scad) Fish (*Decapterus russelli,* Ruppell 1830) Caught from Tomini Bay, Indonesia

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Abstract

Regarding exploitation and optimizing fisheries resources management in Tomini Bay, the Layang scad fish (Decapterus russelli, Ruppell 1830) is one of the small pelagic fishes inhabiting the bay that still lacks biological information. The species becomes the main target commodity for local fishers as it is commonly consumed as a protein source for coastal communities. This study aimed to determine the length-weight relationships and the growth pattern of Layang fish caught by fishers from Tomini Bay. The samples were collected once per month at Gorontalo City Fish Landing Spot from April to June 2020. Tomini Bay was confirmed as the fishing ground of all the landed fish. Layang is caught by Mini purse seines with a minimum mesh size of ¾ inch. A total of 896 samples of Layang fish were collected randomly from the fishers' catch during their unloading activity at the landing site. Abdomen dissection was performed on all samples for determining the fish's sex. The fish samples' total length and body weight were measured using a ruler (nearest = 1 mm) and a scale (nearest = 0.01 gram). The result revealed that the length-weight equation of male Layang was $W = 0.000004\ L^{3.1972}$ *(*$R^2 = 97.57\%$*), and that of female was* $W = 0.0000007\ L^{3.0613}$ *(*$R^2 = 98.99\%$*). This result implied a positive allometric growth pattern, excluding the females in April 2020.*

Keywords: Gorontalo; scad; length-weight relationship

Introduction

Tomini Bay forms a semi-enclosed water area (Miller *et al*., 2016) that is fertile (Kadim *et al*., 2019) with high marine biodiversity supported by the availability of phytoplankton (Kadim *et al*., 2018) as a primary food source. Diverse species of marine mammals also inhabit the bay (Mustika *et al*., 2021), various pelagic fishes (Mardlijah and Patria, 2016; Pasisingi *et al*., 2020a; 2020b; 2021a; 2021b), small amphidromous fishes (Olii *et al*., 2017; Pasisingi and Abdullah, 2018; Olii *et al*., 2019; Pasisingi *et al*., 2021c; 2020b; 2020c), as well as macrozoobenthos (Kadim *et al*., 2022). Moreover, local wisdom supports the sustainable management of coastal and marine resources in Tomini Bay (Obie, 2018).

Scientific data of Tomini Bay pelagic fish population dynamics are still minimal, making the level and utilization of the fish resources uncontrollable. Therefore, efforts to optimize fish resources to maximize the community's welfare around the bay area are still not optimal. Layang fish (*Decapterus russelli,* Ruppell 1830) that has the common name Scad (Sunaryo *et al*., 2019; Suwarso and Zamroni, 2015) or Indian Scad (Poojary *et al*., 2010; Chiesa *et al*., 2019) is one of the pelagic species of the Carangids group which is widely distributed including Tomini Bay as a part of the Indo-Pacific region (Panda *et al*., 2012), western Indian Ocean, and northern Arabian Sea (Kalhoro *et al*., 2017). Apart from having a substantial economic value (Khasanah *et al*., 2020) and being in demand by the broader community due to its taste, the fish also contains protein (Cahyono and Mardani, 2020; Fatma *et al*., 2020) to be consumed as a source of food nutrition. Diversification of Layang fish's products and processing (Tondais *et al*., 2020; Kurniawan *et al*., 2020a; 2020b; Henra *et al*., 2020; Paparang, 2013) were also being developed in order to meet market demand for the commodity.

The lack of scientific data on Layang fish resources in Tomini Bay is a challenge in determining and formulating the proper management direction by considering Layang fish *D. russelli* as the target fish caught by fishers in Indonesia as in Tomini Bay (Lawadjo *et al.*, 2021), Malacca Strait (Alnanda *et al*., 2020), Makassar Strait (Cahyono and Mardani, 2020) and Ternate (Tangke, 2020). *D. russelli* is also one of four species commonly caught by fishers from Ambon Island waters (Pattikawa *et al*., 2018). In Tomini Bay, such information has not been reported. Therefore, comprehensive and up-to-date data on Layang fish's condition in nature is needed to monitor their availability and sustainability. This study aimed

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to ascertain the Layang fish D. russelli's growth pattern and length-weight connections in Tomini Bay.

Materials and Methods

From April to June 2020, sampling was done at Gorontalo City Fish Landing once each month. The location of the fishing area in Tomini Bay was verified. The Layang fish were obtained in Tomini Bay using micro purse seines with a mesh size of no less than 34 inches. 896 Layang fish samples were picked at random from the fishermen's catch at the landing site (Figure 1.). The total length and weight of the samples were estimated using a ruler with a minimum precision of 1 mm and a scale with a minimum precision of 0.01 g. The abdomen was dissected to determine sample sex.

Data analysis

The following equations were used to determine the link between the samples' total length and body weight (De Robertis and Williams, 2008):

$$W = a L^b$$

where: W = body weight (gram); L = total length (mm); a = constant value; b = growth parameter

A natural logarithmic transformation was applied to make a relationship linear as follow:

$$\ln W = \ln a + b \ln L$$

Through least-squares regression, the a and b length-weight relationship parameters and the coefficient of determination (R2) were derived. The growth dimensions of body width, length, and depth were calculated using the slope b value. Testing the value of b from the equation using the t-test with a 95% confidence level allowed researchers to determine the fish growth pattern (Steel et al., 1993). Growth displays an isometric pattern when b = 3, a negative allometric pattern when b 3, and a positive allometric pattern when b > 3. (De Guzman and Rosario, 2020).

Result and Discussion

The length ranges of samples found in this study were 77-290 mm and 87-286 mm for male and female fish, respectively. For example, D. russelli's length ranged from 110 to 225 mm in Trincomalee District, Sri Lanka, from October 2019 to January 2020 (Anushika et al., 2020), whereas the Indian scad's length ranged from 102 to 185 mm in the seas near Tasikagung Fishing Port of Rembang (Khasanah et al., 2020). The total number and variation in length and body weight of D. russelli discovered during the course of the three-month sample period were both observed (Figure 2.). Males' total lengths often fell between 77 and 98 mm and females' total lengths typically fell between 121 and 142 mm across the three-time samplings.

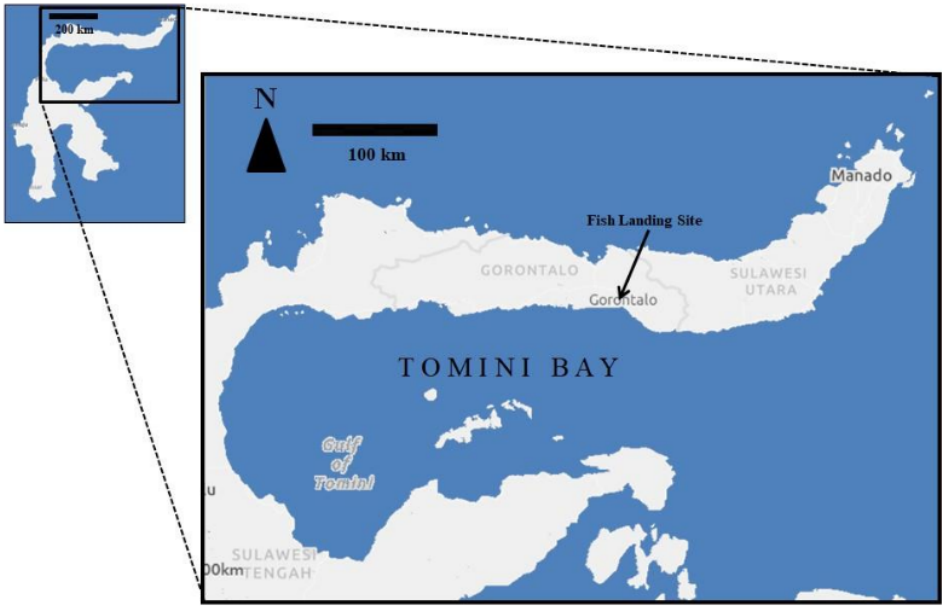

Figure 1. Fishing Area and Gorontalo Fish Landing Site of Layang Fish *Decapterus russelli*

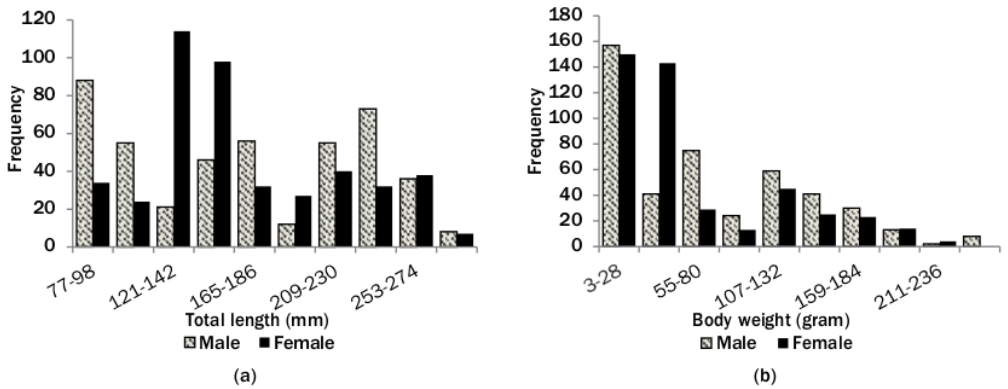

Figure 2. Frequency distribution of *Decapterus russelli* in Tomini Bay based on (a) total length and (b) body weight

The fish length-weight analysis is essential to monitor their stocks and biological conditions to ease the implementation of fish sustainability and biodiversity management (Agista *et al*., 2019). The relationship of total length and weight of male and female *D. russelli* based on monthly and combined data are shown in Figure 3. Khasanah *et al.* (2020) found that the length-weight relationship of the Layang fish in Tasikagung Fishing Port of Rembang from January to April 2019 was W = 0.0000546 $TL^{2.73}$, while in Probolinggo Regency, Indonesia during January to May 2017 it was W = 0.0049 $L^{3.2882}$ (Bintoro *et al*., 2019). In Mayangan Probolinggo, Indonesia, from December 2017 to April 2018, W = 0.014 $L^{2.8513}$ (Bintoro *et al*., 2019).

The determination coefficient (R^2) that describes how well the model fits the data (Nakagawa et al., 2017) on the polynomial equation in this study is relatively high, above 95%. The R^2 value in this study is quite diverse when compared to several previous studies. In comparison, the *D. russelli* caught by purse seine from March to August 2014 in the waters around Pemangkat Fisheries Port, West Kalimantan was W = 0.0093 $L^{3.1309}$ with R^2 = 87.19 % for males and W=0.0094 $L^{3.1359}$ with R^2 = 85.76 % for females (Faizah and Sadiyah, 2020). In addition, the Layang fish in Malaka Strait taken from April to September 2016 had W = 0,0057 $L^{3.2984}$ (R^2 = 97.45 %) for males and W = 0,0079 $L^{3,183}$ (R^2 = 98.25 %) for females (Faizah and Sadiyah, 2020). From the fisheries biology perspective, the length and weight relationship of the fish are important information that need to provide for fisheries resources management (Bernas, 2016).

Many studies employ length-body-weight relationship data to forecast fish growth patterns. Fish can grow isometrically, negatively allometrically, or positively allometrically. An isometric pattern is associated with no change in body shape as a result of personal development. Furthermore, negative allometric growth indicates that the fish becomes more slender as its weight grows, whereas positive allometric growth indicates that the fish becomes deeper or stouter as its length grows. (Riedel et al., 2007). Except for females in April, all growth trends of Layang fish in this study are positive allometric. 2020 (Table 1.). There is no other plausible explanation for the fish growth pattern besides the possibility that it is related to stomach fullness, and it is linked to environmental factors, specific species anatomical traits, and environmental conditions. (Jisr *et al*., 2018). In the present study, it is predicted that the gonadal development of *D. russelli*is in the spawning season. The spawning season of *D. russelli* in this study is the same as in the Malacca Strait waters in which happen from April to October with a peak in October (Hariati *et al*., 2017). In that case, it is assumed that the female Layang fish in Tomini Bay in April 2020 are still at the beginning of gonadic growth. Therefore, the body in April is relatively less plump than in the following months. Environmental elements that are favorable for fish spawning (temperature, salinity, and climate) control the fish spawning season. (Bintoro *et al*.,2019).

The growth pattern of Indian scad for males and females in the south of China Sea (Faizah and Sadiyah, 2020), in Paiton, Probolinggo Regency from January 2017 to May 2017 *(Bintoro et al*., 2019) and in Inengo, Gorontalo from February 2021 to March 2021 (Pasisingi *et al*., 2021d) also revealed positive allometric. However, a negative allometric growth pattern was shown by *D. russelli* in Trincomalee District, Sri Lanka during October 2019 to January 2020 (Anushika *et al*., 2020) and from December 2017 to April 2018 in Mayangan Probolinggo, Indonesia (Bintoro *et al*., 2019). The Layang fish in Latuhalat waters, Ambon in June- August 2016 showed positive allometric growths except for males

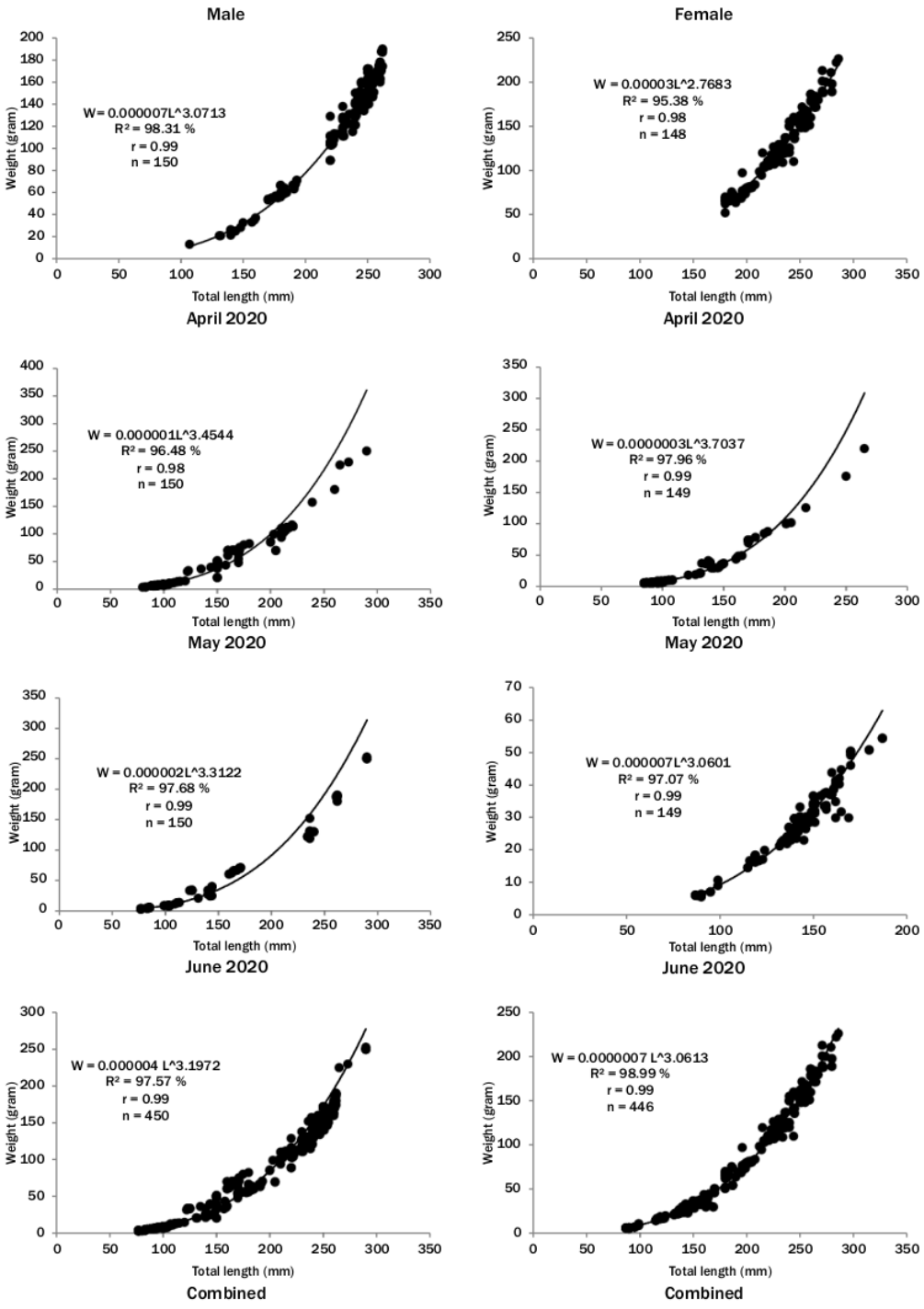

Figure 3. Length-Weight Relations of *Decapterus russelli* in Tomini Bay

Table 1. Linear relation of length-weight data and growth patterns of *D. russelli* in Tomini Bay

Sampling periods	Male		Female	
	Length-Weight linear relationships	Growth pattern	Length-Weight linear relationships	Growth pattern
April 2020	ln W = -11.9189 + 3.0713 ln L	positive allometric	ln W = -10.264 + 2.7683 ln L	negative allometric
May 2020	ln W = -13.6983 + 3.4544 ln L	positive allometric	ln W = -14.9327 + 3.7037 Ln L	positive allometric
June 2020	ln W = -13.0305 + 3.3122 ln L	positive allometric	ln W = -11.8668 - 3.0602 ln L	positive allometric
Total	ln W = -12.5017 + 3.1972 ln L	positive allometric	ln W = -11.8687 + 3.0613 ln L	positive allometric

(p value < 0.05)

of August 2016, which showed an isometric growth pattern (Ongkers *et al*., 2016).

The variation in growth patterns might be caused by differences in species, gonad maturity, spawning factors, food, sex, and age (Randongkir *et al*., 2018). Availability of supportive food and aquatic habitat characteristics might influence the variation of fish growth patterns (Nugroho *et al*., 2018) thus the food consumed will have an impact on each individual's growth and maturity as well as the fish's success in living. (Effendie, 2002).

Conclusion

The polynomial equation for the male Layang scad fish Decapterus russelli's weight and length is W = 0.0000007 L3.0613 (R2 = 98.99%), and for the female it is 0.000004 L3.1972 (R2 = 97.57%). Except for the female pattern in April 2020, the growth of male and female Scad fish in Tomini Bay exhibits a favorable allometric pattern. These numbers illustrated the biological and environmental conditions that the species encountered. These results typically showed that species are under good biological and ideal environmental conditions, notwithstanding the need for more verified time series data. To maximize the use of D. russelli in Tomini Bay, it needs to be preserved or perhaps improved.

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