Biological Aspects of Fourfinger Threadfin, *Eleutheronema tetradactylum* (Shaw, 1804) Caught in Lekok Waters, Pasuruan, East Java

Tri Djoko Lelono[1*], Agus Tumulyadi[1], Wahida Kartika Sari[1], Indri Sari Ismaningsih[1]

[1] Faculty of Fisheries and Marine Sciences, Brawijaya University, Indonesia,
* Correspondence author
*Correspondence Email: t.djoko@ub.ac.id

ABSTRACT

Fourfinger threadfin *Eleutheronema tetradactylum* has a local name, namely laosan fish by the coastal community of Lekok Pasuruan District, a type of demersal fish that can swim in brackish waters. This research aimed to determine the biological aspects, namely the relationship of Length to Weight, sex ratio, and to determine the feasibility of catching based on the measurement results of the length of the first caught (Lc) and the length of the gonads first ripened (Lm). This research was conducted based on catches during Januari - March 2020 for total samples of as much as 450 fish, based on the catch of gill nets. The result informed that the length and weight relationship was negative allometric. The sex ratio between male and female was 1.00: 0.00. During the study, no female gonads were found because the fourfinger threadfin had spawned protandrous hermaphrodites. The value of length at first maturity (Lm) and length at first capture (Lc) was 20.99 ± 0.13 cm and 24.66 ± 0.046 cm. Lc > Lm's value proves that the fish caught is dominant gonad ripe fish so that the fish is suitable for catching and the fishing gear used selectively.

Keywords: *Length-weight relationship, length at first mature (Lm}, Length at First Catch (Lc), Sex Ratio*

1.INTRODUCTION

Eleutheronema tetradactylum in Japan and Taiwan known as Eleutheronema rhadinum (East Asian fourfinger threadfin) likes to inhabit shallow and cloudy areas and is rarely found in clear deep sea waters, is an amphidromous marine species migrating to brackish and freshwater (Riede, 2004,)(Motomura, 2004) (Motomura et al., 2002) (Pember et al., 2005)(with pectoral fin color markings (i.e., solid black versus bright yellow), squamation of the lateral line on the caudal fin membrane, and a different number of scales of the porous lateral line and those above or below the lateral line, E. rhadinum is a commercially crucial species for coastal and inshore small-scale fisheries, but is rarely studied to understand its life history, including age and growth, is known to be present only in the East Asian waters around China, Japan, Taiwan, and Vietnam, being endemic to the area (Motomura, 2003 ; Horne et al., 2013; Su et al., 2020).

Eleutheronema tetradactylum has biological characteristics showing information regarding age composition, growth rate, mortality, and reproductive biology, including length and age at spawning. The growth pattern is the most influential characteristic of life history, to control the population productivity of a fish species. Biological aspects is a such as length and weight relationship can not only explain the different fish stocks but to assist effective management of fishing activities. (Pember, 2006; Ballagh *et al*., 2012).

Biologically *E. tetradactylum* species prefer to inhabit shallow, cloudy areas and are almost never found in clear deepsea waters. Found in tropical to subtropical waters around the world (Indo-West Pacific, from the Persian Gulf to the east to Papua New Guinea and northern Australia-Figure (Motomura, 2004; Zischke *et al*., 2009; Jaferian *et al*., 2010; Ismail *et al.*, 2019). Several studies have shown that the reproduction of the fish species E. tetradactylum undergoes protandric hermaphrodite where there is a change in sex from male to female when growing up (Zamidi *et al*., 2012; Pember, 2006; Ballagh *et al*., 2012).

Fourfinger Threadfin is a silvery gray perciform sea fish from the head to the body

and a lighter color at the bottom of the Polynemidae family. This fish has a characteristic short filament on its pectoral fins that helps it find prey in cloudy waters. It has a lateral line extending from the top of the body to the tip of the caudal fin (Motomura, 2004; Jaferian *et al*., 2010; Pember, 2006). *E. tetradactylum*most were caught using gill nets. In the rainy season, the catch is relatively large. Most of the samples in this study were captured, usually choosing a larger mesh size than other types of fishing gear (Pember, 2006; Ballagh *et al*., 2012; Tirtadanu & Chodrijah, 2018).

The presence of fourfinger threadfin fish is important for the balance of ecology and economic activity. Total production in June 2019 was 1,400 kg with a production value of Rp. 23,800,000 has high economic value. These fish are mostly caught using gill nets with vessels <5 GT. It is feared that this will lead to overfishing of the Lekok waters. This research examines the reproductive biology aspects of fourfinger threadfin so that it can provide information on planning a resource management option so that it can be utilized optimally and sustainably.

2. MATERIAL AND METHODS

Relationship of Length and Weight

The relationship between Weight and Weight was analyzed using the following formula (Ballagh *et al*., 2012):

$$W = axL^b \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where:
W = fish weight (grams)
L = fish length (cm)
$a. b$ = regression coefficient / constant

The above equation is converted into a linear equation as follows (Tirtadanu dan U. Chodrijah, 2018):

$$Ln\, W = Ln\, a + b\, Ln\, L \ldots\ldots\ldots\ldots\ldots (2)$$

To determine the growth pattern, a t-test (partial test) was carried out on the value of b with the following hypothesis:

- H0: the value of b = 3, which means that the relationship between Length and Weight is isometric
- H1: the value of b ≠ 3, which means that the relationship between the length and Weight is allometric

To test whether the value of b is equal to 3, a t test is performed with the following equation (Sasmito *et al*., 2016):

$$T_{hitung} = \left|\frac{3-b}{sdb\,/\,\sqrt{n}}\right| \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where:
sdb = standard deviation of the value of b
n = number of fish samples
T_{tab} = 0,05; (n-1)

Gonad Somatic Index

According to Anjani et al, (2018), it is determined based on the ratio of gonad maturity, which is as follows:

$$GSI = \frac{WG}{WT}\, x\, 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where:
GSI = Gonado Somatic Index
WG = Weight of the gonads (grams)
WT = Fish body weight (grams)

Gonad Maturity Level

According to Wujdi *et al.*, (2013), the level of gonad maturity can be observed visually following the standard gonad maturity scale as follows: TKG I Immature / (immature), TKG II development / (developing), TKG III ripening / (ripening), TKG IV Matured (mature), TKG V spent.

Sex Ratio

The sex ratio is determined by comparing the frequency of male and female fish using the following formula (Anjani *et al.*, 2018):

$$NK = \frac{\sum J}{\sum B} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

where:
NK = Sex ratio (male or female)
$\sum$J = Number of male fish (tail)
$\sum$B = Number of female fish (tail)

Then The x2 test (Chi-square) was carried out using Equation 6 as follows (Dahlan *et al.*, 2015):

$$x2 = \frac{\sum(Oi-Ei)}{Ei} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

where:
$x2$ = Calculated chi-square test
Oi = Observations of male and female fish
Ei = Expected value in male and female fish.

Length at first mature (Lm)

Length at first mature (Lm) is used to

 P-ISSN:2356-3109 E-ISSN: 2356-3117

estimate the first time the fish is cooked gonad, which can then be used to estimate the age of the fish. According to Sparre & Venema (1999), The formula for Lm is as follows:

$$Q = \frac{1}{1+e^{-a(L-Lm)}} \text{ ……..….(7)}$$

where:
Q = Long class fraction of mature gonads
1 = Maximum value indicates 100% ripe
e = 2,718
a = Constant
L = Long class interval
Lm = length of fish when 50% gonads are ripe
Furthermore, the above equation is converted into linear like the following equation (Anjani *et al.*, 2018):

$$Ln\ (Q\ /\ (1\ -\ Q))\ =\ -a\ x\ Lm\ +\ a\ x\ L \quad (9)$$

Length at First Catch (Lc)

According to Sparre & Venema (1999), the value of Lc can be calculated using the following equation:

$$y' = \text{Ln Fc}\ (x + dL) - \text{Fc}(x) \text{…….(10)}$$

Fc (x) is a normal distribution curve that has the following equation (Anjani et al., 2018):

$$\text{Fc}(x) = \frac{n\ x\ dL}{s\sqrt{\pi}} x\ \frac{-(x-\ddot{x})^2}{2s^2} \text{…….(11)}$$

where:
Fc = calculated frequency
n = number of observations
dL = class interval
s = standard deviation
ẍ = average count
π = 3.14
The above equation is converted in linear form into the following equationSparre & Venema (1999):

$$\Delta\ \text{Ln Fc}\ (z) = a - b\ x\ \left(L + \left(\frac{dL}{2}\right)\right) \text{….(12)}$$

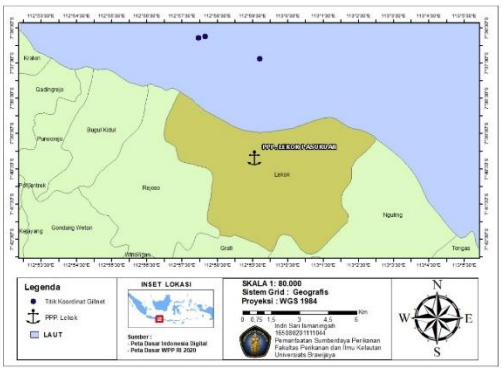
where:
Δ Ln Fc (z) = difference in Length in Ln
Z = difference of two length classes
$L + \left(\frac{dL}{2}\right)$ = upper limit on class length
a, b = constants

3. RESULTS AND DISCUSSION

Results

a. Geographical and Topographic Location

Lekok Subdistrict is a sub-district in Pasuruan Regency which is geographically located at 7 ° 30 "- 8 ° 30" South Latitude and 12 ° 30 "- 113 ° 30" East Longitude with an area of 46.57 km2. The condition of the substrate in the fourfinger threadfin fishing area is muddy sand with shallow water depth. The map of the research location is shown in Figure.
1.



Picture 1. Research Location Map

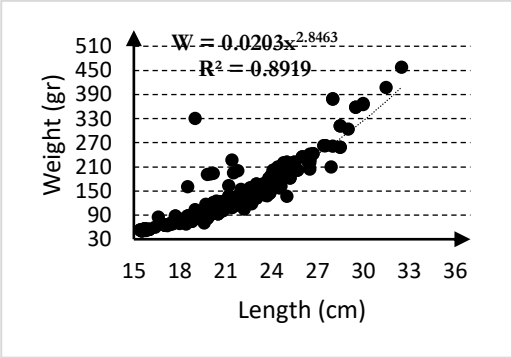
b. Fourfinger threadfin Identification

Fourfinger threadfin (*Eleutheronema tetradactylum*) is shown in Figure 2, has a long, slightly rounded body (torpedo). The mouth type of this fish is terminal. It has two dorsal fins (dorsal), the pelvic fins are located on the pectoral fins, for the anal fin is separated from the caudal fin with a forked tail fin, while the tail fin of the fourfinger threadfin is a white homocercal and has black color on the edge of the tail. His eyes are round and slightly convex outward.

Picture 2. Fourfinger threadfin fish caught by fishermen in Lekok Waters

c. Relationship of Length and Weight

The results of measuring the Length and Weight of 450 fourfinger threadfin in Januari-March 2020 found that this fish is negative allometric (b <3) with the equation W = 0.02 * FL 2.846 and R2 = 0.891, this means that the increase in length is more rapid versus weight gain is shown in Figure 3.



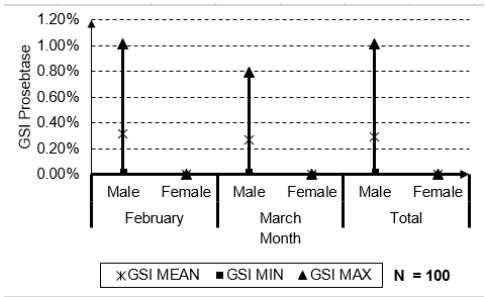
Picture 3. Graph of the Relationship between Length and Weight

d. Sex Ratio

Fish samples obtained were 100 heads consisting of 100% male fish (100) and 0% for female fish). The sex ratio between male and female shows the number 1.00: 0 (100% male and 0% female), male fourfinger threadfin population is more dominant than female fourfinger threadfin.

e. Gonad Somatic Index

The results showed that the average value of the gonad survival index was 0.29% in male fourfinger threadfin and 0% in female fourfinger threadfin as shown in Figure 4. No female gonads were found because they experienced protandausal hermaphrodite spawning.

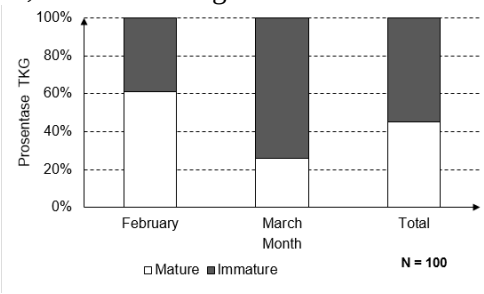


Picture 4. Maturity Index Value of Male and Female Gonads per Month

f. Gonad Maturity Level

Fourfinger threadfin was observed visually with a sample of 250 male fish. Overall, there were no female fish that had various gonad maturity levels (IV), and no gonads were found at the level (V) during the study. In the overall percentage obtained from the calculation of the total amount divided by the number of certain TKG phases, the male fourfinger threadfin yield at TKG I was 22%, TKG II was 33%. TKG III of 26% and TKG IV of 19%

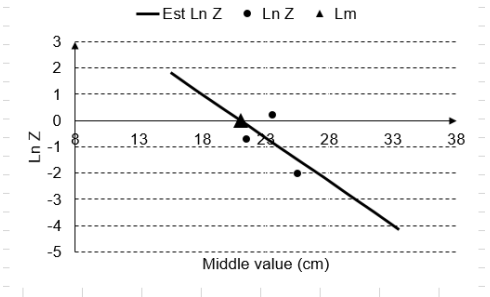
The overall percentage of100 samples obtained 45% mature and 55% immature values , as shown in Figure 5.



Picture 5. Maturity Index Value of Male and Female Gonads per Month

g. Length of First Mature (Lm)

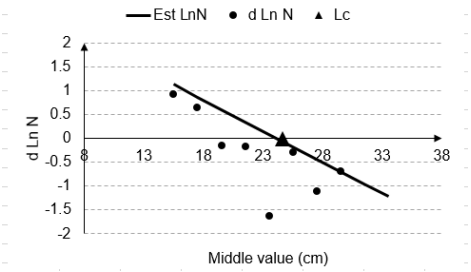
The results in this study obtained the value of the total male fourfinger threadfin with a total sample of 450 fish of 20.99 ± 0.13 cm shown in Figure 6.



Picture 6. Size for the first maturity of male and female gonads

h. Length of First Catch (Lc)

The results of the study with a sample of 450 fourfinger threadfin obtained a length at first capture value of 24.66 cm, where Y = -0.1305x + 3,2181 with a significance F value of 0.029 is shown in Figure 7



Picture 7. Size of the first catch during the study period

 P-ISSN:2356-3109 E-ISSN: 2356-3117

Discussion

According to Gebze & Latupeirissa (2017), differences in length and body weight range are due to food competition, namely the number of other fish that use the same food and the availability of food in the waters, age, the number of male and female individuals and Gonad Maturity Level. Factors that influence fish growth are temperature and water quality, size, age, and type of fish themselves, as well as the number of other fish that use the same resources. The fish size will also affect temporary changes in certain body parts such as fins and growth-related shedding of fish, especially in small fish at the growth stage

During the study, no female gonads were found because the fourfinger threadfin Experienced a hermaphrodite protandrous spawning cycle, namely the ability to change the genital organs along with the development of size and age, maturing first as a male and then becoming a female later in life. However, little is known about the growth and size at maturity of this species (Motomura, 2004; (Wijopriono et al., 2012,). The sex ratio is determined based on the proportion of the number of fish species to male and female. The sex ratio describes the difference between males and females. This difference aims to identify the number of males and females in the waters. The sex ratio describes the difference between males and females. This difference aims to identify the number of males and females in the waters. Sex ratios in tropical areas such as Indonesia are varied and deviate from 1: 1(Aswady et al., 2019).

Gonad Somatix Index is calculated to determine the ratio between gonad weight and body weight expressed in percent. Gonad Somatix Index is a value in% (percent) as a result of the comparison of gonad weight to fish body weight. In line with the growth of the resulting gonads, they will get bigger and heavier to the maximum limit when spawning occurs. The Gonad Somatix Index is information to determine the changes that occur in the gonads quantitatively (Sangadji, 2014).

The fish spawn gradually (partially), not the same as the maturation process of the gonads, is an indication that this fish includes fish that spawn simultaneously (partial spawning) because the process of maturing eggs in the ovary or the miosis event that takes place is also not simultaneously (Asyari & Herlan, 2013). The life of the fish has several cycle stages, namely: egg development stage, larval development stage, juvenile, two-year-old fourfinger threadfin (the phase changes sex to a female), the adult is approximately four years old (female sex) (Kholis et al., 2018). The maturity of fish gonads can be used to determine the ratio between fish that have matured gonads and those that have not been in the waters, determine the size or age of the fish when they first ripen, determine whether or not the fish have spawned, the length of time to spawn and the frequency of spawning in one year. (Sunarni & Maturbongs, 2018).

According to Saputra et al. (2009), The measure of the average length caught is an important thing to study because by relating the average size caught with the size at which the gonads ripen, it can be concluded whether the resource is a sustainable resource or not, meaning that it can be seen whether the fish caught at that size. Experienced spawning or have not experienced spawning. Lm value, according to (Kholis et al., 2018), namely 350 mm (35 cm) for male fish and 450 mm (45) cm for female fish.

According to (Dermawati et al., 2019), the fork lengths of the caught fourfinger threadfin ranged from 16.2 - 22.8 cm. The largest frequency was found in the class range 16.2 - 17.3 with 34 fish, while the smallest frequency was in the class range 20.6 - 21.7 cm with 12 fish. The size of fish that is suitable to catch, based on the Lm value, is 350 mm (35 cm) for males and 450 mm (45 cm) for females. Thus, the obtained fish catch is not included in the category of fish fit to be caught based on the applicable regulations. Based on the catch data, it was found that 100% of the fourfinger threadfin were not yet fit to be caught.

Kurau fish grow very fast during the first six months. At one year of age, this species has a fork length of 300 mm, and at three years of age, it has a fork length of 450 mm. Male *Eleutheronema tetradactylum* fish have an optimal length from 240 mm to 470 mm because these fish experience hermaphrodites from 250 mm to 460 mm, while female *Eleutheronema tetradactylum* fish have a fork length of 280 mm to 720 mm. (Motomura,

2004). The size of the first time caught is calculated with the aim of being the basis for regulating fishing gear used to conserve fish resources. The size of Lm50%, which is greater than the value of Lc 50%, indicates that the fish caught are still in their infancy or have not yet matured. (Anindhita et al., 2014). The size of *Eleutheronema tetradactylum* fish is suitable to be caught, and not fit to be caught quite difficult to do, and there are still very few studies on the size of the fish. (Kholis et al., 2018).

4. CONCLUSIONS

Biological parameters of *Eleutheronema tetradactylum* fish in Lekok waters obtained a negative allometric growth pattern. The sex of male *Eleutheronema tetradactylum* fish is more dominant than female *Eleutheronema tetradactylum* fish. During the study, no female gonads were found because the *Eleutheronema tetradactylum* fish experienced a protandrous hermaphrodite spawning cycle. The level of gonad maturity in male and female *Eleutheronema tetradactylum* is dominated by TKG II and III or development (developing). The value of Lc > Lm, which proves that the fish caught is dominant gonad ripe fish so that the fish are suitable to be caught and the fishing gear used selectively.

Acknowledgments
Thanks to Mr. Dr. Eng Abu Bakar Sambah, S.Pi., MT, as the head of the Department of Fisheries and Marine Resources Utilization. Do not forget to Mr. Nur, the Chairman of the Joint Business Group (KUB) Dora Baru as the guide in collecting field data

5. REFERENCE

Anindhita, G. ., Suradi, W. ., & Abdul, G. (2014). Several Biological Aspects of Swanggi Fish (Prianthus tayenus) Based on Catches Landed in Morodemak PPP. *Diponegoro Journal Of Maquares*, *3*, 144–152.

Anjani, F. ., Wahyu, A., & Eva, U. (2018). Reproduction Aspect of Yellow Selar Fish (Selaroides leptolepis) Landed in Sungailiat Nusantara Fishing Port. *Jurnal Sumberdaya Perairan*, 26–34.

Aswady, T. ., Asriyana, & Halili. (2019). Sex Ratio and Size of First Ripe Cockatoo Gonads (Scarus rivulatus Valenciennes, 1840) in the waters of Tanjung Tiram Village, North Moramo District, South Konawe Regency. *Jurnal Manajemen Sumber Daya Perairan*, *4*(2), 183–190.

Asyari, & Herlan. (2013). Some Biological Aspects of Kurau Fish (Polynemus dubius) in Indragiri River Estuary, Riau. *BAWAL*, *5*(2), 67–72.

Ballagh, A. C., Welch, D. J., Newman, S. J., Allsop, Q., & Stapley, J. M. (2012). Stock structure of the blue threadfin (Eleutheronema tetradactylum) across northern Australia derived from life-history characteristics. *Fisheries Research*, *121–122*, 63–72.

Carpenter, VH Niem - FAO Rome, 2001a. (2001). FAO Species Identification Guide for Fishery Purposes. In *The Living Marine Resources of thr Western Central Pacific* (Vol. 1).

Dahlan, M. ., Sharifudin, B. A. ., & Joeharni, T. (2015). Sex Ratio And First Gonadal Maturity Size Of Mackerel Fish (Decapterus macrosoma Bleeker, 1841) From The Waters Of Bone Strait, South Sulawesi. *Torani (Jurnal Ilmu Kelautan Dan Perikanan*, *25*(April), 25–29.

Dermawati, Mahfud, P., & Najamuddin. (2019). Analysis of Construction and Results of Surface Gill Nets Catch in Maros Regency Waters, South Sulawesi Province. *Ipteks Psp*, *6*(June 2018), 44–69.

Gebze, A. K., & Latupeirissa, I. L. (2017). Growth of kuro fish (Eleutheronema tetradactylum shaw, 1804) in the mouth of the Kumbe River, Merauke Regency. *Agricola*, *7*(1), 129–135.

Horne, J. B., Momigliano, P., Van Herwerden, L., & Newman, S. J. (2013). Murky waters: Searching for structure in genetically depauperate blue threadfin populations of Western Australia. *Fisheries Research*, *146*, 1–6. https://doi.org/10.1016/j.fishres.2013.03.013

Kholis, M. N., Ronny, I. W., Mustaruddin, & Jaliadi. (2018). Structure of Size and Length of Weight Relationship of Kurau Fish in Bengkalis Island. *ALBACORE*, *2*(2), 197–208.

Motomura, H. (2004). *Threadfins of the world (Family Polynemidae): An annotated and illustrated catalogue of polynemid species known to date* (Issue 3). Food & Agriculture Org.

Motomura, H. (2003). An East Asian Endemic Threadfin, Eleutheronema rhadinum (Perciformes : Polynemidae) ; First Record from Vietnam. *Biogeography*, *5*(2002), 33–37. https://www.museum.kagoshima-u.ac.jp/staff/motomura/2003_08_Eleutheronema-rhadinum-Vietnam.pdf

Motomura, H., Iwatsuki, Y., Kimura, S., & Yoshino, T. (2002). Revision of the Indo-West Pacific polynemid fish genus Eleutheronema (Teleostei: Perciformes). *Ichthyological Research*, *49*(1), 47–61. https://doi.org/10.1007/s102280200005

Mulyadi, M. (2013). Quantitative and Qualitative Research and Basic Rationale to Combine Them. *Jurnal Studi Komunikasi Dan Media*, *15*(1), 127–138.

Pember, M. . (2006). Characteristics of fish communities in coastal waters of north-western Australia , including the biology of the threadfin species Eleutheronema tetradactylum and Polydactylus macrochir Submitted by. *Murdoch University*, (Tesis), 1–197.

Riede, K. (2004). *Global register of migratory species: from global to regional scales: final report of the R&D-Projekt 808 05 081*. Federal Agency for Nature Conservation

Sangadji, M. (2014). Biology of selar fish (Selar crumenophthalmus Blooch, 1793) in the waters of the Haruku Strait, Kab. Central Maluku. *Jurnal Ilmiah Agribisnis Dan Perikanan (Agrikan UMMU-Ternate)*, *7*(2), 46–50. 6-50

Saputra, S. ., Prijadi, S., & Gabriela, A. . (2009). DI PERAIRAN DEMAK Biological Aspects of Goatfish (Upeneus spp) on Demak Waters. *Jurnal Saintek Perikanan*, *5*(1), 1–6.

Sasmito, H., Andi, I. ., & Abdullah. (2016). Pola Growth pattern of peperek fish (leiognathus eguulus) in Kendari Bay, Southeast Sulawesi Province. *Jurnal Manajemen Sumber Daya Perairan*, *1*(3), 275–284.

Sparre, P., & Venema, S. . (1999). *Introduction to Tropical Fish Stock Assessment* (p. 434). p. 434.

Sunarni, & Maturbongs, M. R. (2018). Growth and Maturity Level of Kuro Fish Gonads (Eleutheronema tetradactylum) in the Coastal Estuarine Area of Merauke City. *Musamus Fisheries and Marine Journal*, *1*(1), 15–23.

Su, N. J., Lu, Y. S., Wang, C. H., Liao, C. H., Chiang, W. C., & Tseng, C. Te. (2020). Age determination for juvenile fourfinger threadfin (Eleutheronema rhadinum) by using otolith microstructure and length data obtained from commercial fisheries off northwestern Taiwan. *Fisheries Research*, *227*(October 2019), 105560. https://doi.org/10.1016/j.fishres.2020.105560

Tirtadanu and U. Chodrijah. (2018). Some Population Parameters and Exploitation Status of. *Indonesian Fisheries Research Journal*, *24*(November 2016), 91–98.

Wijopriono, Nugroho, D., & Sadhotomo, B. (2012). Trend Of Exploitation Of Threadfins (Polinemidae) Resource In Bengkalis Waters , Malacca Strait. *Trend Pemanfaatan Sumberdaya Ikan*, *18*(4), 205–212.

Wujdi, A., Suwarso, & Wudianto. (2013). Biology Reproduction and Spawning Season Of Bali Sardinella (Sardinella lemuru Bleeker 1853) In Bali Strait Waters. *BAWAL*, *5*(April), 49–57.

Zamidi. I, Samat. A, Zaidi., C. ., Mazlan. A.G, Alam. G.M, Al-Amin. A.Q, & SImon K.D. (2012). 1100-1109.Pdf. *Academic Journals Inc*, *7*(11), 11.

Zischke, M. T., Cribb, T. H., Welch, D. J., Sawynok, W., & Lester, R. J. G. (2009). Stock structure of blue threadfin Eleutheronema tetradactylum on the Queensland east coast, as determined by parasites and conventional tagging. *Journal of Fish Biology*, *75*(1), 156–171.