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Growth Pattern of *Mystacoleucus marginatus* (Valenciennes 1842) in Cimanuk and Cipeles River, West Java

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ABSTRACT Cimanuk River is the second-longest river in West Java, flowing from Garut to Indramayu. One of the Cimanuk River sub-watersheds is the Cipeles River in Sumedang and Majalengka. Genggehek (*Mystacoleucus marginatus*) is a native fish (indigenous) found in these two rivers. The purpose of the study was to determine growth performance, including size distribution, growth pattern, and condition factors. Research methods used in the fish sampling were the field observation method with purposive sampling technique in the dry season September 2020. Using fisheries biology methods, measurement and sample analysis were conducted at the Aquatic Resources Laboratory of Universitas Padjadjaran. The number of fish caught was 231, with a length range of 45 mm to 116 mm and a weight range of 1.1 g to 37.4 g. The growth performance of fish living in the Cimanuk River differed from that in the Cipeles River. Cimanuk River had positive allometric with regression equation $W = 4.10^{-6} L^{3.217}$ and $W = 6.10^{-6} L^{3.144}$. Weight growth was faster than length, and the condition factor was between 1.27 and 1.33. The growth performance of fish growing in the Cipeles River had a negative allometric growth pattern. The length growth was faster than the weight with the regression equation $W = 7.10^{-4} L^{2.118}$ and $W = 7.10^{-5} L^{2.743}$, $R^2 = 0.36$ and 0.92, condition factor K = 1.01 and 1.35.

Keywords: Condition factor; negative allometric; positive allometric

INTRODUCTION

The Cimanuk River is one of the second largest rivers in West Java after the Citarum river, extending from Garut to Indramayu. The upstream of the river is in the Cikajang, Garut; flows across Sumedang, Majalengka; and empties into Indramayu (Azis *et al*., 2018). Cimanuk River has a length of 358 km (Caya *et al*., 2014). Longitudinally, the Cimanuk River is classified into three parts with a total area of 341.453 ha. The upstream Cimanuk River has an area of 145.677 ha, located in Garut & Sumedang. The middle Cimanuk River has 114.477 ha located in Sumedang and Majalengka downstream Cimanuk, which has an area of 81.299 ha located in the Indramayu region. This river is one of the main pillars of water resources in West Java (Rahman, 2016).

M. marginatus belongs to the Chordata phylum, class Actinopterygii, order Cypriniformes, family Cyprinidae, genus Mystacoleucus, and species *M. marginatus* (Kottelat *et al*., 1993). Identification using the Cytochrome Oxidase C Subunit I (COI) gene method showed that *M. marginatus* identified at 681-686 bp has haplotype diversity (Hd) = 0.96 and nucleotides (Pi) = 0.004 phylogenetic topology indicates a monophyletic clade (Valen *et al*., 2019). According to Herawati *et al*. (2017) and Herawati *et al*. (2019), *M. marginatus* is an indigenous fish (Native fish) of the Cimanuk River. This fish is spread in freshwaters in Indonesia, including Sumatra, Java, Kalimantan, and Indochina countries (Herawati *et al*., 2017). *M. marginatus* is fish that is consumed (Wartika *et al*., 2018), in Sumatra is known as Mansai, Cecen and Lamasai fish, in Java it is known as Keprek, Kapyah, Genggehek, Wader, and Wader eco. (FishBase, 2020). The size of the male fish is smaller than the female (Ridwan, 2010).

Suitable habitats for *M. marginatus* are rivers, reservoirs, and lakes with a temperature range between 24-29°C, prefer sandy or gravel waters. The water flow is not too heavy and tends to be precise (Herawati *et al*., 2017). M. marginatus utilizes phytoplankton as the primary food and zooplankton as a complementary food, plant parts, and detritus with a successive percentage of 62.7%, 1.11%, 27.78%, and 8.33% (Tresna *et al*., 2012).

Herawati *et al*. (2017) stated that *M. marginatus* in Jatiluhur Reservoir is a plankton and detritus feeder. Fish found in the upper reaches of the Cimanuk River are herbivores that use phytoplankton and plants as their primary food (Tresna *et al*., 2012). *M. marginatus* lived in the Ir. H. Djuanda Reservoir are detrivores, with the leading food being detritus (Hendrawan *et al*., 2018). When the Jatigede Reservoir was inundated, many *M. marginatus* fish were found, and the largest had a total length of 200 mm, and the gonads began to mature when the total length was 80 mm (Herawati *et al*., 2017).

Kaban *et al*. (2016) stated that population density and growth of M. marginatus correlated with people's activities around the Sibiru-biru river. Hamid *et al*. (2015) stated that *M. marginatus* fish in Temengor Reservoir, Peninsular,

Malaysia, has a positive allometric growth pattern b=3.14 with condition factor K = 1.14, while (Satrawaha & Pilasamorn, 2009) stated that. *marginatus* in the Chi river, Thailand has a negative allometric growth pattern b = 2.80.

Based on the explanation, it is necessary to research the growth pattern of M. marginatus living in Cimanuk and Cipeles River, which can be used as primary data in efforts to manage sustainable fish resources following the Regulation of the Minister of Marine and Fisheries of the Republic of Indonesia Number 29/PERMEN-KP/2016 at WPPNRI PD 433 following Regulation of the Minister of Marine and Fisheries of the Republic of Indonesia Number 9/PERMEN-KP/2020 where the Cimanuk River is located in the inland fisheries management area 433 and to maintain the ecological balance of the waters of the Cimanuk and Cipeles River, especially for conservation efforts of indigenous fish resources of the Cimanuk River.

MATERIALS AND METHODS

Materials

Tools used in the research were fishing gear (Castnet with a mesh size of 0.59 and 2.0 inches, Global Positioning System (GPS) (Garmin 60 CSx, America), ruler (1 mm accuracy), digital scales (Professional Digital Table Top Scale type Pocket, China) (0.01 g accuracy), and millimeter block (1 mm accuracy).

Methods

Research methods used in the fish sampling were the field observation method with purposive sampling technique, measurement, and sample analysis using fisheries biology methods (Effendie, 1997); (Herawati, 2017).

Determination of the season refers to Herawati *et al*. (2019) that the climate around the Jatigede Reservoir from June to October was the dry season. Fish sampling was conducted every day from 14 to 17 September 2020. Two sampling stations for each river were selected to collect the fish samples (Figure 1).

Station 1: Blok Pasir Sawah, Cipasang Village, Cibugel District, Sumedang Regency at coordinates 6°57'56.9" S & 108°04'56.3" E

Station 2: Blok Pasir Cangkudu, Cipasang Village, Cibugel District, Sumedang Regency at coordinates 6°57'49.4" S & 108°04'56.4" E

Station 3: Citepok Village, Tomo District, Sumedang Regency at coordinates 6°48'59.5" S & 108°01'22.5" E

Station 4: Karyamukti Village, Tomo District, Sumedang Regency at coordinates 6°47'03.7" S & 108°05'44" E

The caught fish were classified based on the results of the total length measurement according to the Sturgess method Herawati *et al*. (2017):

$$K = 1 + (3.3) \log n$$

Explanation:
K = Number of Classes
n = Number of observations

The calculation of the growth aspect includes the relationship between the length of the weight and the condition factor (K), which is described in the form of a line equation (Effendie, 1979); (Herawati, 2017):

$$W = aL^b$$

Explanation:
W = Weight (g)
L = Length (mm)
a, b = constant

Testing the value of b with the criteria of decision-making according to Effendie (1979):
1. If b = 3, Isometric growth pattern
2. If b ≠ 3, Allometrik growth pattern

The relationship between length and weight was analyzed using a regression equation. The influence of each variable was calculated by the coefficient of determination (R2), the level of relationship between variables, and the correlation value (r).

The condition factor calculation is done by using a metric system according to (Effendie, 1979), as follows:

$$K = \frac{W}{aL^b}$$

Explanation:
K = Condition factor
W = Average weight of fish (g)
L = Average length of fish (mm).

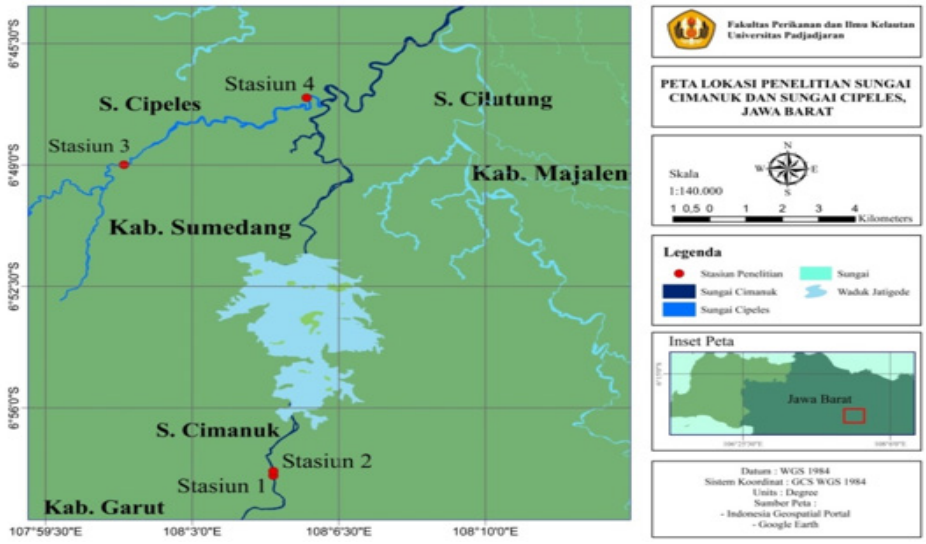

Figure 1. Research locations upstream of the Cimanuk River (Station 1 & 2) and the Cipeles River (Station 3 & 4).

RESULTS AND DISCUSSION

Table 1. Size of the fish *M. marginatus* caught in the Cimanuk River and Cipeles River.

Research Location	Station	N	Range total length (mm)	Length average (mm)	Range body weigth (g)	Weight average (g)	Sex Ratio ♂:♀
River Cimanuk	1	48	50-105	53.5-101.5	1.1-12.9	1.9-12.2	38:62 (1:2)
	2	34	50-126	55.0-121.0	1.5-18.9	2.7-17.7	62:38 (2:1)
		82	50-126	54.0-117.0	1.1-19.0	2.1-16.1	52:48 (1:1)
River Cipeles	3	72	45-100	48.5-96.5	1.4-11.9	2.2-11.2	43:57 (1:1)
	4	77	49-125	54.0-120.0	2.4-40.2	5.1-37.5	55:45 (1:1)
		149	45-125	49.0-112.0	1.5-37.4	3.7-35.1	49:51 (1:1)

The number of fish caught during this study was 231. Fish caught from the Cimanuk River was 35.5% with a male-female ratio of 1:1 and from the waters of the Cipeles River (64.4%) with a ratio of 1:1 (Tabel 1).

Based on the data in Table 1, the fish caught during the research in September 2020 (dry season) were smaller than the research results (Kristina, 2001) on Table 2, which stated that the size of *M. marginatus* in the Cimanuk River had a total length of 107 mm - 173 mm and a weight of 13.64 g – 69.0 g, while the results of the research (Tresna *et al*., 2012) showed a total length of 122 mm - 127 mm and a weight of 20 g - 23 g, and (Kaban *et al*., 2016) a length of between 70 mm - 182 mm in the Sibiru River, North Sumatera. The difference in size is caused by the water quality of the Cimanuk River has decreased (Yuanda climate, geographical location, ecology, and fish habitat also dramatically influences the differences in morphology and fish size (Syafrialdi *et al*., 2020).

The *M. marginatus* caught in the Cimanuk River, and Cipeles River had a balanced sex ratio. In Cimanuk River, female fish were more than male fish at station one and had a sex ratio of 38:62 (1:2). At station two, the number of male fish is more than female fish and has a ratio (2:1) with a percentage of 62:38. In Cipeles River, the female population was more significant, with a percentage of 49:51 (1:1). According to Syafrialdi *et al*. (2020), fish populations in nature have a balanced sex ratio of 1:1. However, this ratio can continue to shift before and during spawning and also due to fishing activity.

Length size distribution

Based on the result, M. marginatus in the Cipeles River was higher than that in the Cimanuk River. *M. marginatus* caught in the waters of the Blok Pasir Sawah, Cipasang Village, Cibugel District, Sumedang Regency (Station 1) (Figure 1) had a total length range of 50 mm to 105 mm, the results of calculations using the Sturgess rule Herawati *et al*. (2017)

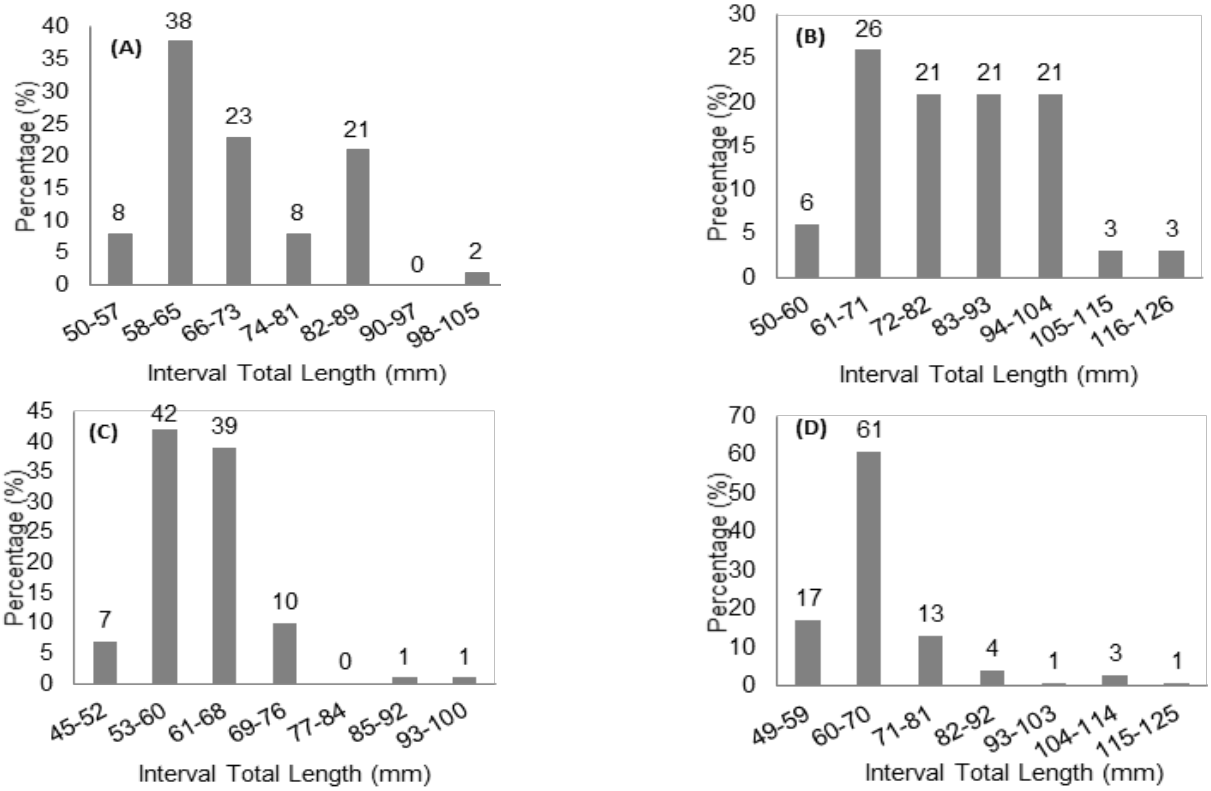

Figure 2. Distribution of the total length of *M. marginatus* at (a) station 1 (b) station 2 of the Cimanuk River and (c) station 3 (d) station 4 of the Cipeles River.

there are seven size groups, *M. marginatus* with an average length of 58 mm to 65 mm was the most caught fish, which was 38% of the total catch at station one.

M. marginatus with a size of 66 mm to 73 mm was the second largest fish caught at 23%, fish with the largest total size 98-105 mm were found in 2%, and fish with a size of 90-71 mm were not caught in the waters (Station 1) (Figure 2).

In the waters of the Cimanuk River in the Blok Pasir Cangkudu, Cipasang Village, Cibugel District, Sumedang Regency (Station 2) (Figure 1) caught *M. marginatus* with a total length of 50-126 mm with seven size groups, fish with a size of 61-71 mm were the most caught by 26%, fish with a size of 72 mm to 82 mm, 82 mm to 93 mm, and 94 mm to 104 mm by 21%, fish with a size of 104 mm to 115 mm, and 116 mm to 126 mm by 3% (Figure 2) the fish caught in the Cimanuk River ranged from 58 mm to 105 mm.

M. marginatus caught in the Cipeles River (Station 3) in the waters of the Citepok, Tomo, Sumedang had a size of 45 mm to 100 mm. The most caught fish was 42% had a size of 53 mm to 60 mm. The second most caught fish was 39% and had a 61 mm to 68 mm. The fewest fish caught was 1% had the highest size range of 85 mm to 92 mm and 93 mm to 100 mm. Fish with a length range of 77 mm to 84 mm were not caught in the waters at Station three.

In the waters of the Karyamukti, Tomo, Sumedang (Station 4), fish caught had a size of 49 mm to 125 mm. The most caught The most caught *M. marginatus* was 61% with an extended range of 60 mm to 70 mm, and the least caught was 1% had a length range of 93 mm to 103 mm and 115 mm to 125 mm. M. marginatus caught had different lengths and weights (Table 1).

Growth performance

The growth of fish caught from Cimanuk River and Cipeles River was shown in Figure 3 and Table 2:

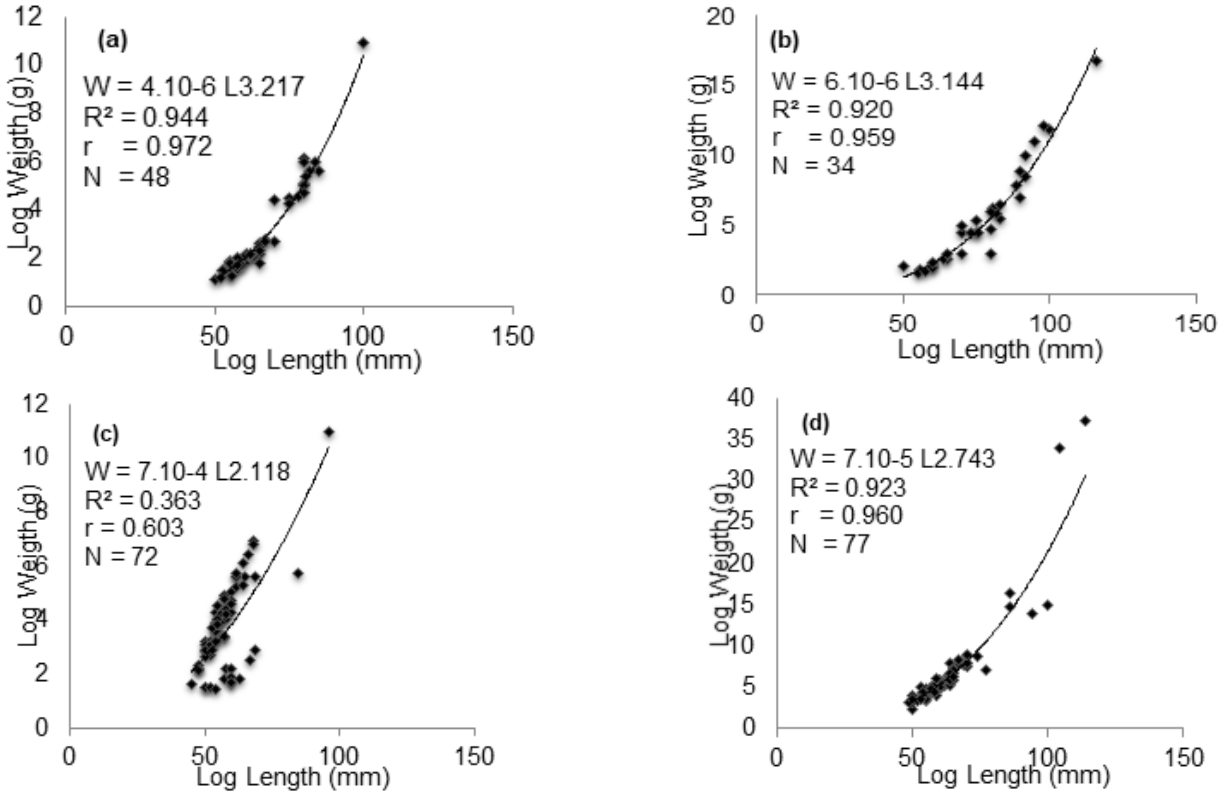

Figure 3. The relationship between length and weight of *M. marginatus* in Cimanuk River (a) station 1 (b) station 2 and in Cipeles River (c) station 3 (d) station 4.

Table 2. Growth performance and condition factors of *M. marginatus.*

Research Location	N	$W=aL^b$	b	R^2	r	K	Growth Pattern
Cimanuk Station 1	48	$W=4.10^{-6} L^{3.21}$	3.217	0.944	0.972	1.33	Allometric+
Cimanuk Station 2	34	$W=6.10^{-6} L^{3.14}$	3.144	0.920	0.959	1.27	Allometric+
Cipeles Station 3	72	$W=7.10^{-4} L^{2.12}$	2.118	0.363	0.603	1.01	Allometric-
Cipeles Station 4	77	$W=7.10^{-5} L^{2.74}$	2.743	0.923	0.961	1.35	Allometric-
Sibiru-biru (2015)*	92	$W=2.10^{-5} L^{2.91}$	2.909	0.913	0.956	N/A	Allometric-
Cimanuk (2001)**	54	$W=4.10^{-6} L^{3.47}$	3.466	0.960	0.990	1.01	Allometric+

Explanantion: N = number of samples; b = Slope; r = correlation coefficient; R^2 = coefficient of determination; K = condition factor; *(Kaban *et al*., 2015) Sibiru-biru River, Deli Serdang, North Sumatera; **(Kristina, 2001) Upstream Cimanuk River, Garut, West Java.

The growth performance of *M. marginatus* caught in Cimanuk River was allometric positive; in the Blok Pasir Sawah (Figure 1, S1), the growth pattern follows the regression equation W = 4.10-6L3.21, slope value (b) = 3.21 (Figure 3[a], Table 2) length growth is influenced by the growth of fish weight (R = 0.94), the level of closeness with the correlation coefficient is very strong (r) 0.97 (Sugiyono, 2007). Other factors that affect the growth of fish are tiny was 0.03. In the Blok Pasir (Station 2), the growth pattern follows the regression equation W = 6.106 L3.14, b = 3.14 correlation coefficient (r) 0.95. The growth factor of *M. marginatus* in the Cimanuk River was strongly influenced by internal factors. Other factors were shallow (Table 2; Figure 3[a,b]). The b value had almost the same results as the research results (Kristina, 2001) b value = 3.46. This value differed from *M. marginatus* found in Cipeles River dan Sibiru-biru River (Kaban *et al*., 2016).

The growth pattern of *M. marginatus* caught in Cipeles River was allometric negative; in the Citepok Village (Figure 1, S3), the growth pattern follows the regression equation W = 7.104 L2.12, slope value (b) = 2.12 (Figure 3[c], Table 2) weight growth is influenced by fish length growth (R = 0.36), the level of closeness with correlation coefficients is strong (r) 0.60 (Sugiyono, 2007). Another factor that affects the growth of medium fish is 0.40. In Karyamukti Village (Station 4) growth pattern follows the regression equation W = 7.103 L2.74, b = 2.74, correlation coefficient (r) 0.92. The factors that affect fish growth in the Cipeles River were different (Table 2; Figure 3[c,d]). Fish growth in Karyamukti Village (Station 4) was strongly influenced by internal factors, while the influence of other factors was shallow. Meanwhile, in Citepok Village (Station 3), internal factors were only 60%, it was suspected that 40% of other factors affect the growth of *M. marginatus*.

The value of b had a value that was almost equal to the results of previous research in the Sibiru-biru River, North Sumatra (Kaban *et al*., 2016) with the value of b = 2.90, Pedu Lake, Kedah, Malaysia (Isa *et al*., 2010) b = 2.70 and Chi River, Thailand Satrawaha & Pilasamorn, (2009) b = 2.80. This value is different compared to *M. marginatus* found in the habitat of Cimanuk River (Kristina, 2001), Upstream Dungun River, Terengganu, Malaysia (Mazlan *et al*., 2007), and Temengor Reservoir, Perak, Malaysia (Hamid *et al*., 2015) which has a positive allometric growth pattern. The similarity in the value of b is due to a favourable environment for *M. marginatus* (Mashor, 2010), which states that a favourable environment will make fish grow better.

The exponential values (b) diversity is closely related to ontogenetic development, age, TKG, gender, geographical location, environmental conditions such as fishing activities, and fish conservation techniques (Türkmen *et al*., 2002). According to (Khan & Sabah, 2013), the relationship between the length and weight of fish cannot be separated from temporal and spatial factors, gender, and gonad maturity. Differences in growth patterns or variations in the value of b are dependent on geographical factors, biological conditions of gonadal development, food availability, environment, temporal and sampling time. (Nofrita *et al*., 2013). Effendie (1997) stated that the relationship between length and weight could be influenced by heredity, age, food availability, sex, disease, and water quality.

Based on the results of field monitoring, the condition of the aquatic habitat of the Blok Pasir Sawah (Station 1), Blok Pasir Cangkudu (Station 2), and the water conditions of the Karyamukti Village (Station 4) have habitat criteria that are very supportive for the survival of *M. marginatus*. These waters have currents that are not too heavy, tend to be transparent green, gravel to the rocky sand substrate, and are not too close to settlements, and fishing activity is not too massive. This statement is appropriate because, according to (Herawati *et al*., 2017), *M. marginatus* fish prefer sandy or gravel waters. The water flow is not too heavy and tends to be precise.

The condition of the Citepok Village area's waters (Station 3) based on direct observations in the field is unfavourable for *M. marginatus* because the area has calm water flows with sandy mud substrate. The location of station 4 in Cipeles River is located on the Cimanuk sub-watershed dam. In the middle of the location, there is a lot of household waste, and many fishing activities are carried out using non-selective throwing nets or kecrik. The water flow is calm, relatively shallow, and close to residential areas, making fishing activity in the area very high.

This statement follows the results of previous research regarding the study of the effects of community activities on *M. marginatus* (Kaban *et al*., 2016), which states that the population density of M. marginatus is correlated with community activities around the river. The denser the population, the higher the population activity, the lower the population density of *M. marginatus* due to a decrease in water quality and high fishing activity.

Condition factor

The growth of *M. marginatus* during the dry season is relatively good. Based on (Table 2) condition factor or ponderal index *M. marginatus*, the average K value in the habitat of Cimanuk River at station one is 1.33 and station two is 1.27, and in the habitat of Cipeles River is 1.01 and 1.35. The average K value of the *M. marginatus* population in the habitat of the Cimanuk River is higher than the average K value of the *M. marginatus* population in the habitat of the Cipeles River. The value of K is highly correlated with the relationship between length and weight. Therefore, the exponential value diversity (b) is significant to assess the fish is in good condition. According to Effendie (1997), this range shows that M. marginatus has a less flattened body shape. This is due to the diversity of size and TKG that varies, food, fish age, sex, and sampling time (Nofrita *et al*., 2013).

According to Effendie (1997), the statement states that K values between 1-3 indicate the fish are in good physical condition to support survival and reproduction. Based on the distribution of total length, it is known that the condition factor of *M. marginatus* is not much different between *M. marginatus* in the habitat of the Cimanuk River and *M. marginatus* in the habitat of the Cipeles River. The results of the analysis of conditional factors show that the population of *M. marginatus* in the habitat of the Cimanuk River and Cipeles River is in its infancy. This shows that the weight of the fish increases and is directly proportional to

the increase in length until the inflexion point, then the weight gain decreases because it is influenced by age, the influence of food, sex, and gonad maturity (Effendi, 2002).

The results of another study regarding the condition factor of *M. marginatus* in the habitat of the Cimanuk River were conducted by Kristina (2001) with an average K value of 1.01 - 1.00. There were differences in the K value in this research. The difference in these condition factors is thought to have occurred because of the variations in the range of length and weight, the number of samples analyzed for M. marginatus, and the research location. The research conducted by Kristina (2001) is in the habitat of the Cimanuk River in the Garut segment of the Leuwi Nini area, Cipicung Village, Banyuresmi, and Leuwi Goong Districts, Sindang Sari Village, Leuwigoong District. Differences in research locations significantly affect the physical, chemical, and biological parameters of *M. marginatus*.

Gupta *et al*. (2011) stated that food availability could cause differences in condition factors at certain times and differences in gonadal development. The statement follows Effendie (2002), which states that differences in condition factors can be caused by the suitability and availability of food related to gonadal development. In addition, fluctuating condition factors due to metabolism during gonadal development to spawning, feeding habits, changing seasons can result in changes in temperature or changes in environmental conditions drastically (Rahman *et al*., 2013). The relative condition factor shows that the fish are following their habitat. The greater the K value, the better the condition of the fish.

The relative condition factor can also be a way to implement a sustainable fishing system following Peraturan Menteri Kelautan dan Perikanan Republik Indonesia Nomor (Regulation of the Minister of Marine and Fisheries of the Republic of Indonesia Number 29/PERMEN-KP/2016. By knowing the growth pattern and condition factors, it is possible to predict the spawning season of *M. marginatus* and establish management such as applying regulations to close fishing activities at the peak of spawning and the rules for the use of more selective fishing gear. This will affect the *M. marginatus* resources found in the Cimanuk River and Cipeles River, West Java Jawa.

CONCLUSION AND RECOMMENDATION

Conclusion

The growth pattern of *M. marginatus* that lives in the Cimanuk River is positive allometric, which means the weight growth is faster than the length growth, and in the Cipeles River, the growth pattern is negative allometric or the length growth is faster than the weight growth.

Recommendation

It is necessary to research environmental aspects in the Cipeles River, which causes the growth pattern of *M. marginatus* to be smaller.

AUTHORS' CONTRIBUTIONS

RK: Established the idea, conducted research, performed the data analysis, corresponding author, manuscript preparation, and editing manuscript

TH: include ideas, doing research, data analysis, corresponding author, manuscript preparation, edit manuscript, and funding.

AY: are Team research, edit manuscript

AN: are Team research, edit manuscript

WP: are edit manuscript

WL: are edit manuscript

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