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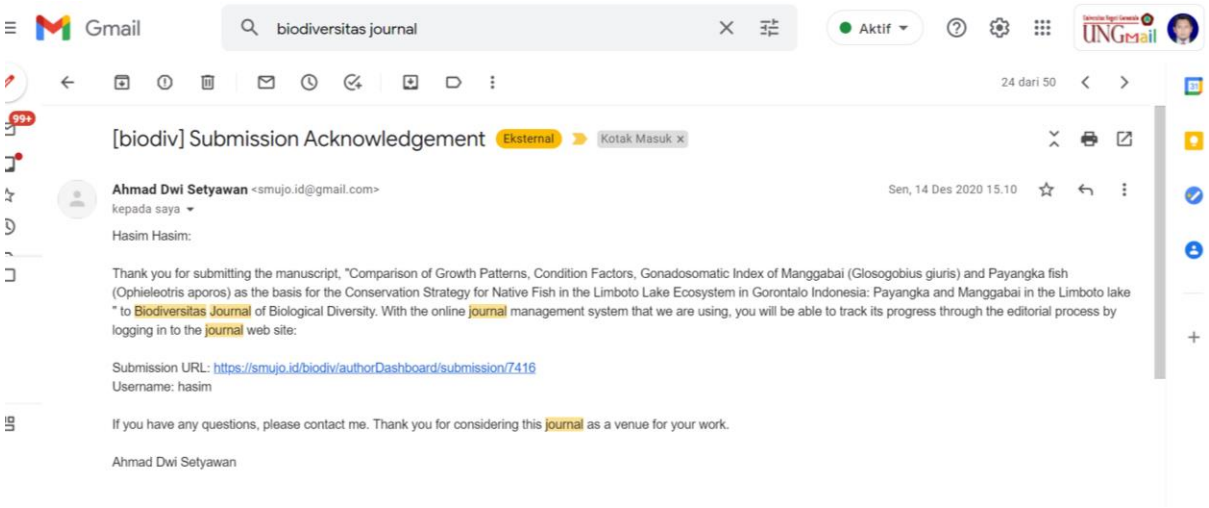

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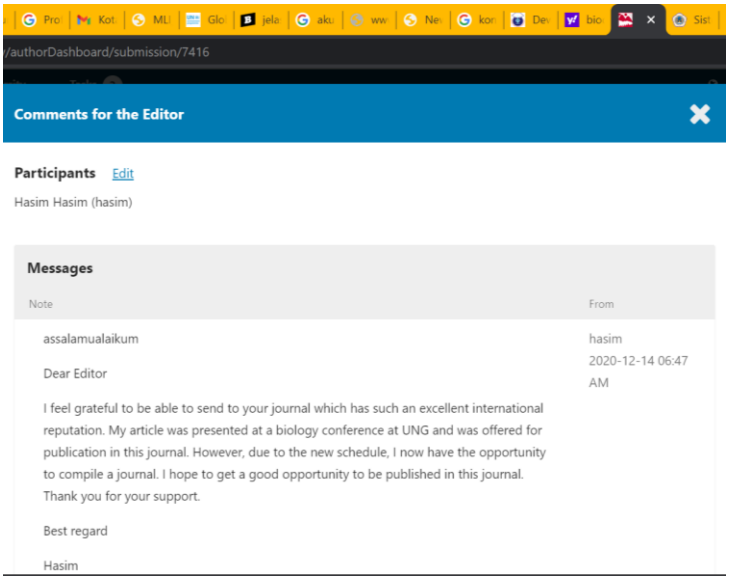
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I feel grateful to be able to send to your journal which has such an excellent international reputation. My article was presented at a biology conference at UNG and was offered for publication in this journal. However, due to the new schedule, I now have the opportunity to compile a journal. I hope to get a good opportunity to be published in this journal. Thank you for your support.
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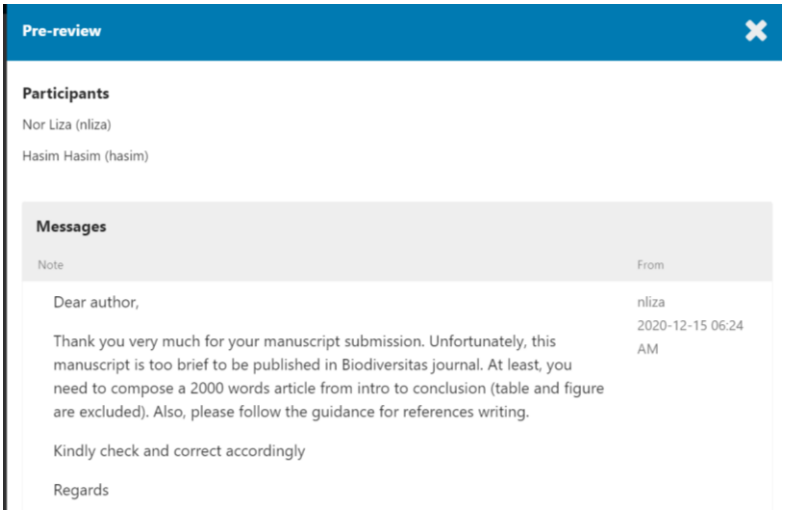
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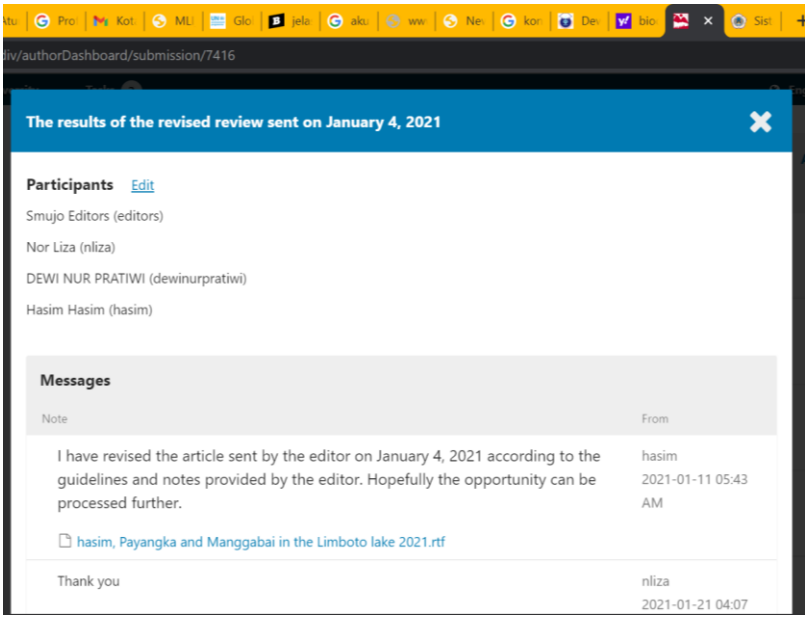
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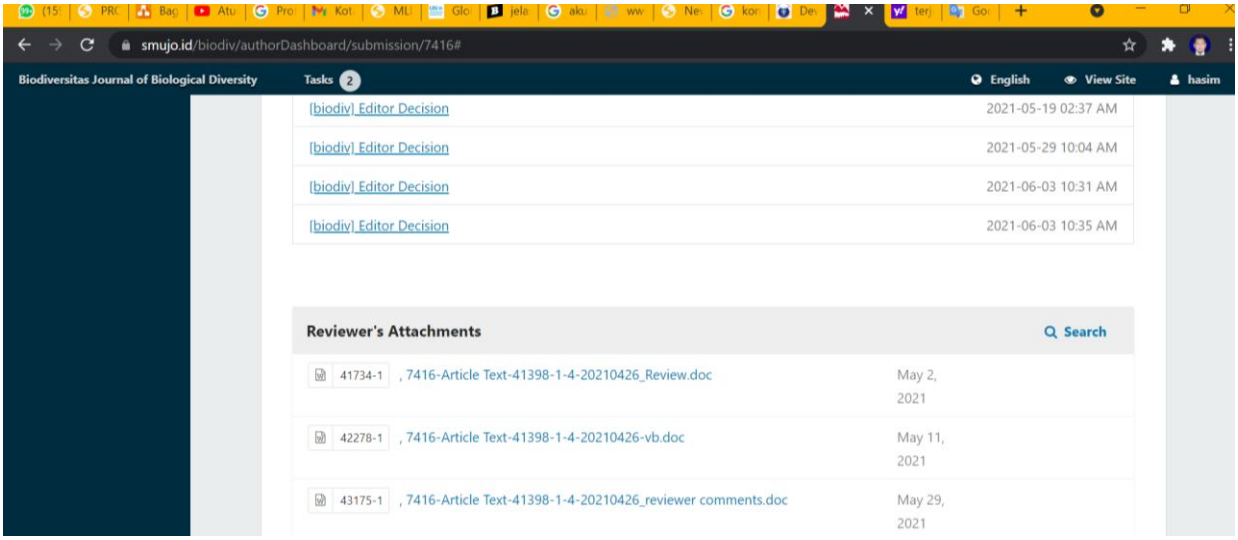
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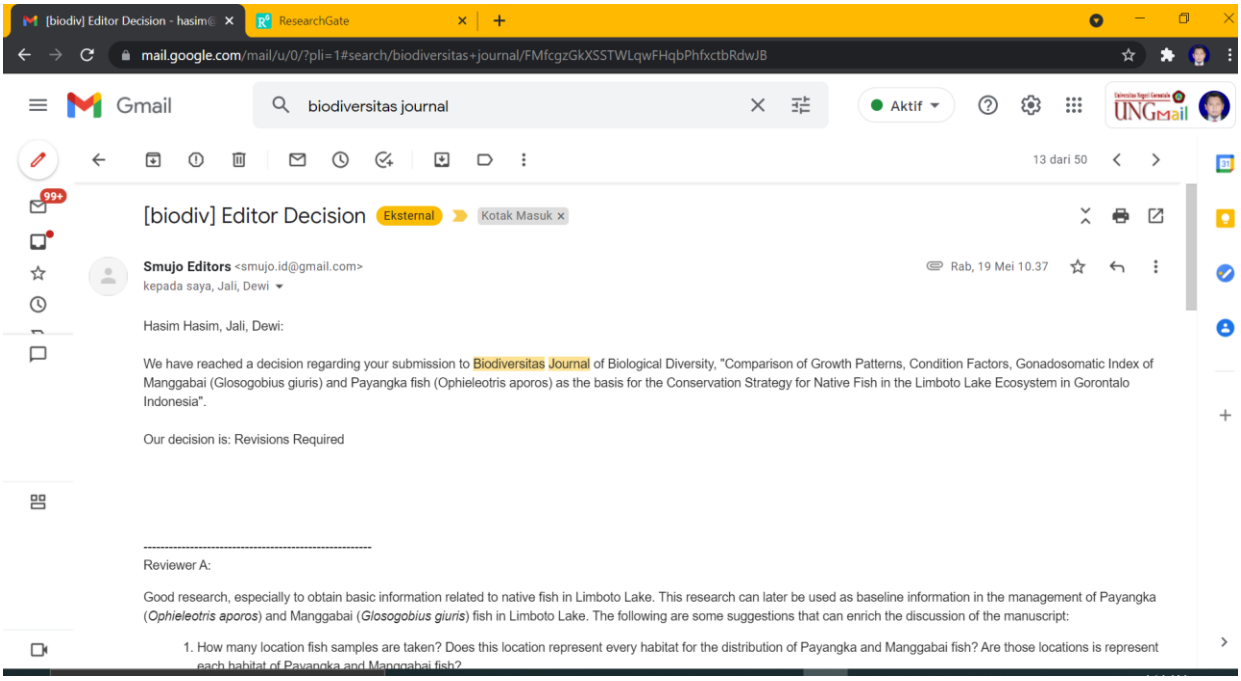
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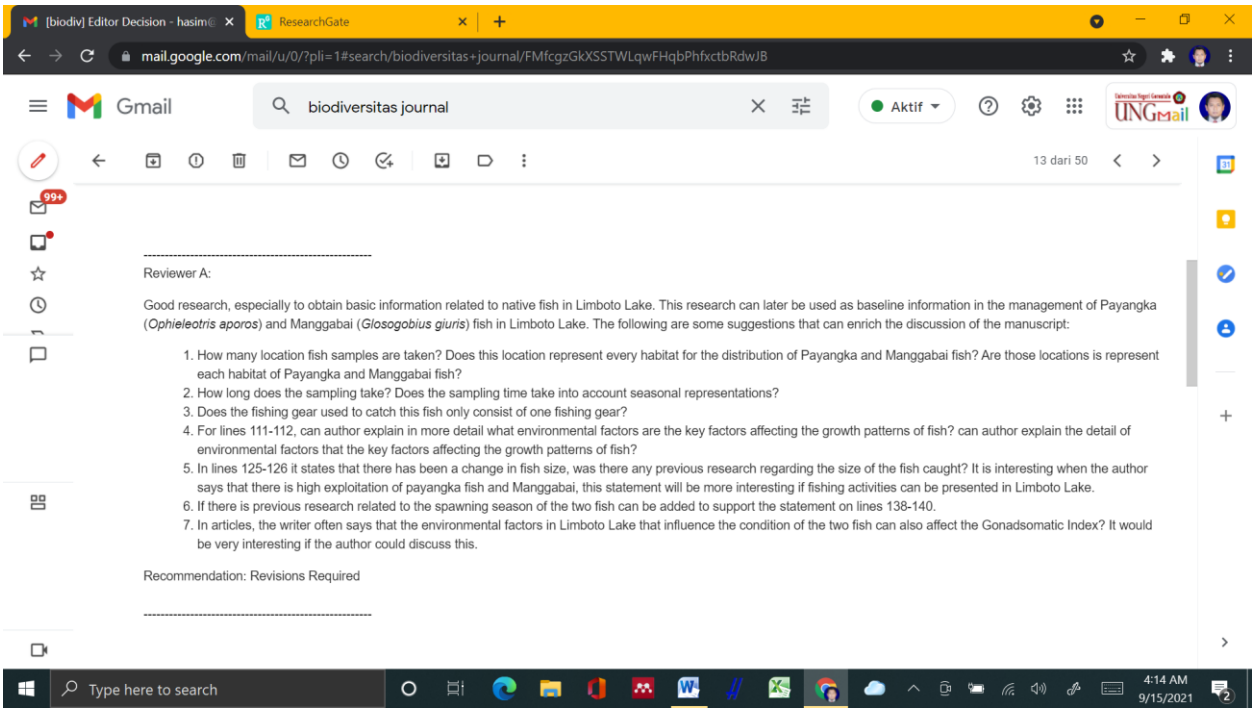
Hasim Hasim, Jali, Dewi:
We have reached a decision regarding your submission to Biodiversitas Journal of Biological Diversity, "Comparison of Growth Patterns, Condition Factors, Gonadosomatic Index of Manggabai (Glosogobius giuris) and Payangka fish (Ophieleotris aporos) as the basis for the Conservation Strategy for Native Fish in the Limboto Lake Ecosystem in Gorontalo Indonesia".
Our decision is: Revisions Required

Reviewer A:
Good research, especially to obtain basic information related to native fish in Limboto Lake. This research can later be used as baseline information in the management of Payangka (Ophieleotris aporos) and Manggabai (Glosogobius giuris) fish in Limboto Lake. The following are some suggestions that can enrich the discussion of the manuscript:
1. How many location fish samples are taken? Does this location represent every habitat for the distribution of Payangka and Manggabai fish? Are those locations is represent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1. How many location fish samples are taken? Does this location represent every habitat for the distribution of Payangka and Manggabai fish? Are those locations is represent each habitat of Payangka and Manggabai fish?
2. How long does the sampling take? Does the sampling time take into account seasonal representations?
3. Does the fishing gear used to catch this fish only consist of one fishing gear?
4. For lines 111-112, can author explain in more detail what environmental factors are the key factors affecting the growth patterns of fish? can author explain the detail of environmental factors that the key factors affecting the growth patterns of fish?
5. In lines 125-126 it states that there has been a change in fish size, was there any previous research regarding the size of the fish caught? It is interesting when the author says that there is high exploitation of payangka fish and Manggabai, this statement will be more interesting if fishing activities can be presented in Limboto Lake.
6. If there is previous research related to the spawning season of the two fish can be added to support the statement on lines 138-140.
7. In articles, the writer often says that the environmental factors in Limboto Lake that influence the condition of the two fish can also affect the Gonadsomatic Index? It would be very interesting if the author could discuss this.
Recommendation: Revisions Required

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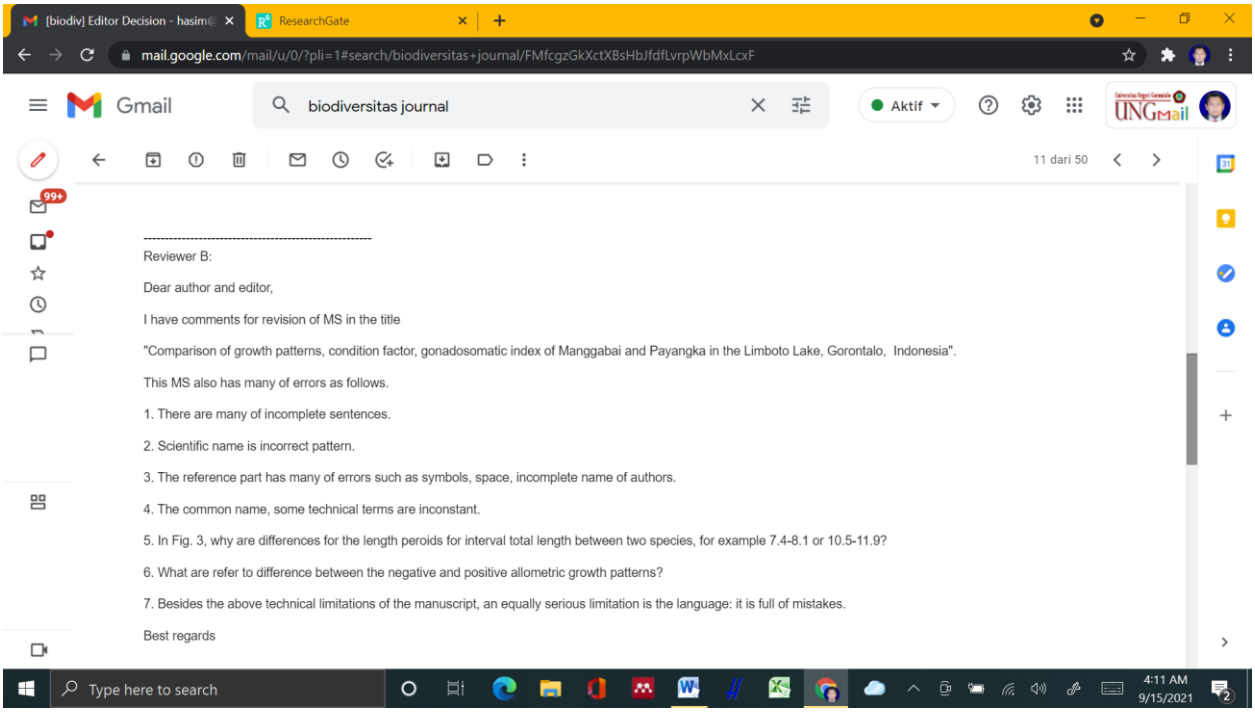

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Reviewer B:

Dear author and editor,

I have comments for revision of MS in the title

"Comparison of growth patterns, condition factor, gonadosomatic index of Manggabai and Payangka in the Limboto Lake, Gorontalo, Indonesia".

This MS also has many of errors as follows.

1. There are many of incomplete sentences.

2. Scientific name is incorrect pattern.

3. The reference part has many of errors such as symbols, space, incomplete name of authors.

4. The common name, some technical terms are inconstant.

5. In Fig. 3, why are differences for the length peroids for interval total length between two species, for example 7.4-8.1 or 10.5-11.9?

6. What are refer to difference between the negative and positive allometric growth patterns?

7. Besides the above technical limitations of the manuscript, an equally serious limitation is the language: it is full of mistakes.

Best regards

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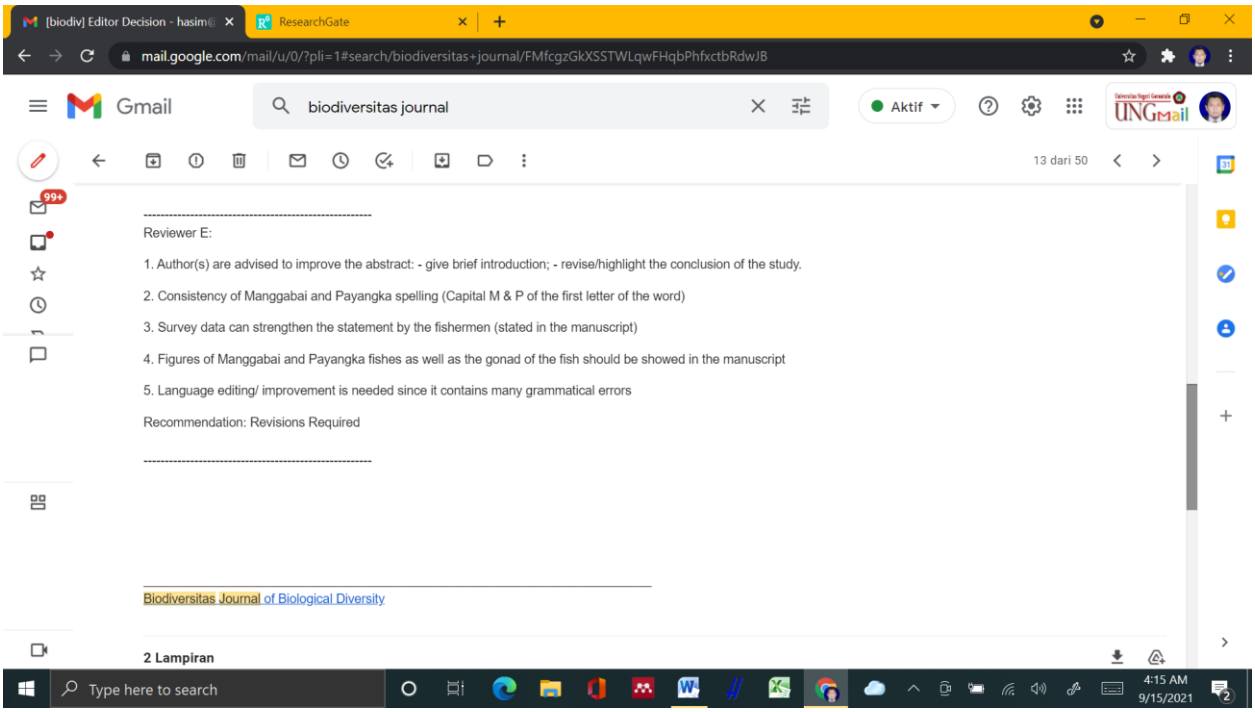

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Reviewer E:

1. Author(s) are advised to improve the abstract: - give brief introduction; - revise/highlight the conclusion of the study.

2. Consistency of Manggabai and Payangka spelling (Capital M & P of the first letter of the word)

3. Survey data can strengthen the statement by the fishermen (stated in the manuscript)

4. Figures of Manggabai and Payangka fishes as well as the gonad of the fish should be showed in the manuscript

5. Language editing/ improvement is needed since it contains many grammatical errors

Recommendation: Revisions Required

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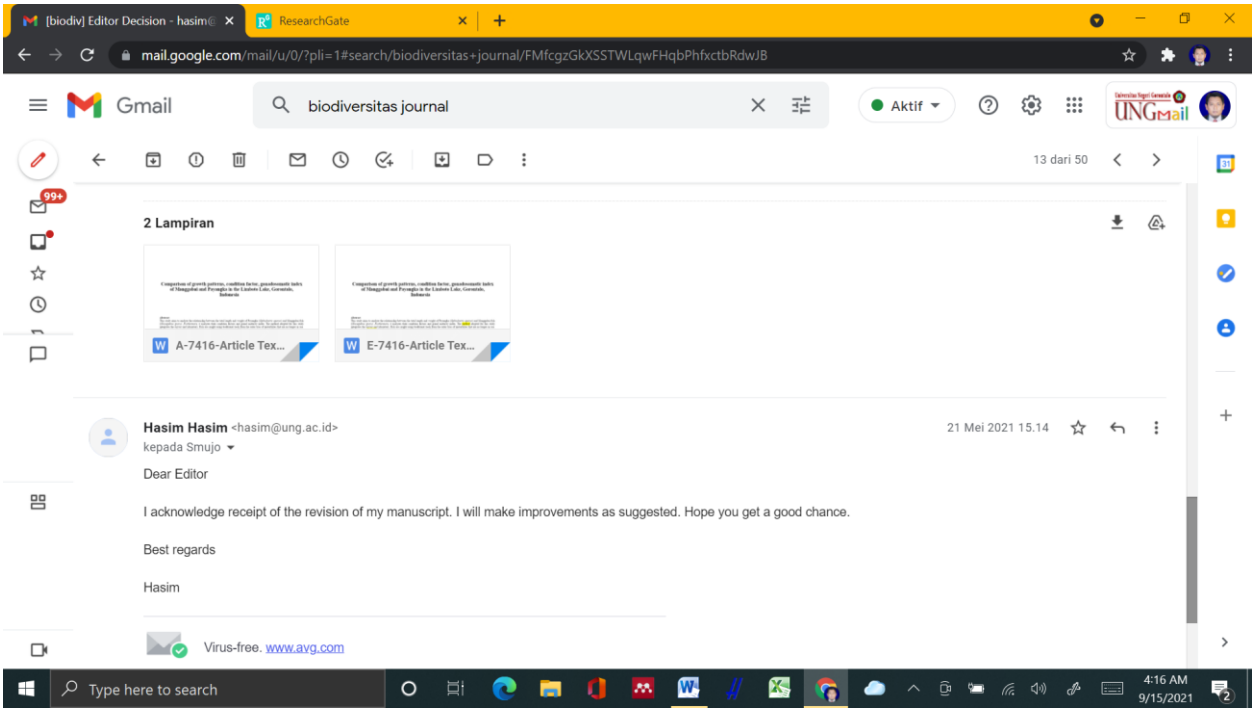
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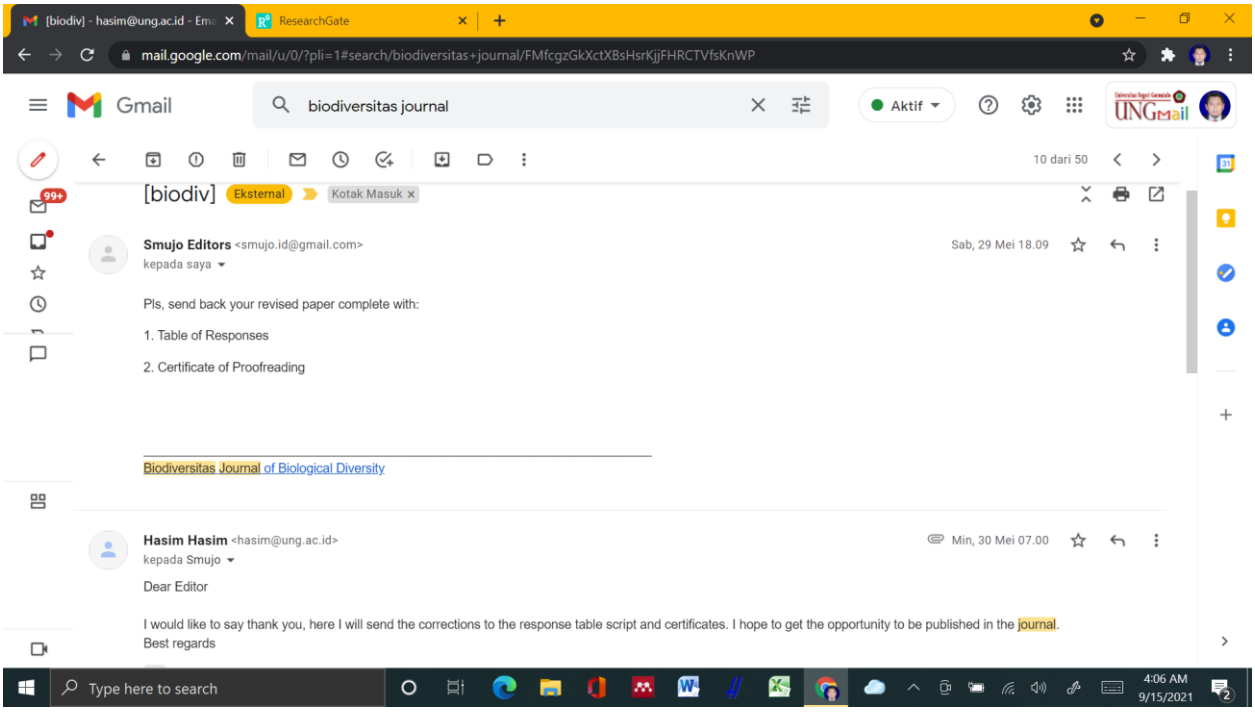
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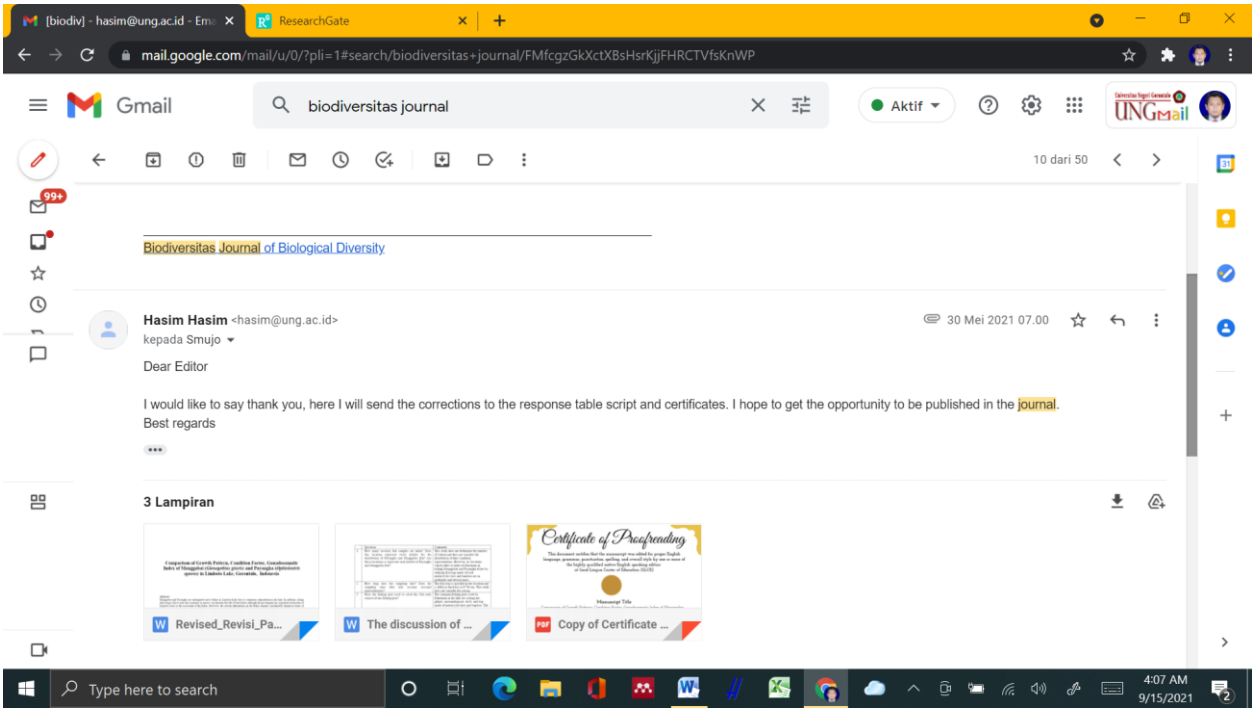
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Comparison of Growth Pattern, Condition Factor, Gonadosomatic Index of Manggabai (*Glosogobius giuris)* and Payangka (*Ophieleotris aporos)* in Limboto Lake, Gorontalo, Indonesia

Abstract
Manggabai and Payangka are endangered native fishes in Limboto Lake due to continuous degradation in the lake. In addition, silting lake along with its area that continues to narrow can threaten the life of both fishes although the government has stipulated restoration of Limboto Lake as the ecosystem of the fishes. However, the current information on the fishes remains considerably limited in terms of making it as a conservation strategy. This study aims to analyze the relationship between the total length and weight of Payangka and Manggabai. Furthermore, it analyzes the condition factors and the gonasomatic index of the two fishes. The research method integrates survey and laboratory techniques. The fishes are collected by using trap made of bamboo and motorcycle tires that are installed for three days and the catches are 60 fishes including 30 Manggabai and 30 Payangka. Then the total length and weight of the fish and their gonad weight were measured. Data analysis used mathematical formulation of the relationship between total weight and length, condition factor, and gonadosomatic index. The result of the analysis shows that the growth pattern of the Manggabai was negative allometric whereas the Payangka was positive allometric.The condition factor for both types is generally less than 1.7. The gonadosomatic index of Manggabai ranges from 4.10-20.00% and Payangka ranges from 0.05-1.98%. These conditions indicate that differences in growth pattern, condition factor, and gonadosomatic index are different forms of response to environmental conditions and in the spawning season of both types of fish.

Keywords: Growth Pattern, Gonadosomatic Index, Condition Factor, Manggabai, Payangka, Limboto Lake

Running title: Payangka and Manggabai in Limboto lake

INTRODUCTION

Limboto Lake, which is the largest and also plays a significant role in Gorontalo Province, is included in the ten national critical lakes, which are a priority to be restored. The multi-function of this Lake and others include an economic source, a center of ecological wealth, a source of clean water, and a tourist destination (Gownaris et al. 2018; Joniak et al. 2013). Furthermore, its ecological pressure continues as indicated by the depth, the decreasing area of the lake, and the polluted water quality (Lihawa and Mahmud, 2017; Hasim, 2012). According to Hasim et al. (2017), the impact on the lake is that the area which has a level of suitability for the application of the floating net cage system is only 0.36% (8.03 ha) while the rest are not suitable. Therefore, it goes against the fact that the fishery activities on the lake are the primary economic source for coastal communities (Hasim & Mopangga, 2018). Consequently, an ecological damage will threaten the fish's survival and, in turn, affect the welfare of community.

Two of the popular fish are Manggabai (*Glosogobius giuris*) and Payangka (*Ophieleotris aporos*), which are known as the native fishes of Limboto Lake. Even (Soeroto, 1988) stated that *Ophieleotris aporos* in Tondano Lake was the introducer of Limboto Lake in 1902, and they were the local fishes of the lake acclaimed by some residents. The existence of Payangka in Gorontalo as an endemic fish was also conveyed by Tweedley et al. (2013). *Ophieleotris aporos* has a rounded tail with black spots extending from the pectoral to the base of the caudal fin with a superior mouth position. However, *Glosogobius giuris* has a tapered tail fin, with several black spots, and a terminal mouth position. They both have important economic values as consumption fish for the Gorontalo people. Similarly, (Hossain et al., 2009; Dana et al., 2019; Dinh and Tran, 2017) reported that, in some places, *Glosogobius giuris* is a source of animal protein that has high economic value. Meanwhile, the increase in demand for both fishes in Gorontalo has signified an increase in fishing activity too.

According to (Suryandari and Krismono, 2011), in 2006, the fish caught in the lake reached 19.8 tons and increased in 2007 to 26.3 tons, and enormously increased to 30.4 tons in 2008. Most of these fish species are *Ophieleotris aporos* and *Glosogobius giuris*. Based on interviews with Limboto Lake fishermen and Gorontalo Fisheries Service officers, it found that there was a reduction in fish production. For example, the present number of fish caught and their sizes have relatively reduced compared to several years ago. However, the condition of the waters of the lake tends to decline. Based on fertility, it is classified as a eutrophication lake (Hasim, 2012) due to the massive growth of macrophytes and microphytes.

Liu et al. (2017) and Scavia et al. (2014) stated that eutrophication is one of the problems in lakes, which is caused by high concentrations of phosphate and nitrogen. Furthermore, changes in these limnological parameters affect the presence as native fish in the lake.

A study covering their aspects of food, habitat, and water quality has been carried out by several researchers (Fazrin et al., 2020; Suryandari and Krismono, 2011). However, detailed information comparing the two fish, including aspect of the relationship between length and weight, condition factor, and gonads, are not available yet, especially in Limboto Lake. Additionally, an information in relation to the length and weight, condition factor, and gonads are highly significant to describe the ecological and physiological factors for management purposes (Rosli and Isa, 2012; Jumawan et al., 2016). The two fishes are taken into consideration as they are native fishes from the lake that experiencing ecological pressure.

MATERIALS AND METHODS

Study area

The study was conducted in Limboto Lake, Gorontalo, Indonesia, which is in the geographic position 0^{O}31'58' NL-0^{O}34'50' NL and 122^{O}57'40' EL-123^{O}02'14' EL. It is located at an altitude of 25 m above sea level with an area of 3000 ha and an average depth of 2.5 m. Furthermore, its area is located in Gorontalo District and Gorontalo City (Lukman, 2010). It has 25 rivers and tributaries that enter its waters and one tributary as an outlet.

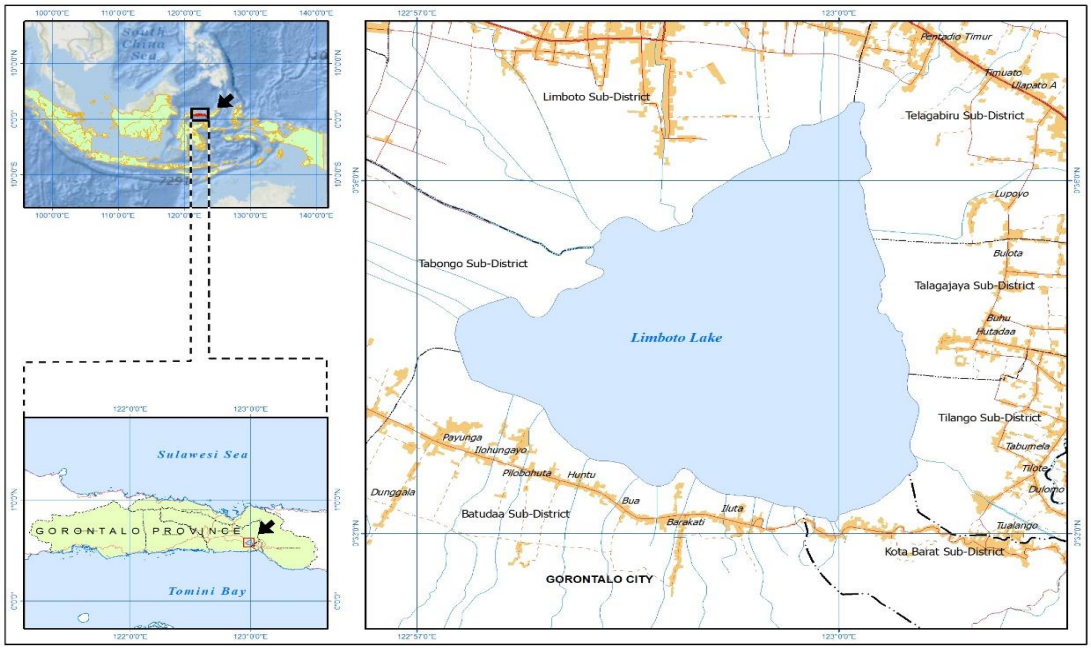

Figure 1. Map of research site in Limboto lake

Figure 2. Fishing gear used by fishermen

Procedure

The samples in this study were Manggabai and Payangka fishes. The number of samples is 60 fishes and each species comprises 30 fish. The samples were obtained from the catch of fishermen who lived around Limboto Lake using traditional fishing gear made of motorcycle tires and bamboo. (Figure 2). The samples that have been stored in a cold box were transported to the laboratory of the Faculty of Fisheries and Marine Sciences, State University of Gorontalo to be analyzed its weight, gonad, and total length using analytical scales and a caliper, respectively following the procedure (Alavi-Yeganeh et al., 2018). Meanwhile, the treatment of the gonads followed the procedure of Mazzoni et al. (2019).

Data Analysis

The result of the length and weight relationship follows the equation $W = a L^b$, where W= Fish Weight (gr), L = Total length (cm), a and b constants (Madhavan et al., 2020; Alavi-Yeganeh et al., 2018). The condition factor uses Fulton's equation (Suleiman et al., 2018) that is $K = W.100/L^{-3}$, where K is the condition factor, while W is the fish weight (gr),L is the total length (cm) and -3 is the length coefficient. Meanwhile, the equation proposed by Ekawaty et al., (2018) states that Gonadosomatic index (GSI) = (GW/ BW) X100%; GW is gonad weight, BW is body weight was used to compare the GSI values of both fish using the T-test carried out upon two independent sample groups and the assumption of different variants using Microsoft excel.

RESULTS AND DISCUSSION

In reference to the data collection in the lake, 60 fishes were captured where 30 of them were Manggabai and the rest 30 were Payangka and this result confirmed data revealed by local fishermen that the population of both fishes have been greatly reduced, particularly for Payangka fish. Additionally, the population of both native fishes, particularly Payangka fish, has been declining due to an excessive fishing and a worsening water quality in the lake (Krismono et al., 2018; Paramata, 2014). The fish sizes illustrated the variation based on the total length as presented in Figure 3, which showed that *Glosogobius giuris* is dominated by a length of 12-13 cm by 43%. Meanwhile, the dominant length of the *Ophieleotris aporos* fish ranged from 8.2-8.9 cm by 30%. Figure 3 shows the trend that the total length of the two fish species are at the lower interval. The result shown that the *Ophieleotris aporos* and *Glosogobius giuris* had an average length of 9.39 cm and 13.6 cm respectively and was relatively the same with that reported by Suryandari and Krismono (2011). However, some of the factors that affect the abundance of *Glosogobius giuris* are water quality, such as contamination from intensive fish farming activities and wild fishes (Lagbas et al., 2017).

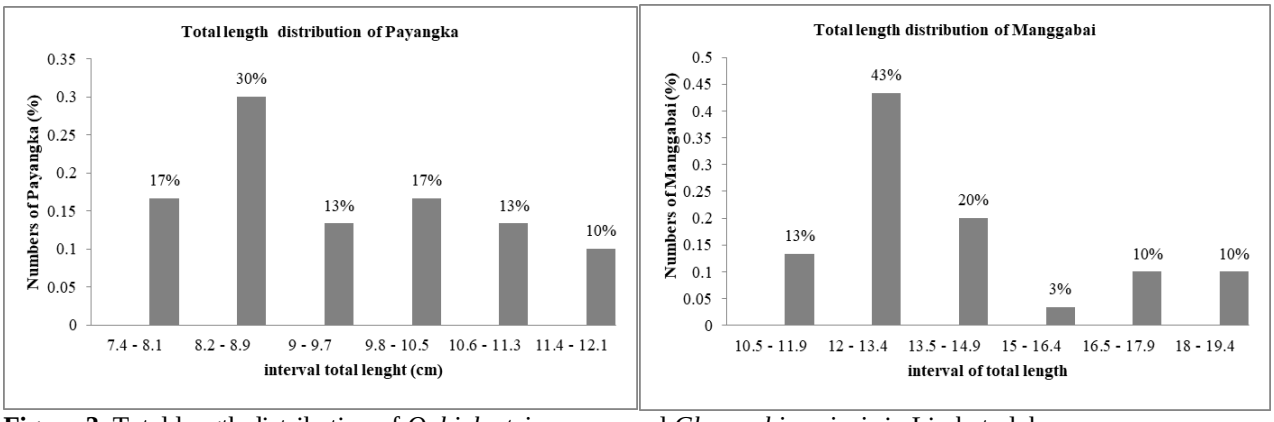

Figure 3. Total length distribution of *Ophieleotris aporos* and *Glosogobius giuris* in Limboto lake

Growth pattern

Analysis of the relationship between length and weight of both fishes is presented in Figure 4, and based on this, the value of b is obtainable. The fish growth pattern is determined from the value of b, when b> 3, b <3, or b = 3, the growth pattern is called positive allometric, negative allometric, or isometric growth pattern, respectively (Isa et al., 2012).

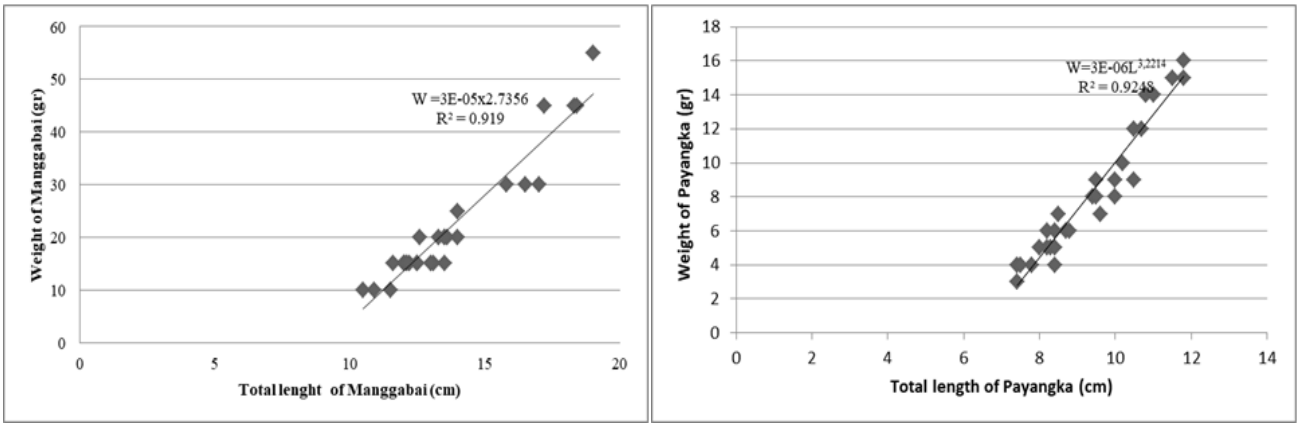

Figure 4. relationship Length and weight of *Ophieleotris aporos* and *Glossogobius giuris* in Limboto lake.

The data analysis signifies that the relationship between total length and weight of both fishes are extremely strong in which it is indicated by the value of the coefficient of determinant (R^2) for both of which are 0.9352 for Payangka and 0.9328 for Manggabai. This suggests that the increase in total length is able to explain the weight gain of fish through regression relationships. The value of b for the relationship between weight and total length of Payangka was 3.2214, the growth pattern was positive allometric, while Manggabai had value of b < 3 for 2.7356 and its growth pattern was negative allometric, which was the same as reported by (Suryandari & Krismono, 2011).

Lihawa & Sutikno (2009) stated that Limboto Lake is the estuary of rivers and tributaries whose water flows carry sediment into the lake. The sediment then becomes the main factor of silting in the Limboto lake and reduces the area of the lake column. On the other hand, there has been many aquaculture activities that are not environmentally friendly, such as intensive pellet feeding for a long time in Limboto Lake. Pellet feed that is not utilized becomes waste which settles to the bottom of the lake by 30% (McDonald et al., 1996). At the same time, in Limboto Lake, there is *bibilo* fishery activity. When the harvest time and the *bibilo* is no longer functioning, the fishermen let it settle to the bottom of the lake so that it becomes garbage (Hasim & Akbar, 2020). These various things have an impact on environmental factors in the demersal zone of the lake as the habitat of Payangka and Manggabai. For example, the dissolved oxygen content especially at the bottom of the lake is low, the high suspended solids, the air temperature increases, the feed is limited (Hermanto et al., 2013; Krismono et al., 2018; Lihawa & Mahmud, 2017; Paramata, 2014). According to the report of Froese (2006); Muchlisin et al. (2010); Das and Bordoloi (2014), many factors that affect the magnitude of the value of b include food availability, aspects of water quality, fish behavior, the maturity of gonads, habitat, and sex.

Condition factor

The fish condition factor is generally influenced by their internal and external environmental conditions, and according to the report of Gomiero and De Souza Braga (2005); Radkhah and Eagderi (2015); Faradonbe et al. (2015), there are some factors that affect the condition of fish, which include, sex, maturity of gonads, climate, and availability of sufficient feed. Furthermore, its value depicts the fish's biological status in relation to its well-being. Based on this calculation on *Ophieleotris aporos,* the value ranges from 0.74 to 1.11 and 0.67 to 1.14 for males and females, respectively. Meanwhile, for *Glosogobius giuris*, it is from 0.61 to 0.91 and 0.67 to 1.00 in male and female, respectively. Furthermore, it indicates that the two types of fish's condition number is less than 1.7, which is relatively low, and also that the lake's ecosystem is not optimal for the growth of both fish. In addition, it is consistent with the report (Hasim et al., 2017), which states that the lake waters have experienced a significant decrease in quality, however, based on interviews with fishers at the research location, it was stated that the size of both fish caught was smaller, and the number obtained was less than in previous years. It shows that the exploitation of these two types of fish is very high in the lake. The fishing gear used by fishermen in Limboto lake varies including gillnet, casting net, fishing rods, sero, trawl, ring nets, dayahu, motorcycle tires, and *bunggo* (Krismono et al., 2018; Makmur et al., 2019). According to (Paramata, 2014) some of these fishing gears are not selective towards the target so that they have an impact on overfishing. Based on the report of Suleiman et al. (2018), several factors that influence condition factor are the quality control parameters of physics, chemistry, biology, natural food collection, and fish exploitation. The T-test on the condition factor between both fish shows that the t count value is greater than the t table for two directions (5.24> 2.00, and p-value <0.005). This explains that the condition factors for the two types of fish are significantly different. In addition, it elucidates that the condition factor of both fishes is

significantly different in which according to (Alam et al., 2013), the difference is caused by different behavior of fish species towards the environment.

Gonadosomatic index

Based on observation, the gonadosomatic index of *Glosogobius giuris* varied between 4.10-20.00%, while *Ophieleotris aporos* varied between 0.05-1.98%. The gonad maturity index value below 4.44% indicates that the fish are not ready to spawn or are in the process of gonad development (Suryandari and Krismono, 2011). However, the *Ophieleotris aporos* are not ready to spawn as indicated by the GSI value for <4.44%, while *Glosogobius giuris* has a higher gonad maturity index. Furthermore, this difference was supported by the results of the T-test analysis ($p < 0.05$), meaning that there was a significant difference between the Gonadosomatic index of Payangka fish and Manggabai fish.

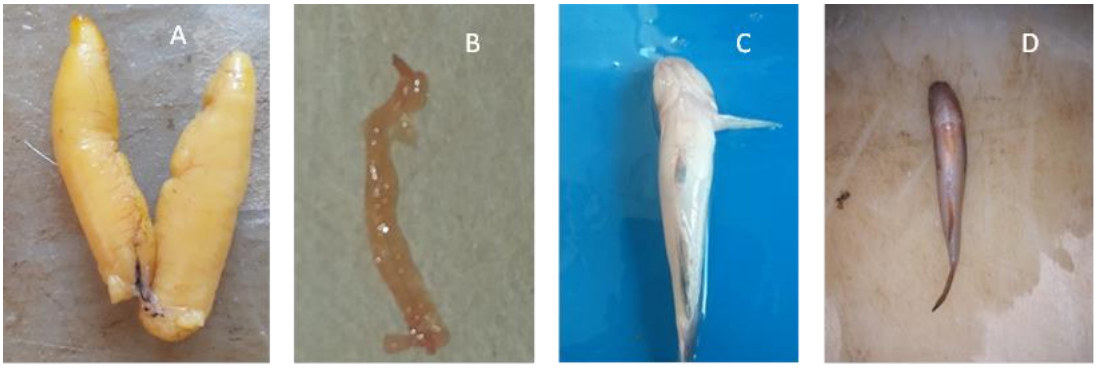

Figure 5. (A) Gonad of Manggabai; (B) Gonad of Payangka; (C) Manggabai; (D) Payangka

According to (Qambrani et al., 2016) Manggabai fish in Manchar Lake experience gonad maturity throughout the year and its peak is in April-June. Meanwhile, according to Sulistiono (2012), Manggabai fish in Ujung Pangka waters, East Java, has a peak spawning season in July-August. This means that the maturity of the Manggabai fish gonads in Limboto Lake reflects the same conditions as in other places. Meanwhile (Putra et al., 2020) stated that Payangka in Bolanu Sau Lake experiences spawning season in August-October. It lso shows that when the research was carried out in Limboto Lake (April) Payangka, the gonads were not mature yet. In addition, that environmental factors, season, and availability of feed are factors that affect the maturity of the gonads (Sulistiono, 2012).

Conclusion: based on the research results it is concluded that: the relationship pattern of total length and weight between Manggabai fish and Payangka fish is different; the value of the condition factor for the two types of fish is relatively low for < 1.7; the gonadosomatic index of Manggabai fish is > 4.44% which means it is ready to spawn, while the gonadosomatic index of Payangka fish is < 4.44% which means it is not ready to spawn. Therefore, in conformity with this condition, one of recommendations for conservation strategy of the two types of fish is paying attention to the spawning season aspect.

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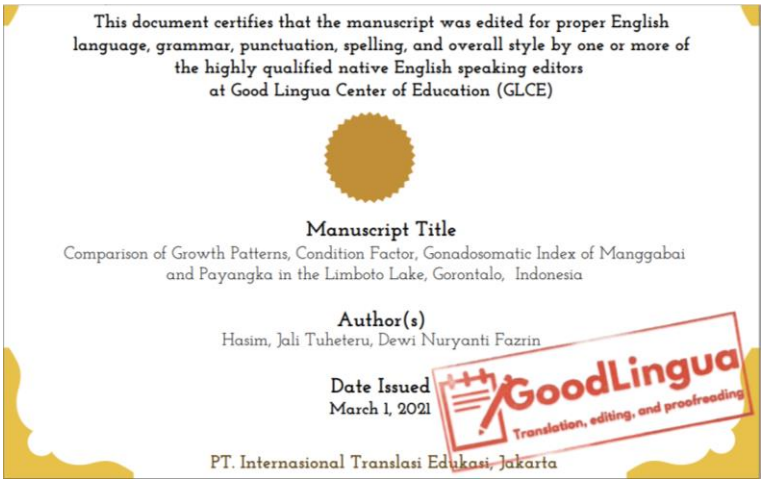
Table of Final Responses

	Question	Comment
1	How many location fish samples are taken? Does this location represent every habitat for the distribution of Payangka and Manggabai fish? Are those locations is represent each habitat of Payangka and Manggabai fish?	This study does not determine the number of station and does not consider the distribution of lake condition representation. However, its locations which refers to habit of fishermen in fishing Manggabai and Payangka fishes by utilizing fish trap made of used motorcycles tires and bamboo are in profundal and littoral zones.
2	How long does the sampling take? Does the sampling time take into account seasonal representations?	The fish trap is installed in the location and is lifted in third day at 07.00 am. This study does not consider the season.
3	Does the fishing gear used to catch this fish only consist of one fishing gear?	The common fishing gears used by fishermen in the lake are casting net, gillnet, surrounding net, trawl, and trap made of motorcycle tires and bamboo. The last trap is used only for Manggabai and Payangka fishes (it has been included in the manuscript)
4	For lines 111-112, can author explain in more detail what environmental factors are the key factors affecting the growth patterns of fish? can author explain the detail of environmental factors that the key factors affecting the growth patterns of fish?	The authors have revised the manuscript by quoting Lihawa & Sutikno (2009), Krismono, Paramata (2014), Lihawa and Machmud (2017); physicochemical parameters cover high turbidity and water column temperature; low dissolved oxygen and toxi chemicals like ammonia. It requires further research to ensure the most influential factor to the environment.
5	In lines 125-126 it states that there has been a change in fish size, was there any previous research regarding the size of the fish caught? It is interesting when the author says that there is high exploitation of payangka fish and Manggabai, this statement will be more interesting if fishing activities can be presented in Limboto Lake.	The data have been in compliance with an interview with fishermen as they state that the number of Manggabai and Payangka fishes continues to decline and their sizes tend to be smaller. Haryono (2004) also utters that the number of Payangka fish in Limboto Lake is extremely aboundant. However, its production declines and it is in line with statements of Paramata (2014) and Krismono (2018).
6	If there is previous research related to the spawning season of the two fish can be added to support the statement on lines 138-140.	To the best of authors' knowledge, the only research concerning on gonads of both fishes in Limboto Lake is conducted by Suryandari and Krismono

		(2009) and it has been quoted in the article. Meanwhile, the researches with the same topic have been conducted by many researchers; According to (Qambrani et al., 2016), gonads of Manggabai fish in Manchar Lake have experienced maturation along the year and its peak is from April to June. In the meantime, Sulistiono (2012) expresses that the peak of spawning season for Manggabai fish in Ujung Pangkah Waters, East Java is from July to August. It indicates that the gonads maturity of Manggabai fish in Limboto lake illustrates the same condition with other regions. Lastly, Putra et. al (2020) states that the spawning season for Payangka fish in Bolanu Sau Lake is from August to October and it confirms that the gonads of Payangka fish during the research in Limboto Lake in April is not mature yet.
7	In articles, the writer often says that the environmental factors in Limboto Lake that influence the condition of the two fish can also affect the Gonadsomatic Index? It would be very interesting if the author could discuss this.	The authors do not study environmental factor to Gonadosomatic index specifically, instead of referring it to Sulistiono (2010) who utters that environmental, season, and feed availability factors are the most influential factors for gonads maturity. Additionally, the authors do not elaborate key environmental factor that impacts GSI of the fishes. Therefore, a future research is indispensable to conduct.
B	Question	Comment
1	Author(s) are advised to improve the abstract: - give brief introduction; - revise/highlight the conclusion of the study.	We agree with the reviewer's assessment and have improved it.
2	Consistency of Manggabai and Payangka spelling (Capital M & P of the first letter of the word)	We agree with the reviewer's assessment and have improved it.
3	Survey data can strengthen the statement by the fishermen (stated in the manuscript)	We agree with the reviewer's assessment and have improved it.
4	Figures of Manggabai and Payangka fishes as well as the gonad of the fish should be showed in the manuscript	We agree with the reviewer's assessment and have improved it.
5	Language editing/ improvement is needed since it contains many grammatical errors	We agree with the reviewer's assessment and have improved it.

CERTIFICATE OF PROOFREADING



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Manuscript Title

Comparison of Growth Patterns, Condition Factor, Gonadosomatic Index of Manggabai and Payangka in the Limboto Lake, Gorontalo, Indonesia

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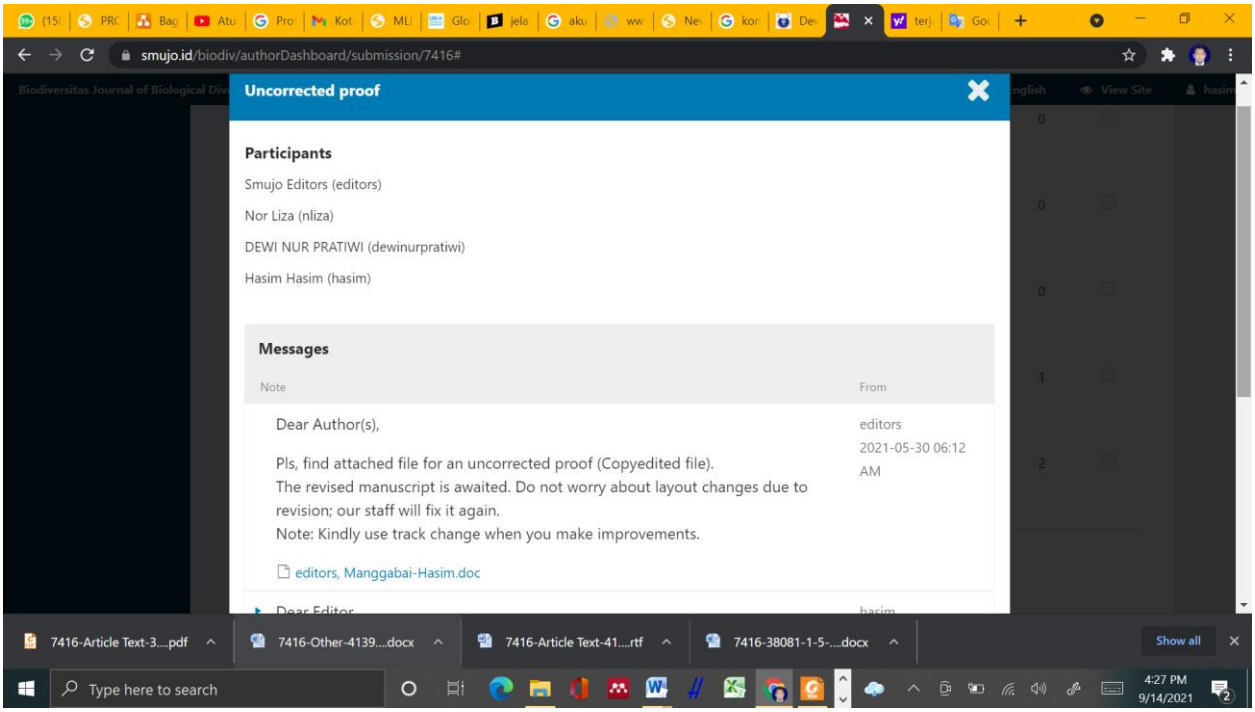

Final revised on publish format

Comparison of growth pattern, condition factor, gonadosomatic index of Manggabai (*Glosogobius giuris)* and Payangka (*Ophieleotris aporos)* in Limboto Lake, Gorontalo, Indonesia

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Abstract. *Hasim, Tuheteru J, Fazrin DN. 2021. Comparison of growth pattern, condition factor, gonadosomatic index of Manggabai (*Glosogobius giuris*) and Payangka (*Ophieleotris aporos*) in Limboto Lake, Gorontalo, Indonesia. Biodiversitas 22: xxxx.* Manggabai and Payangka are endangered native fishes in Limboto Lake due to continuous degradation in the lake. In addition, silting lake along with its area that continues to narrow can threaten the life of both fishes although the government has stipulated restoration of Limboto Lake as the ecosystem of the fishes. However, the current information on the fishes remains considerably limited in terms of making it as a conservation strategy. This study aims to analyze the relationship between the total length and weight of Payangka and Manggabai. Furthermore, it analyzes the condition factors and the gonasomatic index of the two fishes. The research method integrates survey and laboratory techniques. The fishes are collected by using trap made of bamboo and motorcycle tires that are installed for three days and the catches are 60 fishes including 30 Manggabai and 30 Payangka. Then the total length and weight of the fish and their gonad weight were measured. Data analysis used mathematical formulation of the relationship between total weight and length, condition factor, and gonadosomatic index. The result of the analysis shows that the growth pattern of the Manggabai was negative allometric whereas the Payangka was positive allometric.The condition factor for both types is generally less than 1.7. The gonadosomatic index of Manggabai ranges from 4.10-20.00% and Payangka ranges from 0.05-1.98%. These conditions indicate that differences in growth pattern, condition factor, and gonadosomatic index are different forms of response to environmental conditions and in the spawning season of both types of fish.

Keywords: Growth Pattern, Gonadosomatic Index, Condition Factor, Manggabai, Payangka, Limboto Lake

INTRODUCTION

Limboto Lake, which is the largest and also plays a significant role in Gorontalo Province, is included in the ten national critical lakes, which are a priority to be restored. The multi-function of this Lake and others include an economic source, a center of ecological wealth, a source of clean water, and a tourist destination (Gownaris et al. 2018; Joniak et al. 2013). Furthermore, its ecological pressure continues as indicated by the depth, the decreasing area of the lake, and the polluted water quality (Lihawa and Mahmud, 2017; Hasim, 2012). According to Hasim et al. (2017), the impact on the lake is that the area which has a level of suitability for the application of the floating net cage system is only 0.36% (8.03 ha) while the rest are not suitable. Therefore, it goes against the fact that the fishery activities on the lake are the primary economic source for coastal communities (Hasim & Mopangga, 2018). Consequently, an ecological damage will threaten the fish's survival and, in turn, affect the welfare of community.

Two of the popular fish are Manggabai (*Glosogobius giuris*) and Payangka (*Ophieleotris aporos*), which are known as the native fishes of Limboto Lake. Even (Soeroto, 1988) stated that *O. aporos* in Tondano Lake was the introducer of Limboto Lake in 1902, and they were the local fishes of the lake acclaimed by some residents. The existence of Payangka in Gorontalo as an endemic fish was also conveyed by Tweedley et al. (2013). *O.aporos* has a rounded tail with black spots extending from the pectoral to the base of the caudal fin with a superior mouth position. However, *G. giuris* has a tapered tail fin, with several black spots, and a terminal mouth position. They both have important economic values as consumption fish for the Gorontalo people. Similarly, (Hossain et al., 2009; Dana et al., 2019; Dinh and Tran, 2017) reported that, in some places, *G. giuris* is a source of animal protein that has high economic value. Meanwhile, the increase in demand for both fishes in Gorontalo has signified an increase in fishing activity too.

According to (Suryandari and Krismono, 2011), in 2006, the fish caught in the lake reached 19.8 tons and increased in 2007 to 26.3 tons, and enormously increased to 30.4 tons in 2008. Most of these fish species are *O.aporos* and *G. giuris*. Based on interviews with Limboto Lake fishermen and Gorontalo Fisheries Service officers, it found that there was a reduction in fish production. For example, the present number of fish caught and their sizes have relatively reduced compared to several years ago. However, the condition of the waters of the lake tends to decline. Based on fertility, it is classified as a eutrophication lake (Hasim, 2012) due to the massive growth of macrophytes and microphytes. Liu et al. (2017) and Scavia et al. (2014) stated that eutrophication is one of the problems in lakes, which is caused by high concentrations of phosphate and nitrogen. Furthermore, changes in these limnological parameters affect the presence as native fish in the lake.

A study covering their aspects of food, habitat, and water quality has been carried out by several researchers (Fazrin et al., 2020; Suryandari and Krismono, 2011). However, detailed information comparing the two fish, including aspect of the relationship between length and weight, condition factor, and gonads, are not available yet, especially in Limboto Lake. Additionally, an information in relation to the length and weight, condition factor, and gonads are highly significant to describe the ecological and physiological factors for management purposes (Rosli and Isa, 2012; Jumawan et al., 2016). The two fishes are taken into consideration as they are native fishes from the lake that experiencing ecological pressure.

MATERIALS AND METHODS

Study area

The study was conducted in Limboto Lake, Gorontalo, Indonesia, which is in the geographic position $0^{O}31'58'$ NL-$0^{O}34'50'$ NL and $122^{O}57'40'$ EL-$123^{O}02'14'$ EL. It is located at an altitude of 25 m above sea level with an area of 3000 ha and an average depth of 2.5 m. Furthermore, its area is located in Gorontalo District and Gorontalo City (Lukman, 2010). It has 25 rivers and tributaries that enter its waters and one tributary as an outlet.

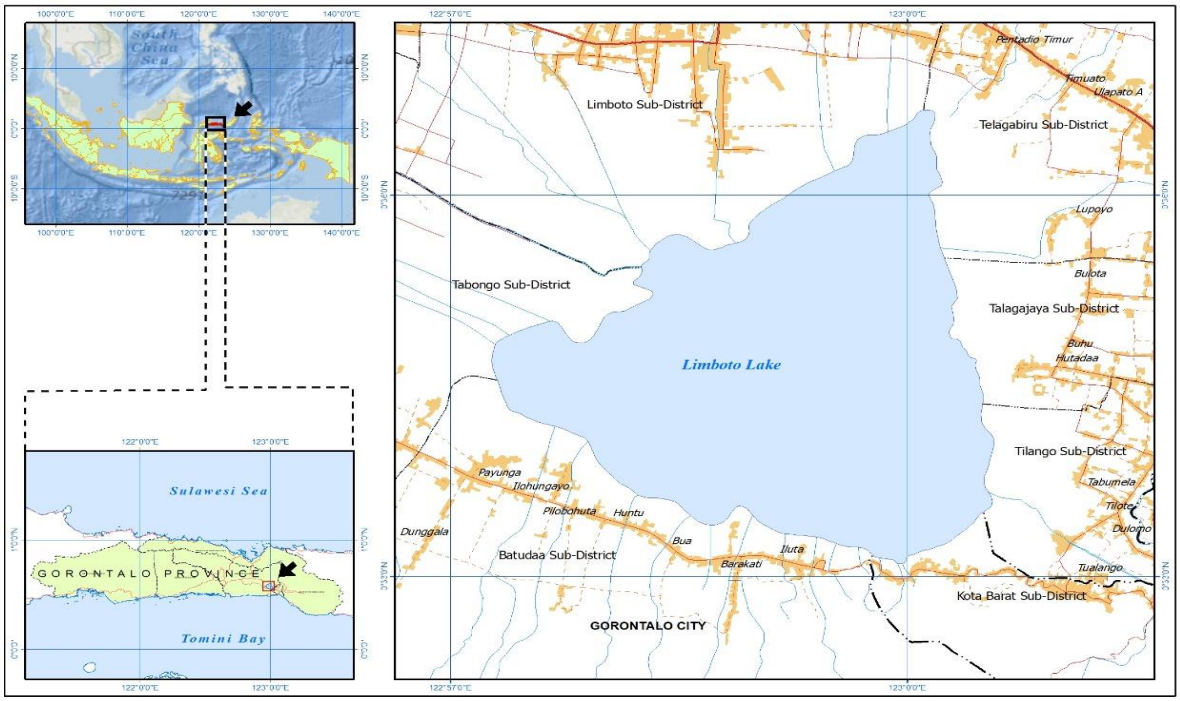

Figure 1. Map of research site in Limboto lake

Figure 2. Fishing gear used by fishermen

Procedure

The samples in this study were Manggabai and Payangka fishes. The number of samples was 60 fishes and each species comprises 30 fish. The samples were obtained from the catch of fishermen who lived around Limboto Lake using traditional fishing gear made of motorcycle tires and bamboo. (Figure 2). The samples that have been stored in a cold box were transported to the laboratory of the Faculty of Fisheries and Marine Sciences, State University of Gorontalo to be analyzed its weight, gonad, and total length using analytical scales and a caliper, respectively following the procedure (Alavi-Yeganeh et al., 2018). Meanwhile, the treatment of the gonads followed the procedure of Mazzoni et al. (2019).

Data analysis

The result of the length and weight relationship follows the equation $W = a L^b$, where W= Fish Weight (gr), L = Total length (cm), a and b constants (Madhavan et al., 2020; Alavi-Yeganeh et al., 2018). The condition factor uses Fulton's equation (Suleiman et al., 2018) that is $K = W.100/L^{-3}$, where K is the condition factor, while W is the fish weight (gr),L is the total length (cm) and -3 is the length coefficient. Meanwhile, the equation proposed by Ekawaty et al., (2018) states that Gonadosomatic index (GSI) = (GW/ BW) X100%; GW is gonad weight, BW is body weight was used to compare the GSI values of both fish using the T-test carried out upon two independent sample groups and the assumption of different variants using Microsoft excel.

RESULTS AND DISCUSSION

In reference to the data collection in the lake, 60 fishes were captured where 30 of them were Manggabai and the rest 30 were Payangka and this result confirmed data revealed by local fishermen that the population of both fishes have been greatly reduced, particularly for Payangka fish. Additionally, the population of both native fishes, particularly Payangka fish, has been declining due to an excessive fishing and a worsening water quality in the lake (Krismono et al., 2018; Paramata, 2014). The fish sizes illustrated the variation based on the total length as presented in Figure 3, which showed that *G. giuris* is dominated by a length of 12-13 cm by 43%. Meanwhile, the dominant length of the *O. aporos* fish ranged from 8.2-8.9 cm by 30%. Figure 3 shows the trend that the total length of the two fish species are at the lower interval. The result shown that the *O. aporos* and *G. giuris* had an average length of 9.39 cm and 13.6 cm respectively and was relatively the same with that reported by Suryandari and Krismono (2011). However, some of the factors that affect the abundance of *G.giuris* are water quality, such as contamination from intensive fish farming activities and wild fishes (Lagbas et al., 2017).

Growth pattern

Analysis of the relationship between length and weight of both fishes is presented in Figure 4, and based on this, the value of b is obtainable. The fish growth pattern is determined from the value of b, when b> 3, b <3, or b = 3, the growth pattern is called positive allometric, negative allometric, or isometric growth pattern, respectively (Isa et al., 2012).

The data analysis signifies that the relationship between total length and weight of both fishes are extremely strong in which it is indicated by the value of the coefficient of determinant (R^2) for both of which were 0.9352 for Payangka and 0.9328 for Manggabai. This suggests that the increase in total length is able to explain the weight gain of fish through regression relationships. The value of b for the relationship between weight and total length of Payangka was 3.2214, the growth pattern was positive allometric, while Manggabai had value of b < 3 for 2.7356 and its growth pattern was negative allometric, which was the same as reported by (Suryandari & Krismono, 2011).

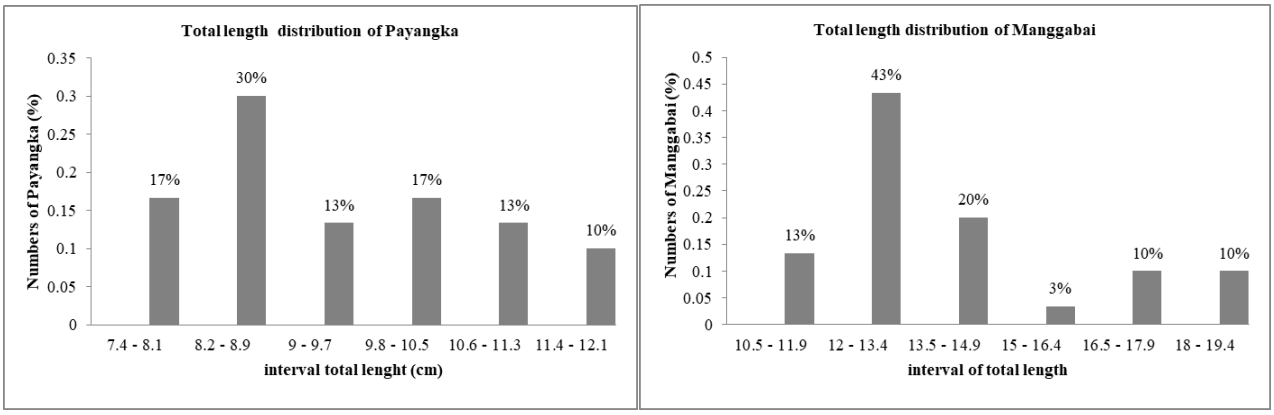

Figure 3. Total length distributions of *Ophieleotris aporos* and *Glosogobius giuris* in Limboto lake

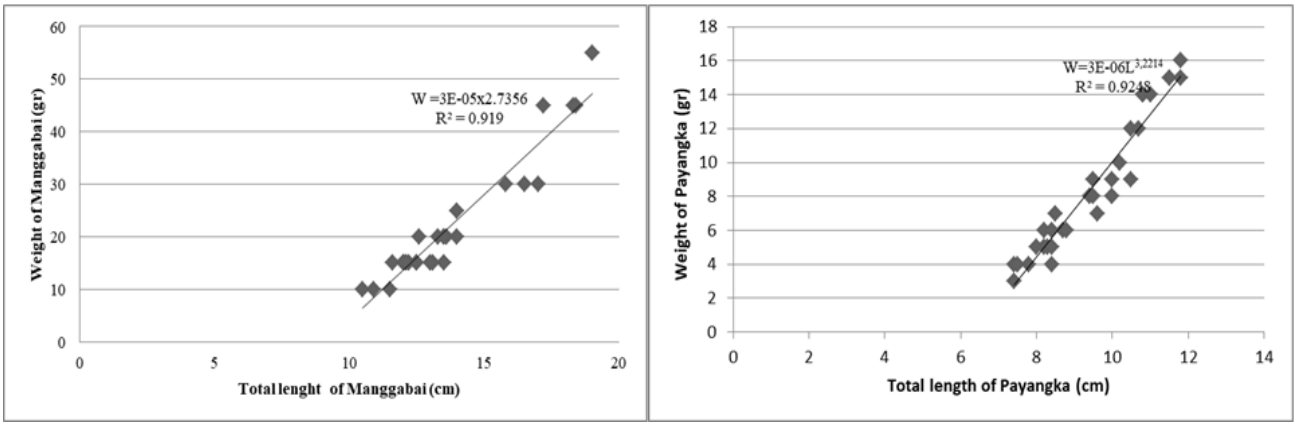

Figure 4. Relationship between Length length and weight of Ophieleotris aporos and Glossogobius giuris in Limboto lake

Lihawa & Sutikno (2009) stated that Limboto Lake is the estuary of rivers and tributaries whose water flows carry sediment into the lake. The sediment then becomes the main factor of silting in the Limboto lake and reduces the area of the lake column. On the other hand, there has been many aquaculture activities that are not environmentally friendly, such as intensive pellet feeding for a long time in Limboto Lake. Pellet feed that is not utilized becomes waste which settles to the bottom of the lake by 30% (McDonald et al., 1996). At the same time, in Limboto Lake, there is *bibilo* fishery activity. When the harvest time and the *bibilo* is no longer functioning, the fishermen let it settle to the bottom of the lake so that it becomes garbage (Hasim & Akbar, 2020). These various things have an impact on environmental factors in the demersal zone of the lake as the habitat of Payangka and Manggabai. For example, the dissolved oxygen content especially at the bottom of the lake is low, the high suspended solids, the air temperature increases, the feed is limited (Hermanto et al., 2013; Krismono et al., 2018; Lihawa & Mahmud, 2017; Paramata, 2014). According to the report of Froese (2006); Muchlisin et al. (2010); Das and Bordoloi (2014), many factors that affect the magnitude of the value of b include food availability, aspects of water quality, fish behavior, the maturity of gonads, habitat, and sex.

Condition factor

The fish condition factor is generally influenced by their internal and external environmental conditions, and according to the reports of Gomiero and De Souza Braga (2005); Radkhah and Eagderi (2015); Faradonbe et al. (2015), there are some factors that affect the condition of fish, which include, sex, maturity of gonads, climate, and availability of sufficient feed. Furthermore, its value depicts the fish's biological status in relation to its well-being. Based on this calculation on *O. aporos,* the value ranged from 0.74 to 1.11 and 0.67 to 1.14 for males and females, respectively. Meanwhile, for *G. giuris,* it is from 0.61 to 0.91 and 0.67 to 1.00 in male and female, respectively. Furthermore, it indicates that the two types of fish's condition number was less than 1.7, which is relatively low, and also that the lake's ecosystem is not optimal for the growth of both fish. In addition, it is consistent with the report of (Hasim et al., 2017), which stated that the lake waters have experienced a significant decrease in quality, however, based on interviews with fishers at the research location, it was stated that the size of both fish caught was smaller, and the number obtained was less than in previous years. It showed that the exploitation of these two types of fish is very high in the lake. The fishing gear used by fishermen in Limboto lake varies including gillnet, casting net, fishing rods, sero, trawl, ring nets, dayahu, motorcycle tires, and *bunggo* (Krismono et al., 2018; Makmur et al., 2019). According to (Paramata, 2014) some of these fishing gears are not selective towards the target so that they have an impact on overfishing. Based on the report of Suleiman et al. (2018), several factors that influence condition factor are the quality control parameters of physics, chemistry, biology, natural food collection, and fish exploitation. The T-test on the condition factor between both fishes showed that the t count value is greater than the t table for two directions (5.24> 2.00, and p-value <0.005). This explains that the condition factors for the two types of fishes ware significantly different. In addition, it elucidates that the condition factor of both fishes is significantly different in which according to (Alam et al., 2013), the difference is caused by different behavior of fish species towards the environment.

Gonadosomatic index

Based on observation, the gonadosomatic index of *G. giuris* varied between 4.10-20.00%, while *O. aporos* varied between 0.05-1.98%. The gonad maturity index value below 4.44% indicates that the fish are not ready to spawn or are in the process of gonad development (Suryandari and Krismono, 2011). However, the *O. aporos* is not ready to spawn as indicated by the GSI value for <4.44%, while *G. giuris* has a higher gonad maturity index. Furthermore, this difference was supported by the results of the T-test analysis ($p < 0.05$), meaning that there was a significant difference between the Gonadosomatic index of Payangka and Manggabai.

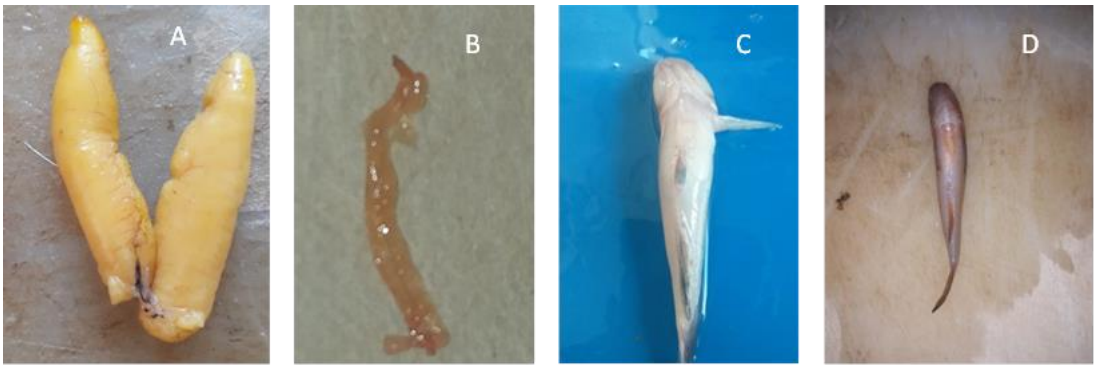

Figure 5. (A) Gonad of Manggabai; (B) Gonad of Payangka; (C) Manggabai; (D) Payangka

According to (Qambrani et al., 2016) Manggabai in Manchar Lake experience gonad maturity throughout the year and its peak is in April-June. Meanwhile, according to Sulistiono (2012), Manggabai in Ujung Pangka waters, East Java, has a peak spawning season in July-August. This means that the maturity of the Manggabai gonads in Limboto Lake reflects the same conditions as in other places. Meanwhile (Putra et al., 2020) stated that Payangka in Bolanu Sau Lake experiences spawning season in August-October. It lso shows that when the research was carried out in Limboto Lake (April) Payangka, the gonads were not mature yet. In addition, that environmental factors, season, and availability of feed are factors that affect the maturity of the gonads (Sulistiono, 2012).

Conclusion: based on the research results it is concluded that: the relationship pattern of total length and weight between Manggabai fish and Payangka fish is different; the value of the condition factor for the two types of fish is relatively low for < 1.7; the gonadosomatic index of Manggabai fish is > 4.44% which means it is ready to spawn, while the gonadosomatic index of Payangka fish is < 4.44% which means it is not ready to spawn. Therefore, in conformity with this condition, one of recommendations for conservation strategy of the two types of fish is paying attention to the spawning season aspect.

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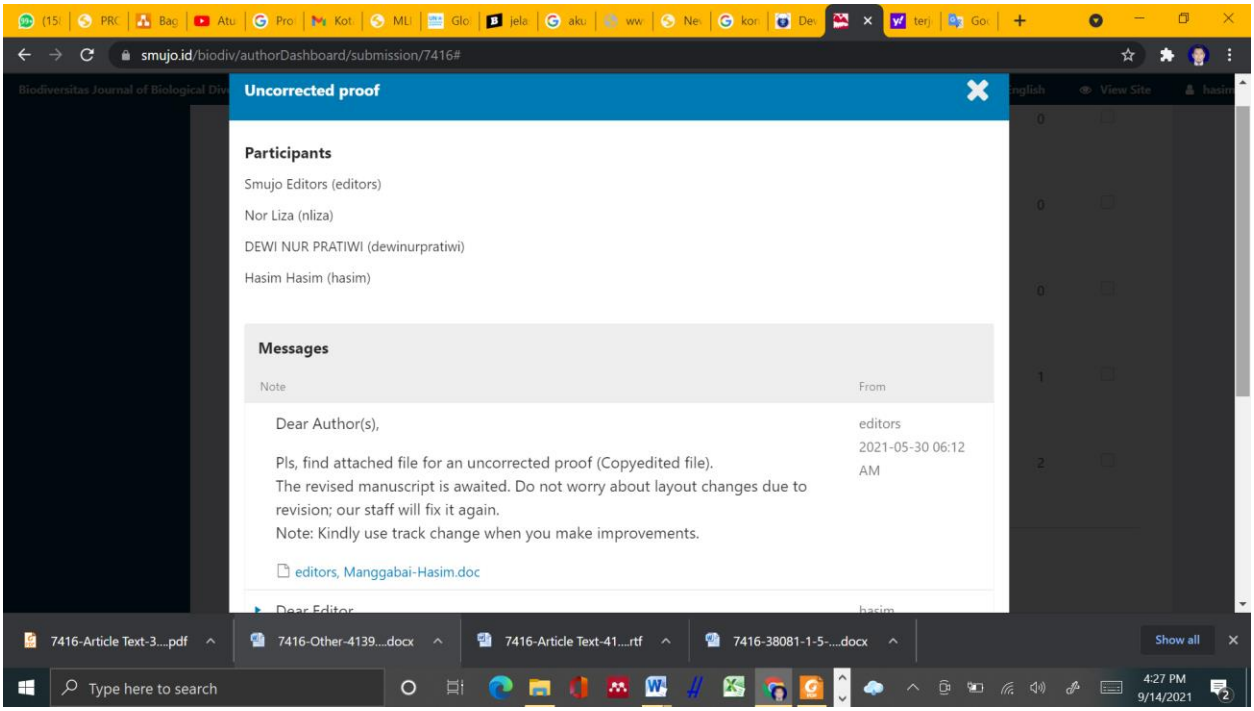
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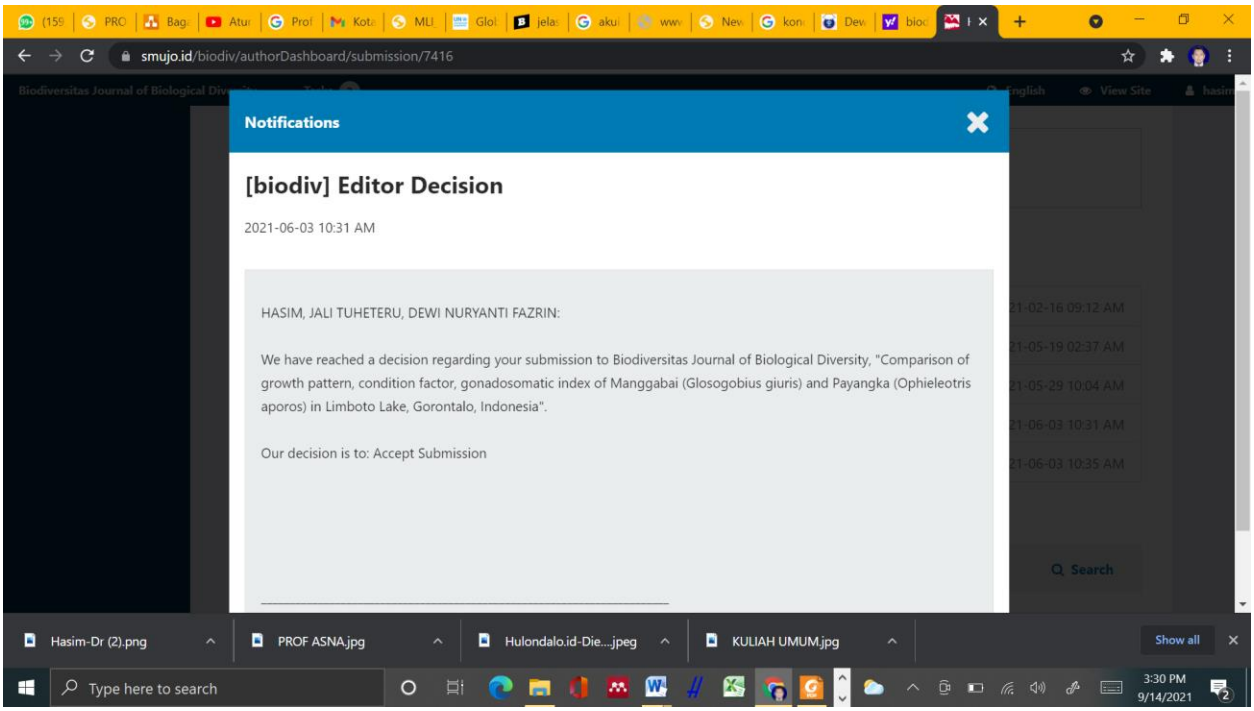
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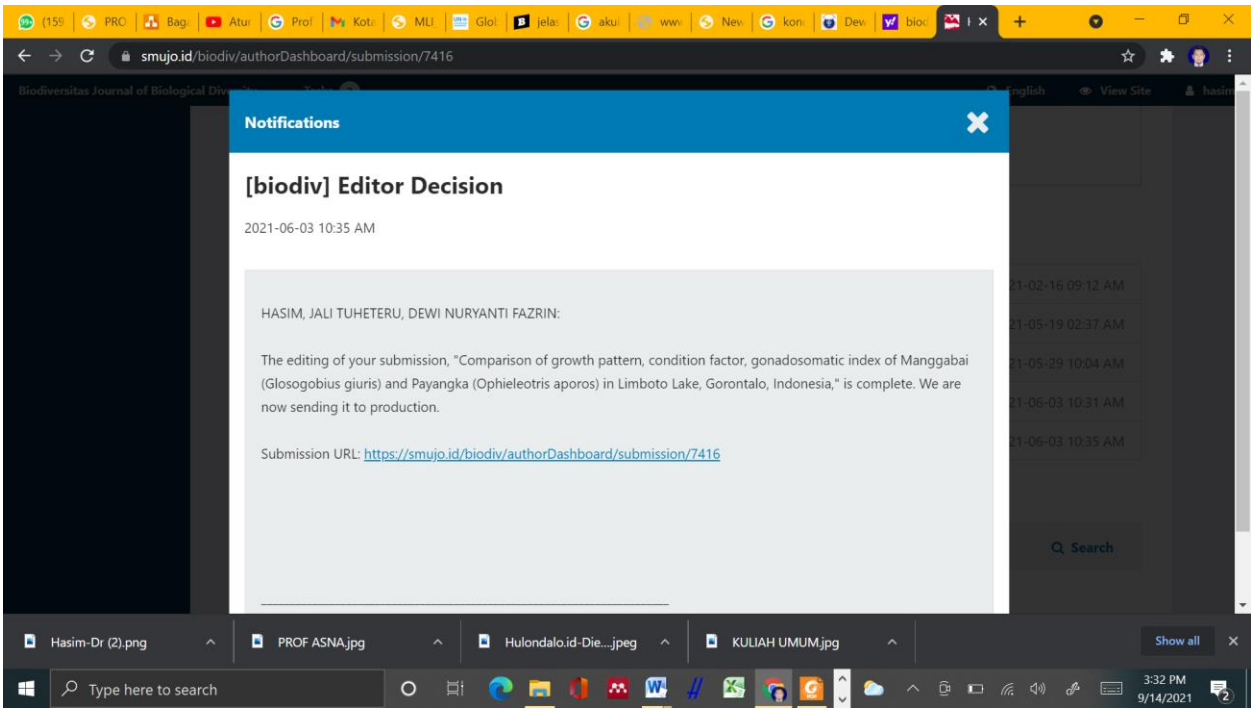
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