Original Research Article

Gonad Maturity and Fecundity of Indian Mackerel (*Rastellinger kanagurta*) in North Gorontalo Waters, Indonesia

Comment [D1]: In October-November

ABSTRACT

Indian mackerel (*Rastellinger kanagurta*) is one of the fish that can be found in North Gorontalo waters. Excessive fishing without regard to the condition of the fish will cause a decrease in the quality and quantity of fish resources. Estimation of size at first maturity is one way to determine population development in water. This study aims to determine the relationship between the level of gonad maturity and the fecundity of Indian mackerel in North Gorontalo waters. This research was carried out in October-November 2021 at the Kwandang Archipelago Fishing Port. The level of maturity of the gonads was observed morphologically and the determination of fecundity was observed using volumetric and gravimetric methods. The maturity level of Indian Mackerel fish in North Gorontalo waters is dominated at level 1. The highest fecundity is 14,800 eggs and the lowest is 5,000 eggs. The relationship between the level of gonad maturity level and fecundity is directly proportional, if the gonadal maturity value is high, the fecundity value will also be higher. The spawning season for Indian mackerel in North Gorontalo waters does not take place in October-December, this is characterized by low fecundity. Based on the gonadal maturity values every month, the peak

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spawning of Indian mackerel (*Rastellinger kanagurta*) allegedly occurred shortly after the highest GSI values.

Keywords: fecundity, gonadal maturity, Gonadal Somatic Index (GSI), spawning time.

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1. INTRODUCTION

North Gorontalo waters are one of the main bases for small pelagic fisheries in Sulawesi sea waters. Kwandang Archipelago Fishing Port is the main base for small pelagic fisheries and large pelagic fisheries. One type of pelagic fish that is widely used in these waters is the Indian mackerel (*Rastrelliger kanagurta*). The use of pelagic fish in Sulawesi sea waters which has increased from year to year can threaten the sustainability of small pelagic fish in these waters [1].

Indian Mackerel (*Rastrelliger kanagurta*) is a small pelagic fish that has great potential and very significant economic value [2]. This fish is very easy to catch in large quantities because it is usually schooled [3]. Indian Mackerel (*Rastrelliger kanagurta*) is one of the many fish found in North Gorontalo waters. Therefore, Indian Mackerel (*Rastrelliger kanagurta*) is one of the types of fish most often caught by fishermen and used by local people.

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Excessive fishing without regard to the condition of the fish, such as the gonadal maturity stage, will cause a decrease in the quality and quantity of fish resources. As

a result, catches will also decrease and the distribution of fish can be exhausted if fishermen do not pay attention to the sustainability of these fish resources. Over time, the fish resources of Indian Mackerel in North Gorontalo Waters will continue to decrease. Reduced fish populations in the future can occur because the fish caught are fish that will spawn or fish that have never spawned [4].

Estimating the size of the first gonadal maturity is one way to determine population development in waters [5]. In addition, by knowing the fecundity, the number of fish that will be produced can be estimated and the number of fish in a certain age class can also be determined. Based on this, the reproductive aspects of the Indian Mackerel (*Rastrelliger kanagurta*) need to be studied to determine the relationship between the level of gonadal maturity and the fecundity and gonad maturity index of the Indian Mackerel (*Rastrelliger kanagurta*) in North Gorontalo Waters.

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2. MATERIAL AND METHODS

This research was carried out in October-November 2021. The sampling location was carried out at the Kwandang Archipelago Fishery Port and the observation process was continued at the Fisheries and Maritime Laboratory of the University of Gorontalo.

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The tools used in this study include; cool box, electric scales, stationery, a camera, sample paper, a petri dish, dissecting set, a microscope, a pipette, and a beaker

glass. The ingredients used include Indian Mackerel (*Rastrelliger kanagurta*), 100 ml of water, and ice cubes.

2.1 Research Procedures

A sampling of Indian Mackerel (*Rastellinger kanagurta*) at the Gorontalo Archipelago Fishing Port is carried out 3 times a month. The caught fish are grouped and counted based on the sampling station. Then the length is measured and weighed, then dissected to determine the sex by looking at the characteristics and differences found in the gonads. Observation of the morphological level of gonad maturity (Table 1) includes color, surface structure, eggs, gonad length, and weight, then followed by observations of fecundity.

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Table 1. Determination of the level of maturity of the gonads morphologically

Maturity Level	Female	Male
I (Immature)	Gonads are clear during the development	The testicles are clear
II (Maturing)	Gonads are yellowish-white. The gonads almost fill half of the testes	The testicles are milky white Half of the peritoneum, milky white fill the testicles
III (Mature)	Egg peritoneum in the form of fine granules greenish yellow	Most of the peritoneum and milky white

Maturity Level	Female	Male
	Gonads fill most of the peritoneum, brownish green and darker in color	
IV (Spawned)	Gonads shrink	Shrinking testes

2.2 Data Analysis

2.2.1 Fecundity

The determination of the value of Fecundity is carried out using the Effendi formula [6], which is as follows:

$$F = \frac{G \times V \times X}{Q}$$

Information :
F : Fecundity
G : Total Gonad Weight (g)
V : Dilution Volume (100 ml)
X : Number of eggs in 1 cc
Q : Egg weight (g)

2.2.2 Gonadal Somatic Index (GSI)

Gonadal Somatic Index (GSI) is calculated from the percentage ratio of gonad weight and fish weight. The GSI value is getting bigger and bigger until the maximum range is reached, then there will be a decrease (spawning) so that the spawning season can be predicted. The GSI value is analyzed based on the following formula:

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$$GSI = \frac{GoW}{GW} \times 100$$

Information :
Gow : gonad weight in grams (g)
GW = gutted weight in grams (g)

3. RESULTS AND DISCUSSION

3.1 Gonad Maturity Level

Based on the results of the study it was found that the gonad maturity level of Indian Mackerel caught from October to December was level I in as many as 136 individuals (50%), level II as 130 individuals (48%), level III as 3 individuals (1%), level IV as 2 individuals (1%).

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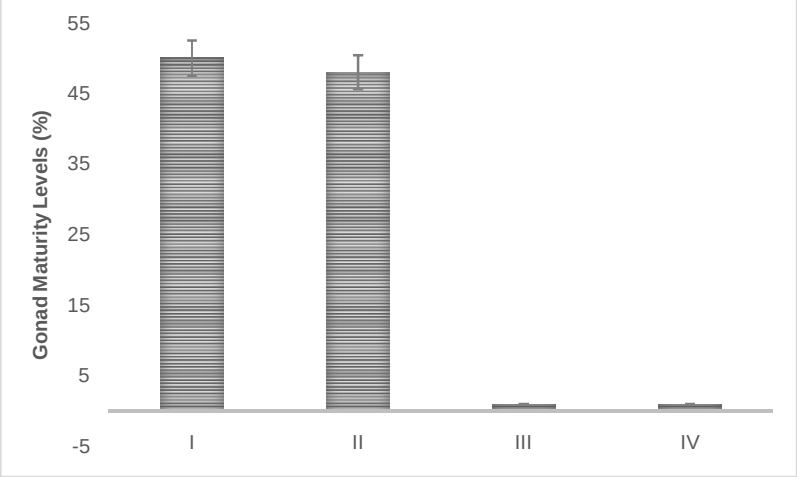

Fig. 1. Gonad Maturity Levels in Indian Mackerel (*Rastrelliger kanagurta*)

Based on Figure 1, the Indian Mackerel fish has a low level of Gonad Maturity Levels III and IV, meaning that the Indian Mackerel (*Rastellinger kanagurta*) is said to be not ready for spawning. This is in accordance with the opinion of Effendi [6] and Auliyah et al. [14] stated that gonad development is part of the fish reproductive process before spawning occurs. The size of the gonads that reach maturity for the first time can vary between species and can also vary within one species. Effendi [6] and Fatah & Adjie [7] stated that this was thought to occur due to factors such as the availability of feed in certain waters, different adaptation patterns and life strategies for each type of fish, and different growth rates for each fish. All of these factors affect the degree of gonad maturity each fish will reach and cause variations in the size of the hgonads that reach maturity first.

Comment [D19]: Throughout the year

3.2 Gonadal Somatic Index (GSI)

Gonadal Somatic Index (GSI) is a value in the form of a percentage obtained through a comparison between the gonadal weight and the body weight of the fish. The GSI value shows the percentage of the total weight of fish that will be used to produce eggs during the spawning process. Based on the results of observations and GSI calculations (Figure 2) in October, Indian Mackerel (*Rastellinger kanagurta*) had a GSI value of 1.27%. The IKG value in November decreased to 0.98% and in December, it decreased again to 0.32%. It can be concluded that October is the month with the highest GSI value for Indian Mackerel (*Rastellinger kanagurta*) compared to November and December with a maximum GSI value of 1.27%. Based on previous research by

Zamroni et al. [17] who studied the reproductive biology and genetics of Indian Mackerel fish populations on the north coast of Java, found the gonadal maturity index (GSI) of Indian Mackerel ranged from 0.49-6.98%. Arrafi et al. [18] reported that the peak spawning of mackerel in western Aceh waters occurred in January-March and July-October, the GSI value of Indian mackerel ranged from 0.32-3.37%.

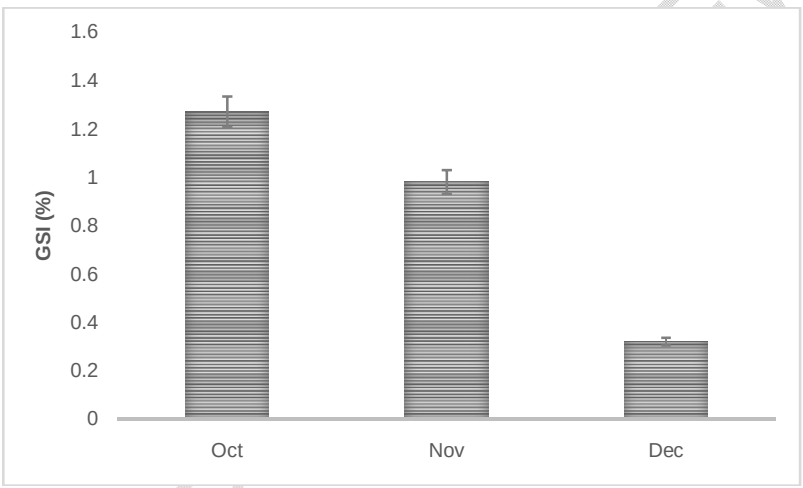

Fig. 2. GSI of Indian Mackerel (*Rastellinger kanagurta*)

The low value of the Gonadal Somatic Index (GSI) for Indian Mackerel in North Gorontalo Waters is due to the group of fish that have matured gonads are not in the fishing ground. This is presumably because they are migrating to spawning grounds and also looking for food and growing. This explanation is in line with the conclusions of Zamroni et al. [17] which states that the GSI value is not always related to fish weight. In December, the GSI value of the Indian Mackerel (*Rastellinger kanagurta*) was lower than the GSI value in

October and November. This is thought to be influenced by the dominance of small fish in the number of fish caught in December, compared to October and November. This is also supported by research by Sembiring et al. [19] which states that the GSI value is not always related to the weight of the fish.

The gonad weight increases with increasing size, including the egg line. The gonad weight reaches its maximum value before spawning, then decreases rapidly during the spawning process. Gonadal Somatic Index (GSI) is a value in percentage that is the result of a comparison between the weight of the gonads and the weight of the fish including the gonads, multiplied by 100% [8]. An increase in the GSI value of fish is an indication of the spawning season. Based on the GSI value every month, the spawning peak of the Indian Mackerel (*Rastellinger kanagurta*) occurs after the GSI value reaches the highest value. This is in line with the opinion of Araffi et al. [18] that a high GSI is an indication of the spawning season. According to Effendi [6], gonadal development is closely related to the gonadal maturity index, so if the GSI value is close to the maximum value, it indicates that spawning is taking place. The GSI value obtained during the study was less than 20%, fish with a GSI value of less than 20% were a group of fish capable of spawning more than once a year [9].

3.2 Fecundity

Based on the results of research conducted in October and November in North Gorontalo Waters, Indian Mackerel Fish have different amounts of Fecundity,

Comment [D20]: Small period

October the fecundity of fish ranges from 14,800 eggs at gonadal maturity level IV with a gonad weight of 4.08 gr. while in November the fecundity of fish ranged from 5000 grains of gonadal maturity level III with a gonad weight of 0.36 gr. Based on previous research such as that of Kasmi et al. [11] the Takalar coastal waters obtained fecundity ranging from 11,235-40,878 grains. Research by Putera & Setyobudiandi [21] fecundity of Indian mackerel in the Sunda Strait ranges from 2314-96924 eggs with an average of 24075 eggs and Arrafi et al. [18] in the western waters of Aceh, the fecundity ranged from 28,542-123,760 eggs. The more eggs released, the higher the reproductive potential of the Indian Mackerel [10].

Knowing the amount of fecundity makes it possible to estimate the number of fries to be obtained and will determine the pattern of the number of fries in the age group. Based on the amount of fecundity in the study, it was smaller than the results of previous studies. Factors such as fertilization, spawning frequency, protection by the parents, egg size, environmental conditions, and food availability affect fecundity [11]. According to Suhendra et al. [13] in Fatah & Adjie [7], the fecundity value of a fish species is also influenced by body weight, not just the total length. Fecundity is often associated with length rather than weight because length does not decrease as easily as weight does. In this case, it is necessary to be careful in taking repeated samples, because if the fish is taken while the gonads are growing, this is not somatic growth. Therefore, there must be a difference between somatic growth and gonadal growth. Older and larger fish usually have relatively low fecundity.

Comment [D21]: Not possible

3.4 Sex Ratio

Based on the results of calculating the sex ratio (Table 2) for Indian Mackerel (*Rastellinger kanagurta*) from October to December 2021 at the Fisheries Laboratory, University of Gorontalo, it is known that the ratio between male and female fish is 1: 0.03. Based on the sex ratio, it can be seen that the male sex is more dominant than the female.

Table 2. Indian Mackerel sex ratio

Type of fish	Total (individuals)	Male (individuals)	Female (individuals)	Sex ratio (M : F)
Indian Mackerel	271	261	10	1: 0,03

According to Suhendra et al. [13], a high proportion of male fish in the population can disrupt the sustainability of this species. When the proportion of male fish is more than the eggs produced by the female and the distribution of sperm is more abundant than the number of females, this can affect the number of offspring which will be fewer and fewer [12]. Differences in the sex ratio of fish in the water can be influenced by differences in behavior, unequal distribution of males and females, and fishing factors [13]. In addition, Effendi [6] in Edi [20] state that other factors that can differentiate the number of sex ratios are distribution patterns caused by food availability, population density, and the balance of the food chain.

3.5 Relationship of Gonad Maturity Level and Fecundity

The fecundity value of Indian Mackerel (*Rastellinger kanagurta*) is associated with the level of gonadal maturity, which is directly proportional, where the level of gonad maturity is higher, the fecundity value obtained is also higher. Gonadal maturity levels and Fecudity from October to December can be seen in Table 3.

Table 3. Correlation between Gonad Maturity Level and Fecundity of Indian Mackerel (*Rasrellinger kanagurta*)

Maturity levels	Fecundity (eggs)		
	Oct	Nov	Dec
I	0	0	0
II	0	0	0
III	3,200	5,000	0
IV	15,400	0	0

Based on Table 3, the level of gonad maturity of Indian mackerel (Level I - II) from October to December did not identify the fecundity value. At the Gonad Maturity Level, level III Indian Mackerel in October had a fecundity of 3200 eggs, in November level III had a fecundity of 5000, whereas in December the fecundity value was not identified. Gonad Maturity Level IV Indian Mackerel fish in October has a fecundity of 15400, and from November to December has no fecundity value. The relationship between fecundity value and gonadal maturity level in Indian Mackerel (*Rastellinger kanagurta*) is directly proportional. Fish with a high degree of gonad maturity have more eggs released during spawning [14]. The resulting fecundity value is higher and is influenced by the body length and body weight of the fish. The maturity

level of the gonads are the same but have different weights and lengths resulting in different fecundity values [14]. The fecundity value of each fish varies because it depends on the type or individual species, age and size of the individual, diet, physiological factors of the body, type of fish, population density, and the environment in which they live. This variation in fish fecundity is also caused by differences in time and location of observation resulting in different amounts of fecundity [16]. By knowing the relationship between gonad maturity and fertility, the estimated time regarding the ratio of reproductive fish to non-reproductive fish in the water can be known. The biological aspect is a piece of basic information that is commonly presented in assessing the level of environmental friendliness of fishing gear or fishing vessel [22].

4. CONCLUSION

Based on the results of the research that has been done, it can be concluded that the maturity level of Indian Mackerel in North Gorontalo waters is dominated at the level I. The spawning season for tuna in North Gorontalo waters does not take place in October-December, this is characterized by low fecundity. Based on the monthly GSI value, the spawning peak of the Indian Mackerel (*Rastellinger kanagurta*) is thought to occur shortly after the highest GSI value. The highest fecundity is 14800 eggs and the lowest is 5000 eggs. The relationship between gonadal maturity level and fecundity is directly proportional, if the gonadal maturity level is high, the fecundity value will also be higher.

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