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REPRODUCTIVE BIOLOGY OF *Moolgarda* sp. IN SEGARA ANAKAN LAGOON CILACAP DISTRICT, CENTRAL JAVA

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Abstract

Segara Anakan lagoon was water located in the estuary between Ciamis regency and Cilacap regency. The purpose of this research is to observe sex ratio, the maturity level of gonad, and the gonad maturity index of Moolgarda sp. Sampling was conducted for three months, from March to May 2017. The method used was a simple random sampling method. The results of research that the sex ratio of Moolgarda sp. male was higher than female. The gonad maturity level of Moolgarda sp. was obtained from levels I, II, III, and IV. The Gonad Maturity Index value Moolgarda sp. males ranged from 0.0022% - 1.3041% while GMI Moolgarda sp. female 0.0424% - 5.5827% with a fecundity of Moolgarda sp. from 7356 - 131350 eggs.

Keyword: Gonad Maturity, *Moolgarda* sp., Segara Anakan Lagoon

Introduction

The total area of Indonesia's sea area is 5.9 million km^2, consisting of 3.2 million km^2 of territorial waters and 2.7 km^2 of aquatic in the Exclusive Economic Zone (Lasabuda, 2013). Indonesia is rich in potential marine resources, be it seas, estuaries, rivers and public waters. Kottelat *et al* (1993) explained that the habitat for fish life is that 41% of fish are found in freshwater, 58% of fish live in marine environments and 1% live in brackish water.

The Segara Anakan area was located between 7° 35'- 7° 46' S and 108° 45' - 109° 01' E, on the border between West Java province and Central Java province south of Java Island. The total area of the Segara Anakan area is around 24,000 Ha, including waters, mangrove forests, and mudflats formed by sedimentation. The Segara Anakan Lagoon is a waters located in the estuary area on the south coast of Central Java, located on the border between Ciamis district, West Java and Cilacap district, Central Java (Legono et al, 2007).

The fish found in the Segara Anakan lagoon are 21 genera with 24 species, such as *Moolgarda* sp., *Mystus gulio*, *Glossogobius* sp., *Scatophagus argus*, *Leiognatus equluus*, *Ambassis nalua*, *Johnius* sp., *Oreochromus niloticus*, *Carangoides ferdau*, *Pomaidasys kaakan*, *Lutjanus argentimaculatus*, *Dichotomyctere nigroviridis*, *Platycephalus* sp., *Eleutheronema tetradactylum*, *Pseudapcryptes elongatus*, *Zenarchopterus*, *Acantophagrus latus*, *Oxyurichtys tentacularis*, *Tylosurus crocodilus*, *Apogon hyalosoma*, dan *Gerress abbreviatus*. Based on several genera of fish caught during research, *Moolgarda* sp. was the dominant fish caught on Segara Anakan. This fish lives in estuaries which is a place of spawning, looking for food, a place of care and shelter for economically important marine biota such as fish and shrimp both at the adult or larval level (Sugiarti et al., 2016). *Moolgarda* sp. has a wide tolerance to salinity and temperature is able to adapt to a variety of foods in its habitat (Gustiana, 2013). Therefore, mullet fish are often found in coastal waters, brackish waters to rivers scattered in tropical and subtropical areas.

Moolgarda sp. will experience a decline if the fishing continues, so it is necessary to conduct research on aspects of fish reproduction in this area. This needs to be done so that the local government can formulate a policy as a form of monitoring and management of the potential fishery resources in Segara Anakan so that it remains sustainable and can increase production and local people's income. This study aims to analyze several aspects of fish reproductive biology in The

Segara Anakan lagoon. The aspects of reproductive biology that are studied include sex ratio, gonad maturity level, and gonad maturity index.

Materials and Methods

Time and Site

The research was conducted in Segara Anakan, Cilacap Regency, Central Java (Figure 1) from March to April 2017. Fish sampling was taken for 3 times with a sampling interval of 1 month based on fishing grounds at six observation points.

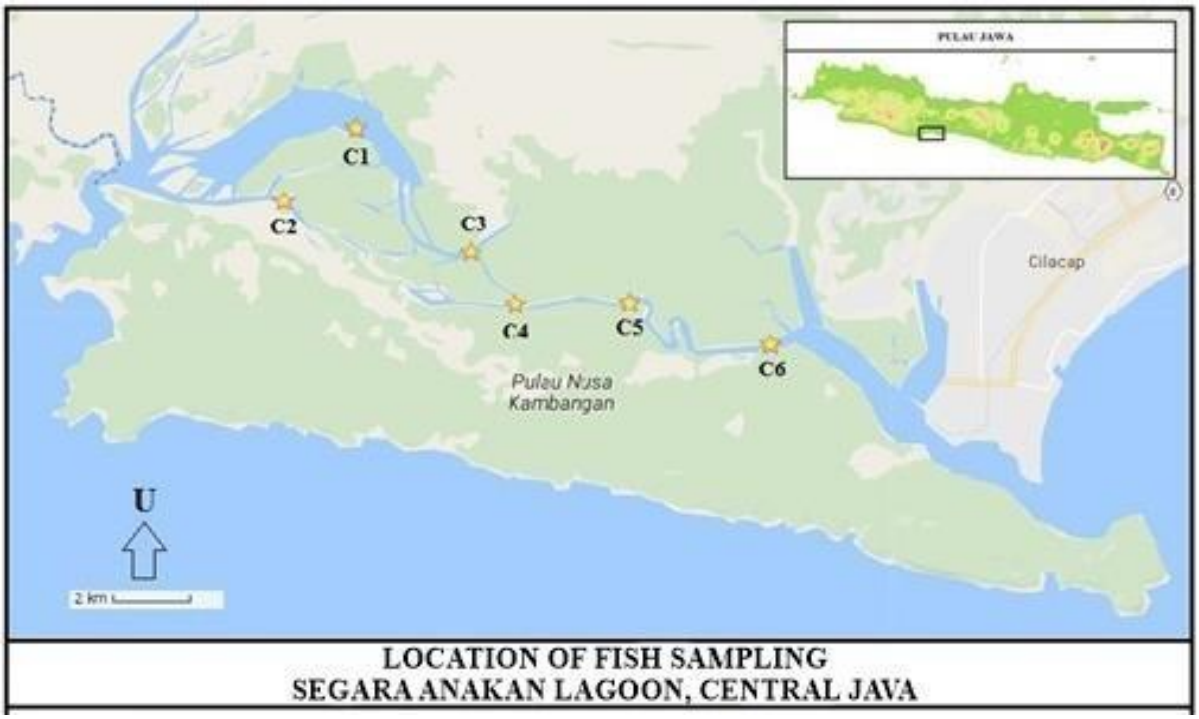

Figure 1. Location of fish sampling in Segara Anakan Lagoon

Observation Method

Data Collection

Sampling of fish is carried out once a month in Segara Anakan waters based on fishing areas commonly carried out by fishermen. Sampling fish was carried out using experimental gillnet fishing gear 1 inch in size, 50 meters long and 1 meter high, and metal mesh using a simple random sampling method. Fish samples were treated with 10% formalin solution. Fish samples were measured for total length (TL) (accuracy 0.1 cm) and weight (accuracy 0.1 gram).

Laboratory Analysis

Fish that had been preserved in 10% formalin solution were transferred to 70% ethanol solution, then the sample fish were identified using the Kottelat (1993) identification book. Laboratory analysis was carried out at the Laboratory of Macro Biology I, Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, Bogor Agricultural University, Bogor.

The total length (TL) (accuracy 0.1 cm) and weight (0.1 gram accuracy) were measured. Then the fish was dissected starting from the anus to the dorsal part under the lateral line to the back of the operculum, then to the ventral to the abdominal floor using surgical scissors to observe the gonads in order to determine the sex and level of maturity of the gonads. Then the gonads are weighed using digital scales with accuracy 0.0001 grams andpreserved using 4% formalin solution. Determination of fecundity was carried out by observing and counting the number of eggs contained in the female gonads of GML III and GML IV. Egg diameter was determined from female fish that had GML III and IV, by observing the diameter of the eggs observed for fecundity. The egg diameter was measured as many as 150 eggs using a microscope equipped with a

micrometer. GML determination was carried out morphologically based on the method of Cassie (1956) in Effendie (2002) which can be seen in Table 1.

Table 1. Determination of GML was done morphologically based on the method of Cassie (1956) in Effendie (2002)

GML	Female	Male
I	Ovaries are like threads, their length reaches the front of the body cavity, and the surface is smooth	The testicles are threadlike, clear in color, and the ends are visible in the body cavity
II	The ovaries are larger in size. The color of the ovaries is yellowish, and the eggs are not clearly visible	The size of the testes is larger, staining like milk
III	The ovaries are yellow and morphologically the eggs are visible	The surface of the testicles looks jagged, the color becomes whiter and the size increases
IV	Ovaries get bigger, yellow eggs, easy to separate. Invisible oil droplets, filling 1 / 2-2 / 3 of the abdominal cavity	In the preserved state, it breaks easily, the testes are getting dense
V	The ovaries are wrinkled, the walls are thick, the remaining eggs are present near the release	The back of the testicle is deflated and the area near the discharge is still filled

Data analysis

Sex ratio

The sex ratio can be calculated by comparing the number of male and female fish. Mathematically, the sex ratio can be calculated with the formula.

While the gonad maturity level (GML) can be determined from this following (Effendie, 2002):

1. A male fish: have testicles, the big or small of testicles, the color of testicles, size of testicles in a body cavity, and out whereabouts of liquid of the testicle.
2. A female fish : have an ovary, the big or small of ovary, color of ovary, size of ovary in a body cavity, smooth and badness of the ovary, and the size eggs in the ovary

The Gonad Maturity Index was measured by comparing body weight with gonad weight of the fish (Effendie, 2002):

$$GMI\ (\%) = \frac{Gw}{Fw} \times 100\% \quad \text{..... (1)}$$

Where :

GMI : Gonad maturity index (%) Gw : Gonad weight (g)

Fw : Fish weight (g)

Fecundity was the number of mature gonads before they are released when the fish are spawning. The aim is to determine the number of eggs contained in the gonads of fish that are in the mature state of the gonads. Fecundity was calculated at conditions of the maturity level of gonads III and IV using the following combined methods (Effendie, 2002):

$$F = \frac{G}{g} \times X \quad \text{..... (2)}$$

Where :

F : Fecundity (eggs)

G : Total gonad weight (g)

X : Number of sample eggs

g : Sample gonad weight (g)

Results and Discussion

Composition of the catch

The composition of the catch in Segara Anakan based on the time of collection varies greatly. Sampling was 93 in March, 158 in April, and 177 in May as can be seen in Figure 2.

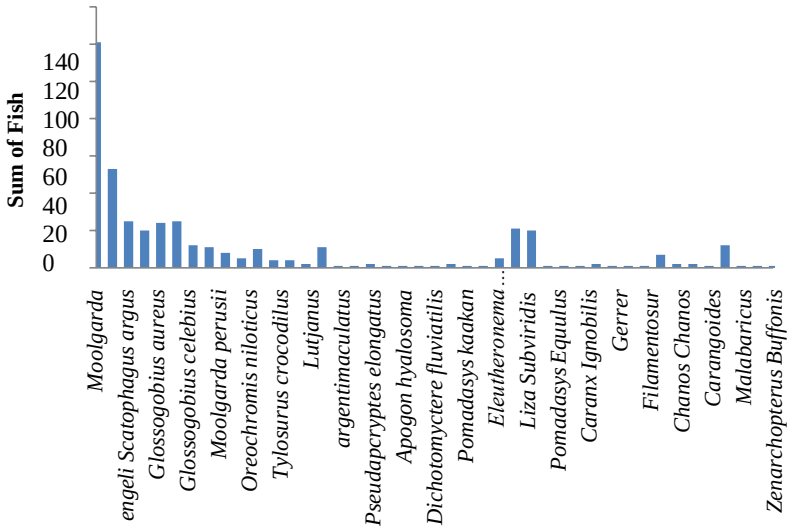

Figure 2. Composition of catch in Segara Anakan, Cilacap Regency

Fish caught using experimental gillnet measuring 1 inch consist of 21 genera with 24 species, such as *Moolgarda* sp., *Mystus gulio*, *Glossogobius* sp., *Scatophagus argus*, *Leiognatus equluus*, *Ambassis nalua*, *Johnius* sp., *Oreochromus niloticus*, *Carangoides ferdau*, *Pomaidasys kaakan*, *Lutjanus argentimaculatus*, *Dichotomyctere nigroviridis*, *Platycephalus* sp., *Eleutheronema tetradactylum*, *Pseudapcryptes elongatus*, *Zenarchopterus*, *Acantophagrus latus*, *Oxyurichtys tentacularis*, *Tylosurus crocodilus*, *Apogon hyalosoma*, dan *Gerress abbreviatus*. While the fish caught on each trip are *Moolgarda* sp.

Sex Ratio

The sex ratio of *Moolgarda* sp. in Segara Anakan during the research there was an imbalance between male and female. In general, more males than females can be seen in Table 2 showing that females are taller than males although it was not significant.

Table 2. The sex ratio of male and female *Moolgarda* sp. **during the research.**

Station	March		April		May		Sum of Fish		Sex Ratio
	Male	Female	Male	Female	Male	Female	Male	Female	
ST I	38	32	14	10	7	1	59	43	1.37
ST II	18	2	2	0	0	0	20	2	10
ST III	6	2	0	0	4	0	10	2	5
ST IV	6	0	0	0	25	6	31	6	5.17
ST V	6	0	0	0	0	0	6	0	6
ST VI	2	0	0	0	0	0	2	0	2

The sex ratio needs to be known to see the stability of fish populations in nature. *Moolgarda* sp. obtained during the study were 181 heads consisting of 128 males (70.72%) and 53 females (29.28%) with a sex ratio of 2.4:1. This was due to different behavior patterns, as female fish were mostly found in mangrove areas so that the chances of catching male fish with mullet nets are greater than female fish. This research was according to Sulistiono et al. (2001) which stated that the number of mullet fish caught on Mayangan Beach varied every month with males (77%; 33 fish) caught greater than females (45%; 26 fish). This fact was different from research conducted by several researchers, Sulistiono et

al. (2001) said that *M. dussumieri* in Ujung Pangkah has a sex ratio of 1: 1.6 or 39% male and 61% female; The sex ratio of male and female *M. liza* in the Tropical Gulf of Brazil was 1: 1.73 (Albieri et al., 2010). Rahardjo (2006), the sex ratio in tropical areas such as Indonesia was varied and deviates from 1: 1.

Gonad Maturity Level (GML)

The results of morphological observations on female fish gonads at gonad maturity levels (GML) 1 and 2 did not show the egg yolk, while at GML 3 and 4 morfologically the ovaries were yellow and egg yolk was found. The distribution of male and female gonad maturity levels can be seen in Table 3 and Table 4.

Table 3. Distribution of male and female gonad maturity levels for each observation station

Station	Male				Female			
	GML I	GML II	GML III	GML IV	GML I	GML II	GML III	GML IV
ST I	39	18	2	0	32	2	1	4
ST II	19	1	0	0	0	2	0	0
ST III	9	1	0	0	2	0	0	0
ST IV	8	23	0	0	0	5	0	1
ST V	6	0	0	0	0	0	0	0
ST VI	2	0	0	0	0	0	0	0

Based on Table 3, it appears that the immature gonads are dominated by fish *Moolgarda* sp.as many as 83 male fish and 34 female fish at GML I and GML II were 43 male and 9 female fish while the mature gonads (GML III and IV) were 2 males and 6 females.

Table 4. Distribution of male and female gonad maturity levels during research

GML	March		April		May	
	Male	Female	Male	Female	Male	Female
GML I	66	26	12	8	5	0
GML II	8	6	4	1	31	6
GML III	2	0	0	1	0	0
GML IV	0	4	0	0	0	1

The highest Gonad Maturity Level of *Moolgarda* sp. in March was 76 male fish and 36 female fish. While the lowest was in April as many as 16 males and 10 females. The development of gonads in a female is more attention than male because the development of egg diameter contained in the gonads is easier to see than sperm in the testes (Effendie, 2002).

Seen morphologically in female GML I, the gonads are still in the form of a pair of coarse threads located in the abdominal cavity, clear in color and smooth surface and the eggs cannot be seen. Histologically it was dominated by oocytes with a larger nucleus. In GML II morphologically, female gonads are larger than GML I, start to turn yellow and the egg grains are not visible to the naked eye. In this phase, there are no egg yolk granules, so it was called the resting phase *(Fujaya, 2002)*. Morphologically, GML III of *Moolgarda* sp. female was reddish-yellow with eggs starting to appear. GML IV showed increase size ovaries and yellow color. The egg grain is clearly visible because the gonad membrane is transparent.

Gonad Maturity Index (GMI)

Based on the research time, the average value of fish IKG *Moolgarda* sp. varies greatly at each station (Figure 3).

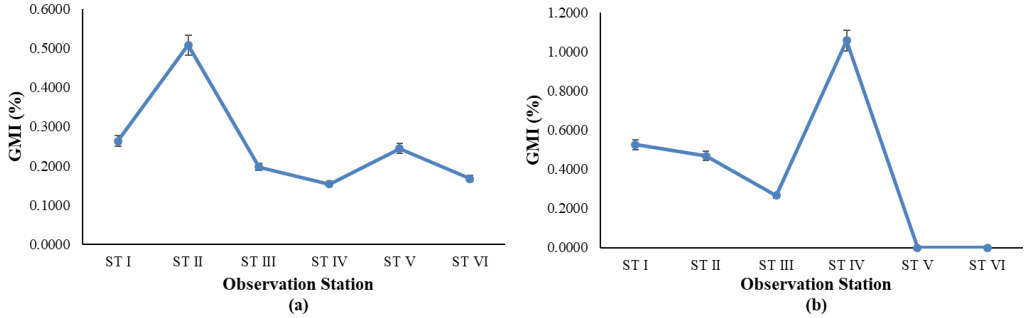

Figure 3. Fish Gonad Maturity Index *Moolgarda* sp. every station based on a) male, b) female

In Figure 3, it can be seen that in *Moolgarda* sp., The highest male GMI value was at station 2 was 0.0165% - 1.3041% and the lowest was at station IV was 0.0022% - 0.4436%, while the highest female GMI value is at station IV was 0.0868% - 5.5827% and the lowest was at stations V and VI because these fish were not found at that station.

The gonad maturity index value of mullet (*M. engeli*) in Mayangan waters fluctuates. For male fish, the GMI average value ranged from 0.2 to 0.6; while the female fish ranged from 1.6-5.6. This was presumably because the growth of female fish was more focused on gonad growth, consequently the weight of female gonads was greater than the weight of male gonads. The largest gonad maturity index value of mullet was found in August and September. Based on the level of gonad maturity (GML), the average GMI of male and female fish increased along with the increase in GML. The GMI value of the fish varies depending on the value of the maturity of the gonads.

The GMI value is closely related to the conditions and GML factors. The GMI value increases and reaches a maximum limit when spawning will occur (GML IV), after which it decreased rapidly during spawning until spawning was complete (Effendie, 2002). The GMI value of female totot fish was greater than that of male fish because the weight of female ovaries was greater than that of male testes. This was due to the presence of eggs that develop in the ovaries, so that the larger the diameter, the GMI increases (Yustina and Arnentis, 2002). The gonad weight of female fish was greater than that of male fish. The gonad weight of female fish ranges from 10-25% of the bodyweight of the fish, while male fish ranges from 5-10% of the bodyweight of the fish (Effendie, 2002).

Fecundity

Fecundity of *Moolgarda* sp. in Segara Anakan consists of 2 GML III and 3 GML IV can be seen in Table 3.

Table 3. Fecundity of *Moolgarda* sp. in Segara Anakan based on GML III and GML IV

Month	GML	Weight	Gonad weight	Sample egg weight	Number of eggs Sample	Fecundity
March	IV	30	1.1690	0.22219	2287	12048
	IV	23	0.4957	0.1275	1892	7356
April	III	212	1.0235	0.0512	1280	25588
May	III	61	0.1613	0.1892	1468	12522
	IV	169	9,4348	0.1331	1853	131350

Based on Table 3, the value fecundity of *Moolgarda* sp. caught during research from 7356 - 131350 eggs. The fecundity of mullets was quite high compared to the blackfish in Mayangan Beach which has a number of eggs between 1,222-29,011 eggs (Putri, 2012) and mullets in Suez-Egypt (number of eggs between 42.312-95.419 eggs) (Halfawy, 2007). When compared with mullets in Ujung Pangkah, Indramayu, and Mangalore India with the number of eggs between 27,117-323,200 eggs (Sulistiono et al., 2001), mullet fecundity in Mayangan appears to be smaller. This was thought to be the adaptive power of mullets to maintain their populations in the wild.

Unus (2009) adds that the size of the fecundity is influenced by food, fish size and

environmental conditions, and can also be influenced by egg diameter. Tropical fish that spawn in the rainy season provide benefits for the young fish to get food and are protected from predators. This spawning adaptation was influenced by several factors such as food availability, changes in water level and quality, and the availability of spawning grounds (Pacheco and Da-Silva, 2009). In addition, flooded environmental conditions will affect endocrine control to produce hormones that support the development of gonads and spawning (Siby, 2009).

Conclusion

The sex ratio of *Moolgarda* sp. was in the balanced condition. The maturity level of gonad obtained on *Moolgarda* sp. male was GML I, II, III, IV. The Gonad Maturity Index value *Moolgarda* sp. males ranged from 0.0022% - 1.3041% while GMI *Moolgarda* sp. female 0.0424% - 5.5827%. The value fecundity of *Moolgarda* sp. caught during research from 7356 - 131350 eggs.

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