Jurnal Pengelolaan Perikanan Tropis (*Journal Of Tropical Fisheries Management*)

Website: http://journal.ipb.ac.id/index.php/jurnalppt
e-ISSN: 2721-1525
Vol. 08 No. 01: 9–16 (2024) DOI: https://doi.org/10.29244/jppt.v8i1.55674

Reproductive Biology Status of Moonfish (*Mene maculata*) in Palabuhanratu Bay during West Monsoon

M Jarier Abdul Gani[1], Zairion Zairion[1,*], Mennofatria Boer[1]

Received: 23 05 2024 / Accepted: 30 06 2024

ABSTRACT
The moonfish (*Mene maculata*) is a demersal fish with important ecological and economical value. The high demand of moonfish as a food sources has the potential to disrupt reproductive patterns, recruitment and stock availability of pitcher fish resources, for which information on reproductive biology is minimal during the west monsoon. This research aims to analyze the reproductive biology status of moonfish in Palabuhanratu Bay. The research period took place from September 2021 to February 2022 (representing the west monsoon), with a sample of 522 fish. Fish samples were taken using a simple random sampling method at Palabuhanratu Nusantara fishing port. The data was analysis to obtain the sex ratio, allometric growth pattern, spawning season, the reproductive potential, and the size at maturity. Results shown that the sex ratio was 1:0.76, which is dominated by male fish. Moonfish have a negative allometric growth pattern. The peak of spawning season during the study period was in September and October. Reproductive potential ranges from 11,988 to 21,164 eggs. The spawning pattern of moonfish is indicated as total spawner. The result of Spearman-Karber method analysis showed that the size of the first maturity of female and male moonfish (Lm_{50}) was 143 mm and 150.5 mm TL, respectively. So, female moonfish mature gonads earlier than male fish.

Keywords: *Moonfish, Palabuhanratu Bay, reproductive potential, Spawning season*

INTRODUCTION

The moonfish (*Mene maculata*) is a member of the Menidae family, has a body length (TL) of up to 25 cm (Emperua *et al.* 2018). Moonfish live in water depths between 50-200 meters and are demersal fish (FAO 2001). The characteristics of the pitcher fish are that it has a silvery white color with a flat, flat body shape, thin scales, and has a soft, long, straight dorsal fin, and there are black spots on the top of its body (Shi-Qiang *et al.* 2012). Another thing that characterizes the pitcher fish is the wide, dorsally inclined mouth and the large curvature of the stomach (Zhong *et al.* 2017).

The distribution of moonfish includes the tropical marine waters of the Indo-Pacific, Eastern Africa, Southern Japan and Australia (Shi-Qiang *et al.* 2012). Moonfish are often caught in Indonesian waters, including in the waters of Palabuhanratu Bay, West Java (Perceka *et al.* 2020). Palabuhanratu Bay is located in a strategic area so it has the potential for a high abundance of fishery resources (Rahmawaty *et al.* 2021). One of the landing locations for fishermen's catches in Palabuhanratu Bay is the Palabuhanratu Archipelago Fisheries Harbor (PPN) with some of fish landed, including pelagic and demersal fish (Putra *et al.* 2018).

Moofish in Palabuhanratu Bay is one of the main catch targets by fishermen to be marketed locally or exported to foreign countries such as Malaysia and the United States (Perceka *et al.* 2020). The high market demand for semar fish is caused by the balanced nutritional content of the fish. Bharadhirajan *et al.* (2014) explained that moonfish contains high levels of protein, amino acids, vitamins, minerals and calcium and low levels of fat and carbohydrates. The high use of moonfish as food fish and the lack of information regarding these fish resources in Palabuhanratu Bay can threaten the sustainability of pitcher fish stocks in the waters.

An information that can be studied as a basis for managing moonfish resources optimally is by studying aspects of the fish's reproductive biology. Research on the reproductive biology of moonfish

*Corresponding author
✉ Zairion Zairion
zairion@apps.ipb.ac.id

[1]Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, IPB University, Indonesia

was carried out by Meilanur (2018) in Palabuhanratu Bay during the east monsoon from May to September. Results showed that moonfish have a negative allometric growth pattern, an unbalanced sex ratio with males being more dominant, the peak spawning season occurs in August, total spawner type, and reproductive potential is categorized as medium with an average fecundity of 6,964 eggs. Therefore, it is necessary to carry out an analysis of the reproductive biology aspect of the moonfish during the west monsoon. So, the results can be obtained to complete the data on the reproduction of the moon fish in different seasons. This data can be used as basic information for managing moonfish resources in Palabuhanratu Bay.

METHODS

Study period and location

The research was conducted from September 2021 to February 2022 with an interval of taking fish samples once a month at the Palabuhanratu Archipelago Fishing Port (PPN), Sukabumi Regency, West Java (Figure 1). The moonfish obtained as samples were then analyzed at the Fisheries Biology Laboratory, Aquatic Resources Management Department, Faculty of Fisheries and Marine Sciences, IPB University.

Data collection

One basket of moofish was taken randomly from several baskets of fish landed from fishermen's catches using “*payang*” (kind of Danish seine) fishing gear with a mesh size of 2.5-3 inches at the time of sampling. Subsequently, samples of 50 to 100 moonfish were taken using the Simple Random Sampling method, according to their availability at the time of sampling in various sizes. The fish samples obtained were stored in a cool box, then transported to the laboratory for further analysis.

The moonfish samples that were obtained were measured for their total length (TL) using a measuring instrument with an accuracy of 0.5 mm. Next, the weight of the fish was weighed using a digital scale with an accuracy of 0.05 g.

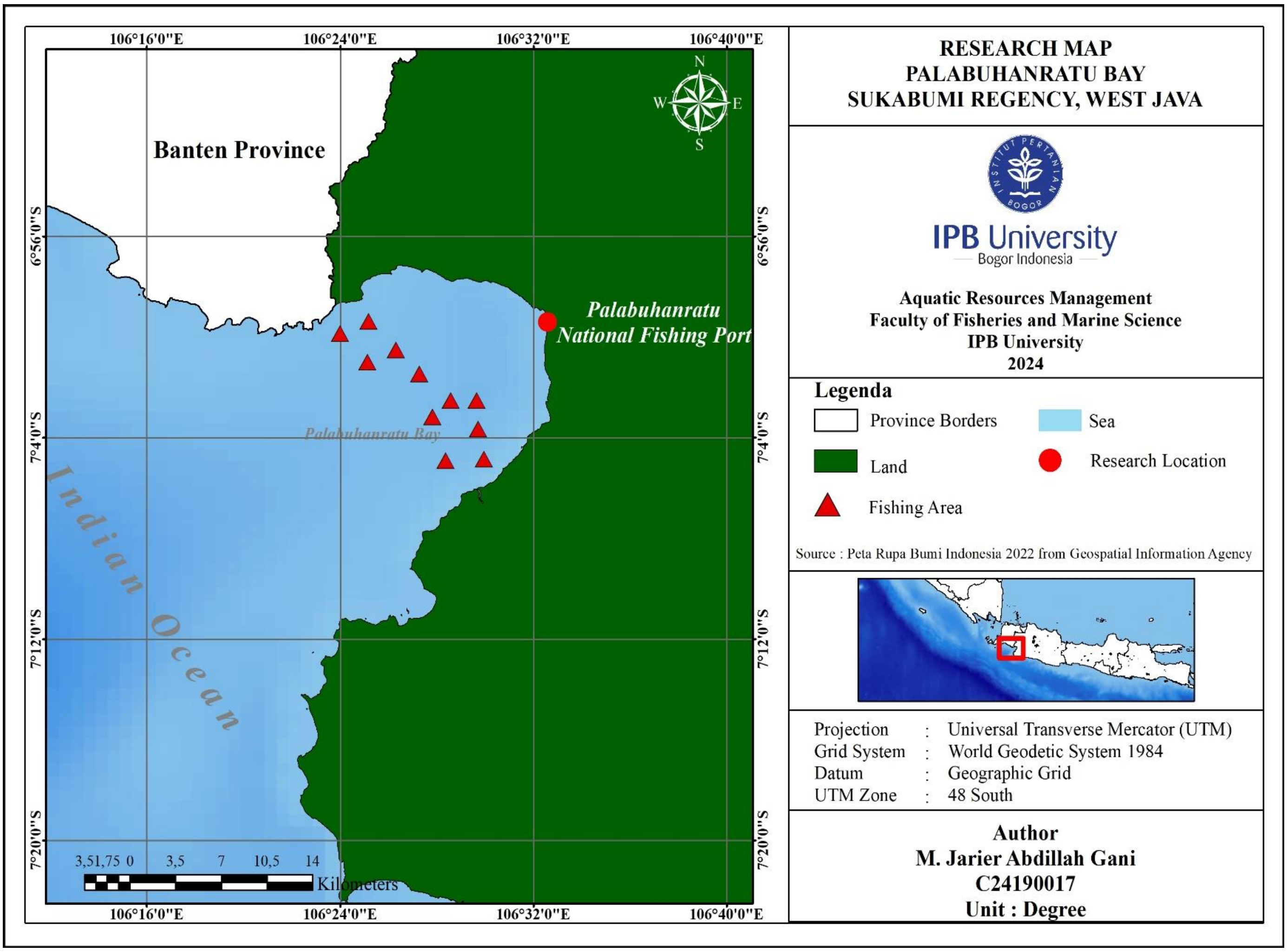


Figure 1. Research location at PPN Palabuhanratu, Sukabumi, West Java and moonfish fishing ground

Furthermore, the fish were dissected and the gonads were observed to determine sex based on primary sexual characteristics, morphological level of gonad maturity (Table 1), weighing the gonads, observing fecundity, and egg diameter. Sex and gonad maturity stage (GMS) can be determined by observing the shape and color of the fish gonads directly based on references to Nikolsky (1963) and Effendie (2002).The gonads of male and female moonfish were weighed on a digital scale. Subsequently, the gonads of female fish in GMS III and IV were preserved using 10% formaldehyde, then stored in sample bottles to observe fecundity and egg diameter. Fecundity calculations were carried out using the combined method. In calculating fecundity, the gonads of stage III and IV female fish were taken as samples representing six parts, the anterior, middle and posterior parts of each gonad on the right and left side.

Data analysis

The sex ratio is the ratio of the number of males to females, then tested using chi-square. The comparison between chi-square counting and table at confidence level of 95% was used to make decision, either balance or unbalance of sex ratio. The chi-square test can be calculated using the following equation (Steel and Torrie 1980).

$$\chi^2_{count} = \sum_{i=1}^{k} \frac{(o_i - e)^2}{e}$$

While the χ^2_{count} = chi-square, o_i = Number of observations of male and female fish, and e = an expected number of male and female fish.

Growth patterns were analyzed first based on Effendie (1979) and followed by t-test (Walpole 1993), then continued with analysis of fish condition or plumpness factors. The gonad maturity index or gonad somatic index (GSI) can be calculated quantitatively by comparing the gonad weight and the total weight of the fish observed (Effendie 1979).

$$GSI = \frac{Wg}{Wt} \times 100$$

while GSI is gonad maturity index or gonad somatic index, W_g is gonad weight (g), and W_t is fish body weight (g).

Reproductive potential was estimated based on the number of eggs produced in one spawning session (fecundity), where the estimated number of eggs produced was calculated using a combined volumetric and gravimetric method (Effendie 1979).

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

F is fecundity (number of egg), G is gonad weight (g), V is dilution volume (ml or cc), X is number egg obtained in 1 cc, and Q is sub-gonad weight (g).

Meanwhile, reproductive patterns are predicted based on egg diameter. Measuring the diameter of fish eggs used laboratory tools such as a binocular microscope with a magnification of 4 x 10 equipped with an ocular micrometer. Estimating the average size of fish when the gonads first mature can use the Spearmen-Karber method (Udupa 1986).

$$m = \left[x_k + \left(\frac{x}{2}\right)\right] - (x \sum p_i)$$

with a 95% confidence level for Lm_{50} as follows:

$$\text{antilog}\left[m \pm 1.96 \sqrt{x^2 \sum \left(\frac{p_i - q_i}{n_i - 1}\right)}\right]$$

while m is the gonads log x of the size at first sexual matures, x_k is log of the mean value of the last length class of fish that have matured gonads, x is log of the increase in length at the median value, p_i is the proportion of fish with mature gonads to the number of fish in length class-i, q_i is 1-p_i, and n_i is number of fish in length class-i.

Table 1. Classification of moonfish gonad maturity stages (GMS)

GMS	Phase	Gonad characteristics
I	Immature	The size of the testicles and ovaries is very small and the eggs cannot be distinguished by the eye
II	Developed	The eggs in the ovaries are still indistinguishable by eye. The color of the testes is white and the color of the ovaries is reddish.
III	Almost mature	Eggs in the ovaries can be distinguished by eye. The testicles change from transparent white to white to cream. The ovaries are yellowish red.
IV	Mature	Eggs are clearly visible in the ovaries. The ovaries are red and surrounded by blood vessels. The testicles are creamy white.
V	Reproducing	Eggs and sperm will come out of the release hole if the fish's stomach is slightly pressed. Gonad weight decreased from the time spawning began until spawning was completed.
VI	Spent	The genital opening of the fish is reddish. The gonads shrink and some eggs remain in the ovaries or sperm in the testicles.

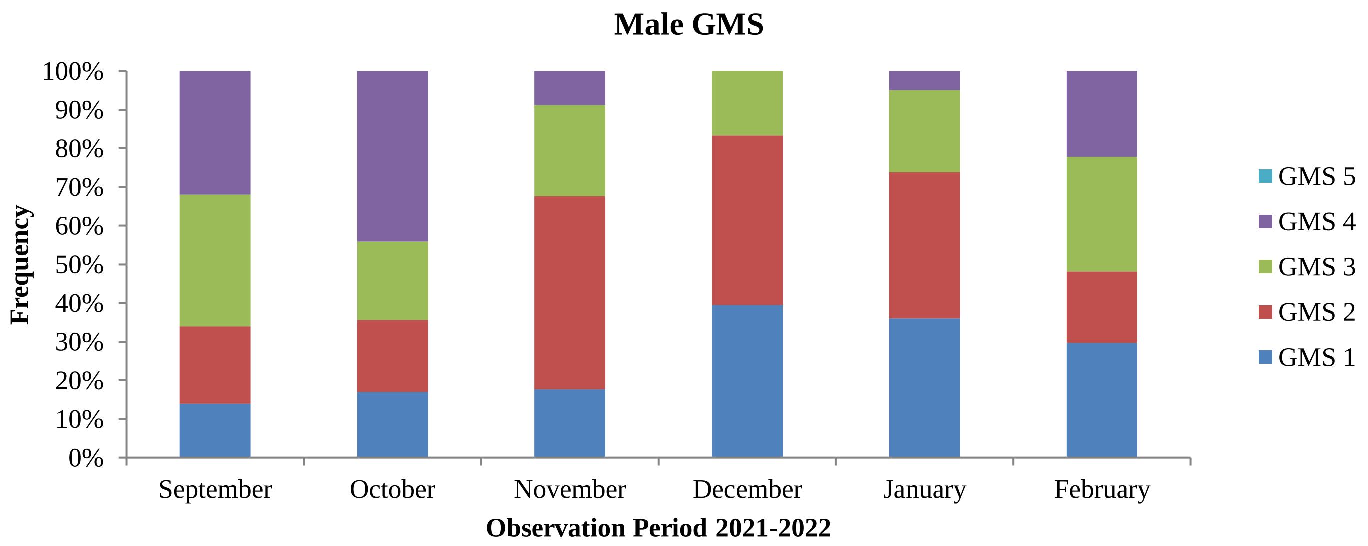
RESULTS AND DISCUSSION

Results

The distribution of the total length of moonfish during the study ranged from 112-188 mm, of which fish with a length class of 140-146 mm were the dominant ones caught, both male and female moonfish. The sex ratio of male and female moonfish during the research period was 1:0.76, which was dominated by males. Based on the Chi-square test with a 95% confidence level, the sex ratio of male and female moonfish caught during the research period in Palabuhanratu Bay was not 1:1 (unbalanced).

The results of the analysis of the relationship between length and weight of male and female moonfish show a "b" value of less than 3 ($b<3$ according to the t test), so that moonfish have a negative allometric growth pattern. These results are then useful in helping determine fish condition factors. The highest average value of male moonfish condition factor was in September, namely 1.0528 ± 0.0702 and the lowest was in February with a value of 0.8460 ± 0.0856. Meanwhile, the highest average condition factor for female moonfish was also found in September with a value of 1.0032 ± 0.0977 and the lowest in February with a value of 0.8449 ± 0.0696.

The level of gonad maturity was determined through morphological observation of the gonads. The results of the analysis of the gonad maturity stage (GMS) of male moonfish during the study period were dominated by GMS II and female moonfish were dominated by GMS IV (Figure 2). The gonad somatic index (GSI) is a percentage of the ratio of gonad weight to fish body weight. The results of analysis showed that the GSI value of female moonfish was higher than the value of male moonfish (Figure 3). In addition, the highest average GSI values of male and female moonfish were found in September, that is 1.26% and 2.17%, respectively. Meanwhile the lowest average GSI values of male and female moonfish were found in January, that is 0.19% and 0.53%, respectively.



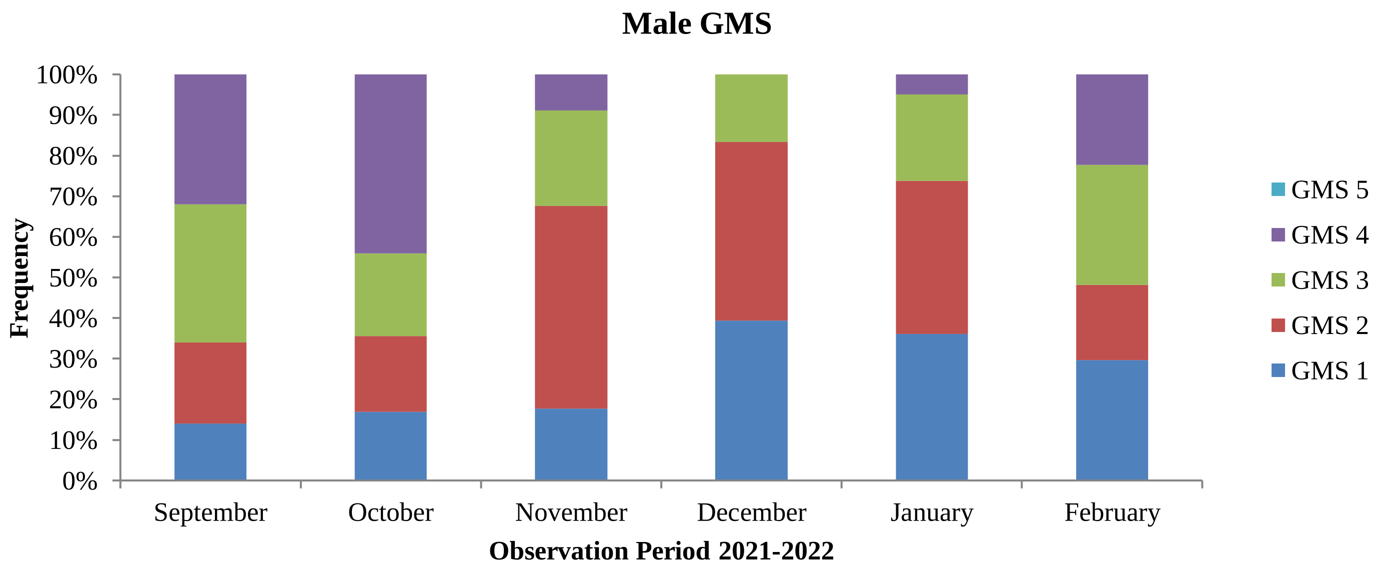


Figure 2. Gonad maturity level of male and female moonfish (*Mene maculata*) during observation periods

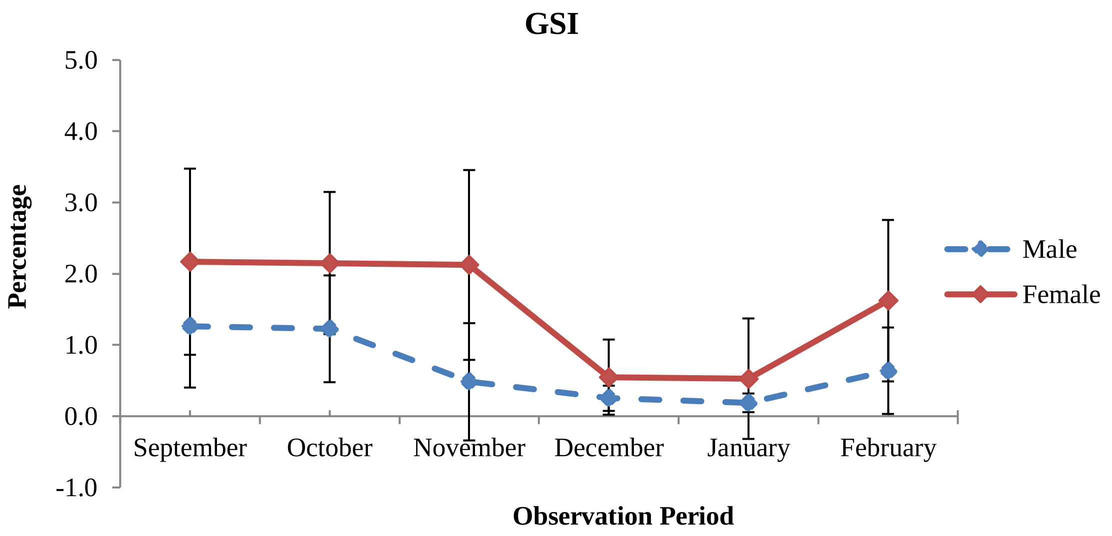


Figure 3. Gonad somatic index (GSI) of male and female moonfish (*Mene maculata*) during observation periods

Moonfish fecundity during the study period ranged from 11,988-21,164 eggs, with an average of 16,515 eggs. Furthermore, the frequency distribution of moonfish (*M. maculata*) egg diameters shows that there is only one peak in the distribution of egg diameter sizes, indicating that moonfish have a total spawner spawning pattern.

Observing the size of the fish when the gonads first mature uses data from fish with GMS IV, which means the fish is ready to spawn. Based on the Spearman-Kaber analysis, the Lm_{50} values for female and male moonfish were 143 mm and 150.5 mm, respectively. So, female moonfish reach their first size maturity earlier than male fish.

Discussion

Moonfish (*Mene maculata*) is one of the species that is often caught in the waters of Palabuhanratu Bay. Based on the results of observations, total length (TL) of the moonfish ranged from 112-188 mm. The highest frequency of total length caught was found at 140-146 mm. The results of the frequency distribution of length measurements in this study are different from the results of research by Meilanur (2018) in the same location in different seasons, whereas the total length of moofish ranges from 42-240 mm. It was also different with in the research of Hwang *et al.* (2002) in the Taiwan Sea with a length distribution of 110-200 mm and the research of Shi-qiang *et al.* (2012) in the South China Sea with a length distribution of 83-256 mm. Differences in length distribution can be influenced by many factors, such as differences in environmental characteristics, fishing time, fishing gear, and the number of fish samples obtained during the research (Restianingsih and Hidayat 2018). Differences in seasons and environmental characteristics affect the abundance and availability of food for growing of fish (Fitrinawati 2004).

The sex ratio obtained during observations shows an unequal ratio between male and female moonfish, where males dominate. The sex ratio obtained in this study is in accordance with research by Meilanur (2018) in Palabuhanratu Bay in different periods. Based on these conditions, the sex ratio of moonfish tends to be unbalanced throughout the year and is dominated by males. Differences in sex ratios can be influenced by eating habits, environmental conditions and seasons (Effendie 1979). Differences in seasons and changes in environmental conditions will affect food availability, which can cause fish to migrate. Fish migration can affect the sex ratio of fish in waters (Dang and Kienzler 2019).

The results of the analysis show that the growth pattern of male and female moonfish is negative allometric or length growth is more dominant than weight growth. This value is in line with the results of research by Melianur (2018) in Palabuhanratu Bay. Based on these conditions, growth pattern of male and female moonfish is negative allometric throughout the year. This growth pattern is supported by the flat and elongated body shape of the pitcher fish. Variations in growth patterns are generally influenced by geographic location, environmental conditions, food availability, variations in length of sample fish, gonad maturity level, and spawning season (Effendie 2002).

Condition factors for male and female moonfish fluctuate every month and are in line with research by Meilanur (2018). This value shows that the condition factors of male and female moonfish are not much different. The condition factor results for male fish are generally always smaller than female fish because the gonads and body weight of male fish are relatively smaller compared to female fish (Rahardjo and Simanjuntak 2008). However, the results of the condition factor for male fish were greater than female fish in this study. This is in accordance with Meilanur's (2018) research in Palabuhanratu Bay, which is thought to occur due to a decrease in the eating intensity of female fish when their gonads are maturing. Apart from that, this difference can also be caused by the size of male and female moonfish not having a significant difference (Hwang *et al.* 2002). Condition factors are also influenced by various factors such as age, gender and environmental conditions (Sutriana *et al.* 2020). According to Mulfizar *et al.* (2012), condition factors can provide information about the health and productivity of fish populations based on the spawning season.

The spawning season is temporally influenced by the level of gonad maturity level (GMS), gonad maturity index (GSI), and condition factors. GMS for each fish species has different characteristics. Based on observations of the moonfish gonads, it is known that fish with mature gonads (GMS IV) are mostly found in September and October. The spawning season is thought to occur throughout the observation period, namely from September to February and the peak spawning season occurs from September to October. This is supported by the highest GSI values for male and female moonfish in September and October and starting to decline in the following month. These results complement previous research in Palabuhanratu Bay, namely that the peak spawning season occurred in August (Meilanur 2018). Therefore, it can be assumed that the peak spawning season for moonfish is from August to October. The internal factors that influence GMS and spawning include the age, species and physiology of the fish, while the external factors are the availability of food, temperature, currents and climatic location of the waters where the fish live (Nikolsky 1963).

Reproductive potential can be estimated by knowing the fecundity produced by the fish (Firmantin *et al*. 2015). Fecundity is the number of eggs contained in the gonads of female fish that have matured gonads (Putera and Setyobudiandi 2019). The moonfish fecundity ranges from 9,568 to 34,080 eggs with an average of 16,515 eggs. These results are different from those obtained by Meilanur (2018), where moofish fecundity ranged from 2,934-17,522 eggs and an average of 6,946 eggs. Differences in fecundity in the same fish species can be caused by the size and age of the fish as well as the availability of food and conditions of the aquatic environment (Effendie 2002). Food availability in the western season tends to be higher due to low water temperatures (Ginzel 2021). Low water temperatures will trigger upwelling, thereby increasing the number of phytoplankton and zooplankton in the waters (Wujdi *et al*. 2012).

Fish spawning patterns can be predicted by knowing the distribution of egg diameter sizes in fish with GMS III and/or with GMS IV. According to Stuart *et al.* (2020), the diameter of the egg is directly proportional to the volume of the gonads in the fish. The bigger the egg, the bigger the gonad volume it has. Moonfish has a total spawning pattern, or spawning that occurs all at once at one time. Previous research also shows that the moonfish spawning pattern in Palabuhanratu Bay was total spawner (Meilanur 2018).

It is important to know the size of the fish when the first gonads maturity (Lm_{50}) as a reference for the size of the fish when they first reproduce. This parameter is useful for determining the smallest size of fish that can be caught so that it can give the fish the opportunity to reproduce once before its catch (Rambun *et al.* 2016). It is known that the Lm_{50} of male moonfish is 150.5 mm and that of female is 143 mm. Based on the percentage of fish with mature gonad, it was found that 29% (85 individual) of male moonfish were caught after gonad maturity, while the remaining 71% or 212 fish were caught before gonad maturity. Meanwhile, 60% (134 individual) of the female moonfish were caught after their gonads had matured, the remaining 40% (90 fish) had not yet matured their gonads. It is feared that the percentage of fish caught before the gonads are mature could affect the existence of the moonfish population in Palabuhanratu Bay because the fish have not yet had time to spawn to continue their offspring (Fauzan *et al.* 2023).

The results obtained Lm_{50} values are different from research by Meilanur (2018) in Palabuhanratu Bay, namely 185.15 mm in male fish and 179.5 mm in female fish. This difference shows that the Lm value decreased from the previous year. This is thought to occur due to the high intensity of fishing and non-selective mesh sizes so that many fish are caught before they reach mature gonad size. Abubakar *et al.* (2019) suggested that differences in Lm values are also influenced by environmental conditions, fishing intensity and population density. Food availability and population density will influence the high level of fish competition in obtaining food, thereby influencing the growth in size and development of fish gonads until they reach a mature condition (Sukendi *et al.* 2015).

These results indicate that the condition of the moonfish resource in Palabuhanratu Bay requires further management efforts to maximize its resource potential. Management efforts that can be taken include reducing catches of fish that have not yet reached mature gonad size. This effort can be made by adjusting the mesh size of the payang fishing gear to be more selective or increasing the mesh size of the payang fishing gear. It is hoped that the selective mesh size will allow fish that have not yet reached mature gonad size to be able to reproduce first. Apart from that, fishing activities need to be adjusted, such as reducing the intensity of moonfish fishing when the fish are experiencing their peak spawning season in August-October.

CONCLUSION

The moonfish (*M. maculata*) caught in Palabuhanratu Bay during west monsoon dominated by male fish. The peak spawning season for moonfish occurs from September to October with a total spawner pattern. Moonfish have relatively high reproductive potential. Female of moonfish reach the first size at gonad maturity (Lm_{50}) faster than male one. It was found that most male moonfish were caught before gonad maturity, while frequently of female fish caught had not yet matured their gonads.

ACKNOWLEDGMENTS

Thanks are expressed to all parties who have helped carry out this research, both to Pusat Kajian Sumberdaya Pesisir dan Lautan (Coastal and Marine Resources Studies Center) IPB University as the research funder and to the leadership and staff of PPN Palabuhanratu, fishermen and fellow researchers.

REFERENCES

Abubakar S, Subur R, Tahir I. 2019. Pendugaan ukuran pertama kali matang gonad ikan kembung (*Rastrelliger* sp.) di Perairan Desa Sidangoli Dehe, Kecamatan Jailolo Selatan, Kabupaten Halmahera Barat. *Jurnal Biologi Tropis.* 19(1):42-51.

Bharadhirajan P, Periyasamy N, Murugan S. 2014. Nutritional evaluation of the moonfish *Mene maculata* (Bloch & Schneider, 1801) from Parangipettai, Southeast coast of India. *Journal of Coast. Life Med*. 2(1): 53-58.

Dang ZC, Kienzler A. 2019. Changes in fish sex ratio as a basis for regulating endocrine disruptors. *Environ. Int*. 130:104928.

Effendie MI. 1979. *Metode Biologi Perikanan.* Bogor (ID) : Yayasan Dewi Sri

Effendie MI. 2002. *Biologi Perikanan*. Yogyakarta(ID): Yayasan Pustaka Nusatama.

Emperua LL, Donia EA, Biaca MJ, Pechon RR, Pautong AT, Balonos TAD. 2018. The small pelagic fisheries of Sarangani Bay, Southern Mindanao, Philippines. *The Philippines Journal of Fisheries*. 25(1):118-127.

FAO 2001. *FAO Species Identification Guide for Fishery Purposes,* "*The Living Marine Resources of The Western Central Pacific.*" FAO, Rome (ITA).

Fauzan IR, Ediyanto, Telussa RF. 2023. Keberlanjutan pengelolaan perikanan semar (*Mene maculata*) di PPN Palabuhanratu ditinjau dari aspek sumber daya ikan. *Jurnal Ilmiah Satya Minabahari*. 8(2):78-90.

Firmantin IT, Sudaryono A, Nugroho RA. 2015. Pengaruh kombinasi omega-3 dan klorofil dalam pakan terhadap fekunditas, derajat penetasan dan kelulushidupan benih ikan mas (*Cyprinus carpio*, L). *Journal of Aquaculture Management and Technology*. 4(1):19-25.

Fitrinawati H. 2004. Kebiasaan makanan ikan rejung *Sillago sihama* di perairan Pantai Mayangan, Subang, Jawa Barat [skripsi]. Bogor: IPB University.

Ginzel FI. 2021. Aspek biologi reproduksi ikan tembang (*Sardinella fimbriata*) selama musim barat di Perairan Teluk Kupang. *Jurnal Bahari Papadak*. 2(2):171-177.

Hwang S, Chen C, Liu K. 2002. Age and growth of the moonfish, *Mene maculata*, before and after heavy exploitation in Southwestern Taiwan Waters. *Journal Fisheries Society Taiwan*. 29(4): 299–311.

Meilanur R. 2018. Biologi reproduksi ikan semar (*Mene maculate* Bloch & Schneider, 1801) di Teluk Palabuhanratu, Sukabumi, Jawa Barat [skripsi]. Bogor: IPB University.

Mulfizar, Muchlizin ZA, Dewiyanti I. 2012. Hubungan panjang berat dan faktor kondisi tiga jenis ikan yang tertangkap di perairan Kuala Gigieng, Aceh Besar, Provinsi Aceh. *Depik*. 1(1):1-9.

Nikolsky GV. 1963. *The Ecology of Fishes*. New York(US): Academic Press.

Perceka ML, Asriani, Fauzan IR. 2020. Kemunduran mutu ikan semar (*Mene* *maculate*) selama penyimpanan suhu chilling. *Indonesian Journal of Maritime*. 1(2):44-52.

Putera MLA, Setyobudiandi I. 2019. Reproduksi ikan kembung lelaki (*Rastrelliger kanagurata*, Cuvier 1816) kaitannya dengan suhu permukaan laut di Perairan Selat Sunda. *Jurnal Pengelolaan Perikanan Tropis*. 3(1):30-37.

Putra HS, Kurnia R, Setyobudiandi I. 2018. Kajian stok sumberdaya ikan layur (*Trichiurus lepturus*) di Teluk Palabuhanratu, Sukabumi, Jawa Barat. *Jurnal Pengelolaan Ikan Tropis*. 2(1):21-33.

Rahardjo MF, Simanjuntak CPH. 2008. Hubungan panjang bobot dan faktor kondisi ikan tetet, *Johnius belangerii* Cuvier (Pisces: Sciaenidae) di perairan Pantai Mayangan, Jawa Barat. *Jurnal Ilmu-ilmu Perairan dan Perikanan Indonesia*. 15(2):135-140.

Rahmawaty D, Patanda M, Syafrie H. 2021. Potensi sumberdaya ikan layur (*Trichiurus lepturus*) di Perairan Palabuhanratu, Sukabumi. *Jurnal Ilmiah Satya Minabahari*. 6(2):71-77.

Rambun A, Sunarto, Nurruhwati I. 2016. Selektivitas alat tangkap purse seine di Pangkalan Pendaratan Ikan (PPI) Muara Angke Jakarta. *Jurnal Perikanan Kelautan*. 3(2):97-102.

Restiangsih Y, Hidayat T. 2018. Analisis pertumbuhan dan laju eksploitasi ikan tongkol abu-abu, *Thunnus Tonggol* (Bleeker, 1851) di Perairan Laut Jawa. *BAWAL Widya Ris Perikan Tangkap*. 10(2):111–120

Shi-Qiang D, Feng B, Hou G, Lu H, Yan Y. 2012. Age and growth of moonfish, *Mene maculata* from mouth of the Beibu gulf, South China Sea. *Journal Fish China*. 36:576–583.

Steel RGD, Torrie JH. 1980. *Principles and Procedures of Statistics. A biometrical approach.* 2nd edition. New York (USA) : McGraw-Hill.

Stuart KR, Armbruster L, Johnson R, Drawbridge MA. 2020. Egg diameter as a predictor for egg quality of california yellowtail (*Seriola dorsalis*). *Aquaculture*. 522:1-6.

Sukendi, Thamrin, Putra RM. 2015. Teknologi domestikasi dan pematangan gonad ikan pawas (*Osteochilus hasselti CV*) dari perairan Sungai Kampar, Riau. *Dinamika Lingkungan Indonesia*. 2(2):108-120.

Sutriana, Yusdi F, Nadia LOAR. 2020. Pola pertumbuhan dan faktor kondisi ikan belanak (*Mugil dussumeri*) di Perairan Pulau Balu, Kecamatan Tiworo Utara, Kabupaten Muna Barat. *Jurnal Manajemen Sumberdaya Perairan*. 5(3):210-219.

Udupa KSS. 1986. Statistical method of estimating the size at first maturity in fishes. *Fishbyte*. 4(2):8–10.

Walpole RE. 1993. *Pengantar Statistika*. Edisi ke-3. Sumantri B. (penerjemah). PT Gramedia Pustaka Umum. Terjemahan dari: Introduction to Statistics 3rd. Jakarta (ID).

Wujdi A, Suwarso, Widianto. 2012. Hubungan panjang bobot, faktor kondisi, dan struktur ukuran ikan lemuru (*Sardinella lemuru* Bleeker, 1853) di Perairan Selat Bali. *BAWAL*. 4(2):83-89.

Zhong S, Zhao Y, Wang X, Song Z, Zhang Q. 2017. The complete mitochondrial genome of moonfish *Mene maculata* (Perciformes: Menidae). *Mitochondrial DNA Part B*. 2(2):875-876.