



Growth Pattern and Reproductive Biology of the Mudskipper (*Boleophthalmus boddarti*) in the Maro River Area, Semangga District, Merauke Regency

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Received: January 2026; Revised: February 2026; Accepted: March 2026; Published: March 2026

Abstract: This study aimed to analyze the growth and reproductive patterns of the mudskipper (*Boleophthalmus boddarti*) in the Maro River area, Semangga District, Merauke Regency. The study was conducted in the Maro River area, Semangga District, Merauke Regency, from August to October 2024. Sampling was carried out twice per month using a purposive sampling technique. Quantitative data analysis was applied to evaluate growth patterns and reproductive characteristics, including sex ratio and gonadal maturity stage (GMS), of the mudskipper (*Boleophthalmus boddarti*). The results showed that a total of 56 mudskippers were collected during the study, consisting of 20 males and 36 females. The growth pattern analysis yielded the equation $W = 0.0018L^{3.5138}$ in Sidomulyo Village and $W = 0.0015L^{3.5831}$ in Urumb Village, indicating a positive allometric growth pattern. In terms of reproduction, the sex ratio of the mudskipper population remained relatively balanced. Regarding gonadal maturity stage, males were found only at GMS I, whereas females were recorded at GMS I and GMS II.

Keywords: *Boleophthalmus boddarti*; growth pattern; reproduction; positive allometry

How to Cite: Hartanty, N. P., Sunarni, & Saleky, D. (2026). Growth Pattern and Reproductive Biology of the Mudskipper (*Boleophthalmus boddarti*) in the Maro River Area, Semangga District, Merauke Regency. *Bioscientist: Jurnal Ilmiah Biologi*, 14(1), 411–421. <https://doi.org/10.33394/bioscientist.v14i1.19986>



<https://doi.org/10.33394/bioscientist.v14i1.19986>

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INTRODUCTION

Mudskippers are amphibious fishes belonging to the family *Gobiidae* and subfamily *Oxudercinae* (Polgar et al., 2017; Asmi et al., 2022). They are widely distributed across Africa, Madagascar, India, South Asia, northern Australia, southern China, Japan, and Indonesia (Ansari et al., 2014). Among coastal fish, mudskippers are particularly distinctive because they are closely associated with mangrove ecosystems and exhibit unique morphological and behavioral adaptations for semi-terrestrial life. These adaptations include the ability to crawl on land and over mangrove roots, large protruding eyes, and muscular pectoral fin bases that function similarly to limbs, enabling movement, jumping, and crawling (Sunarni, 2013). In Indonesia, mudskippers are found in many coastal and mangrove areas (Muhtadi et al., 2016; Akbar et al., 2020), including the intertidal zone of Payum Beach (Sunarni & Maturbongs, 2016), the mangrove area of Cilacap (Wahyudewantoro, 2012), the Ternate region (Akbar et al., 2020), and the Banyuurip River estuary, Ujung Pangkah, Gresik Regency, where they occur in relatively high abundance (Rohmawati et al., 2021).

In addition to their ecological importance, mudskippers also have socio-economic value. They are traditionally used to treat several health conditions, such as asthma and cough, and are believed to improve stamina and support maternal and fetal health during pregnancy (Sunarni & Maturbongs, 2016). Ecologically, mudskippers have also been recognized as biological indicators of mangrove ecosystem condition (Muhtadi,

2016). Given these ecological and practical values, scientific studies on mudskippers are essential to support their sustainable utilization and management.

One important aspect of such studies is the analysis of growth patterns, which is widely applied in fisheries management because it provides valuable information on the condition of fish resources (Purwaningsih et al., 2014; Hamid et al., 2015). Growth pattern refers to changes in length, weight, or volume over time as a result of biological processes, and is often associated with changes in the number of individuals or biomass within a given period. In fish, growth is generally defined as changes in body length or weight over time and is influenced by a range of internal and external factors (Radongkir et al., 2018). Information on growth patterns is therefore important for understanding population condition and supporting appropriate resource management strategies.

In addition to growth, reproductive characteristics are also fundamental components of fish population studies. In mudskippers, particularly *Boleophthalmus boddarti*, important reproductive aspects include sex ratio and gonad maturity level (TKG). Sex ratio describes the proportion of males to females within a population, and its determination is important for estimating fish production potential (Pulungan, 2015). Meanwhile, gonad maturity level is an indicator used to assess gonadal development and sexual maturity in fish. As gonadal maturity increases, gonad volume generally increases as well, which may contribute to higher individual body weight. These reproductive parameters are therefore important for understanding population dynamics and reproductive potential.

Despite the wide distribution and apparent abundance of mudskippers, no previous study has specifically examined their growth patterns and reproductive characteristics in the Maro River area. The limited utilization of mudskippers may be partly related to the lack of information regarding their bioecology and potential uses. Therefore, research on the growth and reproduction of mudskippers is needed to fill this knowledge gap. The results of this study are expected to provide important baseline information for the sustainable management of fisheries resources in southern Papua.

METHOD

Study Period and Location

This study was conducted over a three-month period, from August to October 2024, in the Maro River area, specifically in Sidomulyo Village and Urumb Village, Semangga District, Merauke Regency, South Papua Province (Figure 1).

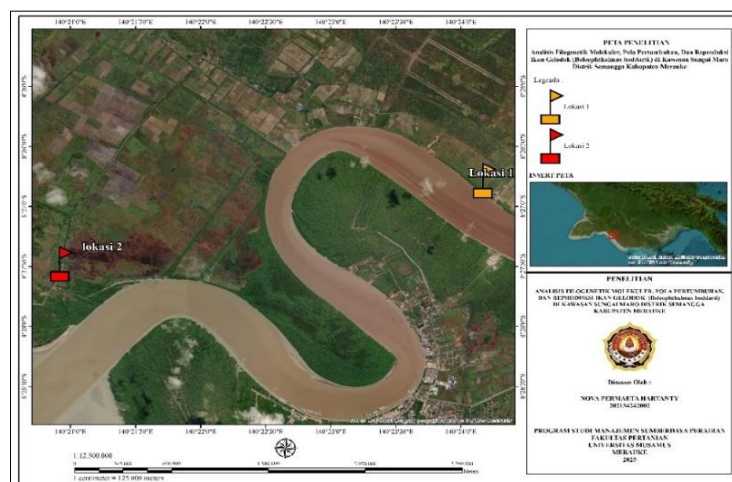


Figure 1. Sampling location of the mudskipper *Boleophthalmus boddarti*

Sampling was carried out twice per month, resulting in a total of six sampling occasions. Analyses of the growth pattern and reproductive aspects of the mudskipper *Boleophthalmus boddarti*, including sex ratio and gonadal maturity stage (GMS), were conducted at the Laboratory of the Department of Aquatic Resources Management, Faculty of Agriculture, Musamus University, Merauke.

Sample Collection and Research Procedures

Fish samples were collected from the Maro River area, specifically from Sidomulyo Village and Urumb Village, located in Semangga District, Merauke Regency. The sampling technique used in this study was purposive sampling, in which samples were selected based on specific considerations using a hand net. The collected mudskipper samples were then identified using FishBase (www.fishbase.org).

Data Analysis

The growth pattern analysis in this study was based on the relationship between fish length and weight. The formula used according to Effendie (1997) was as follows:

$$W = aL^b$$

$$W = \text{long } a + b \text{ long } L$$

Note:

W = body weight of fish (g)

L = body length of fish (cm)

a and **b** = constants

The sex ratio was determined according to Effendie (2002) using the following formula:

$$\text{Nisbah Kelamin} = \frac{J}{B}$$

Note:

J = number of male fish (individuals)

B = number of female fish (individuals)

To determine whether the sex ratio between male and female fish was balanced, a chi-square test (X^2) was applied at a 95% confidence level. If [$x^2_{hitung} < x^2_{tabel} (db = 2 - 1)$], the sex ratio was considered balanced; conversely, if [$x^2_{hitung} > x^2_{tabel} (db = 2 - 1)$], it was considered unbalanced (Mote et al., 2021). The formula used to assess the balance between male and female fish was as follows:

$$x^2 = \frac{\sum(O_i - e_i)^2}{e_i}$$

Note:

(X^2) = chi-square value

(O_i) = observed frequency of male and female fish

(e_i) = expected frequency (male and female frequency divided by 2)

The gonadal maturity stage (GMS) of the mudskipper *Boleophthalmus boddarti* was determined macroscopically through direct observation. The classification of gonadal maturity included the visibility of oocytes or sperm, as well as gonad size and color (Effendie, 2002).

Table 2. Gonadal Maturity Stages (GMS) according to Effendie (2002).

GMS	Male	Female
I	The testes are thread-like, relatively short, with the tip visible in the body cavity, and transparent in color.	The ovaries are thread-like and extend into the body cavity; they are clear in color and surface appearance, and relatively small in size.
II	The testes are larger, milky white in color, and more clearly defined than in GMS I.	The ovaries are larger, slightly yellowish in color, and the eggs are not yet clearly visible.
III	The testes have a serrated surface, appear whiter in color, and increase in size.	The ovaries are yellow, and the egg granules begin to become morphologically visible.
IV	Similar to GMS III, but more distinct, with the testes becoming thicker.	The ovaries are larger; the eggs are yellow and can be separated; oil droplets are not visible; the ovaries occupy one-half to three-quarters of the abdominal cavity, and the intestine is compressed.
V	The posterior part of the testes appears flattened, while the part near the genital opening remains filled.	The ovaries are wrinkled, with many egg granules present near the genital opening, similar to GMS II.

RESULTS AND DISCUSSION

Growth Pattern of Mudskipper (*Boleophthalmus boddarti*)

Growth in fish is defined as changes in weight or length over a certain period and is a biological process influenced by numerous internal and external factors (Radongkir et al., 2018). The results for the growth pattern of mudskipper in Sidomulyo Village and Urumb Village, including the maximum, minimum, and mean values obtained from catches collected during August to October, are presented in Table 1.

Table 1. Maximum, minimum, and mean values of length and weight of mudskipper (*Boleophthalmus boddarti*).

Location	Parameter	Value	Mean
Sidomulyo Village	Maximum length	23.8 cm	17.3 cm
	Minimum length	10.7 cm	
	Maximum weight	109.23 g	47.68 g
	Minimum weight	7 g	
Urumb Village	Maximum length	24.2 cm	18.7 cm
	Minimum length	11.5 cm	
	Maximum weight	118.02 g	60.2 g
	Minimum weight	9 g	

In Sidomulyo Village, the mudskipper catches collected from August to October showed a maximum length of 23.8 cm, a minimum length of 10.7 cm, and a mean length of 17.3 cm. For body weight, the maximum value was 109.23 g, the minimum was 7 g, and the mean was 47.68 g.

In Urumb Village, the maximum length recorded during the same period was 24.2 cm, while the minimum length was 11.5 cm, with a mean length of 18.7 cm. The maximum body weight was 118.02 g, the minimum was 9 g, and the mean weight was 60.2 g. These results differ from those reported from Bahak Indah Beach, Probolinggo, East Java, where mudskipper length ranged from 7.6 to 26.2 cm and body weight

ranged from 5.3 to 15.3 g (Maghfira et al., 2023). Similarly, mudskippers collected from the Karangtalun mangrove forest area had an average body weight of 23.68 ± 7.22 g and an average length of 14.23 ± 1.45 cm (Hastuti et al., 2023). The variation in mudskipper size among different regions is strongly influenced by several factors, including food availability and nutrition, temperature, habitat condition, species, sex, age, and other environmental factors (Amalia & Budijastuti, 2022).

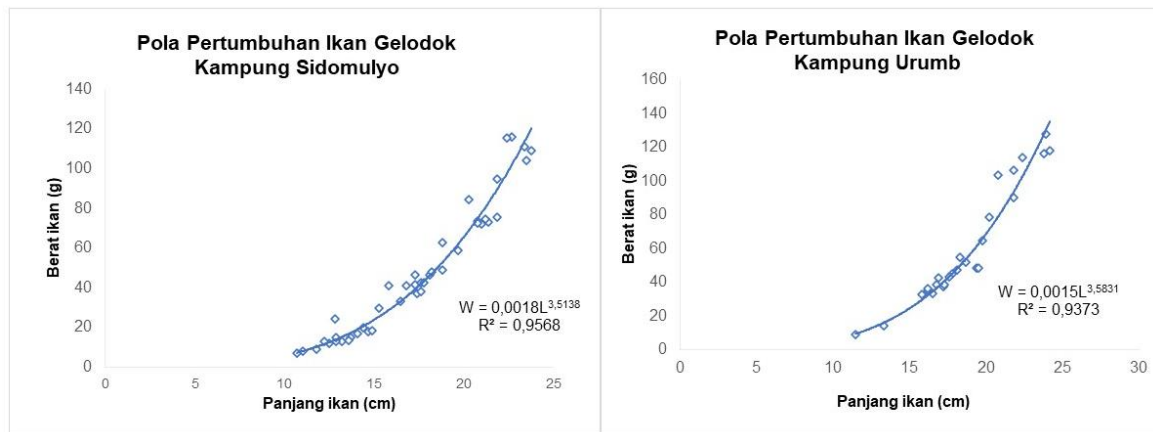


Figure 2. Growth pattern of mudskipper (*Boleophthalmus boddarti*) in Sidomulyo Village and Urumb Village

The analysis of mudskipper growth pattern (*Boleophthalmus boddarti*) (Figure 2) in Sidomulyo Village during August to October produced the equation $W = 0.0018L^{3.5138}$, indicating that the body weight–length relationship has a constant **a** value of 0.0018 and an exponent **b** value of 3.5138 ($b > 3$). In Urumb Village, the corresponding equation was $W = 0.0015L^{3.5831}$, with a constant **a** value of 0.0015 and an exponent **b** value of 3.5831 ($b > 3$).

These results indicate that the growth pattern of mudskipper in both Sidomulyo Village and Urumb Village is positively allometric, meaning that body weight increases more rapidly than body length. This finding is consistent with Effendie (2002), who stated that if $b > 3$, the fish exhibits positive allometric growth, where body weight increases faster than length. In addition, the R^2 value indicates that each increase in body weight is accompanied by an increase in body length over the observation period. This is in accordance with Hartnoll (1983), who stated that the magnitude of the correlation coefficient reflects the extent to which increases in length are followed by increases in body weight.

Reproduction of Mudskipper (*Boleophthalmus boddarti*)

Sex Ratio

Sex ratio is the proportion of male to female fish within a population. Determination of sex ratio is important as a tool for estimating fish production (Pulungan, 2015). To determine the sex ratio of mudskipper (*Boleophthalmus boddarti*), observations of male and female characteristics are required to facilitate identification. In this species, sex can be distinguished by specific external features. Mudskipper (*Boleophthalmus boddarti*) possesses a papilla that can be used as a sex-specific character; females have a larger papilla than males (Figure 3).

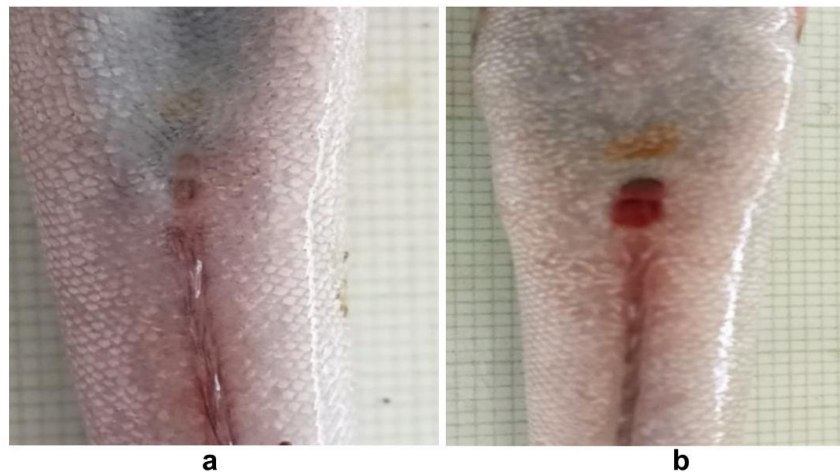


Figure 3. Sex differences in mudskipper (*Boleophthalmus boddarti*): (a) male, (b) female

The sex ratio analysis of mudskipper (*Boleophthalmus boddarti*) in Sidomulyo Village and Urumb Village during August–October 2024 showed a balanced pattern (Tables 2 and 3). In Sidomulyo Village, the calculated χ^2 values were 0.4 in August, 0.1 in September, and 2.6 in October, compared with a χ^2 table value of 3.08. In Urumb Village, the calculated χ^2 values were 0.2 in August, 3.6 in September, and 0.1 in October, with a χ^2 table value of 3.86.

Table 2. Sex ratio of mudskipper (*Boleophthalmus boddarti*) in Sidomulyo Village.

Month	Male (ind.)	Female (ind.)	Sex ratio	X ² calculated	Description
August	4	6	0.7:1	0.4	Balanced
September	4	5	0.8:1	0.1	Balanced
October	4	10	0.4:1	2.6	Balanced
Total	12	21			

Table 3. Sex ratio of mudskipper (*Boleophthalmus boddarti*) in Urumb Village.

Month	Male (ind.)	Female (ind.)	Sex ratio	X ² calculated	Description
August	2	3	0.7:1	0.2	Balanced
September	1	6	0.2:1	3.6	Balanced
October	5	6	0.8:1	0.1	Balanced
Total	8	15			

The chi-square test results showed that **X² calculated < X² table**, indicating that the sex ratio of mudskipper remained balanced. To maintain population sustainability, the proportion of males and females is expected to be balanced, or at least to include more females than males (Purwanto et al., 1986). When the ratio of males to females is balanced, the probability of fertilization between eggs and spermatozoa increases, thereby contributing to the maintenance and growth of the mudskipper population.

Conversely, an imbalanced sex ratio may hinder population development (Effendie, 1979). Such imbalance may result from differences in behavior, growth rate, and mortality between males and females (Bal & Rao, 1984). In addition, differences in capture probability may arise when males and females are not present in the same spawning area. Sex ratio balance may also change prior to spawning. During spawning

migration, the population may initially be dominated by males, but as spawning approaches, the proportions of males and females tend to become more balanced.

Gonadal Maturity Stage (GMS)

Gonadal maturity stage is defined as a particular stage in gonadal development before and after spawning (Effendie, 2002). The analysis of gonadal maturity stage (GMS) in mudskipper (*Boleophthalmus boddarti*) from Sidomulyo Village showed that males were found only at GMS I, whereas females were observed at GMS I–III.

In this study conducted in Sidomulyo Village, no mudskipper (*Boleophthalmus boddarti*) with fully mature gonads (GMS IV–V) was found in either males or females. Male mudskippers collected during August–October were consistently recorded at GMS I. Female mudskippers were observed at GMS I–III in August, at GMS II in September, and at GMS I–II in October. The monthly distribution of gonadal maturity stages in Sidomulyo Village is presented in Table 4.

Table 4. Gonadal maturity stage (GMS) of mudskipper (*Boleophthalmus boddarti*) in Sidomulyo Village by month.

Male

No. Month	Total Males	GMS I	GMS II	GMS III	GMS IV	GMS V
1 August	4	4	0	0	0	0
2 September	4	4	0	0	0	0
3 October	4	4	0	0	0	0
Total	12	12	0	0	0	0

Female

No. Month	Total Males	GMS I	GMS II	GMS III	GMS IV	GMS V
1 August	6	2	2	2	0	0
2 September	5	0	5	0	0	0
3 October	10	2	8	0	0	0
Total	21	4	15	2	0	0

The findings showed that no mudskipper (*Boleophthalmus boddarti*) with fully mature gonads (GMS IV–V) was detected in either sex. The peak spawning period is therefore presumed to occur at the end of October. This is consistent with Demartini (1999), who reported that the rainy season (October–April) corresponds to the reproductive season, when gonads enter the reproductive phase and spawning occurs. Gonads at GMS II–IV generally show an increase in gonadosomatic index (GSI) due to vitellogenesis, which is the process of yolk deposition in developing oocytes, causing the gonads to become heavier (Hayati, 2018; Deeng et al., 2022). A high gonadosomatic index is considered an indicator of reproductive age (Effendie, 2002).

The analysis of gonadal maturity stage (GMS) in mudskipper (*Boleophthalmus boddarti*) from Urumb Village during August–October showed that males were found only at GMS I, whereas females were found at GMS I–II. The gonadal maturity stage of mudskipper in Urumb Village is presented in Table 5.

Table 5. Gonadal maturity stage (GMS) of mudskipper (*Boleophthalmus boddarti*) in Urumb Village by month.

Male							
No. Month	Total Males	GMS I	GMS II	GMS III	GMS IV	GMS V	
1 August	2	2	0	0	0	0	0
2 September	1	1	0	0	0	0	0
3 October	5	5	0	0	0	0	0
Total	8	8	0	0	0	0	0

Female							
No. Month	Total Males	GMS I	GMS II	GMS III	GMS IV	GMS V	
1 August	3	0	3	0	0	0	0
2 September	6	2	4	0	0	0	0
3 October	6	0	6	0	0	0	0
Total	15	2	13	0	0	0	0

No mudskipper in Urumb Village was found to have fully mature gonads. This may be because spawning had not yet occurred during August and September, whereas the spawning process had begun by October. This is supported by Nasution (2016), who stated that the peak gonadal maturation of mudskipper occurs from late October to December, followed by natural spawning.

The percentage distribution of gonadal maturity stages in mudskipper (*Boleophthalmus boddarti*) from Sidomulyo Village during August–October was based on 33 individuals, consisting of 12 males and 21 females. In males, only GMS I was observed, whereas females were found at GMS I–III (Figure 4).

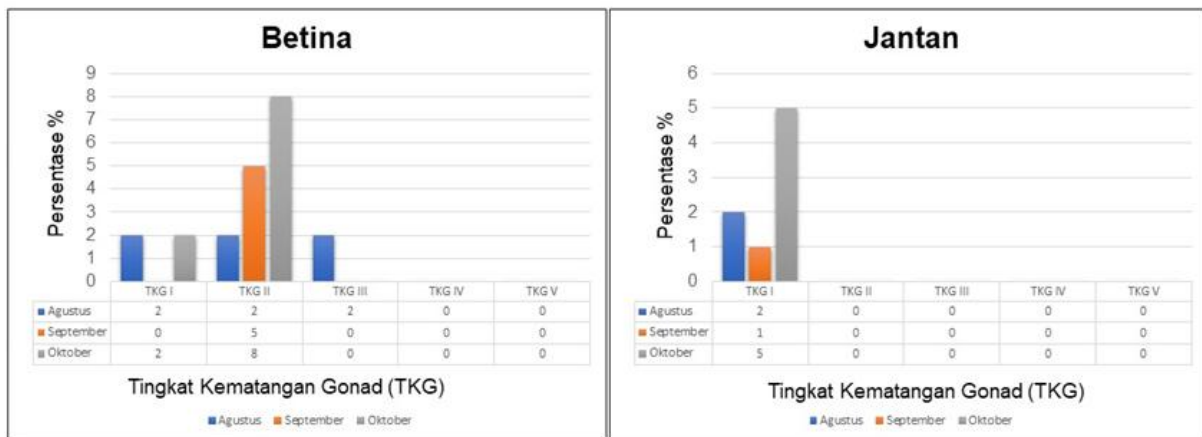


Figure 4. Percentage distribution of gonadal maturity stages (GMS) of mudskipper (*Boleophthalmus boddarti*) in Sidomulyo Village

In Urumb Village, the gonadal maturity stage analysis during August–October included 23 individuals, consisting of 8 males and 15 females. As in Sidomulyo Village, males were found only at GMS I, whereas females were recorded at GMS I–II (Figure 5).

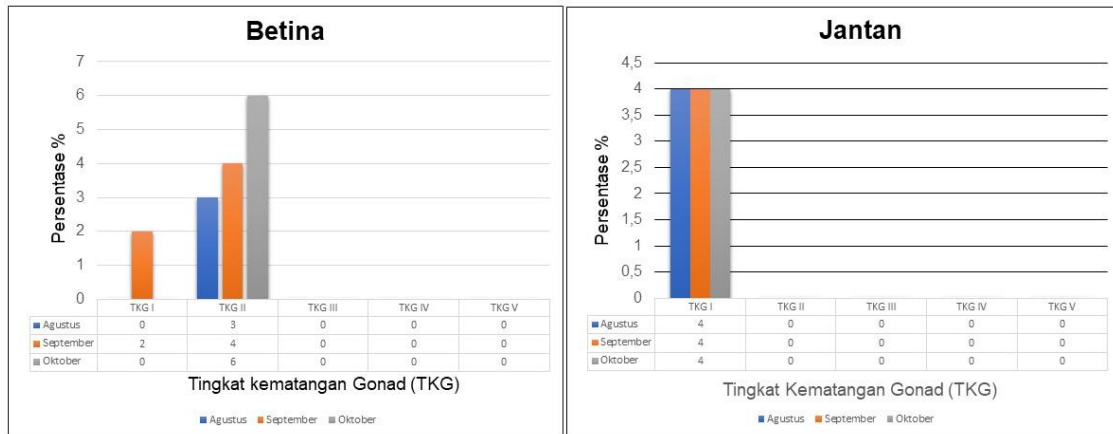


Figure 5. Percentage distribution of gonadal maturity stages (GMS) of mudskipper (*Boleophthalmus boddarti*) in Urumb Village

In female mudskipper, gonadal maturity stage can be identified based on the shape, color, size, clarity of the eggs, and the extent to which the ovaries fill the body cavity. In males, gonadal maturity is determined from the color, shape, and size of the testes located within the body cavity.

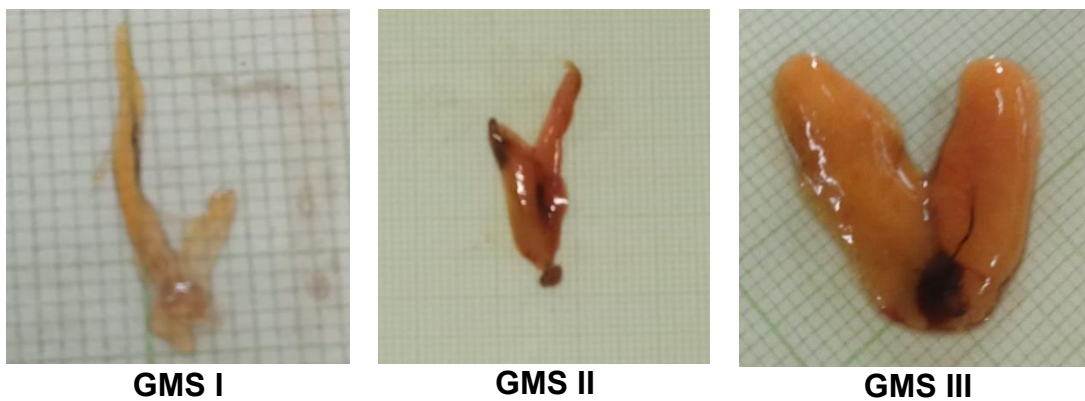


Figure 6. Gonadal development of mudskipper (*Boleophthalmus boddarti*)

During the changes occurring in the ovaries and testes, corresponding changes also occur in gonad weight and volume, which serve as indicators for determining gonadal maturity stage (Syandri, 1996). The classification of gonadal maturity stages is important for identifying the proportion of fish that are reproductively active and those that are not. It also helps determine whether the organism is about to spawn, has just spawned, or has completed spawning (Nasution, 2016).

CONCLUSION

The analysis of the growth pattern of mudskipper (*Boleophthalmus boddarti*) in Sidomulyo Village and Urumb Village during August to October indicated a positive allometric growth pattern, in which body weight increased more rapidly than body length. The reproductive analysis showed that the sex ratio in both villages during August–October 2024 was balanced. Regarding gonadal maturity stage (GMS), mudskipper from Sidomulyo Village showed that males were found only at GMS I, whereas females were found at GMS I–III. In Urumb Village, males were also found only at GMS I, while females were recorded at GMS I–II during the same period.

RECOMMENDATION

Based on the findings of this study, further research on the fecundity and genetic population structure of mudskipper (*Boleophthalmus boddarti*) in natural populations is recommended.

ACKNOWLEDGMENT

The authors express their sincere gratitude to the management of the Laboratory of the Department of Aquatic Resources Management, Musamus University, for their assistance in conducting this research, as well as to all parties who contributed to the successful completion of this study.

REFERENCES

- Akbar, N., Bode, I. D., Baksir, A., Tahir, I., Paembonan, R. E., Marus., I., & Wibowo, E. S. (2020). Distribusi dan karakteristik habitat ikan tembakul (Gobiidae sp) di pesisir Pantai Pulau Ternate Provinsi Maluku Utara. *Jurnal Maritim*, 1(2), 49–58.
- Amalia, P.R., & Budijastuti, W. (2022). Morfometri Ikan Gelodok (Famili Gobiidae) di Perairan Mangrove Wonorejo Surabaya. *LenteraBio*, 11(3), 457-472.
- Ansari, A.A., Trivedi, S., Saggi., & H. Rehman. (2014). Mudskipper: A biological indicator for environmental monitoring and assessment of coastal waters. *Journal of Entomology and Zoology Studies*, 2 (6), 22-33.
- Asmi, W.I., Mulyaningrum, E.R., & Dewi, L.R. (2022). Keanekaragaman jenis dan kelimpahan ikan gelodok (*Periophthalmus* sp.) di kawasan mangrove Pantai Kertomulyo Pati Jawa Tengah. *Jurnal Impresi Indonesia (JII)*, 1(2), 128-134.
- Bal, D.V., & Rao, K.V. (1984). *Marine Fisheries*. Tata Mc Graw-Hill Publishing Company Limited. New Delhi.
- DeenG, R.B., Kusen, J.D, Kumampung, D.R.H, Ompi, M, Paruntu, C.P., & Tombokan, J. (2022). Analisis tingkat kematangan gonad dan indeks kematangan gonad pada ikan kakatua Family Scaridae. *Jurnal Pesisir dan Laut Tropis*, 1 (3): 231-240
- Demartini, E. E. (1999). *Intertidal Spawner*. in Horn MH. Martin KL. Chotkowaki MK. *Intertidal Fishes. Life in Two Word. California, USA: Academic Press*.
- Effendie, M.I. (1979). *Metoda Biologi Perikanan*. Yayasan Dewi Sri. Bogor, 112 hlm.
- Effendie, MI. (1997). *Biologi Perikanan*. Yogyakarta : Yayasan Pustaka Nusatama 163 halaman.
- Effendie, M. I. (2002). *Biologi Perikanan*. Buku Perkuliahan. Fakultas perikanan. IPB. Bogor, 163 hal.
- Hamid, A.M., Mansor, M., & Mohd Nor, S. A. (2015). Length-weight relationship and condition factor of fish populations in Temengor Reservoir: *Indication of environmental health*. *Sains Malaysiana*, 44(1), 61–66.
- Hartnoll, R. G. (1983). *Growth in The Biology of Crustacea Embriology*. Morphology. and Genetic. Academic Press. New York.
- Hastuti, D. W. B., Riviani. R., Nugrayani. D., Prasetio. L. A., & Armaiti. N. S. (2023). Jenis dan Hubungan Panjang Berat Ikan Gelodok (Mudskipper) Di Kawasan Hutan Mangrove Karangtalun. Cilacap. *Jurnal Perikanan Unram*, 13(3). 837-845.
- Hayati, I. (2018). Studi Aspek Biologi Reproduksi Ikan Paweh (*O. hasselti*) di Sungai Tarai Desa Tarai Bangun Kecamatan Tambang Kabupaten Kampar. Provinsi Riau [Skripsi]. Fakultas Pertanian dan Kelautan. Pekanbaru: Universitas Riau.
- Maghfirah, L., Latuconsina, H., & Prasetyo. H. D. (2023). Inventory of potential and community structure of mudskipper at coast of Bahak Indah. Probolinggo-East

- Java. *Jurnal Pengelolaan Perikanan Tropis (Journal of Tropical Fisheries Management)*, 7(1), 1-9.
- Muhtadi. A., Ramadhani, S.F., & Yunasfi. (2016). Identifikasi dan Tipe Habitat Ikan Gelodok (Famili : Gobiidae) di Pantai Bali Kabupaten Batu Bara Provinsi Sumatera Utara, *Biospecies*, 9(2). 1-6.
- Mote. N., Sunarni. I. M., & Pakidi, C. S. (2021). Reproduksi Ikan Betok (*Anabas testudineus* Bloch. 1792) di Rawa Wasur Taman Nasional Wasur Kabupaten Merauke. *Jurnal Ilmu Kelautan dan Perikanan Papua*, 4(2), 63-68.
- Nasution, S., Ghalib, M., & Parnanda, A. (2016). Kematangan Gonad dan Fekunditas Ikan Gelodok (Mudskipper), *Periophthalmus variabilis* Eggert dari Pantai Pulau Rupa. *Jurnal Perikanan dan Kelautan*, 21(1), 47-53.
- Polgar, G., Ghanbarifardi, M., Milli, S., Agorreta. A., Aliabadian, M., Esmaeili, H. R., & Khang, T. F. (2017). Ecomorphological adaptation in three mudskippers (Teleostei: Gobioidae: Gobiidae) from the Persian Gulf and the Gulf of Oman. *Hydrobiologia*, 795, 91-111.
- Pulungan, C.P. (2015). Nisbah Kelamin dan Nilai Kemontokan Ikan Tabingal (*Puntioplites bulu Blkr*) Dari Sungai Siak. Riau. *Jurnal Perikanan dan Kelautan*, 20(1), 11-16.
- Purwanto, G., Bob, W.N., & Bustaman, S J. (1986). Studi Pendahuluan Keadaan Reproduksi dan Perbandingan Kelamin Ikan Cakalang Katsuwonus pelamis di Perairan Sekitar Teluk Biru dan Elpaputih P. Seram. *Jurnal Penelitian Perikanan Laut*, 34, 69–78.
- Purwaningsih. S., Salamah. E., & Dewantoro. R. (2014). Chemical Composition and Fatty Acids of Glodok Fish by High Thermal Processing. *Jurnal Pengolahan Hasil Perikanan Indonesia*, 17(2), 165–174.
- Radongkir, Y. E., Simatauw. F., & Handayani, T. (2018). Aspek Pertumbuhan Ikan Layang (*Decapterus macrosoma*) di Pangkalan Pendaratan Ikan Sanggeng Kabupaten Manokwari. *Jurnal Sumberdaya Akuatik Indopasifik*, 15, 24.
- Rohmawati, V. D., Latuconsina. H., & Zayadi, H. (2021). Fish Community in Different Mangrove Habitat in Banyuurip Ujung Pangkah–Gresik Regency. *Agrikan: Jurnal Agribisnis Perikanan*, 14(1), 73-79.
- Ramadhani, S. F., & Muhtadi. A. (2016). Hubungan Panjang Bobot Dan Kondisi Ekologi Ikan Gelodok (*Periophthalmus Chrysospilos Bleeker*. 1852) Di Pantai Bali Desa Masjid Lama Kecamatan Talawi Kabupaten Batu Bara Provinsi Sumatera Utara.
- Sunarni. (2013). Kajian Bioekologi Dan Pengelolaan Ikan Blodok (*Boleophthalmus boddarti*) Di Perairan Kabupaten Merauke. *Tesis*. 1-15.
- Sunarni., & Modesta, M. R. (2016). Biodiversitas dan Kelimpahan Ikan Gelodok (*Mudskipper*) di Daerah Intertidal Pantai Payum. *Prosiding Seminar Nasional Kemaritiman dan Sumberdaya Pulau – Pulau Kecil*, 1(1), 125-131.
- Syandri, H. (1996). Aspek Reproduksi Ikan Bilih (*Mystacoleucus padangensis*) Bleeker dan Kemungkinan Pembenihannya di Danau Singkarak [disertasi]. Program Pasca Sarjana. Institut Pertanian Bogor. Bogor. 121 hal.
- Wahyudewantoro, G. (2012). Ragam Ikan Mangrove di Muara Sungai Bojong Langkap dan Sungai Ciperet. *Segara Anakan-Cilacap. Zoo Indonesia*, 21(1), 9-15.