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Reproductive Aspects of Mangrove Crabs (*Scylla* sp.) Caught by Fishermen in the Bagek Kembar Essential Ecosystem Area, West Lombok

Baiq Gina Amalia Niarni, Karnan*, Anindita Suliya Hangesti Mandra Kusuma, Mahrus

Biology Education Study Program, University of Mataram, Mataram, Indonesia
*e-mail: karnan.ikan@unram.ac.id

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Abstract: Mangrove crabs are a high-value fishery resource that is closely associated with mangrove ecosystems, but their uncontrolled use has the potential to threaten the sustainability of the population. This study aims to analyze the reproductive aspects of mangrove crabs (*Scylla* sp.) caught by fishermen in the Bagek Kembar Essential Ecosystem Area (KEE), West Lombok, as the basis for sustainable fisheries management. The research was conducted in March-May 2025, using a quantitative survey method and observation-based data collection. The sampling technique in this study is purposive sampling. The observed parameters included gender, carapace width, body weight, gonadal maturity level (TKG), and gonadal maturity index (IKG). Data were analyzed descriptively and inferentially to describe growth patterns and reproductive conditions. The results showed a dominance of females, with a male:female ratio of 0.83:1. The relationship between carapace width and body weight is negative allometric ($b < 3$), indicating that carapace growth is faster than body weight growth. The distribution of TKG is dominated by TKG I and III, while the average IKG ranges from 2.05–5.72% with a frequency of 80%. The novelty of this research lies in providing location-based mangrove crab reproductive data in essential ecosystem areas that remain limited. The results of the study confirm the importance of regulating catch size and protecting mature gonadal individuals, and recommend further research on seasonal reproductive dynamics to support ecosystem-based fisheries management.

Keywords: KEE Bagek Kembar; Reproductive Aspects; *Scylla* sp.; Sex Ratio.

Introduction

Indonesia is one of the world's megadiverse countries, with a marine ecosystem of very high biodiversity. As an archipelago with the second-longest coastline in the world, Indonesia's waters are home to a variety of economically and ecologically important fishery resources, including mangrove crab (*Scylla* sp.) [1]. This species belongs to the family *Portunidae*, which is widespread in the Western Indo-Pacific region, especially in mangrove, estuary, and brackish-water ecosystems [2].

The ecological relationship between mangrove crabs and mangrove ecosystems is interdependent: mangroves provide habitat for growth and protection, while crabs play a role in nutrient cycling and ecosystem stability [3]. Mangrove density and substrate quality are known to significantly affect the distribution and reproductive success of *Scylla* sp. in coastal habitats [4]. One area that illustrates this ecological linkage is the Bagek Kembar Mangrove Forest in Cendi Manik Village, West Lombok, which has been designated as an Essential Ecosystem Area (KEE) [5].

From an economic aspect, mangrove crab is a high-value fishery commodity in the domestic and export markets. Indonesian crab products contributed USD 0.43 billion, an increase of 40.4% from the total value of national fisheries exports until September 2024 [6]. Crab meat and eggs are rich in protein, minerals, and essential fatty acids, making them a superior product with an ever-increasing global demand [7]. However, dependence on natural catches, which accounts for 61.6% of total production, poses a threat to the sustainability of the population, especially due to overfishing and exploitation of egg-laying females [8].

As a control measure, the Indonesian government has enacted Regulation of the Minister of Marine Affairs and Fisheries No. 07/Permen-KP/2024, which sets minimum catch sizes and prohibits the capture of egg-laying crabs. This regulation aims to maintain the sustainability of natural stocks and reduce the risk of overfishing [9]. However, implementation at the local level still faces obstacles, especially in coastal areas such as Cendi Manik Village, where traditional fishing practices are still carried out without a formal monitoring system [10].

In the context of sustainable management, understanding the reproductive biology aspects of mangrove crabs is an important basis for determining the right catch size and season. Parameters such as sex ratio, gonad maturity rate (TKG), and gonad maturity index (GI) play an important role in assessing the natural reproductive conditions and the population's regeneration potential [11]. Therefore, research on the reproductive biology of mangrove crabs in the Bagek Kembar Mangrove Forest, West Lombok, was conducted to provide basic data to support sustainable, ecosystem-based crab resource management policies.

Research Methods

The research was conducted for 3 months, from March to May 2025, in the mangrove crab catchment area

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for fishermen within the Bagek Kembar Essential Ecosystem Area, Cendi Manik Village, Sekotong District, West Lombok Regency (Figure 1).

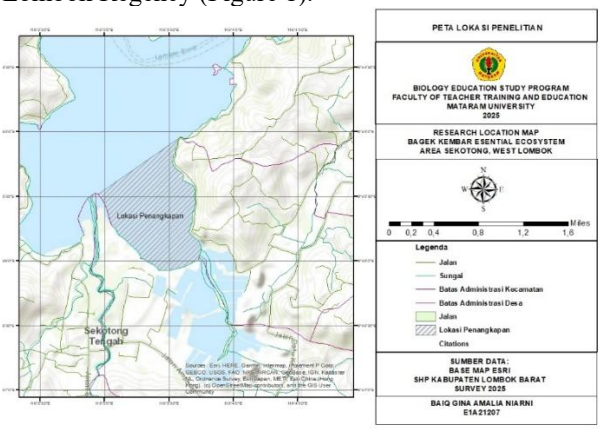

Figure 1. Research Map

This study uses a quantitative survey research method, with data collected through observation. The study population consisted of all mangrove crabs caught by fishermen in the Bagek Kembar Essential Ecosystem area of West Lombok. Mangrove crab samples were taken from fishermen, consisting of mangrove crabs of various sizes, provided that all limbs were complete. The observed data included gender, carapace width, body weight, TKG, and IKG.

Sampling was carried out once every month for three months using the purposive sampling method, which is random sampling from fishermen by determining certain criteria such as the completeness of mangrove crab (*Scylla* sp.). Gender identification is carried out based on abdominal morphology. The width of the carapace was measured with callipers, while body weight and gonad weight were measured using a digital scale with an accuracy of 1 gram. TKG determination was carried out morphologically through surgical analysis of mangrove crab samples with reference to [12]. The level of maturity of mangrove crab gonads is determined based on the morphological development of their gonads, which includes aspects of color, size, and the extent to which the gonads fill the mangrove crab's body cavity [13]. The maturity level of the gonads can be grouped, i.e. levels I-II belong to the category of immature gonads, Levels III-IV are classified as mature, and level V is the category in which the gonads have spawned [14]. Meanwhile, data on the Gonad Maturity Index (GMI) were obtained by comparing gonad weight with mangrove crab body weight, which was then multiplied by 100%.

In this study, the applied data analysis methods are descriptive and inferential statistics. Descriptive statistics is a method for collecting and presenting data to provide useful information [15]. Descriptive statistics in this study present data on the average table of carapace width and body weight of mangrove crabs, tables of tkg and ikg of male and female mangrove crabs and statistical data tables of mangrove crab ikg at KEE Bagek Kembar. The formula for measuring the average is as follows:

$$\bar{x} = \frac{X_1 + X_2 + \cdots + X_n}{n}$$

Description:
$\bar{x}$ = Mean count
X_n = Sample value
n = Number of samples

The Gonad Maturity Index (IKG) of mangrove crabs is determined by paying attention to the comparison between body weight and gonad weight of male and female mangrove crabs as follows:

$$\text{IKG} = \frac{\text{Bg}}{\text{Bt}} \times 100$$

Description:
CHI = Gonadal maturity index
Bg = Body Weight
Bt = Gonad weight

Inferential statistics are a method used to determine the population based on samples by analyzing and interpreting data into a conclusion [16]. Inferential statistics in this study were used to analyze the relationship between carapace width and body weight and sex ratio of mangrove crabs, which are described as follows:

The analysis of the relationship between carapace width and body weight aims to understand the growth pattern of mangrove crabs in the essential ecosystem area of Bagek Kembar Sekotong, West Lombok. This analysis is used to determine whether body weight gain is proportional to carapace width. The equation for calculating the width of the carapace and the weight of the body of a crab, according to Efendi (1997) in [17], is as follows:

$$W = a.L^b$$

Description:
W = Body weight
L = Carapace width
a and b = Kostanta

The values of the constant a and the coefficient of growth b are obtained by simple linear regression. If the value of b = 3, the growth is isometric, if the value of b > 3 the growth is positive allometric, and if the value of b < 3, then the growth is categorized as negative allometric.

Furthermore, the determination of the sex ratio in this study was determined based on the number of male and female mangrove crab samples obtained during the study. The sex ratio, which is based on the number of male and female mangrove crabs caught, is calculated using equations [18]:

$$\text{NK} = \frac{\sum \text{J}}{\sum \text{B}}$$

Description:
NK = sex ratio
$\sum J$= number of male mangrove crabs (tails)
$\sum B$= number of male mangrove crabs (tails)

The relationship between males and females in a population can also be determined by analyzing the sex ratio of mangrove crabs using *the chi-square* (X^2) test.

Results and Discussion

Average Carnation Width and Body Weight of Mangrove Crab

The results of research on mangrove crabs (*Scylla* sp.) in the Bagek Kembar Essential Ecosystem Area (KEE) during the period March-May 2025 show that the captured crab population is dominated by female individuals. Of the

total 97 mangrove crabs, 44 (45.36%) were males, and 53 (54.64%) were females. The predominance of females persisted throughout the observation month, indicating that the mangrove area and surrounding waters play an important role in the growth and maturation of mangrove crab gonads.

The average carapace width of the highest male crab was found in March at 80.05 mm and decreased to 70.40 mm in May. The same pattern was also seen in body weight, with the highest value recorded in March (112.1 g) and the lowest in May (82.6 g). The relatively small standard value of carapace width deviation (1.16–1.48) suggests that carapace size between individuals is fairly uniform, while high variation in body weight, especially in March (SD 65.2), reflects differences in the physiological conditions of male crabs.

In female crabs, the highest average carapace width and body weight were recorded in May, at 80.42 mm and 110.8 g, respectively, while the lowest values occurred in April (70.49 mm and 73.6 g). The high variation in female body weight in May (SD 57.4) indicates a difference in the level of gonad maturity, which affects the accumulation of energy reserves prior to the spawning process.

Based on the Minister of Maritime Affairs and Fisheries Regulation No. 07/Permen-KP/2024, which sets the standard size for a suitable catch (>12 cm carapace width or >150 g body weight), only 14 fish met the criteria. This indicates that most of the crabs caught at the study site are still immature, as they predominantly have carapace widths < 12 cm. The catch of mangrove crabs that tend not to be suitable for catching is due to increasing consumer demand, which is in accordance with the opinion [19]. Arresting pressure on individuals who are not yet eligible for arrest risks creating Growth Overfishing, a condition in which organisms are captured before they reach optimal size for reproduction and growth.

Gonad Maturity Level and Index

The determination of the gonadal maturity level of mangrove crabs is also based on the description by [20], which classifies mangrove crab TKG into five categories. Observation of the maturity level of the gonads showed that the mangrove crabs caught covered all stages of gonad development, starting from TKG I to TKG V. The maturity level of gonads I (TKG I) was the most dominant category with a proportion of 31.96%, followed by TKG III (27.84%), TKG IV (16.49%), TKG II (15.46%), and TKG V (8.25%). The dominance of early TKG indicates that most of the captured mangrove crabs are still in the early stages of gonadal development. Observation of the maturity level of mangrove crab gonads caught by fishermen in the West Lombok Twin Bagek Essential Ecosystem Area, TKG I to V, is presented in Figures 2 and 3.

The value of the gonadosomatic index (GSI) of mangrove crabs ranged from 0.49–11.76, with most of the data (80%) in the interval of 2.05–5.72. The highest average GSI score was recorded in May (44.29%), while the lowest score occurred in April (28.07%). This pattern showed an increase in reproductive activity at the end of the observation period, although mature gonadal individuals were still found in March and April. [21] It reveals that the mangrove crab breeding season lasts year-round, but each body of water has a different peak.

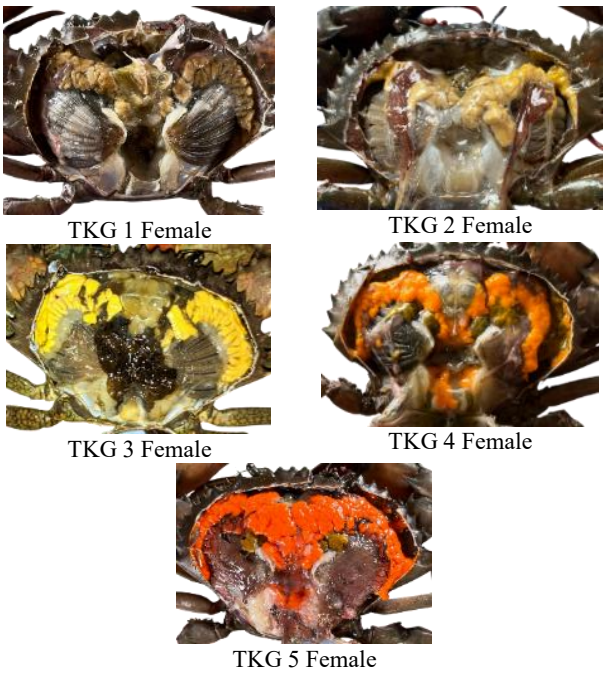

Figure 2. Female TKG

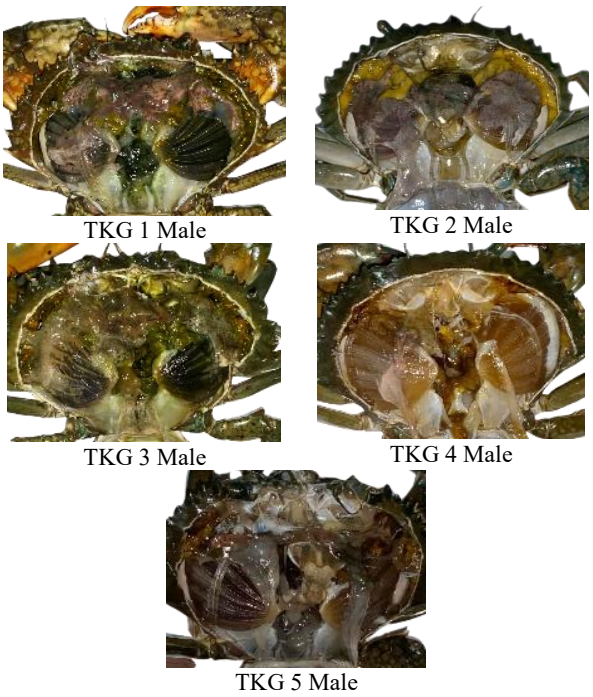

Figure 3. TKG Male

Table 1. Mangrove Crab IKG Statistical Data

No	Interval	F	Percent
1	0.49-1.05	4	4%
2	2.05-2.60	30	31%
3	3.60-4.16	28	29%
4	5.16-5.72	19	20%
5	6.72-7.27	9	9%
6	8.27-8.83	3	3%
7	9.83-10.39	3	3%
8	11.39-11.95	1	1%

The gonadal maturity index of male and female mangrove crabs (*Scylla* sp.) based on time over time can be seen in Figure 4.

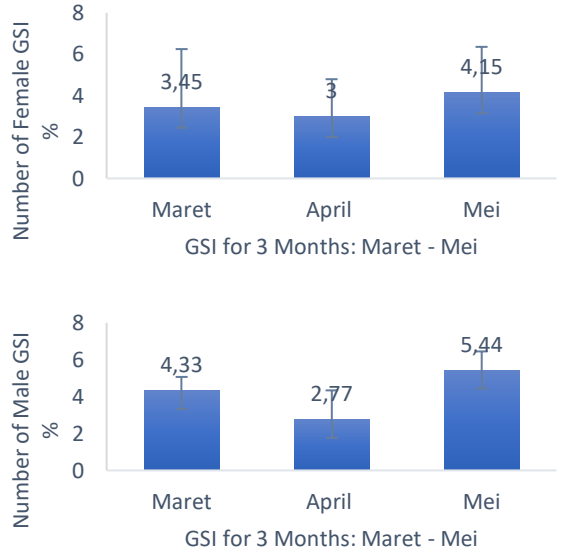

Figure 4. Graph of Female and Male IKG

The presence of female crabs at the advanced gonadal maturity level (TKG V) shows that the Twin Bagek KEE plays an important role as a habitat in the reproductive cycle of mangrove crabs. However, the dominance of crabs at the early gonadal maturity level indicates that many fishing activities still target individuals who are not ready to reproduce. This condition emphasizes the need for capture management that takes into account the size and reproduction period to maintain the sustainability of the mangrove crab population and the stability of the mangrove ecosystem.

The Relationship of Carapace Width and Body Weight

Figure 5 shows the relationship between carapace width and body weight of mangrove crabs, showing a negative allometric growth pattern. Analysis of the equation in male crabs produced an equation with a coefficient of determination (R^2) of 0.45, while in female crabs, an equation with an R^2 value of 1 was obtained. A growth coefficient value (b) of less than 3 in both sexes indicates that the increase in carapace width is faster than the increase in body weight [22].$W = 5{,}83.L^{0{,}61} W = 1.L^{2{,}09}$. The growth pattern of mangrove crabs is negative allometric which is suspected to be related to the process of shell release that occurs in mangrove crabs, where the body weight of mangrove crabs will increase by about 1/3 of the time from before while the width of the carapace will increase by 5-10 mm (about 2 times the original size) in adult crabs during the shell release process [23].

The difference in the growth coefficient value between males and females indicates differences in growth strategies related to the biological functions of each sex [24]. Male crabs tend to allocate energy to claw activity and development, while female crabs focus growth more on the widening of the carapace and increasing body weight in preparation for reproduction. In addition to physiological factors, environmental conditions such as feed availability and water quality also affect the variation in growth patterns.

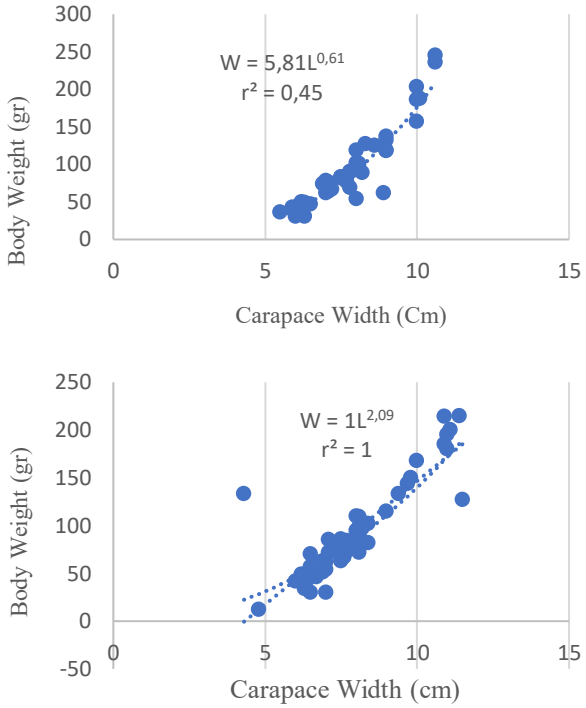

Figure 5. Relationship of carapace width to mangrove crab body weight

Sex Ratio of Mangrove Crab

The sex ratio of mangrove crabs in KEE Bagek Kembar was obtained at 0.83:1 (male:female). The results of the chi-square test showed a calculated χ^2 value of 11.06, exceeding the table χ^2 value of 5.99 at the 0.05 significance level, indicating that the sex ratio was unbalanced. This condition indicates that the mangrove crab population at the study site is dominated by females.

The dominance of female crabs is thought to be related to the characteristics of mangrove habitats that provide adequate protection and feed sources during the gonadal maturation phase. In addition, the migration pattern of mangrove crabs, especially females moving towards seawaters ahead of spawning, also affects the distribution of captured individuals. This gender imbalance could affect population dynamics if more catches target female crabs, which play an important role in reproductive sustainability.

Conclusion

Based on the study's results, the population of mangrove crabs (*Scylla* sp.) caught in the Bagek Kembar Essential Ecosystem Area, West Lombok, is dominated by females (sex ratio 0.83:1) and is statistically unbalanced. The growth patterns of male and female mangrove crabs showed negative allometric properties ($b < 3$), which indicated a faster increase in carapace width than body weight. The gonad maturity level was dominated by TKG I and TKG III, while the value of the gonad maturity index (IKG) was mostly in the range of 2.05–5.72%, which indicates that most of the crabs caught were still in the early phase until they reached gonad maturity. These results confirm that the Twin

Bagek KEE plays an important role as a habitat for the growth and reproduction of mangrove crabs, so it is necessary to manage fisheries that pay attention to the size of the catch and the protection of mature gonadal individuals to maintain the sustainability of mangrove crab resources.

Author's Contribution

B. G. A. Niarni plays a role in research planning, field data collection, data analysis, and the preparation and writing of article manuscripts. Karnan, A. S. H. M. Kusuma, and H. Mahrus played a role in supervising the entire research process, providing theoretical foundations and inputs, as well as reviewing and approving the final manuscript for publication

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