Journal of Science and Technology
https://jurnalfkip.unram.ac.id/index.php/JPM

ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

Reproductive Aspects of Scad Fish (*Selar crumenophthalmus*) Landed at the Fish Landing Base of PPI Tanjung Luar, East Lombok

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Received: November 28, 2025. Accepted: December 28, 2025. Published: December 31, 2025

Abstract: *Selar crumenophthalmus*, known as the bigeye scad, is a commercially important small pelagic fish widely exploited in East Lombok waters. This study aims to examine the reproductive characteristics of the species, including gonadal maturity stages (GMS), gonadosomatic index (GSI), sex ratio, length–weight relationship, and length–fecundity relationship, based on samples collected at PPI Tanjung Luar from June to August 2025. This study employed a descriptive exploratory research design, with samples collected using quota sampling consisting of 90 individuals who landed at PPI Tanjung Luar from June to August 2025, and the data were analyzed descriptively. The species designated GMS I–V, with GMS II and III being the most dominant stages across months. The highest GSI values for both sexes occurred in June, indicating the peak spawning period, with female GSI reaching 2.34% and male GSI 0.80%. Monthly sex ratios shifted from 2.13:1 (June) to 0.64:1 (July) and 1:1 (August). The length–weight relationship showed positive allometric growth in males (b = 3.05) and negative allometric growth in females (b = 2.189). Fecundity ranged from 9,312–11,843 eggs in June and 8,495–15,006 eggs in July, with a strong positive correlation to body length in mature females. These findings indicate that reproduction peaks in June, providing essential information for the sustainable management of the species in Tanjung Luar.

Keywords: Fecundity; Gonadosomatic Index; Gonadal Maturity Stages; Reproductive Biology; *Selar crumenophthalmus*.

Introduction

The scad (*Selar crumenophthalmus*), also known as the "bigeye scad," is a member of the Carangidae family. It is a small pelagic fish that lives in schools near the coast down to a depth of 80 meters. It can grow up to 30 cm in length, but is typically found at 20 cm [1]. It is also known to prefer neritic waters, and is particularly well-suited to murky waters at night [2].

This type of fish is a commodity with high economic value due to high market demand, coupled with the availability of wild populations throughout the year [3]. Exploitation of this fish is still carried out intensively to provide a source of animal protein and as a raw material in various processing industries in Southeast Asia [4].

If the demand for trevally increases, the number of fish caught will also increase, resulting in continuous fishing without regard for the recovery of fish stocks. This can lead to overfishing. excessive or overfishing [5]. Meanwhile, it is known that these fish spawn simultaneously. If fishing is carried out during spawning, fish that are ready to spawn will also be caught, potentially leading to a decline or extinction of the fish population. Therefore, determining the characteristics of fishing season patterns is necessary so that fish in nature can spawn or reproduce to maintain stock availability [6].

The scad is one of the fish species targeted by fishermen at the Tanjung Luar Fish Farming Center (PPI) in East Lombok. This is evident in the variety of fish caught by the fishermen and the availability of stocks. [7]. Fishermen generally catch this fish in the waters of the Alas Strait, which is the sea between the islands of Lombok and Sumbawa, using fishing gear such as gill nets [8]. This species of fish is one of the most widely consumed types of fish in the community. This certainly has an impact on increasing market demand, which in turn poses a risk of overfishing. Therefore, sustainable management is necessary to maintain the population of this fish [9].

One method applied to address overfishing is to understand the reproductive aspects of fish, particularly those related to gonad development. Based on this description, the availability of scientific information related to biological conditions, particularly fish reproduction, reviewed in terms of gonad maturity level (GMT), gonad maturity index (IKG), sex ratio, and fecundity is necessary to understand as a basis for sustainable fish management in the Alas Strait waters, which is the sea between the islands of Lombok and Sumbawa.

Research methods

Time and Place of Research

Fish sampling in this exploratory descriptive study will be conducted at the Tanjung Luar Fish Landing Base (PPI), East Lombok, West Nusa Tenggara Province (NTB). Observations of the research samples will be conducted at the Biology Education Laboratory, Faculty of Teacher Training and Education, University of Mataram. The research period will span from June 2025 to August 2025.

How to Cite:
S. Aldauria, K. Karnan, M. Yamin, and I. W. Merta, "Reproductive Aspects of Scad Fish (Selar crumenophthalmus) Landed at the Fish Landing Base of PPI Tanjung Luar, East Lombok", *J. Pijar.MIPA*, vol. 20, no. 8, pp. 1584–1590, Dec. 2025.
https://doi.org/10.29303/jpm.v20i8.11185

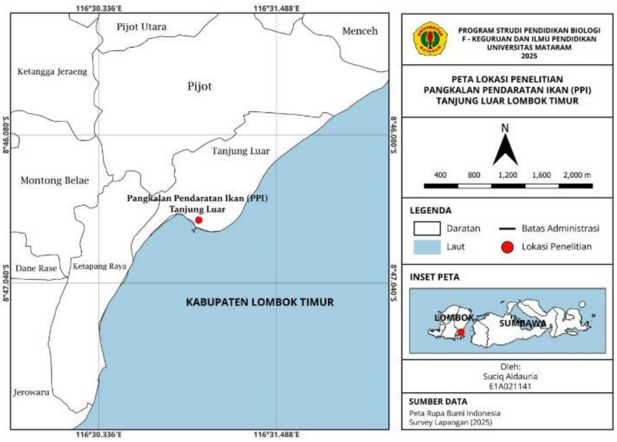

Figure 1. Research location at PPI Tanjung Luar, East Lombok

Population and Sample

The population studied in this study consisted of all scad fish (S. crumenophthalmus) caught by fishermen and landed at Tanjung Luar PPI, East Lombok, between June 2025 and August 2025. The sample in this study consisted of scad fish obtained randomly using a quota technique with the following criteria: including the Selar crumenophthalmus species and being in an intact condition. The variables in the study included sex, total length, body weight, gonad weight, gonad maturity level (TKG), gonad maturity index (IKG), and fecundity.

Tools and materials

Research equipment includes measuring tools for fish length and weight, dissection equipment, documentation and data recording tools, sample storage containers, and laboratory materials and equipment for preserving and counting female fish gonad eggs.

Data collection

Sampling employed a quota technique, with a total of 30 fish per month for three months, resulting in a total sample of 90 scad [10]. The total length of the fish was measured from the tip of the snout to the tail, and the weight was measured using a digital scale [11] [12]. Determination of sex and TKG is done through surgery and observation of gonad morphology, while IKG is calculated from the ratio of gonad weight to fish body weight [13].

Data analysis

The gonad maturity index (IKG) is an index of gonad size relative to fish size, calculated using the formula:

$$IKG = \frac{\text{weight of gonad}}{\text{weight of fish}} x\ 100$$

Where:
IKG = Gonad Maturity Index [14].

The sex ratio of trevally was analyzed by comparing the total number of male and female fish samples. The sex ratio between male and female fish was calculated using SR $= \frac{M}{F}$ Where: SR = Sex ratio, M = Number of male fish, and F = Number of female fish [15].

The number of eggs that have matured when the fish spawn before being released is called fecundity. Fecundity can be calculated using the formula: $F = \frac{G \times V \times X}{Q}$. Where F = fecundity, G = Total gonad weight (grams), V = Dilution volume (ml), X = Number of eggs in 1 ml, Q = Sample egg weight (grams) [16].

The length–weight relationship of fish was analyzed using the equation $W = aL^b$ to determine growth patterns. A value of b = 3 indicates isometric growth, while b ≠ 3 indicates allometric growth, with b > 3 being positive and b < 3 being negative [11].

Results and Discussion

Gonad Maturity Index

Gonad Maturity Index (GMI) values *of S. crumenophthalmus* during June–August 2025 exhibited a seasonal pattern, with the highest values in June and a gradual decrease until August in both males and females. The GMI of females was consistently higher than that of males, reflecting the peak of gonad maturation in June as an indication of the spawning period. This pattern aligns with [17] and is influenced by the increase in ovarian weight during the vitellogenesis process [18]. The decrease in GMI values after June indicates the post-spawning phase, characterized by gonadal regression and body energy recovery. The pattern of decreasing GMI in July–August is consistent with the findings of [19] and indicates that the reproductive cycle of S. *crumenophthalmus is* active at the beginning of the east monsoon, then enters a recovery phase after peak spawning.

The dominance of low IKG in July–August reflects the post-spawning phase, while high IKG in June indicates gonadal maturity in some individuals, in line with the batch-spawning nature of trevally [1].

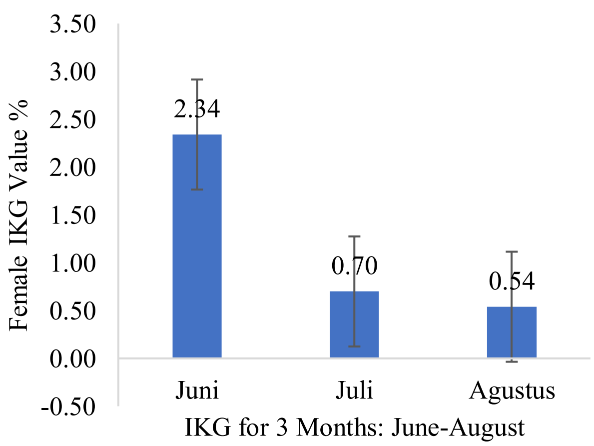

Figure 2. Gonad Maturity Index of Female Fish

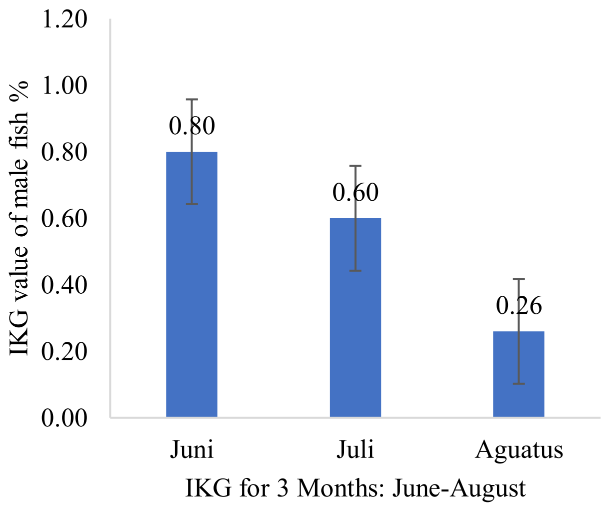

Figure 3. Gonad Maturity Index of Male Fish

Table 1. Distribution of Female Gonad Maturity Index Values

Range			Frequency	Percentage (%)
0	-	1	29	64.44%
1	-	2	9	20.00%
2	-	3	2	4.44%
3	-	4	4	8.89%
4	-	5	1	2%

Table 2. Distribution of Male Gonad Maturity Index Values

Range			Frequency	Percentage (%)
0	-	1	31	68.89%
1	-	2	12	26.67%
2	-	3	2	4.44%

Low GSI values in males reflect the dominance of early to mid gonadal development phases and show a positive association with gonad maturity level (GML), consistent with previous findings [20].

Body weight variation is closely related to IKG values and gonadal maturity, especially in females which show greater weight as IKG increases due to ovarian development. In contrast, in males, body weight distribution is relatively uniform and weight changes are smaller, reflecting the limited contribution of the testes to body mass, as reported by [17][21].

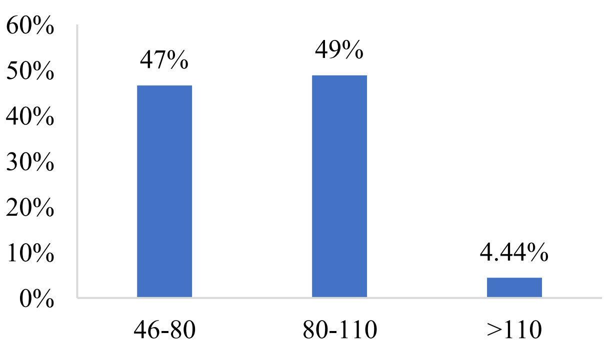

Figure 4. Body Weight of Male Fish

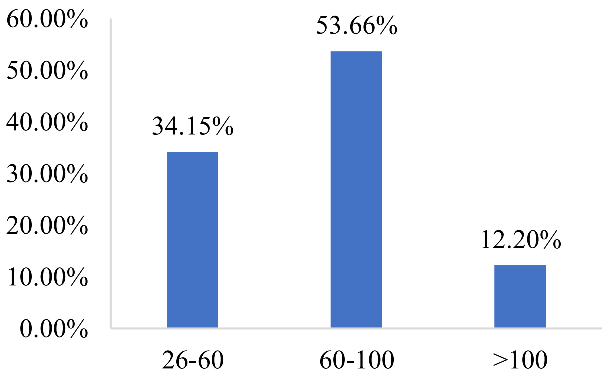

Figure 5. Body Weight of Female Fish

Gonad Maturity Level

The gonadal maturity level (GMP) of S. crumenophthalmus landed at the Tanjung Luar PPI varied between months and was classified into five stages (GMP I–V) based on morphological characteristics and gonadal development [22].

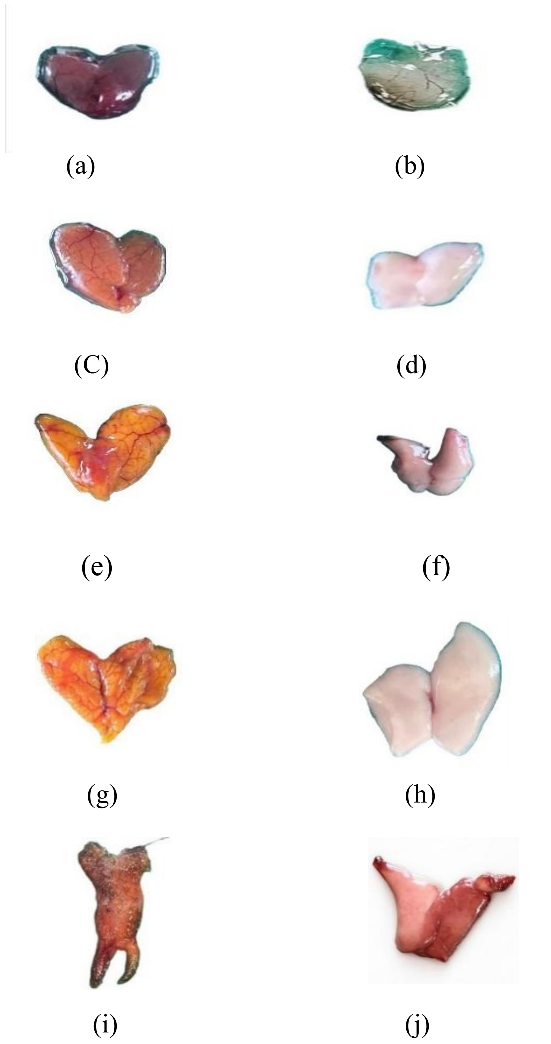

Figure 6. Gonad maturity levels (TKG I–V) of Selar crumenophthalmus: (a–e) female and (f–j) male.

Table 3. Distribution of Fish Gonad Maturity Levels *Selar crumenophthalmus*

Gonad Maturity Level for the Period June-August 2025						
Month	Sex	TKG I	TKG II	TKG III	TKG IV	TKG V
June	J	5.88%	41.18%	41.18%	11.76%	0.00%
	B	12.50%	12.50%	12.50%	62.50%	0.00%
July	J	21.43%	28.57%	14.29%	28.57%	7.14%
	B	69.57%	0.00%	0.00%	13.04%	17.39 %
August	J	14.29%	64.29%	21.43%	0.00%	0.00%
	B	35.71%	57.14%	7.14%	0.00%	0.00%

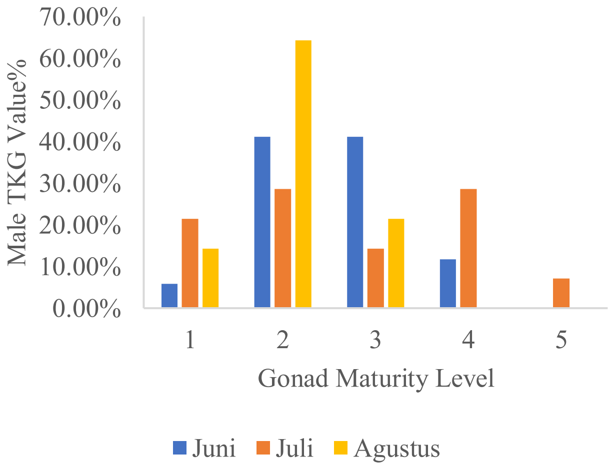

Figure 6. Gonad Maturity Level of Male Fish

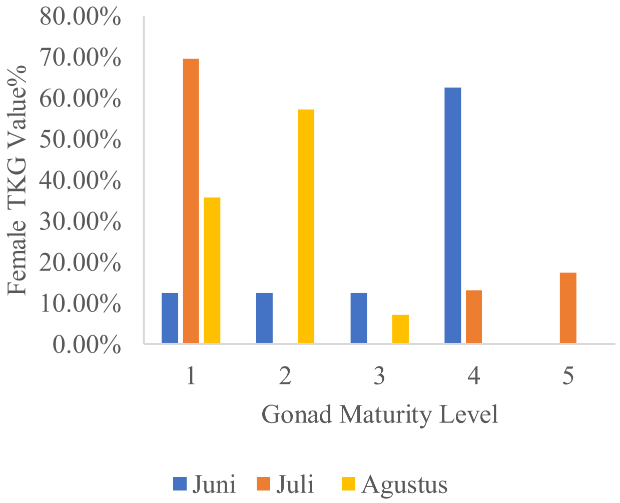

Figure 7. Female Gonad Maturity Level

In male fish, the dominance of TKG II–III in June indicates an early to mid-gonadal development phase, consistent with the reproductive pattern of small pelagic fish at the beginning of the east monsoon [23]. The increase in the proportion of TKG IV in July indicates peak spawning readiness, as reported for Decapterus macrosoma in Banda Waters [24], although in contrast to the findings of [25], which reported peak maturity in September. In August, the disappearance of TKG IV–V and the re-dominance of TKG II indicate a post-spawning phase and gonad regeneration, consistent with the character of small pelagic fish that have short spawning intervals [26].

In female fish, the dominance of TKG IV in June indicates earlier gonadal maturity compared to males, indicating an earlier onset of spawning. This pattern is in line with findings [18] in pelagic fish and reflects a reproductive strategy to increase fertilization success.

In July, the dominance of TKG I in female fish indicates the post-spawning phase and gonad recovery, in line with [1]. In August, the dominance of TKG II reflects the gonad regeneration phase, while the absence of TKG IV–V indicates the end of the main reproductive cycle.

Sex Ratio, Body Weight, and Body Length

Table 4. Sex Ratio, Body Weight, and Body Length

Month	Sex Ratio (J:B)	Body Weight	St. Dev.	Body Length	St. Deviation
June	2.13:1	79.32 grams	25.04	18.82	1.25
July	0.74:1	69.70 gr	26.44	17.55	2.36
August	1:1	82.68 gr	18.25	19.43	1.03

The sex ratio of *S. crumenophthalmus* shows temporal variation, with male dominance in June (2.13:1), female dominance in July (0.74:1), and equilibrium in August (1:1). This pattern is thought to be related to spatial segregation and reproductive activity, with males being more easily captured at the beginning of the spawning season [27], while females dominate at the peak of spawning [28]. The equilibrium ratio in August reflects the stability of the post-spawning population [29]. The lowest body weight and length were recorded in July, indicating the post-spawning phase, while the increase in August indicates the recovery and growth phase, which is influenced by environmental and biological factors [30]. [31].

Relationship between Length and Weight

In female fish, b values < 3 indicate negative allometric growth, where length increase is more dominant than weight, in line with the dominance of TKG I–II and the findings of [32]. In contrast, male fish have b values > 3, which reflect positive allometric growth with faster weight accumulation, consistent with [30] and influenced by differences in reproductive strategies and nutritional requirements [33].

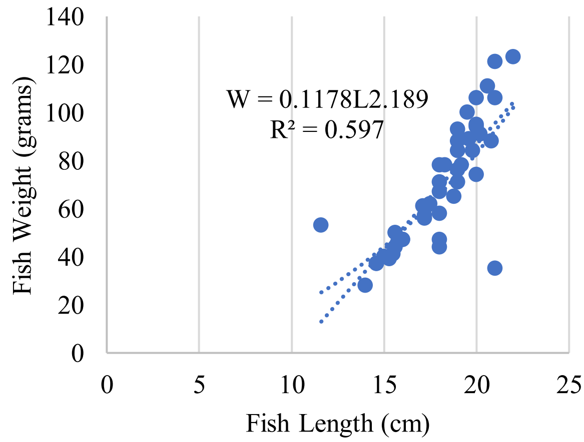

Figure 8. Relationship between Length and Weight of Female Fish

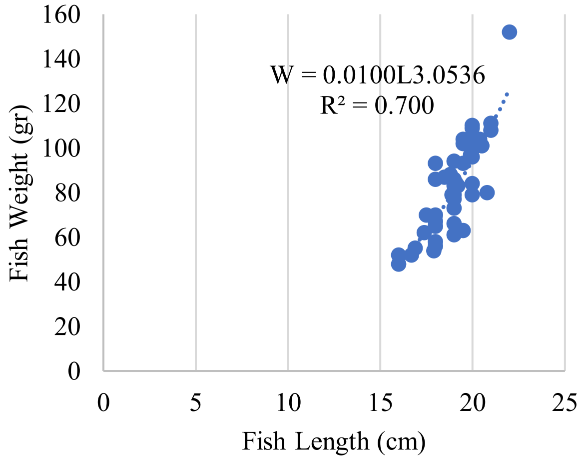

Figure 9. Relationship between length and weight of male fish

Fecundity

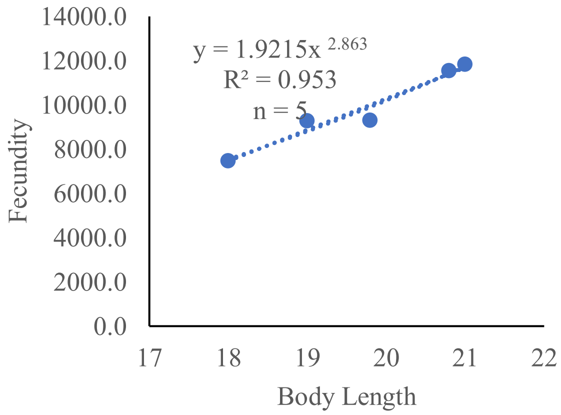

Figure 10. Relationship between Body Length and Fecundity in June

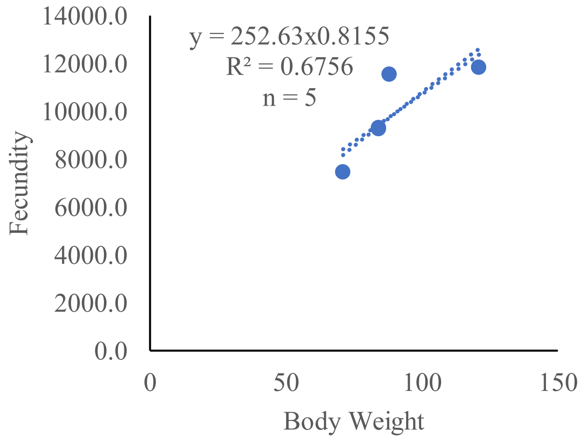

Figure 11. Relationship between Body Weight and Fecundity in June

Fecundity analysis of *S. crumenophthalmus* showed a close relationship between body size and egg number, with a fecundity of 7,460–11,842 eggs in individuals measuring 18–21 cm in June. This value aligns with the fecundity range in TKG IV reported by [34] and confirms that body size, particularly length, is a significant indicator of fecundity near spawning, as also reported by [1].

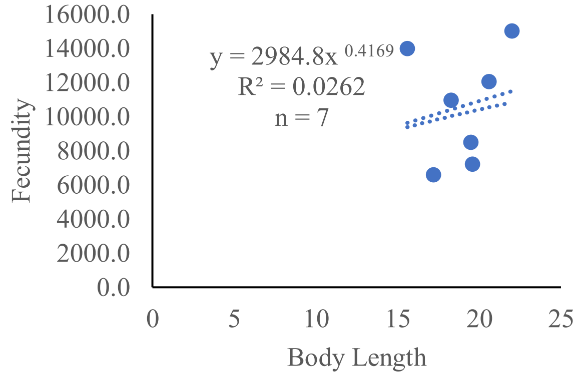

Figure 12. Relationship between Body Length and Fecundity in July

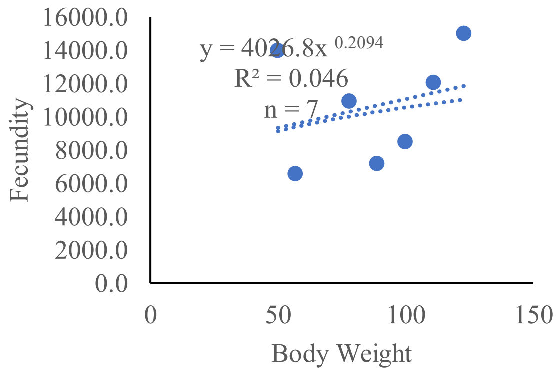

Figure 13. Relationship between Body Weight and Fecundity in July

In July, the relationship between body size and fecundity of *S. crumenophthalmus* was very weak (R^2 length–fecundity = 0.0262; weight–fecundity = 0.046), despite a relatively wide range of fecundity. This weak relationship is thought to be due to the high variation in gonadal maturity levels between individuals in the post-spawning and early gonadal development phases, in line with findings [35].

Conclusion

The gonadal maturity level (GMP) of S. crumenophthalmus during June–August 2025 varied from GMP I to GMP V, indicating non-uniform gonadal development within the population. The highest gonadal maturity index (GMI) values for both males and females occurred in June, after which they decreased until August, with the GMI of females consistently higher than that of males. The sex ratio changes from male dominance in June to female dominance in July, and then becomes balanced in August. Growth patterns differ between the sexes, with males exhibiting positive allometric growth and females exhibiting negative allometric growth. The relationship between body length and fecundity exhibits a strong correlation in female fish, characterised by a relatively uniform level of gonad maturity.

Author's Contribution

S. Aldauria: conducted the research and drafted the manuscript. Karnan & M. Yamin: supervised the study and revised the manuscript. I. W. Merta: provided academic evaluation and constructive feedback. All authors approved the final manuscript.

Acknowledgements
The authors thank Allah SWT for His blessings and their parents for their continuous support. Sincere appreciation is extended to Dr. Drs. Karnan, M.Si., Dr. HM Yamin, M.Si., and Drs. I Wayan Merta for constructive guidance and suggestions, as well as PPI Tanjung Luar for assistance during data collection.

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