

# Evaluation on Fecundity of Jelawat (*Leptobarbus hoevenii*, Bleeker 1851) Cultured in Floating Net Cages in Swampy Pond, Jambi

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**Abstract.** The economic importance of riverine fish species of jelawat (*Leptobarbus hoevenii*) has been traditionally cultured. The culture development requires the availability of fish fry from hatcheries in sufficient quantities. Estimation of the fry production requires data and information on its fecundity. A study was carried out to evaluate the fecundity of jelawat cultured in floating net cages set in a pond, Jambi. The broodfish used in the study were selected from grown-out ponds. Selection of matured egg female fish was carried out monthly. The matured gonadal female fish was weighed and injected using a 0.7 mL/kg commercial hormone. The eggs were stripped and weighed. Egg samples were taken out as a subject of weight measurement per g. The results showed that the broodfish's length and weight ranged from 47.0-60.0 cm ( $57.6 \text{ cm} \pm 3.30$ ) and 1500-4500 g ( $3100 \text{ g} \pm 0.71$ ), respectively. Fecundity tended to increase with increasing total length and weight of the fish, respectively. The average egg somatic index value was  $11.04\% \pm 1.92$ . One gram of fish eggs consisted of  $590 \text{ eggs} \pm 29.51$ . The number of eggs of the females ranged from 32 103 - 96 557 per kg.

## 1 Introduction

Jelawat (*Leptobarbus hoevenii*, Bleeker, 1851) is a riverine native species in Southeast Asia, spread across Indonesia (Sumatra, Kalimantan), Malaysia, and Thailand [2,17,24]. In Indonesia, jelawat is one of the freshwater fish commodities belonging to a group of indigenous species with local names, such as the *kelemak* fish in Jambi. This fish can be consumed and is very popular, especially in Sumatra and Kalimantan. Jambi Province is one of the main producers of jelawat fish larvae and seeds from several of its lakes, which are directly related to the flow of the Batanghari River. Several of these lakes (Teluk Lake and Sipin Lake) are nursery grounds for jelawat, so during the spawning season, larvae and seeds of jelawat are obtained from nature. The cost of feed requirements in cultivating these fish

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can be reduced because these fish are omnivorous and tend to be herbivores [2,17,24], so they can save expensive commercial feed. Around 60% of production costs in fish farming are for feed costs. Technically, this fish culture can rely on natural food through leaves [4].

Jelawat fish farming until now still relies on seed sources from nature or from hatcheries. Efforts to spawn jelawat using hormonal stimulation have been successfully carried out in Jambi City since 1986, but the number is limited [24] and until 2018, its management status was less sustainable [9]. The development of jelawat fish culture requires a sufficient supply of seeds. One of the efforts to predict the production of fish fry is by measuring the fecundity of the broodfish. Fecundity describes the potential of the eggs contained in the ovarian sacs of female fish or describes the ability of the broodfish to produce larvae. The amount of this fecundity depends on the environmental conditions of its maintenance and feed availability. In nature, the broodfish matures its gonads in the middle of a river body. Spawning occurs during the spawning season. Fecundity could be defined as the potential offspring of fish during the natural spawning season or as releasing matured eggs [27]. In addition, Information on fecundity is needed to assess their economic potential. The relative fecundity of female jelawat fish ranged from 84 043-92 907 eggs per kg [7]. The gonadal maturity index value of females reared in cages at Jambi Lake was 16.6% [20]. This study aimed to evaluate the fecundity of jelawat reared in floating net cages in swampy ponds and fed intensively on a commercial diet.

## 2 Materials and methods of research

The study was carried out at Sungai Gelam Freshwater Aquaculture Development Center in Jambi, Indonesia, spanning from January to December 2021. The selected jelawat broodfish were in a mature state and prepared for the purpose of spawning. Females ready for spawning are usually 2-5 years old with an average weight of 1500-4500 g, while male broodfish are 2-5 years old with an average weight of 1400-3000 g with a condition of healthy fish and not disabled. Selection of the broodfish jelawat can be made visually or by looking at the physical condition of the fish to determine the maturity of the female and male broodfish gonads. For each individual, morphometrics were assessed.

The fish were monthly observed for measuring total length (TL) having 0.1 cm in decimal value, weight (W) using digital balance having 0.01 in accuracy, and egg maturation using an egg diameter of 0.5-1.6 mm. The equation of the L-W relationship is figured out as follows:  $W = aL^b$ , where a and b are regression parameters [8, 22]. Parameters a and b were calculated by the regression analysis [16]. The growth pole was tested using confidence limits of 95% [16].

The ovulation of eggs (G) was weighed using a scientific balance of 0.0001 g in accuracy. One gram of eggs (Q) was sampled as a subject to calculate the total number of eggs (N). Absolute fecundity (F) was calculated using an equation as follows [8, 15]:

$$F = (G/Q) \times N \quad (1)$$

Relative fecundity (RF) was indicated as the proportion ratio of absolute fecundity (F) and fish total length or weight (TL and W). The equation of  $F = aL^b$  followed in exponential regression and  $F = aW^b$  followed linear regression analysis ( $F = a + b \times W$ ), where 'a' is the regression constant, and 'b' signifies the regression coefficient.

The value of the gonad somatic index (GSI) is calculated following the formula :

$$GSI = (Wg / Wb) \times 100\% \quad (2)$$

Information :

Wg = Weight of the gonads (g)

Wb = Body weight (g)

Adult jelawat (♀: 1500-4500 g; ♂: 1400-3000 g; body weight) from the earthen pond was put into the research containers used were eight floating net cages (KJA) of the Flexi Quadrilateral Type, consisting of several cylindrical buoyant devices made from Prime Grade High-Density Polyethylene (HDPE) material with anti-UV properties, connected with monoblock connecting components. The cylindrical buoyant devices possess hydrodynamic characteristics that facilitate water circulation within the cages, especially surface water circulation rich in oxygen, which is beneficial for fish growth. The buoyant devices are bright blue in color to minimize heat absorption from sunlight and enhance visibility from a distance. They are equipped with a track with an anti-slip pattern on the top surface for user safety when moving on the cage. The cultivation net measures 4 x 4 x 2,5 m<sup>3</sup>. On top of the net, there is a cover made of HDPE material to prevent fish from escaping the container and to prevent the entry of pests. The mesh size of the net used is 3/4 inch (Fig. 1).



**Fig. 1.** Floating net cages (KJA)

The cages are placed in a pond/reservoir covering an area of approximately two hectares with a depth ranging from 3 to 3.5 meters. This pond is constructed on peatland at the Freshwater Aquaculture Development Center in Sungai Gelam, Jambi. The water source comes from underground springs or rainfall. The pond water has a pH level of around 5.5-6.5. Measurements of other water quality parameters such as dissolved oxygen (DO), temperature, ammonia, nitrite, and nitrate are also carried out.

Broodfish were randomly stocked into eight HDPE net cages (KJA) measuring 4x4x2.5 m<sup>3</sup> with a density of 1-2 individuals per m<sup>3</sup>. Females and males are kept separately (♀: five KJA; ♂: three KJA). The feed used was commercial sinking type feed with a protein content of 36-45% with a frequency of feeding twice daily in the morning and evening *at satiation* for 12 months of the rearing period. A formulated diet containing 35% protein in these species resulted in gonad maturation the whole year and successfully spawned under a controlled hatchery [18]. Apart from being given commercial feed, the females are also given cassava leaf feed which is offered two times a week. Every month females were caught for weight measurement, total length, and selection of gonad maturity.

The selected broodfish was placed in an incubation tank as a fiber tub measuring 2x1x0.5 m<sup>3</sup> with a water height of 30 cm for the incubation tank for the female broodfish. The male broodfish is placed in an incubation tank in the form of a cement tub measuring 2x1x1 m<sup>3</sup> with a water level of 50 cm. The incubation containers for female and male broodfish are equipped with aeration and covers in the form of hapa and boards so that the

broodfish do not jump out. Criteria for female and male broodfish that are ready to spawn are shown in Table 1.

**Table 1.** Broodfish criteria males and females mature gonads

<b>Female</b>	<b>Male</b>
Proportionate body and not deformed	Proportionate body and not deformed
The abdomen enlarges towards the genital opening on the side of the abdomen (oviducts). The stomach feels protruding when touched outside, and when pressed feels soft.	The abdomen tapers towards the genitals.
The genitals are swollen and reddish.	The genitals are tapered and red.
Wide body shape	Slim body shape
Slow movement	Aggressive and agile
Short dorsal fin	Longer dorsal fin
The pectoral fin rays are smooth, and the surface of the operculum is soft to the touch.	The pectoral fins and the operculum surface are rough to the touch.

The artificial spawning process for jelawat conducted at the Freshwater Aquaculture Development Center in Sungai Gelam, Jambi involves the use of hormones containing salmon gonadotropin-releasing hormone analog (sGnRH-a) and anti-dopamine. These hormones are used to stimulate and induce gonadotropin hormone in the fish's body, accelerating the ovulation process during spawning. The injection dosage for females is 0.7 ml/kg of body weight, while for males, it is 0.25 ml/kg of body weight. The injection process for females is performed three times, with a time interval of 12 hours between the first and second injections, and a time interval of 6 hours between the second and third injections. The distribution of injection doses involves administering 25% of the total dosage during the first injection, 25% during the second injection, and 50% during the third injection. The injections are given intramuscularly (behind the dorsal fin), precisely in the soft part of the body with a 45° angle. For male broodfish, only one injection is administered, as the process of sperm maturation in males occurs more rapidly compared to females.

The release of eggs (ovulation) in jelawat usually occurs 4-12 hours after the last injection. Ovulation checks on jelawat are conducted at 10:00 a.m. This involves stripping the abdomen of the female broodstock towards the genital papilla. A female that has ovulated will release eggs during this manipulation. Ovulation times can vary, so ovulation checks are performed every hour. Females that have ovulated undergo stripping. Before the stripping process, anesthesia is administered by adding 0.5 ml of anesthesia/stabilizer to 20 liters of water, which is then introduced into a plastic bag. Equipment and materials used in the stripping process include an anesthetic, NaCl, ice cubes, tissue, basin, Falcon tube, syringe, digital scale, and towel.

Stripping the male is done first before checking the ovulation of the female. This is to facilitate immediate fertilization after egg stripping, preventing damage to egg quality. Sperm can be preserved using ice, prolonging its viability for fertilization. Prior to stripping, the male is anesthetized until it loses consciousness. Then, the male is placed on a towel with its head on the left and tail on the right, facilitating the stripping process. The abdominal and urogenital areas are dried with tissue to prevent the sperm from mixing with water. Sperm collection from the male is done using a syringe filled with 1 ml of physiological NaCl solution. The stripping process involves holding the base of the tail with the left hand while using the right hand to massage the front abdomen towards the urogenital area with the urogenital opening directed downwards (Fig. 2).

The stripping process for females is similar to males. However, a basin is used as a container to collect eggs, and it is weighed and dried with tissue to prevent eggs from mixing with water. The collected eggs are then weighed, subtracting the weight of the container, to determine the egg weight per female (fecundity). Dry containers and drying the female before stripping are essential to ensure that the micropyle openings on the eggs remain unobstructed. If these openings are closed, sperm cannot enter, leading to unsuccessful fertilization. To ascertain the number of eggs in terms of kg per female, egg sampling is performed three times to ensure data accuracy.



**Fig. 2** Ovulation and spermiation process

### 3 Results

During the study, a total of 24 mature female jelawat were obtained in a controlled environment. The total lengths, weights of the fish, and weights of jelawat ovaries ranged from 47 to 60 cm, 1 500 to 4 500 g, and 185 to 455 g, respectively (Table 2). According to the AARD report [1], the spawning jelawat in the waters around Muara Tebo, Jambi, have weights ranging from 3 700 to 5 000 g, while in the Tembeling River, Malaysia, the average weight is 2 500 g [10]. In their natural habitat, jelawat can attain weights of over 10 000 g.

Female selection is carried out alternately every month from one broodfish rearing unit (KJA) to the next (sequentially from KJA number one to KJA number five). The aim of this alternating female broodfish selection process is to optimize the maturation of female fish gonads, thereby enhancing ovulation and egg-hatching processes. The development of fish gonads can be evaluated using its gonad maturation index (GSI). The obtained data (Table 2) indicates that the average GSI of jelawat is 11.04%. This result differs from [20], who found a GSI value of 16.6% for jelawat reared in KJA's in Lake Teluk, Jambi. Jelawat reared in ponds in the Bogor region and Malaysia, have lower GSI values, approximately 10% [19,20]. Generally, mature fish ovaries make up around 10-20% of their body weight [5].

Based on Table 2, it can be seen that each broodfish that was used as the egg sampling sample had a different number of eggs. Where the mean total number of eggs produced was 73 494 eggs/kg with a range of 32 103-96 557 eggs/kg. Jelawat's fecundity was 35 467-128 067 eggs while the highest fecundity was observed in a 1000 g fish. The difference in fecundity is believed to be influenced by various environmental factors, especially those related to food availability [25]. The fecundity of each female individual depends on age, size, species, and environmental conditions such as food availability, water temperature, and season [29]. Furthermore, the magnitude of fecundity is influenced by food, fish size, and

environmental conditions, and can also be affected by egg diameter [28]. Generally, fish with egg diameters of 0.50-1.00 mm have a fecundity of 100 000 - 300 000 eggs. The distribution of data regarding the relationship between fish fecundity and length, body weight, and gonad weight is shown in Fig. 6-8.

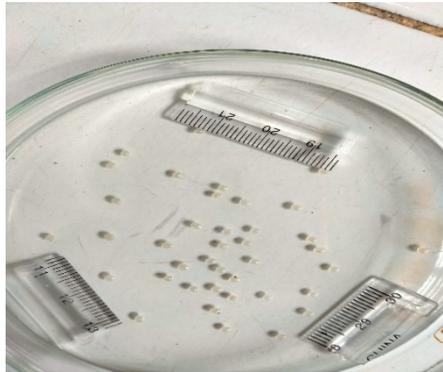
**Table 2.** Total length, fish weight, gonad weight, GSI, and fecundity of jelawat

No	Fish Weight (g)	Total Length (cm)	Gonad Weight (g)	GSI (%)	Number of Sample Eggs (eggs)	Total Number of Eggs (eggs/kg)	Fecundity (eggs/fish)
1	3400	60	185	5.44	590	32 103	109 150
2	2300	55	380	11.18	565	93 348	214 700
3	2500	55	322	9.47	610	78 568	196 420
4	3000	59	340	10.00	553	62 673	188 020
5	3000	60	318	9.35	663	70 278	210 834
6	2300	53	377	11.09	550	90 152	207 350
7	3000	60	360	10.59	570	68 400	205 200
8	2500	56	380	11.18	580	88 160	220 400
9	1500	47	220	6.47	600	88 000	132 000
10	2700	55	380	11.18	620	87 259	235 600
11	3700	60	450	13.24	559	67 986	251 550
12	2800	55	380	11.18	560	76 000	212 800
13	4000	60	420	12.35	620	65 100	260 400
14	2500	55	376	11.06	642	96 557	241 392
15	3000	59	400	11.76	554	73 867	221 600
16	4000	60	425	12.50	590	62 688	250 750
17	3600	60	450	13.24	580	72 500	261 000
18	3800	60	455	13.38	600	71 842	273 000
19	2700	55	390	11.47	585	84 500	228 150
20	4000	60	410	12.06	590	60 475	241 900
21	4500	60	410	12.06	610	55 578	250 100
22	3500	60	364	10.71	557	57 928	202 748
23	3600	60	440	12.94	600	73 333	264 000
24	2700	58	380	11.18	615	86 556	233 700

Based on observations, the average number of jelawat fish eggs in a 1 g sample was 590 eggs/g  $\pm$  29.51 (Table 2). This result differs from other studies which reported 550 eggs/g of ovaries [3]; 407 eggs/g of ovaries; and 792 eggs/g of ovaries [20]. The egg formation process is influenced by food availability. In domesticated carp *Cyprinus carpio*, a higher egg count of 929 eggs/g of ovaries was obtained [12]. This can be influenced by the egg's diameter and the quality of the eggs from each broodfish. In addition, the feed given to the

broodfish is one of the factors that can affect the quality of the eggs. Good nutrition in feed, such as protein, fat, carbohydrates, minerals, and vitamins, will affect the maturation of the broodfish gonads, fecundity, and good egg quality [13].

The diameter of fish eggs varies among species as well as among individuals within the same species. The diameter of fish eggs ranges from 0.25 to 7.00 mm [23]. The measured range of the diameter of jelawat egg is 0.5-1.6 mm (Fig. 2). This aligns with different research, which reported that jelawat eggs have a circular form, measuring approximately 0.5-1.5 mm in diameter [20]. The measured diameter of ovulated eggs is 0.8-1.5 mm. Jelawat eggs typically have an average diameter of approximately 1.55 mm in their natural habitat [10]. Jelawat egg diameter ranged from 0.5-1,855 mm. Two to five groups of egg class were detected, indicating that *L. hoevenii* is a multiple spawner [25].



**Fig. 3.** Egg diameter measurement

The ovaries of jelawat are situated along the body cavity and have a bright green color. These ovaries are divided into two unequal parts, with the right part being larger than the left [20]. Within the ovaries, there is a layer of fat. This aligns with the nature of jelawat engaging in migratory reproduction. This body fat functions as an energy source for engaging in migratory reproduction [21].



**Fig. 4.** The ovary of jelawat

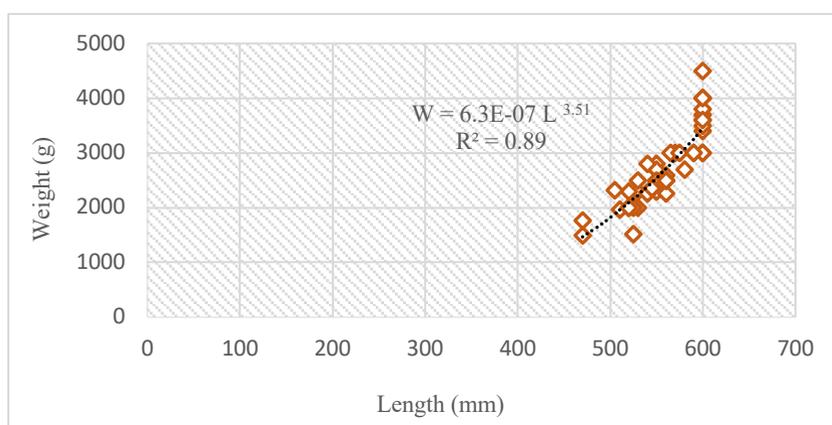
Water quality measurements were also conducted in the floating net cages (KJA). The data for temperature, dissolved oxygen (DO), ammonia, nitrate, and nitrite are presented in Table 3. Based on Table 3, the water quality conditions still support the fish's life.

**Table 3.** Measurement of water quality and optimal range for broodstock maintenance

Parameter	Range	Optimal Range
pH	5.5-6.5	5-7
Temperature (°C)	28-30	23-31
DO (mg/l)	3-4	>4
Ammonia (mg/l)	0.05	-
Nitrite (mg/l)	0.11	-
Nitrate (mg/l)	0.5	-

The length-weight relationship of female *L. hoevenii* was determined as  $W = 6.3E-07 \times L^{3.51}$  ( $R^2 = 0.89$ ) (Figure 5). Regarding the growth pattern, the 95% confidence interval of parameter b was computed at 3.51, indicating that the population's growth pattern was positive allometric ( $b > 3$ ). The typical range for parameter b in fish usually falls between 2.5 and 3.5 [22].

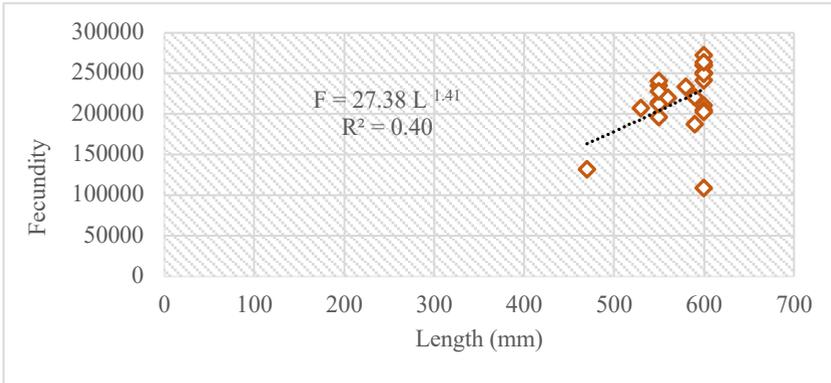
To estimate the species' fecundity, a total of 24 individuals collected between January to December of 2021 were utilized. The mean absolute fecundity for mature females was 221 365 eggs (with a standard deviation of 38 869.3), exhibiting a range from 109 150 eggs (at 60 cm TL) to 273 000 eggs (at 60 cm TL) (Table 2).



**Fig. 5.** Diagram of the length-weight relationships of *L. hoevenii* in Jambi

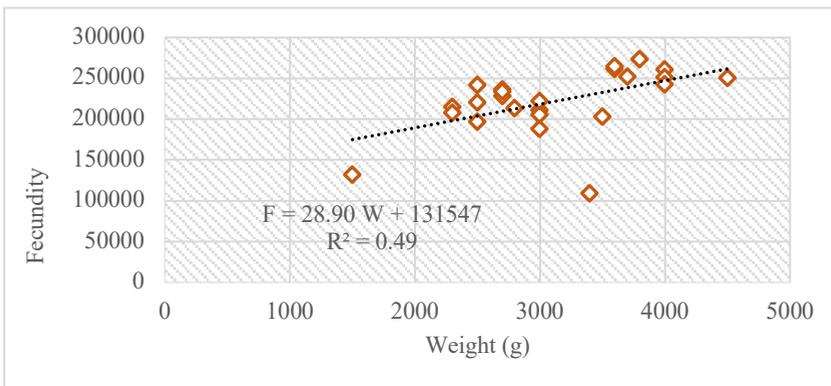
The data distribution for the relationship between fish fecundity and length, body weight, and gonad weight is presented in Fig. 6-8. There was a positive correlation observed between body length, weight, and absolute fecundity. The fecundity-length relationship was expressed as  $F = 27.38 \times L^{1.41}$  ( $R^2 = 0.40$ ), while the fecundity-weight relationship was given by  $F = 28.9 W + 131\ 547$  ( $R^2 = 0.49$ ) (Figure 5, 6). Moreover, a relationship between absolute

fecundity and body length was observed, with an  $R^2$  value of 0.40. A relationship between absolute fecundity and body weight was observed, with an  $R^2$  value of 0.49.

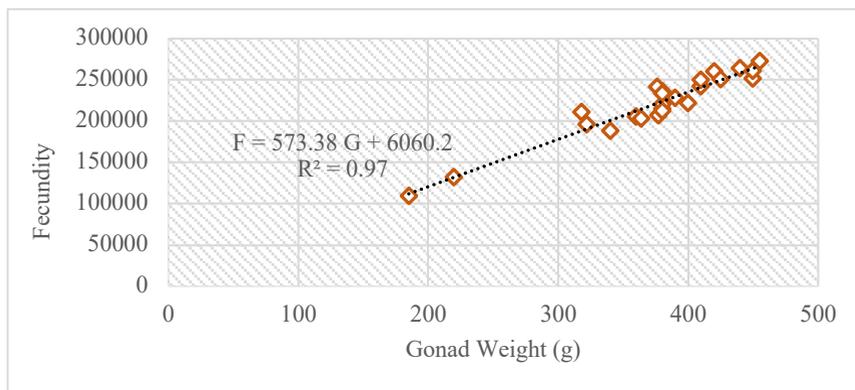


**Fig. 6.** Diagram of the fish length-fecundity relationships of *L. hoevenii* in Jambi

Fecundity can be influenced by a variety of factors, including the size, weight, age, and life-history characteristics of fish, along with environmental conditions like food availability, population density, and temperature [23]. In the conducted research, a positive association between fecundity and both fish length and weight was observed. Specifically, fecundity increased with larger fish exhibiting greater length and weight, resulting in the production of a higher number of eggs. The strength of the relationship between fish length and fecundity, as indicated by the coefficient of determination ( $r^2$ ), was substantial, surpassing ( $r^2 = 0.40$ ). Conversely, the coefficient of determination for the relationship between fish weight and fecundity was calculated to be 0.49. This minor disparity in values could potentially be attributed to the limited size and weight range of the fish samples used in the study. Fecundity increased with larger fish exhibiting greater length and weight, resulting in the production of a higher number of eggs.



**Fig. 7.** Diagram of the fish weight-fecundity relationships of *L. hoevenii* in Jambi



**Fig. 8.** Diagram of the gonad weight-fecundity relationships of *L. hoevenii* in Jambi

Not always do fish with maximum body weight possess high fecundity. This is suspected to occur because the increase in body weight is due to a larger stomach size, while the gonad weight remains small, leading to a decrease in fecundity at that weight. Another cause is the presence of a supplementary food supply. Up to a specific size or weight, fecundity rises and then declines in response to enhanced nutrition. This leads to accelerated gonad maturation, increased maturation of plumper individuals, and reduced intervals between spawning cycles [14]. Environmental factors also influence fecundity, although this is challenging to determine precisely. The significant factor influencing fish fecundity is the abundant availability of food in the environment [26].

In this study, the linear relationship between fecundity and body weight, as well as gonad weight, indicates that the number of eggs within the ovaries follows proportionally with both of these variables. This is supported by another study that affirms the correlation between the enlargement of fish gonads and the simultaneous increase in the number of eggs produced [6]. This is in line with another study that indicates jelowat fish fecundity increases with its length, weight, and age increase [20]. In general, the fecundity of female fish rises in accordance with their size. When there is an abundance of food, fish grow faster, leading to an increase in fecundity [11].

## 4 Conclusion

The length and weight of the broodfish ranged from 47.0-60.0 cm ( $57.6 \text{ cm} \pm 3.30$ ) and 1500-4500 g ( $3100 \text{ g} \pm 0.71$ ), respectively. Fecundity tended to increase with increasing total length and weight of the fish, respectively. The average egg somatic index value was  $11.04\% \pm 1.92$ . One gram of fish eggs consisted of  $590 \text{ eggs} \pm 29.51$ . The number of eggs of the females ranged from 32 103 - 96 557 per kg.

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