



Reproductive Biology Study of Silver Barb *Barbonymus gonionotus* (Bleeker: 1849) in the Waters of Way Sekampung Dam, Pagelaran District, Pringsewu Regency, Lampung

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ABSTRACT

Barbonymus gonionotus, the silver barb, is a consumer fish with great development potential. Silver barbs have an important role in maintaining the balance of aquatic ecosystems. To sustain silver barb resources in Way Sekampung Dam, it is necessary to analyze their biological characteristics. This research was conducted from September to December 2024 at Way Sekampung Dam, Pagelaran District, Pringsewu Regency, Lampung. The purpose of this study is to analyze the biological aspects of silver barb reproduction, which includes sex ratio, gonad maturity stages (GMS), gonad somatic index (GSI), fecundity, egg diameter, and analyze the type of silver barb spawning. Fish samples were obtained from a local fisherman who caught fish using gill nets. The sex ratio of silver barbs obtained indicates that males outnumber females. During the study, 250 male and 167 female fish were used. Most of the silver barbs obtained are fish with undeveloped gonads, namely in phases I-III. GMS IV and V are most commonly found in November and December. Based on the GSI calculation, the percent values obtained are 0.035-13.858% for male fish and 0.155-14.269% for female fish. The fecundity of the silver barb obtained an average of 47,192 eggs. The diameter of silver barb eggs was measured, with a range of 0.27-0.85 mm. The results of measuring egg diameter also show a single peak, indicating that the silver barb in Way Sekampung dam has a total spawner type.

Keywords: Reproduction, Silver Barb, Way Sekampung Dam.

INTRODUCTION

Silver barb, also known as tawes (*Barbonymus gonionotus*), is one of the consumed fish species in the Way Sekampung Dam in Lampung Province. Silver barb, as a consumed fish, has a protein value of 13 percent and an omega-3 fatty acid content of 1.5 grams per 100 grams of meat. People love this fish for its chewy meat and its low-fat content. In addition, the price of silver bars is also affordable to the community (Diana & Safutra, 2018). Apart from being a food source, the silver barb also has an important role in maintaining the balance of aquatic ecosystems. It plays a significant ecological role in the aquatic food chain as both a producer and a consumer. Its presence also serves as a food source for higher-trophic-level predators. Its presence not only makes an important contribution to the fisheries sector but also significantly impacts aquatic ecosystems, with complex interactions with other environmental

components. The silver barb's important role in the aquatic environment underscores the need to conserve this fish. Understanding aspects of silver barb reproductive biology is essential, as it can help guide the design of appropriate conservation measures to maintain population sustainability, aquatic biodiversity, and sustainable fisheries management (Tamsil, 2024). Information on the reproductive biology of the silver barb in Way Sekampung Dam has never been studied before. These aspects of fish reproduction consist of sex ratio, gonad maturity stages, gonadosomatic index, fecundity, and spawning type. Therefore, it is necessary to research the reproductive aspects of the silver barb (*B. gonionotus*) found in Way Sekampung Dam, Pringsewu Regency, Lampung.

MATERIAL AND METHOD

Research area

The research was conducted for 4 months, from September to December 2024, in the waters of Way Sekampung Dam, Pagelaran Subdistrict,

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Pringsewu Regency, Lampung. Research activities included field activities and laboratory analysis. Fish dissection was carried out at the Laboratory of the Department of Fisheries and Marine Sciences, Faculty of Agriculture, University of Lampung.

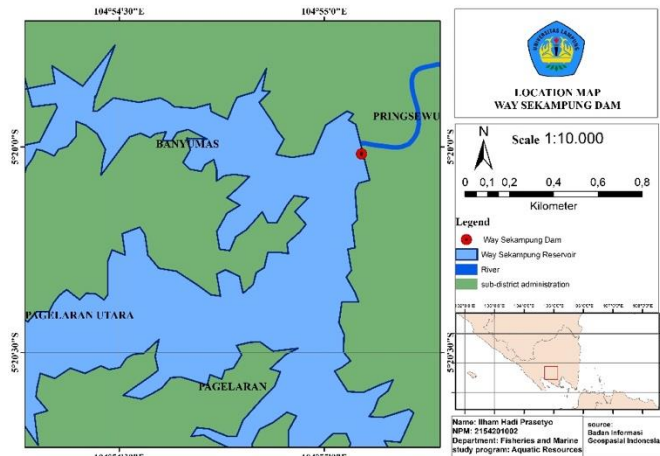


Figure 1. Research area at Way Sekampung Dam, Pagelaran Subdistrict, Pringsewu Regency, Lampung

Data collection

Samples were obtained from the catch of one of the fishermen. The fishing gear used by fishermen to catch fish is a midwater gillnet. The sampling method used is random sampling. The sampling process is carried out every two weeks. The fish samples were stored in a cool box and transported to the laboratory for further analysis. Fish samples obtained were measured for total length (TL) and weight before dissection. Fish were dissected using surgical tools, starting from the anus to the linea lateralis area to the back of the operculum. Sex and gonad maturity stages (GMS) can be determined by directly observing the shape and color of the fish gonads, as described by Tamsil (2024). The gonads of male and female silver barb were weighed with digital scales.

Furthermore, female fish gonads in GMS IV were preserved with 10% Neutral Buffered Fixative (NBF), then stored in sample bottles to observe fecundity and egg diameter. Fecundity calculations were carried out using the volumetric method. In calculating fecundity, stage IV female fish gonads were taken as samples representing six parts, namely the anterior, middle, and posterior parts of each gonad on the right and left sides.

Data analysis

By comparing the numbers of male and female fish based on variations in gonadal morphological traits, the sex ratio can be determined using the equation.

$$SR = \frac{nM}{nF}$$

The percentage between the number of male and female fish found during sampling can be calculated using the formula.

$$Pi (\%) = \frac{A}{B} \times 100$$

Notation

SR: Sex ratio

nM: Number of male fish (ind)

nF: Number of female fish (ind)

Pi (%): Sex ratio percentage (%)

A: Number of specific fish species (male or female)

B: Total number of individual fish (male + female)

The Chi-square test can be used to analyze the sex ratio of fish to ascertain the relationship between males and females in a population (χ^2) (Steel *et al.*, 1997):

$$\chi^2 = \frac{\sum(Oi - ei)^2}{ei}$$

Notation

χ^2 : The value for a random variable whose sampling distribution approximates the Chi-square distribution.

oi: Total observed frequency of male and female fish (ind)

ei: Expected frequencies of male and female fish (ind)

The hypotheses used are as follows:

H_0 : $0=0$, the number of male and female fish is balanced.

H_1 : $0 \neq 0$, the number of male and female fish is not balanced.

The gonad somatic index (GSI) can be calculated quantitatively by dividing the gonad weight by the total weight of the fish (Effendie, 1979).

$$GSI (\%) = \frac{Wg}{Wb} \times 100$$

While GSI is gonad somatic index or gonad somatic index, Wg is gonad weight (g), and Wb is fish body weight (g).

The reproductive potential of fish can be estimated from the fecundity value calculated on fish that have gonad maturity stages IV using the volumetric method (Effendie, 1979):

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

Notation

F: Fecundity (grains)

G: Total gonad weight (gram)

V: Dilution volume (ml)

X: Number of eggs in 1 mL

Q: Average weight of sample gonads (gram)

Gonad maturity stages are determined based on the morphological characteristics of the gonads developed by Tamsil (2024).

Table 1. Classification of Silver barb fish gonad maturity stages (GMS)

GMS	Male	Female
I (immature)	Thread-like testicles, shorter in size than the ovary, are clear in color.	Thread-like ovaries, elongated in shape inside the upper abdominal cavity (under the backbone), clear in color, smooth surface,
II (developing)	Enlarged testes, larger than GMS I testes; milky white in color	Ovari semakin besar lebih besar dari ovari GMS I, berwarna Ovaries are larger than GMS I ovaries, pale white in color, egg grains are visible, estimated to fill 10-20% of the abdominal cavity.
III (developed)	Testes are getting bigger and larger than GMS II. The testicular surface appears jagged, with a milky white color.	Ovaries have begun to enlarge and are white in color; egg grains are clearly visible, but still difficult to separate. Estimated to fill almost 20%-50% of the abdominal cavity.
IV (mature)	The testes are larger than GMS III and are clearly visible; their surfaces are grooved. Milky white in color.	Ovaries are getting larger and whiter, with egg grains visible, easily separated, and estimated to fill 50-70% of the abdominal cavity.
V (spent)	Testicles wrinkled, look like GMS I	The ovary is wrinkled and white, containing unfertilized eggs.

RESULT AND DISCUSSION

Result

The research identified several aspects of silver barb reproduction originating from the Way Sekampung Dam, including sex ratio, gonad maturity stages, gonad somatic index, egg diameter, and spawning type.

Sex ratio

Sex ratio is the ratio of the number of male and female fish in a population. Observations showed a sex ratio of 1.4:1 for silver barbs, as presented in Table 2.

Table 2. Sex ratio of silver barb from September to December

Observation time	Gender		Sex ratio
	Male	Female	
September	78	22	3,5:1
October	43	46	0,9:1
November	44	35	1,2:1
December	85	64	1,3:1
Amount	250	167	1,4:1

The research results showed that 417 silver barbs were present. The results of the sexual ratio show that male silver barbs are obtained more than female silver barbs. The total percentage comparison between male and female silver barbs is shown in Figure 2 below.

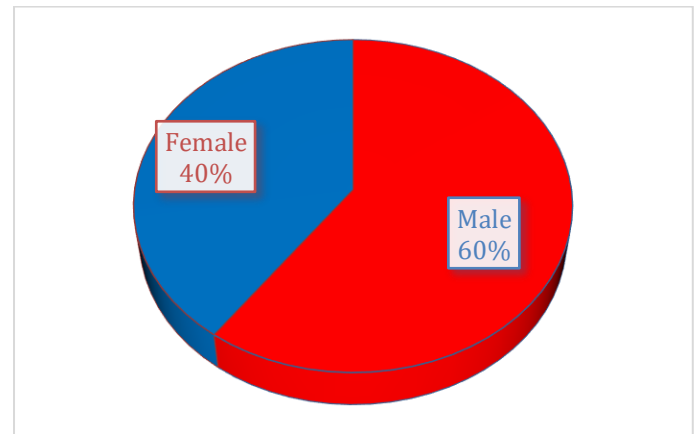


Figure 2. The sex ratio proportion of the silver barb.

Based on the calculations and results of the "Chi-Square" test with a 95% confidence interval ($\alpha = 0.05$), the X^2_{count} value is 16.483. The X^2_{count} value exceeds the X^2_{Table} value of 3.84. Based on this, H_0 is rejected, indicating that silver barbs caught in the Sekampung Dam exhibit unbalanced sex differences.

Gonad Maturity Stages

During the study, silver barb fish with Gonadal Maturity Stages (GMS) I-V were obtained, both male and female. The percentages of male and female silver barbs at each GMS are shown in the figure below.

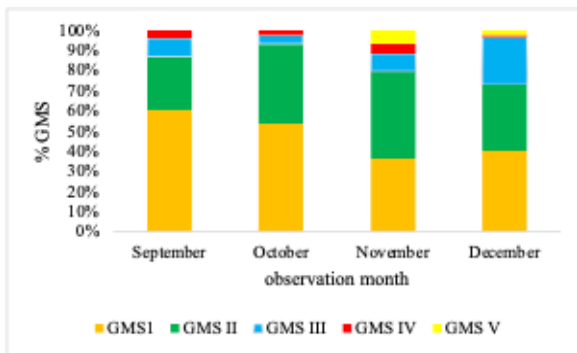


Figure 3. Gonado maturity stage percentage of male silver barb

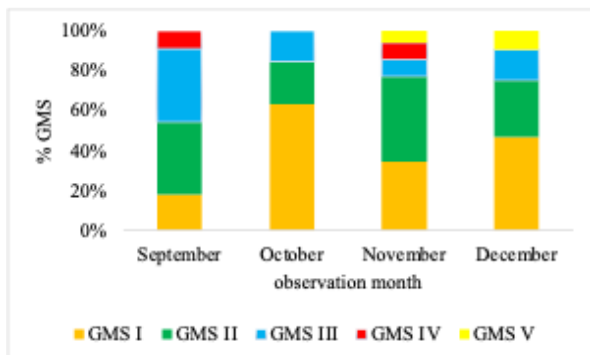


Figure 4. Gonado maturity stage percentage of female silver barb

The graphs (Figures 3 and 4) show that the female silver barb fish with the highest percentage of GMS IV occurs in September (9.09%), while in Figure 6, the percentage of male fish with GMS IV is 4.54% in November. Silver barb fish GMS graph also shows that the number of fish whose gonads have matured (GMS IV) is less than the number of silver barbs that have not matured gonads (GMS I). The results of research on the stages of gonad maturity based on fish size can be seen in the figure below:

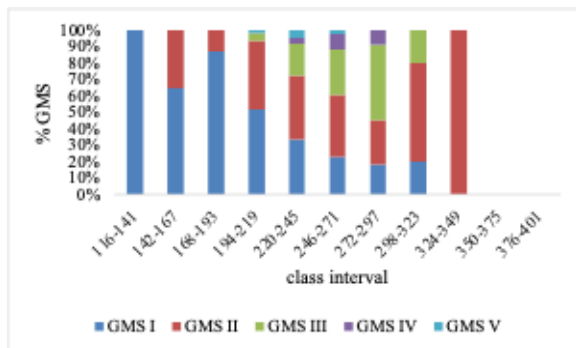


Figure 5. Male silver barb gonad maturity stages

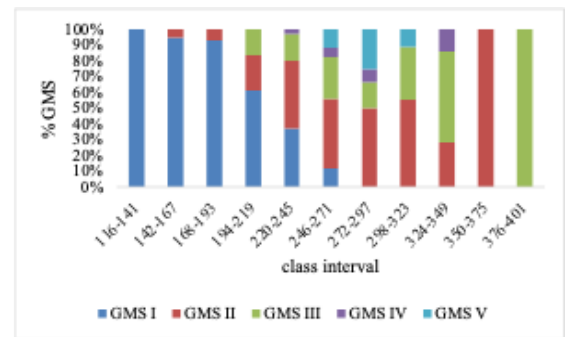


Figure 6. Female silver barb gonad maturity stages

Gonad Somatic Indeks

Gonado somatic indeks is an indikator to know the spawning period. Gonado somatic indeks also influence size and growth of length. The relation between GSI and length of fish show as figure below.

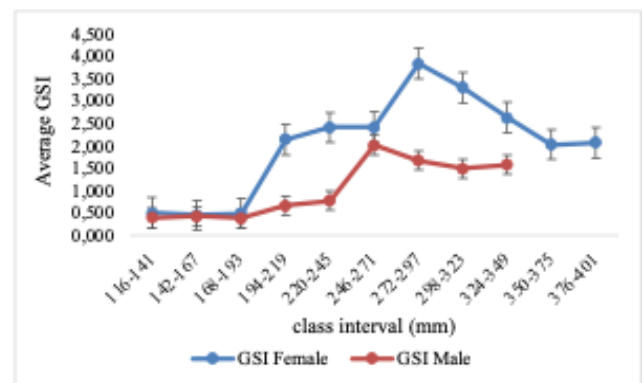


Figure 7. Gonad somatic index (GSI) of male and female silver barb

The highest average % GSI value for male fish was at 246-271 mm with an average GSI value of 2.273%, while female fish were at 272-297 mm with an average GSI value of 3.850%.

Fecundity

Based on the catch of silver barb from Way Sekampung Dam, 5 female fish are entering the GMS IV phase with different weights and fecundities.

Table 2. The total length, fish weight, gonad weight, and fecundity of the Silver barb fecundity

No	Total length (mm)	Fish weight (g)	Gonad weight (g)	Egg quantity 1 ml			Fecundity
				A	M	P	
1	255	137	6,335	1.423	1.029	785	32.026
2	240	97	5,517	1.051	780	670	24.245
3	344	478	10,603	1.108	1.262	1.934	46.297
4	294	361	23,033	2.829	3.204	3.580	99.348
5	261	247	8,984	586	1.683	1.022	34.043
Average							47.192

Description: A: Anterior, M: Middle, P: Posterior

Based on the silver barb fecundity table, the maximum fecundity was found at a total length of 294 mm with a fish body weight of 361 g and gonad weight of 23.033 g. The lowest fecundity was observed in fish measuring 240 mm, with a body weight of 97 g and a gonad weight of 5.517 g. The lowest fecundity was observed in fish measuring 240 mm, with a body weight of 97 g and a gonad weight of 5,517 g. The calculation of the fecundity of silver barb fish obtained an average of 47,192 eggs.

Egg Diameter and Spawning Type

After measuring the egg's diameter with a microscope, an ocular micrometer calibrated with an objective micrometer yields a result of 0.013. Next, the value is multiplied by the measured egg diameter, as shown in Figure 8.

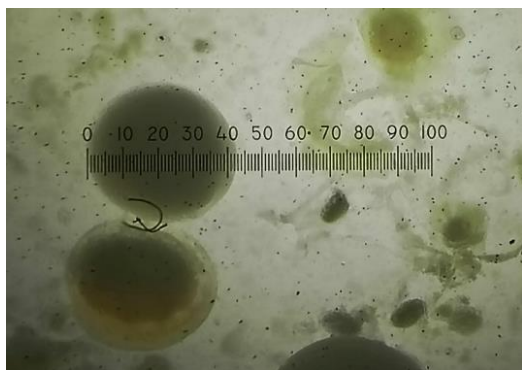


Figure 8. Egg diameter of silver barb

Discussion

Conversely, the environment is not suitable for population sustainability or reproduction if there are more males than females, and recruitment efforts are often hampered (Saranga *et al.*, 2018). A sex ratio of 1:1 is ideal, but in nature it is often different due to food availability, population density, food chain balance, and fish distribution patterns (Effendie, 2002). In nature, silver barb fish usually do mass spawning (Nisa & Khairunissa, 2023).

Research by Nisa & Khairunissa (2023) found that the spawning process of silver barb involved more males than females. This is done because the male parent has a greater chance of fertilizing eggs, thereby increasing egg production. Several factors cause male silver barb fish to be found more than female fish. Halfawy *et al.* (2007) stated that an unbalanced male-female sex ratio is related to growth tactics for reproductive success.

In general, male fish mature their gonads faster due to their relatively long size compared to female fish. This is also related to spawning season

The diameter of silver barb eggs from Way Sekampung Dam ranged from 0.273-0.845 mm (n=750 eggs) from 5 female GMS IV. The distribution of egg diameter in silver barb fish from Way Sekampung Dam is shown in Figure 9.

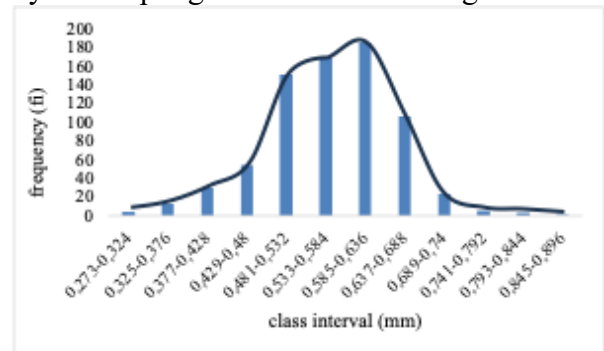


Figure 9. The Silver barb fish egg diameter distribution

Based on the silver barb fish egg diameter graph, it can be seen that the graph has only one peak. The peak of the graph above shows the egg diameter size class interval of 0.585-0.636 mm.

and environmental factors. A previous study on the sex ratio of silver barb fish in the Brantas River by Maknuun (2016) found a male-to-female ratio of 1.12:1, indicating that male fish outnumber females. Research conducted by Tamsil (2024) in Lake Tempe found a ratio of 1:1.05 between males and females, indicating that female silver barb fish are more numerous than males.

The presence of fish with GMS IV indicates that they have entered the spawning season. Silver barb fish can spawn naturally only during the rainy season (Sumsanto *et al.*, 2023). November and December 2024 are the peak of the rainy season, according to BMKG (Meteorology, Climatology and Geophysics Agency). In November and December 2024, western Indonesia is at the peak of the rainy season. Based on the graph of the GMS percentage of silver barb fish, it can be seen that the percentage of silver barb fish that have entered the GMS V phase, both males and females, is mostly found in November and December, which means that the fish are caught by fishermen after the fish have spawned. Most of the fish caught during the

study were in GMS I-III, indicating that the gonad maturity stages of the fish caught in Way Sekampung Dam are mostly in the immature phase. The size of silver barb fish with GMS IV phase for male and female fish is 220-245 mm. Male and female silver barb fish at 116-141 mm are fully in the GMS I phase. Based on the graph of the gonad maturity stages of silver barb fish (Figures 5 and 6), it can be seen that the majority of silver barb fish in Way Sekampung Dam with sizes 116-193 mm are still in the immature gonad phase, namely GMS I to II. While silver barb fish in other areas with this size have entered the mature gonad phase, as the results of research conducted by Oktaviany *et al.* (2023), the length of the first mature gonad of silver barb fish caught in Teteaji Village, Sidenreng Rappang Regency, is 167 mm (female) and 189 mm (male). Two factors influence the first time gonad occurs, namely internal and external factors. Internal factors include differences in size, shape, and physiology, as well as physical characteristics such as the ability to adapt to the environment and the availability of reproductive hormones. External factors include food and differences in kelamin types (Karau, 2022).

Comparison of the range of GSI values between male and female fish shows that the GSI of female silver barb fish is greater than that of male silver barb fish. This is because female silver barb fish have greater weight and gonad size than male silver barb fish. According to Sulistiono *et al.* (2011), the GSI value of male fish generally has a lower value than that of female fish. GSI values in silver barb fish vary depending on environmental conditions and gender. Based on the silver barb fish Gonad somatic index graph (Figure 7), it can be seen that the peak of the male silver barb fish Gonad somatic index is at a size of 246-271 mm, and females 272-297 mm, indicating that this size is the maximum limit when the fish spawns. In the graph of the gonad maturity stages of silver barb fish (Figures 5 and 6), silver barb fish at that size have entered the gonadal maturity phase. As noted by Prestianingtyas (2015), the gonads will increase in weight and size until they reach a maximum size, at which point the fish will spawn. GSI increases in size and reaches its maximum during spawning, as stated by Effendie (2002). When spawning is ready to occur, the GSI value reaches the upper limit of its range along with the development of the gonads.

Fecundity can indicate the number of new individuals that will be present in the stock population (recruitment). However, not all eggs released will hatch and become adult fish. In

addition, greater fecundity will lead to more recruitment opportunities (Tamsil, 2024). Based on observations, silver barb fecundity is directly proportional to the weight of fish gonads. The heavier the female gonads are, the more eggs are produced. Just like other fish with the genus *Barbonymus* that produce eggs in large quantities, such as the lalawak fish (*Barbonymus balleroides*), which produces eggs with an average of 31,124 eggs (Kusmini *et al.*, 2016). This amount is quite high compared to other fish, such as tilapia, which produces only 100-448 eggs (Fitria, 2016). The fecundity of the silver barb also varies based on the location where the fish was found. The fecundity of silver barb fish in Tempe Lake, Wajo Regency, South Sulawesi Province, ranges from 2,481 to 83,822 eggs (Tamsil, 2024). Furthermore, silver barb fish in the Padma River, Bangladesh, have a fecundity between 13,192-98,325 eggs (Jasmine & Begum, 2016). Based on research conducted by Setyaningrum & Wibowo (2016), silver barb fish can produce between 120,400 and 217,150 eggs. Age, size, species, environmental conditions, and food availability can affect the number of eggs produced by female fish, thereby influencing fecundity (Fitria, 2016).

Based on the silver barb egg diameter graph (Figure 9), there is only one peak. This indicates that the size of silver barb eggs is the same or not much different, so the type of silver barb spawning in Way Sekampung Dam is a total spawner, which means that the fish releases all its eggs in one spawning season. When the eggs in the ovary are of the same size, the spawning trait of the species is short (total spawner). If the eggs are not the same size, the species is a long-spawning (partial spawner) (Prestianingtyas, 2015). According to the research of Katiandagho & Marasabessy (2017), the gonads of total spawning fish have the same egg size, which indicates the same level of development, so that these fish can spawn fully at the time of spawning. This spawning type is similar to that of the silver barb from the Serayu River, Central Java, Indonesia (Haryono *et al.*, 2015), where this species thrives as a total spawner. However, this result is the opposite of that reported by Efizon *et al.* (2021), who found gradual spawning (partial spawner). Haryono *et al.* (2015) reported that spawning patterns in fish are influenced by the availability of food sources, water temperature (season), and location. Therefore, fish of the same species but from different locations may have different spawning patterns, as found in this study.

CONCLUSION

The sex ratio of silver barb fish in Way Sekampung Dam is 1:1.4, meaning there are more male silver barb fish than female fish. The gonad maturity stages of silver barb fish caught are more prevalent in the GMS I and II phases. Based on the calculation of the Gonad somatic index, male silver barb fish have a range of 0.035-13.858%, while female fish have a range of 0.155-14.269%; the female GSI is greater than the male GSI. The average silver barb fecundity is 47,192 eggs per female parent with GMS IV. The diameter of silver barb fish eggs that have entered the spawning phase (GMS IV) ranges from 0.27 to 0.85 mm. Through the results of egg diameter analysis, the type of spawning of silver barb fish in Way Sekampung Dam is total spawning or total spawner.

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