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Gonadosomatic-hepatosomatic index and sex ratio of beardless barb (*Cyclocheilichthys apogon*) from Lebak Kalong Floodplain, Ogan Komering Ilir, South Sumatra, Indonesia

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Abstract

The beardless barb (*Cyclocheilichthys apogon*) is one of the freshwater fish species native to Indonesia. Gonadosomatic index (GSI), hepatosomatic index (HSI), and sex ratio are parameters in the study of fish reproductive biology. The aim of this study was to calculate the gonadosomatic index, hepatosomatic index and sex ratio of *C. apogon* from the Lebak Kalong Floodplain, Ogan Komering Ilir Regency. A total of 30 *C. apogon* samples were used in this study. *C. apogon* samples were dissected to remove gonadal organs and liver organs from the abdominal cavity. The gonads and liver were weighed for the calculation of GSI and HSI, respectively. The results showed that the gonadosomatic index of female *C. apogon* ranged from 3.33% to 15.83%, and that of males ranged from 1.04% to 7.27%. The hepatosomatic index of female *C. apogon* ranged from 0.20% to 2.86%, and that of male fish ranged from 0.34% to 1.92%. The gonadosomatic index and hepatosomatic index of female *C. apogon* were heavier than those of males. The sex ratio was 1:1 (♂:♀). Knowledge of the gonadosomatic index, hepatosomatic index, and sex ratio can be used to determine the reproductive biology aspects of *C. apogon*. Further studies should be conducted to obtain more information on the reproductive aspects of *C. apogon*.

Keywords: Fish reproduction; Gonadal maturation; Spawning; Vitelllogenesis

1. Introduction

The beardless barb (*Cyclocheilichthys apogon*) is a species of freshwater fish in the family Cyprinidae. It is widespread in Southeast Asia. The species is found in Singapore, Myanmar, Thailand, Cambodia, Laos, Vietnam, Malaysia, and Indonesia (Hamid et al., 2015; Kenthao and Jearranaiprepame, 2018; Lumbantobing and Vidthayanon, 2023; Rosli and Zain, 2016). In Indonesia, this species is found in Sumatra and Kalimantan. This species inhabits freshwater. Some habitats where this species is found include the Musi River, Palembang (Hedianto et al., 2010), Penukal River (Muslim, 2012), Menduk River, Bangka (Suhendra et al., 2017), Batutegi Reservoir, Lampung (Marson and Hidayah, 2021), Nyanyi River, Bali (Hasan et al., 2021), Jatiluhur Reservoir, West Java (Warsa et al., 2021), Rawas River, Rupit (Yusnaini et al., 2022), Kelekar Floodplain, Ogan Ilir (Muslim and Syaifudin, 2022), Singkarak Lake, Diatas Lake, and Dibawah Lake, West Sumatra (Roesma et al., 2023). *C. apogon* is omnivorous, having the characteristic of being euryphagic, with aquatic plants as basic food; detritus, worms, phytoplankton, and insects as secondary food; and zooplankton as supplement food (Hedianto et al., 2010). *C. apogon* is one of Indonesia's native fish species that has the potential to be cultured (Muslim et al., 2020).

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The gonadosomatic index (GSI) is the ratio between the weight of the gonads and the total weight of the individual (Ribeiro et al., 2016). The relative weight of the gonad to the weight of the fish is shown by the metric known as GSI (Flores et al., 2015). GSI has been routinely utilized to assess the time of reproduction (Lowerre-Barbieri et al., 2011). The GSI is widely utilized to compare individual reproductive status with that of other groups of individuals (Flores et al., 2019). In order to offer information on maturation and seasonal trends in gonad development, changes in GSI are primarily determined by differences in yolk concentration during different oocyte stages (Duan et al., 2016; Ghaffari et al., 2011). The hepatosomatic index (HSI) is defined as the ratio of liver weight to total body weight (Mahboob and Sheri, 2016). HSI is commonly used as an indicator of energy reserves in the liver (Sharma and Ram, 2020). In the reproductive system of fish, HSI is associated with GSI. Vitellogenesis occurs in the fish liver to synthesize vitellogenin as a yolk precursor (Hara et al., 2016; Levavi-Sivan et al., 2017; Sharma and Ram, 2020). Assessing reproductive potential and determining stock size in fish populations requires the use of basic information such as the sex ratio (Radhakrishnan et al., 2020; Vicentini and Araujo, 2003). Studies on the sex ratio give information on the ratio of male to female fish in a population. They also show which sex ratio is more prevalent in a particular population, which is fundamental knowledge required for determining stock size and fish reproduction (Hashmi et al., 2013; Olowo et al., 2022).

The aim of this study was to investigate the gonadosomatic index, hepatosomatic index, and sex ratio, which are some aspects of the reproductive biology of *C. apogon* in the Lebak Kalong Floodplain, Ogan Komering Ilir, South Sumatra, Indonesia. It is hoped that the information obtained from this study will contribute to our knowledge of the reproductive biology of *C. apogon* and will be useful for fisheries and aquaculture production.

2. Materials and Methods

The collection of *C. apogon* samples was conducted in the Lebak Kalong Floodplain, Pematang Buluran Village, Jejawi Sub-district, Ogan Komering Ilir District, South Sumatra Province, Indonesia. Fish samples were collected from June to August 2023 in collaboration with local fishermen. The fishing gear used was bubu (fish traps), hand fishing line, and a gill net. The morphology of *C. apogon* used in this study is presented in Figure 1. The *C. apogon* collected in this study was 30; the fish samples obtained were transported to the Fisheries Laboratory, Faculty of Fisheries, Universitas Islam Ogan Komering Ilir Kayuagung, for weighing. Body-weight *C. apogon* samples were weighed individually using digital scales (accuracy 0.1 g). After completing the body weight measurement, the sample fish was dissected using a dissecting set. The tip of the surgical scissors is inserted into the urogenital pore, and then the surgeon dissects the abdomen of the fish from the head to the back of the operculum. Next, the internal organs in the abdominal cavity are removed, and the gonads and liver are separated. The gonads and liver were weighed using a digital scale (@Camry, accuracy 0.01 g). The sex ratio was determined based on the number of female and male fish (female:male). Data on the body weight and liver weight of fish samples were tabulated and processed with the help of the Microsoft Excel program. Calculation of the gonadosomatic index and hepatosomatic index of *C. apogon* samples using the formula:

$$\text{GSI (\%)} = \frac{\text{Gonad weight (g)}}{\text{Body weight (g)}} x\ 100 \qquad \text{HSI (\%)} = \frac{\text{Liver weight (g)}}{\text{Body weight (g)}} x\ 100$$

Figure 1 Morphology of beardless barb (*Cyclocheilichthys apogon*) from Lebak Kalong Floodplain, Ogan Komering Ilir, South Sumatra, Indonesia

3. Results and Discussion

A total of 30 *C. apogon* samples were successfully weighed for body weight, gonad weight, and liver weight. Body weights of female *C. apogon* ranged from 8.2 g to 85 g per individual, and males weights ranged from 3.5 g to 26 g per individual. Female *C. apogon* gonad weights ranged from 0.45 g to 72 g per individual, and male ranged from 0.09 g to 1.00 g per

individual. The liver weights of female *C. apogon* ranged from 0.05 g to 0.80 g per individual, and those of males ranged from 0.02 g to 0.50 g per individual. Body weights and gonad weights of *C. apogon* samples are presented in Figure 2. The GSI of female *C. apogon* ranged from 3.33% to 15.83%, and that of males ranged from 1.04% to 7.27%. The HSI of female *C. apogon* ranged from 0.20% to 2.86%, and that of male fish ranged from 0.34% to 1.92%. The GSI and HSI of *C. apogon* are presented in Figure 3. The sex ratio of *C. apogon* in this study was 1:1 (female:male) (Figure 4).

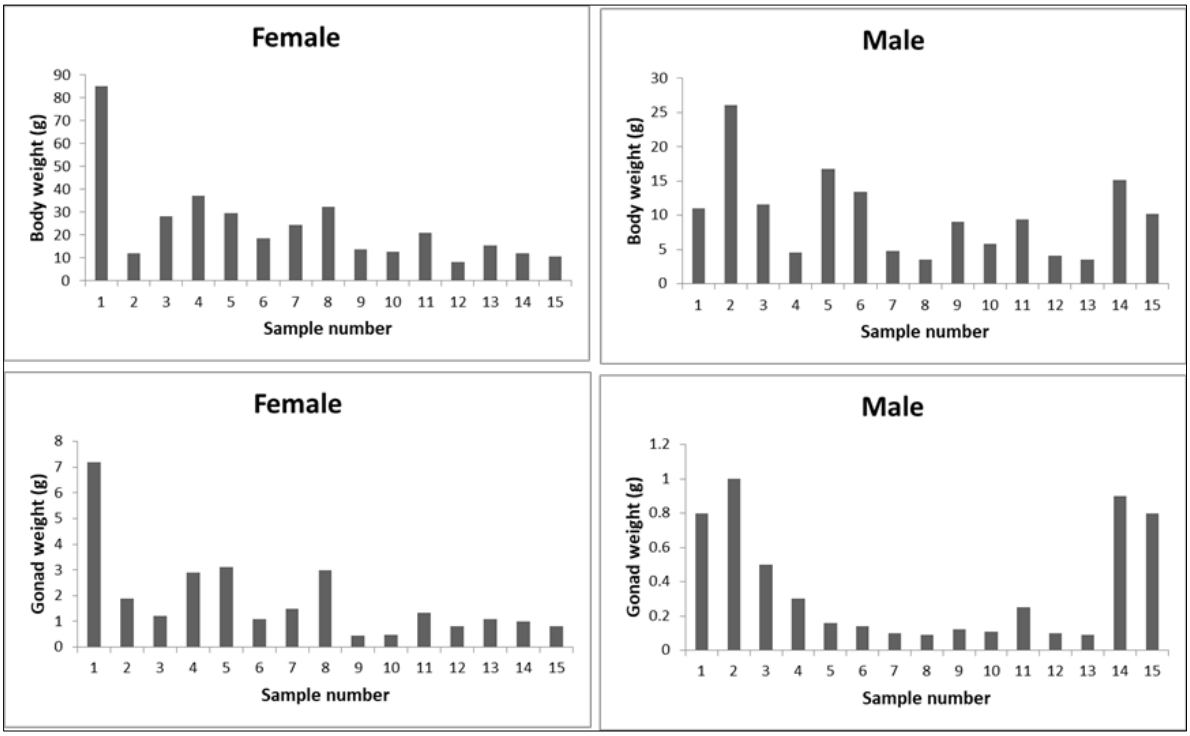

Figure 2 Body weight and gonad weight of beardless barb (*Cyclocheilichthys apogon*) from Lebak Kalong Floodplain, Ogan Komering Ilir, South Sumatra, Indonesia

The present study showed that the body weight, gonad weight, liver weight, GSI, and HSI of female *C. apogon* were heavier than those of male specimens. The body weight of *C. apogon* collected in this study was heavier than the results of the study conducted by Hedianto et al., (2010), which were 1.88–71.79 g. According to Zulkafli et al., (2016), the body weights of *C. apogon* in Tembeling River Pahang ranged from 8.9 g to 340.6 g per individual. The body size of the samples obtained in this study was dominated by small-sized fish. According to information from local fishermen, the body weight of *C. apogon* is more than 100 g per individual. In this study, the heaviest body weight was 85 g per individual. The decrease in fish body size obtained is one indicator that there has been a decline in the *C. apogon* population at the study site.

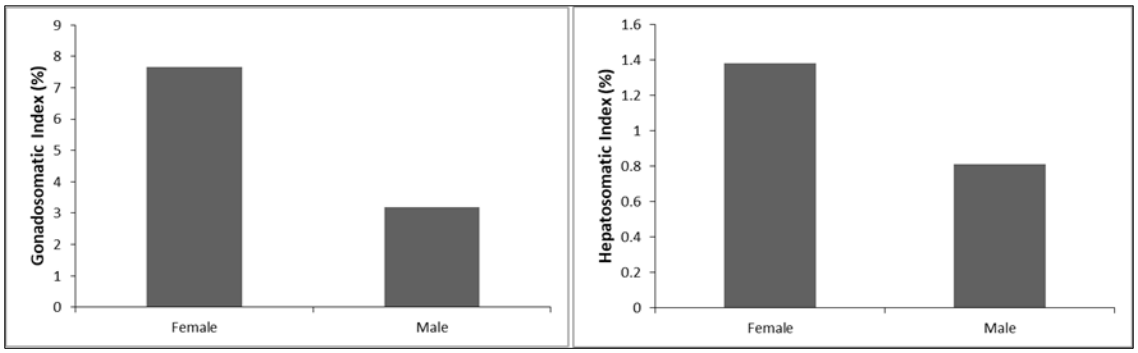

Figure 3 Gonadosomatic index and hepasomatic index of beardless barb (*Cyclocheilichthys apogon*) from Lebak Kalong Floodplain, Ogan Komering Ilir, South Sumatra, Indonesia

The GSI is the percentage of the gonad weight and fish weight ratio, which includes gonads that quantitatively represent gonadal alterations. The ratio between the weights of liver and fish is known as the HSI. The present study shows that the GSI and HSI of *C. apogon* females are higher than those of males. The HSI is related to the GSI because of the vitellogenesis process that synthesizes vitelogenin (Hismayasari et al., 2015). In fish, vitelogenin is a yolk precursor synthesized in the liver and indicated by estradiol 17β (Fernandes, 1994; Hara et al., 2016; Ortiz-Tirado et al., 2017). Vitelogenin is secreted in the blood and transported to oocytes, causing yolk accumulation. This accumulation leads to changes in oocyte size and an increase in ovarian weight (Sullivan et al., 2018; Williams et al., 2014). This vitelogenesis activity can increase the HSI and the GSI.

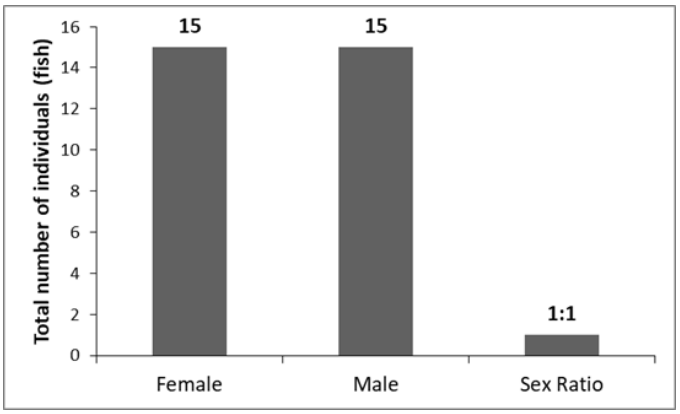

Figure 4 Sex ratio of beardless barb (*Cyclocheilichthys apogon*) from Lebak Kalong Floodplain, Ogan Komering Ilir, South Sumatra, Indonesia

In total, 30 collected individuals, including 15 females and 15 males, were used to examine the sex ratio of *C. apogon* in the Lebak Kalong Floodplain. The sex ratio of *C. apogon* was 1:1 (females: males). The current study shows that the sex ratio of *C. apogon* caught at the study site is balanced. The Suhendra et al., (2017) study showed that the sex ratio of *C. apogon* is 1:1.8, which is different from the results of this study. Estimating the sex population refers to the abundance of each sex at any particular period in a natural environment (Vicentini and Araujo, 2003). To ensure equal fishing for the two sexes, it is crucial to be knowledgeable about fish sex- ratios. This knowledge also helps determine how well a population can reproduce. Studies of fish sex ratios reveal the proportion of male and female fish in a population (Adebiyi, 2013).

4. Conclusion

This study provides information on the GSI, HSI, and sex ratio of *C. apogon* from the Lebak Kalong Floodplain, South Sumatra, Indonesia. The GSI of female *C. apogon* ranged from 3.33% to 15.83%, and that of males ranged from 1.04% to 7.27%. The HSI of female *C. apogon* ranged from 0.20% to 2.86%, and that of male fish ranged from 0.34% to 1.92%. The GSI and HSI of female *C. apogon* were heavier than those of males. The sex ratio was 1:1 (♂:♀). Knowledge of the GSI, HSI, and sex ratio can be used to determine the reproductive aspects of *C. apogon*. Further studies should be conducted to obtain more information on the reproductive aspects of *C. apogon*.

Compliance with ethical standards

Acknowledgments

We appreciate the assistance of the neighborhood fisherman in setting up the fishing gear, gathering field samples, and providing the tools necessary to transport the fish to the laboratory.

Disclosure of conflict of interest

None of the authors disclosed any potential conflicts of interest regarding this article.

Statement of ethical approval

The project was approved by the local ethical committee in Universitas Islam Ogan Komering Ilir Kayuagung, Kayuagung, Indonesia.

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