REPRODUCTIVE BIOLOGY OF JAVAEAN BARB (*Systomus rubripinnis* VALENCIENNES, 1842) IN THE BODO RIVER, CENTRAL JAVA AS THE BASIS FOR INLAND FISHERIES MANAGEMENT

Siti Rukayah*, W. Lestari, Moh. Husein Sastranegara
Faculty of Biology, Universitas Jenderal Soedirman, Jl. DR. Soeparno No.63, Karawangkal, Purwokerto, Central Java

*Email: siti.rukayah@unsoed.ac.id

Abstract. The Javaean barb, an indigenous freshwater fish species belonging to the family Cyprinidae, was the focus of a reproductive biology study conducted in the Bodo River, Kebumen Regency, Central Java. This research aimed to elucidate the species' reproductive characteristics as a foundation for inland fisheries management. Sampling was performed using purposive random techniques, with data analyzed both descriptively and quantitatively over a period spanning February to December 2023. The observed sex ratio in December is more optimal, with a value of 0.94:1 or 85 male fish and 90 female fish. The dominant size distribution or the highest peak size distribution is dominated by young fish (less than 13.6 cm). Gonadal maturity stages (TKG) were predominantly identified at stages I, II, and III. The highest gonadosomatic index (GSI) was recorded in December, with males exhibiting a lower value (0.51%) than females (4.27%). Fecundity ranged from 1953 to 4652 eggs peaked in December. The length at first gonadal maturity was smaller in males (13.69 cm) than in females (16.33 cm). These findings indicate that the Javaean barb in the Bodo River possesses strong reproductive potential and consistent gonadal development, supporting its viability as a biological basis for inland fisheries management.

Keywords: Bodo, javaean barb, reproduction, river

1. Introduction

Rivers are flowing aquatic ecosystems that are in sync with the ever-changing physical environment, providing unique habitats for fish that have adapted to moving water conditions [1,2]. One of the rivers in Kebumen Regency is the Bodo River. The Bodo River, upstream from a hilly area with a height of 210-260 m above sea level, flows through Tlogosari and Candirenggo Villages, Kebumen Regency, Central Java. It is about 36 km long from north to south, and downstream it is called Bengawan Bodo, especially around the estuary near Ayah Beach [3]. The Bodo River is the habitat of various species of fish, one of which is Javaean barb (*Systomus rubripinnis*).

Systomus rubripinnis is a freshwater fish of the Cyprinidae family distributed in the Indo-China region, including the islands of Java, Sumatra, and Kalimantan in Indonesia. This fish can grow up to 25 cm, and is often caught at a size of 15 cm. The body shape of this fish is torpedo or slightly elongated; there are red spots on the operculum, the tail fin is red, and there is a black line at the base of the tail fin [4,5]. Previous research on species *S. rubripinnis* regarding the fish community in the Cikawung River, Central Java, revealed various species, one of which is *S. rubripinnis* [6]. Research on the digestive system of *S. rubripinnis* in Sungai Banjaran, Central Java [7], and research on the genetics of several fish of the Cyprinidae family, including *S. rubripinnis* in Sungai Klawing, Central Java [8]. However, research on the

reproduction of *S. rubripinnis* as a basis for inland fisheries management, it has never been done.

Fish reproductive biology is an important aspect in the effective management and utilization of fishery resources [9]. Determination of the sex and maturity of the gonads provides fundamental knowledge of the potential for fish reproduction. This information helps in identifying the spawning season and reproductive readiness of the fish, so that it can be used as a basis for proper management [10].

The sex ratio is determined by counting the number of male and female fish in the population sample, which provides insight into population structure and reproductive potential [11]. The maturity level of the gonads is visually assessed based on the size, color, and texture of the gonads. It is usually classified in several stages, from immature to mature gonads [9]. The gonadosomatic index (GSI) is calculated as the ratio of gonadal weight to total body weight, indicating Reproductive investment and maturity time [12]. Fecundity refers to the total number of eggs produced by a female, which is often estimated by counting eggs from the ovaries of an adult female [13]. The length of the first mature gonads is a measure of the minimum length of the fish that is able to reproduce for the first time, which is influenced by age, feed availability, water quality, and spawning place [14].

Information on reproductive biology, including sex ratio, gonad maturity rate, gonad maturity index, fecundity, and size when gonads first mature are important for fisheries management. Research on the reproduction of *S. rubripinnis* in the Bodo River has never been researched, therefore this study was carried out to answer the lack of information related to the biological aspects of the reproductive aspects of fish species of high economic value living in the Bodo River. The data obtained is expected to be a strong scientific foundation for stakeholders in designing fish population management strategies. Overall, the results of this study are aimed at supporting the conservation of *S. rubripinnis* resources and strengthening the sustainability of inland fisheries in the Kebumen Regency area. This study aims to analyze the reproduction of Javaean barb (*S. rubripinnis*) in the Bodo River, including sex ratio and size distribution. gonadal maturity rate, gonadosomatic index, fecundity, and length when the gonads first mature.

2. Methods

2.1. Research Time and Place

The object of this study, the Javaean barb *Systomus rubripinnis,* is shown in Figure 1. Research on Javaean Barb reproduction in February-December 2023 with a time interval of 2 months. The method used in this study is a survey method with purposive random sampling data collection techniques in Sungai Bodo, Kebumen Regency, Central Java. The sampling station consists of 9 stations, which can be seen in Figure 2.

Figure 1. Javaean Barb, *Systomus rubripinnis* in Bodo River

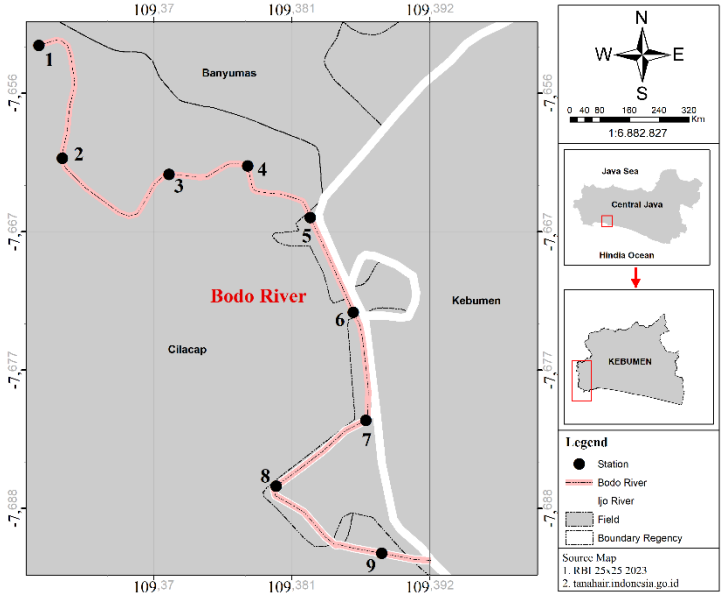


Figure 2. Sampling location in Bodo River, Kebumen Regency, Central Java.

2.2. Research Materials

The material in this study consists of 2 types, namely tools and materials. The tools used in this study are boats, ice boxes, gillnets, stocking nets, stationery and labels, tray, plastic, sectio sets, scales (0.01 g and 1 g), droppers, syringes, sample bottles, petri glass, microscope, and camera. The materials used in this study were Javaean barb (*S. rubripinnis*), water from the Bodo River, ice, latex glove, Gilson liquid, 4-10% formalin, and 70% alcohol.

2.3. Methods of Taking Fish

Fish samples were taken in the Bodo River, Kebumen, with the help of fishermen using stocking nets and a *Gillnet*. The fish samples obtained were then collected and separated according to sex, and then taken to the ecology laboratory, Faculty of Biology, for surgery. The surgery is performed from the anus towards the dorsal body. The gonads were visually observed to include color and shape, then matched with the gonad maturity level table according to Haryono's (2015) criteria [15]. After observation of the gonads, the level of maturity of the gonads is determined according to the literature, and then the fish gonads are removed using tweezers. The gonads are then weighed from the weighed gonads taken partially, approximately 10% taken from three parts, namely the anterior, middle, and posterior of the total gonad weight to be weighed, and then the number of eggs is calculated. This value is the number of partial eggs. Then put it in a sample bottle and add a Gilson solution until the gonad sinks.

2.4. Fish Data Collection Methods

The data to be obtained include sex ratio, gonad maturity stage (GMS), gonadosomatic index (GSI), fecundity, and length of maturity (Lm). The acquisition of research data is determined using several equations, which are as follows.

Sex ratio

The sex ratio of male and female fish is calculated using a formula from [16] as follows.

$$Sex\ ratio = \frac{number\ of\ females}{number\ of\ males}$$

Description: SR (Sex Ratio), M (Male), F (Female)

Size Distribution

The size distribution is determined by grouping male and female fish into 6 groups based on the number of individuals of each class.

Gonad Maturity Stage (GMS)

Gonadal maturity rate (GMS) *S. rubripinnis* Determined based on references from research Haryono et al. (2015), as follows.

Table 2. Gonad maturity stage (GSM) of the family Cyprinidae species *Barbonymus balleroides* By [15]

Internship (Mature)	Female Gonads (Ovaries)	Male Gonads (Testes)
I (Immature)	Thread-like, length to the front of the abdominal cavity, clear, slippery surface.	Thread-like, shorter, not reaching the front of the abdominal cavity, and clear.
II (Developing)	Extend to the front of the abdominal cavity, fills less than one-tenth of the cavity, clear white, with small oocytes visible as granules.	Larger, milky white color, shape more clearly defined than the first stage.
III (Developed)	Filling nearly half of the abdominal cavity, eggs begin to be clear, with a yellowish ovary.	Fill nearly half of the abdominal cavity and are white in color.
IV (Source)	Fill most of the abdominal cavity, the color becomes yellow and darker. Eggs are clearly visible, separated from each other.	Grew are white milk in color, and fill most of the abdominal cavity.
V (Spent)	Ovaries contain the rest of the yellow-green eggs. Ovary deflated in the posterior because the eggs have been released (spawned).	Testes deflated at the posterior end.

Gonadosomatic index (GSI)

The gonadosomatic index (GSI) is a quantitative method to determine the level of gonad maturity, described in percent terms as a result of the comparison of gonad weight to fish body weight. The gonadosomatic index is calculated using the equation [17] as follows.

$$GSI = \frac{gW}{bW} \times 100\%$$

Description: GSI (Gonadosomatic index), gW (gonadal weight), bW (body weight).

Fecundity

The determination of fecundity is carried out by taking the ovaries of all mature gonad-mature fish. The ovaries of the whole fish are weighed, and then part of the ovaries is taken. Fish fecundity is determined using the formula [18] as follows.

$$F = \frac{G \times n}{g}$$

Description: F (fecundity), G (gonadal weight), n (number of partial eggs), g (proportion of gonadal weight).

Length of Maturity (Lm)

Estimation of the length of the first mature gonads was carried out to find out when the Javaean barb first matured its gonads. The calculation of the size of the first maturation of the gonads follows the Spearman-Karber equation [19] as follows.

$$m = x\,k + \left(\frac{x}{2}\right) - (x \sum \quad pi)$$

Description: m (average length of maturity), xk (log of Lm length class), x (log of mean increase in length), p (proportion of gonad maturity fish).

2.5. Data Analysis

Sex ratio data were analyzed using Chi-Square statistical analysis to test whether there was a significant difference between the number of male and female fish observed. Data on gonadal maturity rate, gonadosomatic index (GSI), and fecundity were analyzed descriptively. The size of the first mature gonads was statistically analyzed using the Spearman-Karber equation.

3. Results And Discussion

3.1. Sex Ratio Javaean Barb

The results of this study were obtained as many as 897 javaean barb, the number of male fish caught was 482, while the number of female fish was 415. The sex ratio of male and female Javaean barb is 1.16 : 1 which means that the ratio of male and female Javaean barb is still relatively balanced. During this study, the sex ratio of male and female javaean barb obtained in the Bodo River is shown in Figure 3 as follows.

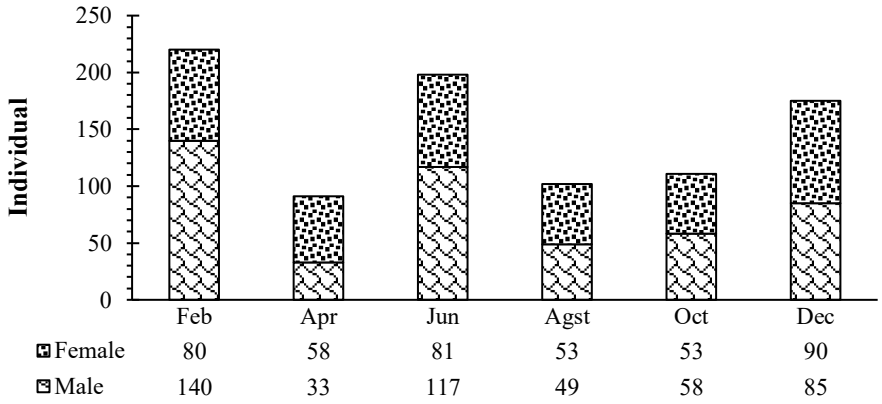


Figure 3. Sex ratio of *S. rubripinnis* in Bodo River, Kebumen

Based on Figure 3, it is obtained that the sex ratio of S. *rubripinnis* in December showed a balanced value of 0.94:1, or as many as 85 male fish compared to 90 females. The sex ratio is considered to support reproductive continuity if the ratio between male and female fish is balanced (1:1), or the number of female fish is higher than that of male fish [20]. The sex ratio obtained in this study has the potential to support reproductive success, as a higher proportion of females can increase the chances of spawning and population regeneration. The sex ratio can change, influenced by habitat characteristics, feed availability, and spawning behavior [21].

3.2. Size Distribution Javaean Barb

The size distribution of *S. rubripinnis* based on research that has been carried out ranges from 3.9-23 cm as many as 897 fish. The highest size distribution is in the range of 7.1-10.2 cm, which is as many as 325 male fish and 110 female fish. The results obtained are in Figure 4, as follows.

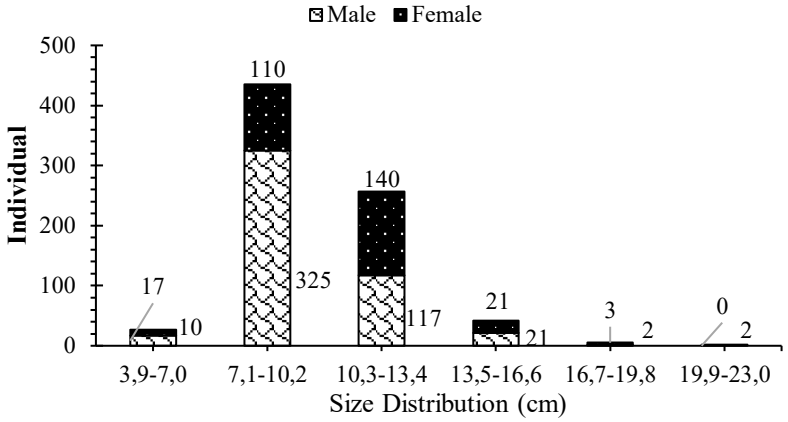
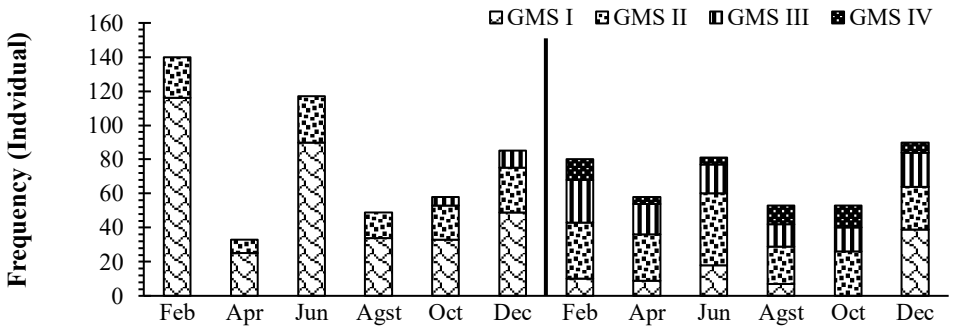


Figure 4. Size distribution of *S. rubripinnis* in Bodo River, Kebumen

The results showed that the distribution of the total length of S. rubripinnis fish individuals in Sungai Bodo, Kebumen, included several age groups or size classes, ranging from immature fish (less than 13.5 cm) to adult individuals (larger than 13.5 cm). This population structure is important in fish management because it shows the recruitment potential and diverse status of stocks. The dominant size or peak of the highest size distribution is found in the range of 7.1–10.2 cm. This class includes the largest number of individuals, namely 325 males and 110 females, for a total of 435 heads. Size distributions with less than 13.5 cm in size were more widely obtained, indicating that the highest capture occurred in individuals who were not expected to have reached the length size of the first mature gonads or were still approaching that size. This condition should be of serious concern because intensive capture at young sizes can interfere with the reproductive and regeneration potential *of S. rubripinnis* populations in the future.

3.3. Gonad Maturity Stage (GMS) of *S. rubripinnis* in Bodo River, Kebumen

The results of the study showed that the gonad maturity stage (GMS) of *S. rubripinnis* consisted of GSM I to GMS IV. The gonad maturity stage (GMS) by male fish was found to be higher in GMS I, which was 347, and lower in GMS III, which was 15. In female fish, the highest GMS was found in GMS II, which was 175, and the lowest in GMS IV was 50. The results of these acquisitions are found in Gamber 5, as follows.



	Male						Female					
GMS IV	0	0	0	0	0	0	12	4	4	11	13	6
GMS III	0	0	0	0	5	10	25	18	17	13	14	20
GMS II	24	8	27	15	20	26	33	27	42	22	26	25
GMS I	116	25	90	34	33	49	10	9	18	7	0	39

Figure 5. Gonad Maturity Stage (GMS)

The results from Figure 5 show that from February to June, *S. rubripinnis* in the Bodo River, Kebumen, is more commonly found in TKG I and II. In August-December *S. rubripinnis* in

TKG III-IV has begun to be seen. This indicates that the fish is preparing to reproduce in their habitat. Peak fish spawning *Systomus rubripinnis* is in the rainy season between October and January [22]. Based on the catch, the fish caught in December showed optimal TKG for spawning, which indicates that in December, spawning was underway. Some of the factors that affect the development of gonads in fish include water quality, feed sources, and hormones [23].

3.4. Gonadosomatic index (GSI) of *S. rubripinnis* in Bodo River, Kebumen

The Gonadosomatic Index (GSI) shows the ratio of gonad weight to the body weight of the fish, interrelated with the level of gonad maturity. The gonadosomatic index will increase as the gonads develop, reaching a peak before the fish spawns, so the GSI value is used to predict when the fish will spawn [23]. Gonadosomatic index of Javaean barb (*Systomus rubripinnis*) in the Bodo River is shown in Figure 6, as follows.

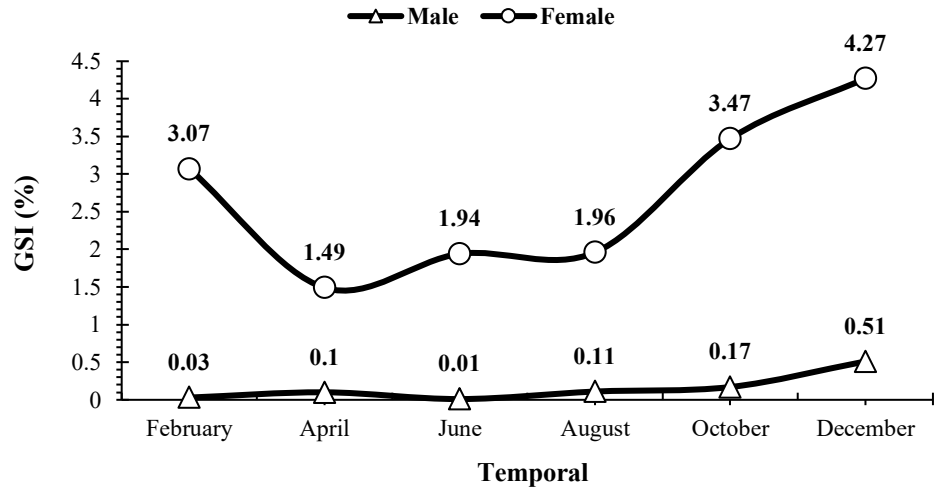


Figure 6. Gonadosomatic Index (GSI) of *S. rubripinnis* in Bodo River, Kebumen.

The results of the study showed that the GSI of Javaean barb in the Bodo River ranges from 0.03-4.27%. Gonadosomatic index *S. rubripinnis* Female sex obtained a higher rate (1.49%-4.27%) than male sex (0.03-0.51%). In April, simultaneously, *S. rubripinnis* males and females obtained the lowest GSI, while in December, it was the highest peak of GSI for ceba. The highest gonadosomatic index in December showed that spawning would happen immediately. This is suspected to be due to environmental climate changes such as increased rainfall, changes in water levels, or the availability of nutrients that often trigger spawning in freshwater fish [15].

3.5. Fecundity of *S. rubripinnis* in Bodo River, Kebumen.

Fecundity is the number of eggs that are ripe before they are released at the time the fish will spawn [24]. Fecundity of *S. rubripinnis* in Sungai Bodo, Kebumen, was obtained for 6 months with an average ranging from 1953 to 4652 eggs. The results obtained are in Figure 7, as follows.

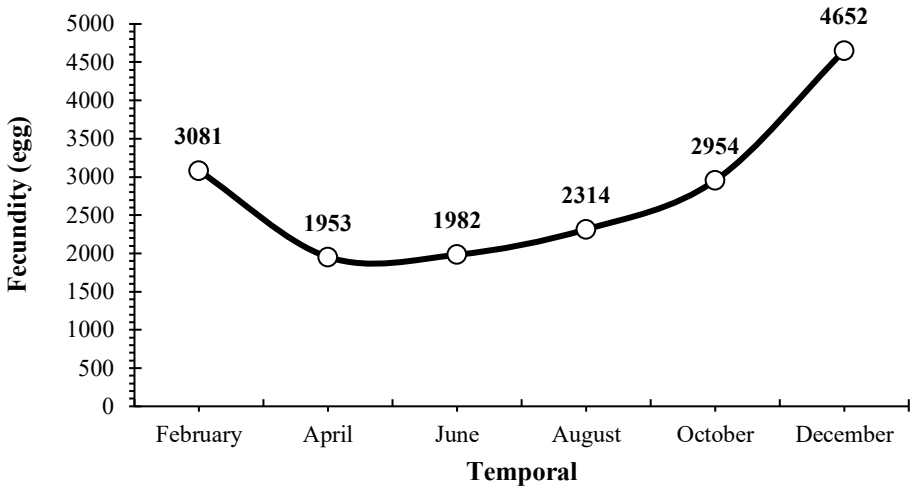


Figure 7. Fecundity of *S. rubripinnis* in Bodo River, Kebumen.

Based on Figure 7, it is obtained that the fecundity of *S. rubripinnis* in the Bodo River is the highest in December, with as many as 4652 eggs, and the lowest in April, with as few as 1953 eggs. The high and low values of fecundity are influenced by body weight. The more gonads increase, the greater the fecundity value. In addition, the Gonadosomatic Index is also positively correlated with increased fecundity [25]. Spawning frequency, egg size, water quality, and feed availability are important factors that affect fecundity [26].

3.6. Length of Maturity of *S. rubripinnis* in Bodo River, Kebumen.

Estimation of the size of the first mature gonads is one method to find information on the development of fish populations, such as the time before spawning, just spawning, or having spawned [27]. The size of the first mature gonads of *S. rubripinnis* differs between the male and female sexes. The difference is found in Figure 8, as follows.

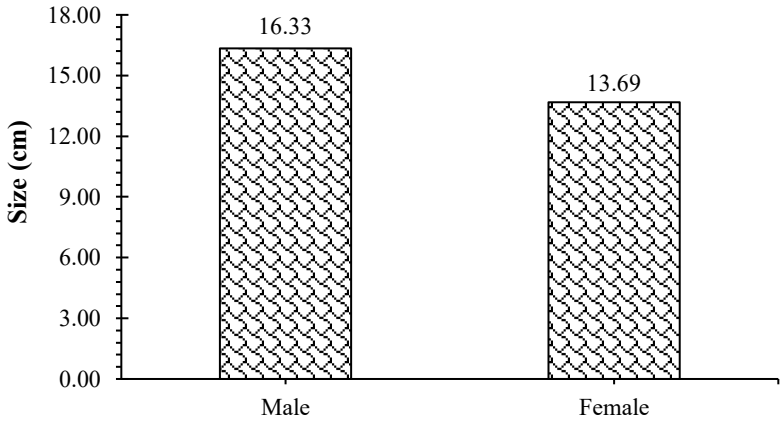


Figure 8. Length of Maturity (Lm) of *S. rubripinnis* in Bodo River, Kebumen.

The length of the first maturation of the gonads can be used to determine the size of the net if it is related to the length of the first catch [28]. Based on the results that have been obtained, the size of the first mature gonads of *S. rubripinnis* females (13.69 cm) is faster than that of male fish (16.33 cm). The same results were also obtained in the species *Cyclocheilichthys apogon*: Cyprinidae in the Sungai Menduk, Bangka Belitung, where the first mature size of female fish gonads is 20 cm larger than that of male fish, which is 16 cm [29]. The size of the

first mature gonads of each fish varies, either between species or within the same species [27]. The difference in size when the gonads first mature can be triggered by age, size, species differences, as well as physiological traits such as adaptability to the environment, and sex differences [30].

4. Conclusion

The sex ratio *of S. rubripinnis* shows a greater number of males than females, with a size distribution dominated by young fish (less than 13.6 cm). The maturity levels of gonads I and II peak in February and June, while stages III and IV are more common in December. The gonadosomatic index (GSI) was highest in December, with females showing much higher values (1.49-4.27) than males (0.03-0.51). Fecundity ranged from 1,953 to 4,652 eggs, with the highest value also observed in December. The size of the first mature gonads in females (13.69 cm) is earlier than in males (16.33 cm). Based on this, it can be assumed that the spawning of *S. rubripinnis* takes place in December.

5. Acknowledgement

The author would like to thank the LPPM for funding this research. Special thanks are also extended to the local community along the Bodo River, whose insights and hospitality have enriched my fieldwork experience. I also greatly appreciate the guidance and constructive input from my academic advisors, colleagues, and students, whose expertise has significantly contributed to this research.

References

[1]. Bataragoa, N. E. & Kambey, A. D. (2021). 'Spesies Ikan pada Sungai-Sungai di Semenanjung Utara Pulau Sulawesi'. *Platax*, 9(1), 66–88.

[2]. Zega, A., Telaumbanua, B. V. Laoli, D. & Zebua, R. D. (2023). 'Parameter Kualitas Fisik Perairan di Sungai Boyo Desa Onowaembo, Kecamatan Gunungsitoli, Kota Gunungsitoli'. *Jurnal Perikanan Tropis*., 10(2), 167–86. https://doi.org/10.5281/jpt.v10i2.2023.

[3]. PemKab Kebumen. (2016). 'Pantai Ayah - Kebumen'. *Diakses Pada 2015-10-29*.,.

[4]. Kottelat, M. & Whitten, T. (1996). Freshwater fishes of Western Indonesia and Sulawesi: additions and corrections. Periplus Editions Hong Kong.

[5]. Lumbantobing, D. (2019). 'Systomus rubripinnis:'. *IUCN Red List of Threatened Species*. https://doi.org/10.2305/IUCN.UK.2019-3.RLTS.T188062A1850240.en.

[6]. Nuryanto, A. Bhagawati, D. Abulias, M. N. & Indarmawan. (2015). 'Fauna Ikan di Sungai Cikawung Kabupaten Cilacap Jawa Tengah'. *Jurnal Iktiologi Indonesia*, 15(1), 25–37. https://doi.org/10.32491/jii.v15i1.73.

[7]. Susilo, U., Rachmawati, F. N., & Wibowo, E. S. (2022). 'Protease and Amylase Activities of Javaen barb (*Systomus rubripinnis* Val.)'. *Jurnal Biodjati*., 7(1), 45–55. https://doi.org/10.15575/biodjati.v7i1.15535.

[8]. Nuryanto, A. & Saprudin. (2024). 'DNA barcoding reveals possible misidentification of selected barb species (Cypriniformes) from Klawing River, Central Java, Indonesia'. *AACL Bioflux*, 17(2), 591–604.

[9]. Genovia, J. A. Barquilla, M. B. & Baludo, M. Y. (2023). 'Reproductive Biology of Rasbora Philippina At Lake Wood for Basis Management'. *Journal of Environmental Science and Sustainable Development*., 6(1), 149–66. https://doi.org/10.7454/jessd.v6i1.1112.

[10]. R. Domínguez-Petit, H. Murua, F. S.-R. and E. T. (2017). Applied Fisheries Reproductive Biology for Stock Assessment and Management.Vigo, Spain, 2–52.

[11]. Ayu, S. Putri, I. Khairul, K. & Harahap, H. S. (2025). 'Sex Ratio and Size Class of *Trichopsis vittata* in North Sumatra Province'. *Jurnal Bios Logos*, 15(1), 26–32. https://doi.org/10.35799/jbl.v15i1.58326.

[12]. Balogun, A. T., Ajibare, A. O. & Ojo, O. B. (2025). 'Sex Ratio, Gonado-Somatic Index and Hepato-Somatic Index of *Coptodon zilli* and *Oreochromis niloticus* Inhabiting Ureje Reservoir, Ado-Ekiti'. *Fudma Journal of Sciences*, 9(2), 1–5. https://doi.org/10.33003/fjs-2025-0902-2742.

[13]. Sultana, T., Mazumder, S. K., Kubra, J. Nishad, N. Khalil, S. M. I. Das, S. K. et al. (2022). 'A multidisciplinary method to assess the reproductive biology of Mystus bleekeri'. *Aquaculture and Fisheries*, 8(3), 280–7. https://doi.org/10.1016/j.aaf.2021.12.017.

[14]. Deshmukh, M. & Shillewar, K. (2023). 'A Study of Sex Ratio of Fresh Water Fish Puntius sarana From Godavari River at Nanded Region, Maharashtra State (India)'. *International Journal of Life Sciences Research*, 11(1), 71–3. https://doi.org/10.5281/zenodo.7762510.

[15]. Haryono Rahardjo, M. Affandi, R. & Mulyadi. (2015). 'Reproductive Biology of Barb Fish (Barbonymus balleroides Val. 1842) in Fragmented Habitat of Upstream Serayu River, Central Java, Indonesia'. *International Journal of Sciences: Basic and Applied Research*, 23(1), 189–200.

[16]. Rajbongshi, A. Phukan, B. Gogoi, R. Sharma, J. Najnin, A., & Barman, M. J. (2025). 'Seasonal Variation in the Reproductive Biology of Gangetic Mystus: Mystus cavasius (Hamilton-Buchanan, 1822) from the Brahmaputra River in Assam'. *Uttar Pradesh Journal of Zoology*, 46(10), 173–87. https://doi.org/10.56557/upjoz/2025/v46i104976.

[17]. Devlaming, V., Grossman, G. & Chapman, F. (1982). 'On the use of the gonosomatic index'. *Comparative Biochemistry and Physiology -- Part A: Physiology*., 73(1), 31–9. https://doi.org/10.1016/0300-9629(82)90088-3.

[18]. Holden, M. & Rait, D. F. (1975). 'Manual of Fisheries Science Part 2 - Methods of Resource Investigation and their application. Rome, Italy. FAO corporate document repository. Food and agriculture organization of the united nations, 115-211'.

[19]. Udupa, K. (1986). 'Statistical Method of Estimating the Size at First Maturity in Fishes'. *Fishbyte ICLARM*., 4(2), 8–10.

[20]. Tamsil, A. & Hasnidar, H. (2024). 'Reproductive biology of silver barb, Barbonymus gonionotus (Bleeker, 1850), in Lake Tempe, Indonesia'. *Iranian Journal of Fisheries Sciences*, 23(6), 877–92. https://doi.org/10.22092/ijfs.2024.131908.

[21]. Aibesa, Y. Mudjirahayu, M. Handayani, T. Manangkulangi, E. Toha, A. H. A. Simatauw, F. F. C. et al. (2022). 'Distribusi Ukuran dan Tingkat Kematangan Gonad Ikan Julung-Julung Hemiramphus lutkei (Valenciennes, 1847) yang diperdagangkan di Kabupaten Manokwari Papua Barat'. *Jurnal Ilmu Kelautan Dan Perikanan Papua*, 5(2), 73–81. https://doi.org/10.31957/acr.v5i2.2572.

[22]. Mote, N., Affandi, R. & Haryono, H. (2014). 'Biologi Reproduksi Ikan Brek (Barbonymus balleroides Cuvier & Val. 1842) di Sungai Serayu Zona Atas dan Bawah Waduk Panglima Besar Soedirman, Jawa Tengah'. *Jurnal Iktiologi Indonesia*, 14(2), 111–22.

[23]. Nugraha, M. R., Solichin, A. & Hendrarto, B. (2018). 'Aspek Reproduksi Ikan Wader Ijo (*Ostheochilus hasselti*) di Danau Rawapening Ambarawa, Kabupaten Semarang'. *Management of Aquatic Resources Journal (MAQUARES)*, 6(1), 77–86. https://doi.org/10.14710/marj.v6i1.19813.

[24]. Jasmine, S. & Begum, M. (2016). 'Biological aspects of Barbonymus gonionotus (Bleeker, 1849) in the Padma River, Bangladesh' 4(5), 661–5.

[25]. Mohamad, I. Farooz, I. Bhat, A. Balkhi, I. M. Tasaduq, I. Shah, H. et al. (2018). Relationship Among Body Weight, Body Length, Ovary Weight, and the Fecundity of *Cyprinus carpio* Var. Communis in Kashmir Himalaya. *Journal of Pharmacognosy and Phytochemistry*, 7(6), 2018–20. https://doi.org/10.22271/phyto.2018.v7.i6.6523.

[26]. Wagaw, S. Sisay, A. Bazezew, A. Enawgaw, Y.,& Wosnie, A. (2024). 'Aspects of *Oreochromis niloticus* (Linnaeus, 1758) in Geray Reservoir, Ethiopia for Effective Sustainable Fisheries'. *Fish Aquat Sci*., 27(2), 100–10. https://doi.org/10.47853/fas.2024.e11.

[27]. Tagarao, S. M., Solania, C. L., Jumawan, J. C., Masangcay, S. G., & Calagui, L. B. (2020). 'Length-Weight Relationship (LWR), Gonadosomatic Index (GSI) and Fecundity of *Johnius borneensis* (Bleeker, 1850) from Lower Agusan River basin, Butuan City, Philippines'. *J Aquac Res Development*, 11(6), 598. https://doi.org/10.35248/2155-9546.20.11.598.

[28]. Aswady, T. U. Asriyana & Halili. (2019). 'Rasio Kelamin dan Ukuran Pertama Kali Matang Gonad Ikan Kakatua (Scarus rivulatus Valenciennes , 1840) di Perairan Desa Tanjung Tiram , Kecamatan Moramo Utara, Kabupaten Konawe Selatan'. *Jurnal Manajemen Sumber Daya Perairan*, 4(2), 183–90.

[29]. Suhendra, C. Utami, E. & Umroh. (2017). 'Biologi Reproduksi Ikan Keperas (*Cyclocheilichthys apogon*) di Perairan Sungai Menduk Kabupaten Bangka'. *Akuatik Jurnal Sumberdaya Perairan*, 11(1), 1-11. https://doi.org/10.33019/akuatik.v12i2.697.

[30]. Setiyowati, D. & Mustofa, A. (2024). 'Kualitas Perairan Pantai Seribu Ranting Jepara'. *Jurnal Disprotek*, 15(1), 81–6. https://doi.org/10.34001/jdpt.