

Seasonal Fluctuations in the Sex Ratio of the Striped Snakehead, *Channa striata* (Bloch 1793), from Nagapur Dam, Maharashtra, India

Somnath B. Choure¹, Meghraj S. More², Jagdish V. Jagatkar³, and Anil N. Shelke^{*1}

¹Department and Zoology Research Centre, Mrs. Kesharbai Sonajirao Kshirsagar Alias Kaku Arts, Science & Commerce College, Beed - 431122, Maharashtra, India

²Department of Zoology, Maulana Azad College of A.S.C, Chhatrapati Sambhajnaga, India

³Department of Zoology, Vaidyanath College Parli Vaijnath, District Beed, MH, India

Received 11 November 2025 | Revised 13 December 2025 | Accepted 10 January 2026 | Available Online 06 February 2026

*Corresponding Author: Anil N. Shelke | Email Address: somphd27@gmail.com

Citation: Somnath B. Choure, Meghraj S. More, Jagdish V. Jagatkar, and Anil N. Shelke (2026). Seasonal Fluctuations in the Sex Ratio of the Striped Snakehead, *Channa striata* (Bloch 1793), from Nagapur Dam, Maharashtra, India. *Life Science Review*. DOI: <https://doi.org/10.51470/LSR.2026.10.01.27>

Abstract

The striped snakehead, *Channa striata*, is a commercially and ecologically significant freshwater fish in South and Southeast Asia. Sustainable management of its populations requires a thorough understanding of basic demographic parameters, such as the sex ratio. This study investigated the annual and seasonal sex ratio of *C. striata* in the Nagapur Dam, Beed district, Maharashtra, a semi-arid region for which such data is lacking. A total of 178 specimens were collected monthly from local fishermen from January to December 2024. Sex was determined through macroscopic and, when necessary, microscopic gonad examination. The overall annual sex ratio was 1.14:1 (male:female), which did not deviate significantly from the expected 1:1 ratio ($\chi^2 = 0.719$, $p > 0.05$). However, significant seasonal variations were observed. The sex ratio was balanced at 1:1 during summer but became significantly skewed towards females (1:1.78) during the monsoon ($\chi^2 = 5.062$, $p < 0.05$). A male-biased ratio (1.35:1) was observed in the post-monsoon season, though it was not statistically significant. The pronounced female bias during the monsoon is likely due to the increased vulnerability of gravid females to fishing gears during their spawning migration. These findings suggest that the current unregulated fishing during the breeding season could negatively impact recruitment. We recommend implementing a seasonal fishing closure during peak monsoon months to protect spawning females and ensure the long-term sustainability of this valuable fishery.

Keywords: *Channa striata*, sex ratio, seasonal variation, fishery management, Nagapur Dam, spawning, selective fishing.

1. INTRODUCTION

The sustainable management of inland fisheries is a critical challenge in tropical regions, where they serve as a vital source of nutrition and livelihood for millions. Success in this endeavour hinges on a comprehensive understanding of the biological and population parameters of key fishery species. The striped snakehead, *Channa striata* (Bloch 1793), is a highly adaptable, freshwater air-breathing fish belonging to the family Channidae. It is widely distributed across South and Southeast Asia, including various river systems and reservoirs in India. Ecologically, as a top-level predator, it plays a pivotal role in structuring aquatic food webs by regulating prey populations [15]. Economically, it is a highly prized food fish, renowned for its taste and nutritional value, commanding a strong market price that makes it a significant contributor to the income of small-scale fishers.

In the semi-arid Beed district of Maharashtra, where water resources are often limited, reservoirs like the Nagapur Dam

are crucial aquatic assets. The fishery in this dam is a classic example of a small-scale, multi-species operation, with *C. striata* representing one of the most valuable and prominent predatory species. The sustainability of this specific fishery, however, remains uncertain due to a lack of scientific data upon which to base management decisions.

Among the fundamental demographic parameters, the sex ratio of a fish population is a primary indicator of its health and reproductive stability. A ratio of 1:1 (male: female) is considered the evolutionarily stable strategy in most animal populations, as theorized by [4]. Significant deviations from this equilibrium can have profound implications. A skewed sex ratio can reduce the effective population size, limit genetic diversity, and ultimately impair reproductive success, leading to a population decline [12]. Such deviations can be driven by various factors, including differential growth rates, sex-specific mortality, habitat segregation, and, most notably, selective fishing pressure.

© 2026 by the authors. This is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) and source are credited. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>.

For instance, if a fishery selectively targets larger-sized individuals and one sex grows significantly larger, it can lead to the disproportionate removal of that sex from the population [7].

While the general biology and reproductive ecology of *C. striata* have been studied in other parts of India, such as the River Krishna [8] and the Ganga River [14], there is a stark paucity of information from the unique semi-arid climatic conditions of the Marathwada region. The hydrological regime of Nagapur Dam, characterized by distinct seasonal fluctuations, likely imposes specific pressures on the resident fish populations that may not be evident in perennial water bodies.

Therefore, these findings from this study will provide an essential baseline for understanding the population dynamics of *C. striata* in this region and form the scientific foundation for developing targeted conservation and sustainable harvest strategies.

2. MATERIALS AND METHODS

2.1. Study Area

The investigation was carried out at the Nagapur Dam (18°51' N, 76°32' E), an earth-fill dam on the Wan River near Parli Vaijnath in the Beed district of Maharashtra, India. The climate of the region is classified as semi-arid, with a distinct tri-seasonal pattern that heavily influences the reservoir's limnology and associated biota. The monsoon season (June to September) brings heavy rainfall, leading to a sharp rise in water level, increased turbidity, and a drop in surface water temperature. The post-monsoon season (October to January) is characterized by falling water levels and cooler temperatures, while the summer season (February to May) is marked by high atmospheric temperatures, significant evaporation, and the lowest water levels of the year, often concentrating the fish population. The study was conducted over a full annual cycle, from January to December 2024, to capture data across all three hydro-climatic seasons.

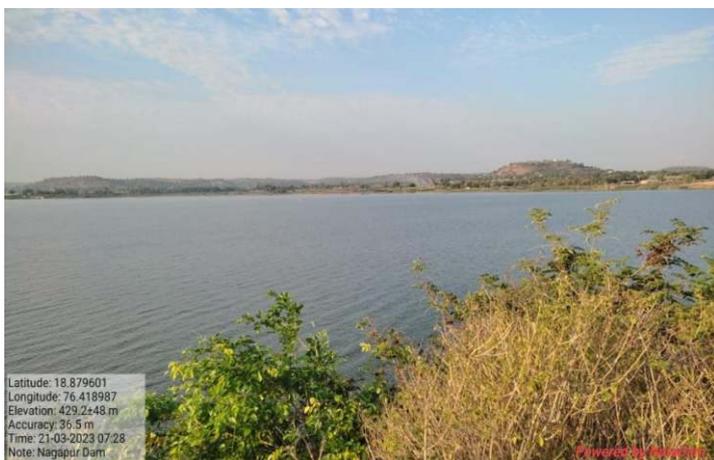


Fig. 1: Study site Nagapur Dam, Parli Vaijnath, District Beed.

2.2. Sample Collection

Fish specimens were collected on a monthly basis from the landing centres of local fishermen operating in the reservoir.

Sampling was designed to be random with respect to the fishermen's daily catch to ensure a representative sample of the population being exploited. The primary fishing gears employed by the fishers, and thus the source of our samples, were gill nets with stretched mesh sizes ranging from 20 mm to 60 mm and baited longlines.

Upon collection, each specimen was assigned a unique identification code. Morphometric data were recorded immediately to prevent errors due to post-mortem changes. The Total Length (TL) of each fish was measured to the nearest 0.1 cm using a standard measuring board. The Body Weight (BW) was recorded to the nearest gram using a calibrated portable digital balance (Laboratory Weighing Scales-1000gm). The fish were then preserved on ice in an insulated box and transported to the laboratory for further biological analysis.

2.3. Laboratory Procedure and Sex Identification

In the laboratory, each fish was dissected ventrally to expose the visceral cavity. The primary method for sex identification was macroscopic examination of the gonads. The gonads were carefully observed for their morphology, size, colour, and vascularization, following the standard keys provided by [7]:

- **Females:** Ovaries were paired, sac-like, and exhibited a highly lobulated or granular texture, especially in mature individuals. Their colour ranged from translucent or orange in immature stages to a deep yellow or orange in ripe individuals, often filling a significant portion of the body cavity.
- **Males:** Testes were also paired but were typically smooth, elongated, and flattened structures. They were generally creamy white or pale pink in colour and lacked the granular appearance of ovaries.

In cases where the gonads were small, regressed (e.g., in post-spawning phase), or the macroscopic features were ambiguous, a confirmatory microscopic examination was performed. A small tissue sample was teased apart on a glass slide with a drop of distilled water, covered with a coverslip, and observed under a compound microscope (Magnus MS-24) at 40x and 100x magnification. The identification was confirmed by the presence of oocytes (in females) or spermatozoa (in males).

2.4. Data Analysis

The sex ratio was calculated as the number of males per female. The analysis was conducted at three levels: (i) overall annual ratio, (ii) monthly ratio, and (iii) seasonal ratio (pooled by season as defined in 2.1). The null hypothesis that the observed sex ratio did not deviate significantly from the expected 1:1 parity was tested using the Chi-square (χ^2) goodness-of-fit test [20]. The formula applied was:

$$\chi^2 = \sum [(O - E)^2 / E]$$

where O is the observed number of individuals of a sex and E is the expected number (i.e., total sample size for the period divided by 2). A probability value of $p < 0.05$ was considered statistically significant. All statistical computations were performed using the in Statistics Department of Dr. Babasaheb Ambedkar Marathwada University Chhatrapati Sambhaji Nagar.

3. OBSERVATIONS

A total of 178 specimens of *Channa striata* were procured and examined over the 12-month study period. The population sampled displayed a wide size range, with total length varying from 18.5 cm to 42.0 cm and body weight from 85 g to 810 g. This size distribution confirmed that the sampling captured a spectrum of the population, from sub-adults to large, mature adults, which is crucial for a representative demographic analysis.

The process of gonad examination was highly effective. Macroscopic identification was unequivocal for 170 specimens (95.5% of the total), primarily during the developing, mature, and spawning stages. The eight specimens that required microscopic examination were predominantly collected during the late post-monsoon and early summer months, a period corresponding to the sexually regressed or resting phase, where gonads were shrunken and less distinctive.

The monthly breakdown of the collected specimens, detailed in Table 1, reveals clear fluctuations in the catch composition of males and females. The data for April and November have been updated as per the revised values, which has consequently altered the seasonal and overall totals.

Table 1: Monthly Sex Distribution of *Channa striata* from Nagapur Dam

(n=178)

Month	Season	No. of Males	No. of Females	Total Monthly Catch	Monthly Sex Ratio (M:F)
January	Post-Monsoon	9	7	16	1.29 : 1
February	Summer	11	9	20	1.22 : 1
March	Summer	8	12	20	1 : 1.5
April	Summer	9	8	17	1.12 : 1
May	Summer	7	9	16	1 : 1.29
June	Monsoon	6	10	16	1 : 1.67
July	Monsoon	5	11	16	1 : 2.2
August	Monsoon	4	12	16	1 : 3.0
September	Monsoon	8	8	16	1 : 1
October	Post-Monsoon	9	7	16	1.29 : 1
November	Post-Monsoon	13	11	24	1.18 : 1
December	Post-Monsoon	7	9	16	1 : 1.29
Total		96	114	178	1.14 : 1

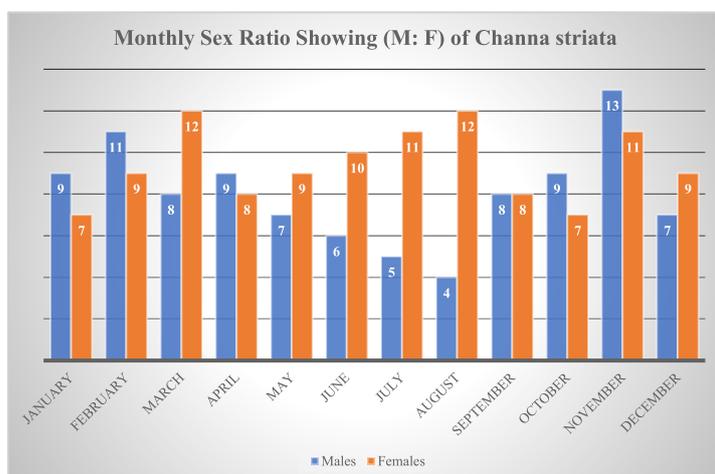


Fig.2. A: Female *Channa striata* & B: Male *Channa striata*.

Fig.3: Graphical representation of the monthly sex ratio showing (M: F) of *Channa striata* in Nagapur Dam, showing a distinct peak in female proportion during the monsoon months (June-August).

To elucidate these seasonal trends, the monthly data was aggregated into the three predefined seasons. The consolidated seasonal data, presented in Table 2, provides a clearer picture of the demographic shifts occurring throughout the annual cycle. The totals have been recalculated based on the revised monthly figures.

Table 2: Seasonal Sex Distribution of *Channa striata*

Season	No. of Males	No. of Females	Total Catch	Sex Ratio (M:F)	χ^2 value	p-value
Summer	35	38	73	1 : 1.09	0.123	> 0.05
Monsoon	23	41	64	1 : 1.78	5.062	< 0.05
Post-Monsoon	38	28	66	1.35 : 1	1.515	> 0.05
Overall	96	82	178	1.14 : 1	0.719	> 0.05

4. RESULTS

The detailed analysis of the sex ratio data, incorporating the revised figures for April and November, yielded the following results:

1. Overall Sex Ratio: The annual pool of 178 specimens comprised 96 males and 82 females. This resulted in an overall sex ratio of 1.14:1 (male: female). The Chi-square goodness-of-fit test ($\chi^2 = 0.719$, $df = 1$, $p > 0.05$) confirmed that this slight male bias was not statistically significant, indicating that the population, when viewed over the entire year, is in a state of demographic equilibrium.

2. Monthly Sex Ratio Fluctuations: A more granular, month-by-month analysis revealed significant variability that was masked in the annual average. The most striking deviations were observed during the monsoon period. The month of July had a ratio of 1:2.2, and August was even more skewed at 1:3.0, representing a three-fold increase in the capture of females compared to males. The revised ratios for April (1.12:1) and November (1.18:1) show a milder male bias compared to the previous data. These monthly fluctuations are presented graphically in Figure 2, which clearly illustrates the trend of increasing female proportion leading into the peak monsoon.

3. Seasonal Sex Ratio Dynamics: The aggregation of data into seasons provided robust statistical insights:

- **Summer (Feb-May):** The sex ratio was 1:1.09 (35 males and 38 females). The Chi-square test confirmed no significant deviation from the expected 1:1 ratio ($\chi^2 = 0.123$, $p > 0.05$).
- **Monsoon (Jun-Sept):** The sex ratio was significantly skewed, with a value of 1:1.78 (23 males: 41 females). This deviation from the expected 1:1 ratio was found to be statistically significant ($\chi^2 = 5.062$, $p < 0.05$).
- **Post-Monsoon (Oct-Jan):** The ratio was calculated at 1.35:1 (38 males: 28 females), indicating a male bias. However, this deviation was not statistically significant ($\chi^2 = 1.515$, $p > 0.05$).

In summary, the key finding of this study is the presence of a stable annual sex ratio but a dynamically shifting seasonal ratio, characterized by a statistically significant female bias during the critical monsoon spawning season.

5. DISCUSSION

The findings of this study provide crucial insights into the population dynamics of *Channa striata* in Nagapur Dam, revealing complex interactions between biological characteristics and fishing pressures.

The overall sex ratio of 1.14:1 (male:female) observed in this study aligns with Fisher's principle of natural selection, which predicts an evolutionary trend toward 1:1 sex ratio in stable populations [4]. This equilibrium suggests that, on an annual basis, the population maintains demographic stability without consistent, unidirectional pressures disproportionately affecting either sex. Similar balanced ratios have been reported for *C. striata* in other Indian water bodies [2] and for other freshwater species in the region, including *Mastacembelus armatus* [1].

The most significant finding of this investigation is the marked seasonal fluctuation in sex ratio, particularly the pronounced female bias (1:1.78) during the monsoon season. This pattern can be attributed to several interconnected biological and behavioural factors related to the species' reproductive ecology. *C. striata* is a known seasonal breeder whose reproductive cycle is synchronized with the monsoon period [8]. The environmental cues of increased photoperiod, rainfall, and rising water levels trigger physiological changes that prepare the fish for spawning. Studies on related species have demonstrated significant increases in gonadosomatic index (GSI) during pre-monsoon and monsoon months, indicating active gonad development and maturation [5] [11]. During the peak spawning period, gravid females exhibit distinct behavioural changes that increase their vulnerability to fishing gear. The increased mobility in search of suitable spawning grounds, combined with their bulkier body condition due to mature ovaries, makes them more susceptible to capture in gill nets. This phenomenon of spawning aggregation fisheries leading to sex-selective harvest is well-documented in various fish species [7]. [3] reported similar patterns in *C. striata* from Philippine waters, where females dominated catches during breeding seasons due to their spawning migrations.

The physiological investment in reproduction differs substantially between sexes, with females bearing higher energetic costs for egg production and maturation. Research on *Channa gachua* has shown that females allocate significant resources to vitellogenesis and oocyte development, making them more conspicuous and vulnerable during spawning periods [5]. This differential reproductive investment creates temporal windows where one sex becomes disproportionately available to fishing gear.

The shift toward male bias (1.35:1) in the post-monsoon season represents a complex interplay of post-reproductive mortality and behavioural factors. The substantial energetic expenditure during spawning likely renders female *C. striata* more susceptible to post-spawning mortality, physiological stress, and predation.

Similar patterns of increased female mortality following reproduction have been observed in other tropical fish species, including *Micropogonias furnieri* [18]. The parental care behaviour exhibited by male *C. striata*, which involves guarding eggs and fry [15], may initially reduce their vulnerability to fishing pressure. However, this protective behaviour is energetically demanding and may contribute to increased catchability once parental duties conclude.

The balanced sex ratio observed during summer months (1:1.09) reflects a period of reproductive quiescence and population stability. During this phase, fish are less segregated by reproductive behaviours and exhibit more uniform distribution patterns. This seasonal stabilization has been documented in various tropical fish species, including *Leiognathus berbis* [19] and *Channa bleheri* [13], where non-breeding seasons typically show more balanced sex ratios.

Contextualizing our findings within broader ichthyological research reveals both consistencies and variations in sex ratio patterns among snakeheads and related species. [11] reported a consistent male-dominated ratio (1.5:1) for *Channa punctatus* in lentic ecosystems of Bangladesh, attributing this pattern to sex-specific growth rates and mortality. Similarly, studies on *Channa bleheri* have documented sexual dimorphism that could influence catchability and sex ratio data [13]. These interspecific variations underscore that sex ratios are not fixed species-specific traits but rather dynamic parameters influenced by local environmental conditions, fishing pressure, and population-specific characteristics.

The contrast between our findings and those from other regions highlights the importance of location-specific studies. The semi-arid environment of Nagapur Dam, with its pronounced seasonal hydrology and distinct fishing pressures, creates unique selective pressures that shape population dynamics differently from perennial floodplain wetlands or riverine systems.

Fishery Management Implications

The significant female bias observed during the monsoon spawning season has profound implications for fishery sustainability. The selective removal of mature females during peak reproductive periods represents a substantial threat to population recruitment and long-term viability. As emphasized by [10], the reproductive value of large, mature females disproportionately influences future population levels, as fecundity typically increases exponentially with fish size.

Based on our findings, we recommend implementing a seasonal fishing closure during July and August, coinciding with peak spawning activity. This management strategy has proven effective in various tropical fisheries for protecting spawning stocks and ensuring sustainable recruitment. Additionally, regulations on minimum mesh sizes for gill nets could reduce the capture of immature individuals, thereby protecting the stock before it reaches reproductive maturity. Studies on Indian major carps have demonstrated the effectiveness of mesh size regulations in maintaining

sustainable fisheries [17].

The establishment of length-weight relationships and condition factors, as conducted for *C. striata* in other regions [16] [3], would provide valuable supplementary data for assessing population health and implementing size-based management measures.

Future Research Directions

This study identifies several promising avenues for future research. Detailed investigations into fecundity, spawning frequency, and gonadosomatic index (GSI) variations, following methodologies employed by [1] and [3], would provide deeper insights into the reproductive biology of *C. striata* in this ecosystem. Research on length-weight relationships and condition factors, as conducted for various freshwater species [6] [9], would enhance our understanding of population health and growth patterns.

The integration of catch-per-unit-effort (CPUE) data with biological parameters would enable more precise quantification of fishing impacts and support the development of data-driven management strategies. Long-term monitoring programs would also facilitate the detection of temporal trends and the evaluation of management intervention effectiveness.

CONCLUSION

In conclusion, this study demonstrates that while *C. striata* in Nagapur Dam maintains an annually balanced sex ratio, significant seasonal fluctuations occur, driven primarily by reproductive behaviour and fishing patterns. The female-biased ratio during the monsoon spawning season underscores the vulnerability of gravid females to fishing pressure and highlights the need for targeted management interventions. By integrating our findings with comparative research on related species, we have identified both universal patterns and location-specific dynamics that should inform conservation and management strategies for this valuable fishery resource. The implementation of seasonal fishing closures and mesh size regulations, coupled with continued research on reproductive biology and population dynamics, will be essential for ensuring the long-term sustainability of the *C. striata* fishery in Nagapur Dam.

REFERENCES

1. Ahirrao, S. D. (2002). Status of gonads in relation to total length (TL) and gonadosomatic index (GSI) in freshwater spiny eel (pisces) *Mastacembelus armatus* (Lacepede) from Marathwada region, Maharashtra. *Journal of Aqua Biology*, 17(2), 55–57.
2. Bhatt, J. P., Nautiyal, P., & Singh, H. R. (2000). Population structure of Himalayan mahseer, a large cyprinid fish in the regulated foothill section of the river Ganga. *Fisheries Research*, 44(3), 267–271. [https://doi.org/10.1016/S0165-7836\(99\)00083-1](https://doi.org/10.1016/S0165-7836(99)00083-1)

3. Dumalagan, F. A., Juarlito, B. G., & Lilia, Z. B. (2017). Reproductive biology, length-weight relationship, and condition factor of *Channa striata* (Bloch, 1793) from tributaries of Lake Kilobidan, Agusan Marsh. Philippines. *International Journal of Computing, Communications and Instrumentation Engineering (IJCCIE)*, 4(1), 2349–1477.
4. Fisher, R. A. (1958). *The genetical theory of natural selection* (2nd ed.). Dover Publications.
5. Gaikwad, M. V., Shingare, S. M., Hiwarale, D. K., More, V. R., & Khillare, Y. K. (2009). Study on the gonado-somatic and fecundity relationship in the air-breathing fish *Channa gachua* (Ham. 1822) from Godavari near Aurangabad. *African Journal of Basic & Applied Sciences*, 1(1-2), 59–61.
6. Gupta, S., & Banerjee, S. (2015). Length-weight relationship of *Mystus tengara* (Ham-Buch., 1822), a freshwater catfish of the Indian subcontinent. *International Journal of Aquatic Biology*, 3(2), 114–118.
7. Jhingran, V. G. (1991). *Fish and fisheries of India*. Hindustan Publishing Corporation.
8. Krishna, P. V., Dedeepya, P., Aradhya Sarma, B. V. L., & Saroja, K. (2024). Reproductive biology of striped snakehead *Channa striata* inhabiting the River Krishna. *International Journal of Advanced Research*, 12(9), 375–385. <https://doi.org/10.21474/IJAR01/19465>
9. Kumar, D. B., Singh, N. R., Bink, D., & Deveshish, K. (2014). Length-weight relationship of *Labeo rohita* and *Labeo gonius* (Hamilton-Buchanan) from Sone Beel, the biggest wetland of Assam. *Indian Journal of Environmental Research and Development*, 8(3), 591–595.
10. Lorenzen, K. (2014). Understanding and managing enhancements: why fisheries scientists should care. *Journal of Fish Biology*, 85(6), 1807–1829. <https://doi.org/10.1111/jfb.12542>
11. Mian, S., Hossain, M. A., & Shah, A. W. (2017). Sex ratio, fecundity, and gonadosomatic index of spotted snakehead, *Channa punctatus* (Channidae), from a lentic ecosystem. *International Journal of Fisheries and Aquatic Studies*, 5(1), 360–363.
12. Nikolsky, G. V. (1963). *The ecology of fishes*. Academic Press.
13. Rinku, G., Behera, S., Bibha, C. B., & Sonmoina, B. (2013). Sexual dimorphism and gonadal development of a rare murrel species, *Channa bleheri* (Bleher), in Assam. *The Bioscan*, 8(4), 1265–1269.
14. Singh, M., Serajuddin, M., & Mustafa, S. (2020). Age and growth of the striped snakehead, *Channa striata* (Bloch, 1793) from the Ganga River, India. *Indian Journal of Fisheries*, 67(2), 1–8.
15. Talwar, P. K., & Jhingran, A. G. (1991). *Inland fishes of India and adjacent countries* (Vol. 2). Oxford & IBH Publishing Co.
16. Toke, Y. Y., & Aung, N. N. (2020). Estimation of length-weight relationship and condition factor of freshwater commercial fish *Channa striata* (Bloch., 1793) from Pantanaw environs, Ayeyarwady region. *Banmaw University Research Journal*, 11(1), 227–303.
17. Ujjania, N. C., Kohli, M. P. S., & Sharma, L. I. (2013). Length-weight relationship and condition factors of Indian major carps *C. catla*, *L. rohita*, and *C. mrigala* in Mahi Bajaj Sagar, India. *Research Journal of Biology*, 2(1), 30–36.
18. Vicentini, R. N., & Araujo, F. G. (2003). Sex ratio and size structure of *Micropogonias furnieri* (Desmarest, 1823) (Perciformes, Sciaenidae) in Sepetiba Bay, Rio de Janeiro, Brazil. *Brazilian Journal of Biology*, 63(4), 559–566. <https://doi.org/10.1590/S1519-69842003000400003>
19. Wardhani, D. K., Omar, S. B., Tresnati, J., & Umar, M. T. (2024). Sex ratio and length at first maturity of the berber ponyfish, *Leiognathus berbis*, at Takalar waters, South Sulawesi, Indonesia. *Aquaculture, Aquarium, Conservation & Legislation*, 17(5), 1673–1685.
20. Zar, J. H. (1999). *Biostatistical analysis* (4th ed.). Prentice-Hall.