p ISSN 1693-0339
e ISSN 2579-8634

Jurnal Iktiologi Indonesia

(Indonesian Journal of Ichthyology)

Volume 23 Number 1 February 2026

Published by:
Masyarakat Iktiologi Indonesia
(The Indonesian Ichthyological Society)

Jurnal Iktiologi Indonesia

(*Indonesian Journal of Ichthyology*)

p ISSN 1693-0339

e ISSN 2579-8634

Jurnal Iktiologi Indonesia was established in 2000,
the journal resumed publication in February 2026 following a temporary publication hiatus

Volume 23 Number 1 February 2026

Gd. Widyasatwaloka, Bidang Zoologi, Badan Riset dan Inovasi Nasional/BRIN
Jln. Raya Jakarta-Bogor Km 46, Cibinong 16911, West Java, Indonesia
Website: jurnal-iktiologi.org
Website: www.iktiologi-indonesia.or.id
E-mail : jurnal.iktiologi@gmail.com

Jurnal Iktiologi Indonesia (JII) is a peer-reviewed scientific journal published by the Masyarakat Iktiologi Indonesia (Indonesian Ichthyological Society). The journal that publishes three times a year, covering original research articles covering all aspects of fish (Pisces) in freshwater, brackish, and marine environments. The journal encompasses a broad range of disciplines, including fish biology, physiology, taxonomy and systematics, genetics, and ecology, as well as their applications in capture fisheries, aquaculture, fisheries management, and conservation.

Kapuasia falaris
(photo source: Tan Heok Hui)

Foreword

After a two-year publication hiatus, Jurnal Iktiologi Indonesia (the Indonesian Journal of Ichthyology) is pleased to resume its publication in 2026. The Editorial Board sincerely appreciates the continued support and encouragement from authors, reviewers, readers, and the Indonesian Ichthyological Society, which have made the journal's revival possible.

Beginning with the 2026 publication, the Indonesian Journal of Ichthyology publishes all accepted manuscripts exclusively in English. This policy is intended to enhance the journal's international visibility, broaden its readership, and strengthen its contribution to the global ichthyological research community. We hope that this renewed publication and new language policy will further promote the dissemination of high-quality scientific knowledge on fishes and fisheries, both in Indonesia and internationally.

The February 2026 issue features five articles focusing on the ecology and biology of fishes inhabiting natural waters.

The first article, by Hanif *et al*., describes Morphological and Morphometric Characteristics of Otolith Tinfoil Barb in The Kamijoro Dam, Kulon Progo Regency. It is followed by a paper by Astuti *et al*., which discusses Biodiversity of Ichthyofauna in The Pabelan River, Magelang Regency. The third article, by Nuur *et al.,* reports on the Fish Species Diversity in The Krasak River Srumbung Subdistrict Magelang Regency Central Java. The fourth paper, by Adiara *et al*., presents a study on Diet Composition and Feeding Habits of the Gobiid Fish *Eleotris fusca* in the Ummiding River, Polewali Mandar, West Sulawesi Finally, this issue concludes with an article on Reproductive Biology of the Goby *Sicyopterus longifilis* from the Matama River, West Sulawesi, Indonesia by Tikawati *et al.*

We hope that the articles published in this issue will contribute to the advancement of ichthyological science and inspire further research. The Editorial Board is committed to maintaining the quality and regular publication of the journal in the years to come.

We wish you an enjoyable and rewarding reading experience.

The Editors.

Morphological and Morphometric Characteristics of Otolith Tinfoil Barb (*Barbonymus Schwanefeldii* Bleeker, 1854) in The Kamijoro Dam, Kulon Progo Regency

Navida Vinca Hanif*[1], Astuti[1], Ainun Rodhiyah Nurhayati[1], Maryam Tirta Nuur[1], Nurul Azizah Puteri Rahma Dewi[1], Tony Budi Satriyo[1], Eko Hardianto[1]

[1]Department of Fisheries, Faculty of Agriculture, Universitas Gadjah Mada, Jl. Flora, Bulaksumur, Yogyakarta 555281, Indonesia
*Author: navidavincahanif@mail.ugm.ac.id

Recieved: January 5, 2026; Accepted: February 28, 2026

Abstract

The Tinfoil barb (*Barbonymus schwanefeldii*) is a freshwater fish in the family Cyprinidae, commonly found in Southeast Asia, including the waters of the Kamijoro Dam in Yogyakarta. This study aims to analyse the morphological and morphometric characteristics of the otoliths of Tinfoil barb across fish size classes. The study was conducted from October to December 2025. A total of 267 Tinfoil barb samples were collected and grouped into three size classes: small (8.5 – 14.9 cm), medium (15.0 – 18.9 cm), and large (19.0 – 29.0 cm). The otoliths used were of the sagitta type, and the following parameters were measured: length, width, area, perimeter, weight, and six otolith shape indices. The result showed that Tinfoil barb otoliths are asymmetrically elliptical in shape with a heterosulcoid sulcus type. All analyzed otolith morphometric parameters showed a significant increase as fish body size increased ($p < 0.001$). The small-sized group showed mean values for the OL, OW, OA, OP, and OWt parameters of 0.282 ± 0.044 cm; 0.219 ± 0.030 cm; 0.042 ± 0.012 cm²; 0.933 ± 0.149 cm; and 0.002 ± 0.001 g. The medium-sized class had mean values for OL, OW, OA, OP, and OWt parameters of 0.352 ± 0.037 cm; 0.261 ± 0.021 cm; 0.060 ± 0.010 cm²; 1.176 ± 0.125 cm; and 0.004 ± 0.001 g. The large size class showed average values for OL, OW, OA, OP, and OWt of 1.518 ± 6.000 cm; 1.383 ± 6.023 cm; 1.152 ± 6.063 cm²; 2.719 ± 5.813 cm; and 1.036 ± 6.084 g. The relationship between fish length and otolith parameters was positive, with a coefficient of determination value ranging from indices that reflect ontogenetic changes, namely a decrease in roundness, form factor, and rectangularity, as well as an increase in circularity, aspect ratio, and ellipticity, indicating a change in shape from a transparent, round form to a more elongated, compact, and complex one.

Keywords: population, tengadak, shape index, and waters

Introduction

The Kamijoro Dam is a water resources infrastructure facility located on the border between Bantul and Kulon Progo Regencies in the Special Region of Yogyakarta. It dams the Progo River and provides irrigation water for the Pijenan District, covering an area of 2,370 hectares. According to Kementerian PUPR (2015), the dam's primary functions are to provide irrigation water, raw water, and flood control during the rainy season. Beyond its hydrological functions, the dam area has become a tourist attraction and a public space for local community fishing. These activities indicate that the waters of the Kamijoro Dam possess significant biological resource potential, particularly in terms of the diversity of freshwater fish inhabiting the Progo River.

One of the fish species frequently caught in the Kamijoro Dam area is the Tinfoil barb (*Barbonymus schwanefeldii*). This fish belongs to the family Cyprinidae, is benthopelagic, and is widely distributed in Southeast

Asian waters, including Java and Kalimantan (Dahruddin *et al*., 2021; Froese & Pauly, 2025; van der Laan & Fricke, 2023). The Tinfoil barb holds significant economic value as both a food and an ornamental fish (Apriani *et al*., 2025). Optimal management of fishery resources requires adequate biological information, including studies on otolith structure. In addition, research by Akmal *et al* (2025) succeeded in revealing morphological variations between *B. schwanefeldii* populations related to adaptation to different habitats. Another study showed that *B. schwanenfeldii* and *Barbonymus* sp. have overlapping morphological characteristics, while *B. gonionotus* is clearly different. Therefore, it is assumed that *B. schwanenfeldii* and *Barbonymus* sp. are the same species of *B. schwanenfeldii* (Batubara *et al*., 2018; Efizon *et al.*, 2021). Although geographical environmental conditions can be the main factor in the occurrence of different external morphological and otolith adaptations; however, with the analysis of morphological and otolith descriptions, it turns out that they can be used as indicators of genus apomorphy (Samuel *et al.,* 2025). Although there are many floating net cages in general waters, the results of research by Sari *et al.* (2022) show that there are no significant morphological and meristic differences between fish living in areas with cages or in areas without floating net cages.

Otoliths (fish ear stones) are hard structures composed of calcium carbonate and organic proteins found in the inner ear of teleost fish (Popper & Fay, 2011). In addition to serving as organs of balance and hearing, otoliths exhibit specific morphological and morphometric characteristics that vary by species, making them useful for species identification, stock assessment, and aquatic ecological studies (Campana, 2004). Morphometric parameters of otoliths, such as length, width, area, perimeter, and weight, as well as shape indices (roundness, form factor, aspect ratio, circularity, rectangularity, and ellipticity), can reflect differences in habitat, life history, and environmental factors that influence fish growth (Tuset *et al*., 2008; Kontas & Bostanci, 2015). Furthermore, the research results of Bostancı and Yedier (2018) stated that otolith morphometry can provide an easy and reliable discrimination tool for invasive fish populations. According to Chalupnicki and Dittman (2016) using a new laboratory method to enter the brain cavity from the ventral side of the fish to expose the otoliths more easily than other otolith extraction methods found in the literature. Also according to D'Iglio *et al.* (2024) comprehensive research on otoliths shows variability in geographically related otolith features and size, which may be related to genetics, environmental conditions, and variations in living habits. Research into otoliths (fish ear stones) provides vital demographic data—such as age, growth rates, stock structure, and migration patterns—needed to understand fishing impacts, define harvest strategies, and support sustainable management in tropical fisheries (Green *et al.*, 2009).

Fish body size indicates an individual's growth stage. Small fish are generally referred to as juveniles, while large fish represent the adult stage. The relationship between water quality and the psychological response of juvenile tinfoil barb fish, recorded an optimal pH of around 6-7 (Oktavia *et al.*, 2024) As body size increases, the otolith also undergoes structural development, as evidenced by changes in its morphology and morphometry. In small fish, otoliths tend to be transparent with an immature morphological structure; conversely, in adult fish, the morphology of the otolith becomes denser, opaque, and more complex (Campana & Thorrold, 2001). Therefore, analysis of variations in fish size is a key factor in understanding the ontogenetic growth patterns of otoliths, which can be used to estimate fish age and life history. According to Breton *et al*. (2013), using the Huggins mark–recapture model were simple method for correcting length-frequency estimates for imperfect detection could be widely applied when mark–recapture data are available. According to Erzini (1990) the use of the modified Bhattacharya method, shows that life history characteristics must be taken into account when designing sampling strategies for length frequency-based analysis. In addition, several researchers concluded that otolith shape analysis can help fish identification activities (Rai & Rani, 2022).

Although the Tinfoil barb has ecological and economic value, research on its otolith characteristics remains very limited, particularly in Indonesian waters. This study aims to: (1) analyze the morphological characteristics of Tinfoil barb (*Barbonymus schwanefeldii*) otoliths found in the Kamijoro Dam area; (2) analyze the relationship between otolith morphometric parameters and Tinfoil barb body size; and (3) describe variations in the shape and size of Tinfoil barb otoliths based on fish size classes. The results of this study are expected to provide scientific data on the otolith characteristics of the Tinfoil barb as a basic reference for fish biology studies in tropical waters and to support strategies for the sustainable management and conservation of fish resources. If public waters are managed properly, according to Kartamihardja *et al*. (2009), it will have an impact on increasing production by at least 20% and ecological function, so that inland public water fisheries can be used as a mainstay for the economic development of the community, especially fishermen.

Materials and Methods

Study Site

The study was conducted at the Kamijoro Dam, located on the border of Bantul and Kulon Progo Regencies in the Special Region of Yogyakarta, specifically along the Progo River. Fish and otolith samples were collected from October to December 2025. Sample analysis was performed at the performed at

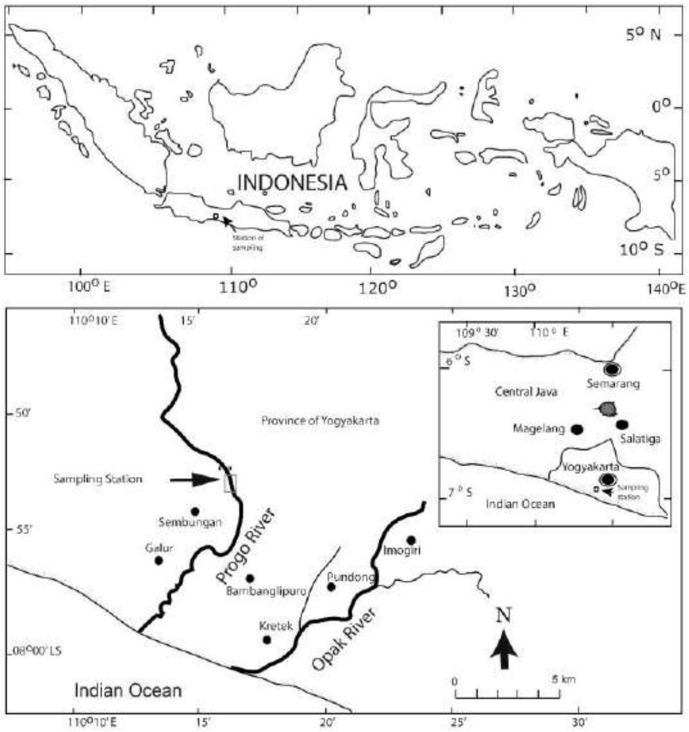

Figure 1. Map of the Kamijoro dam located downstream of the Progo River as a sampling for fish sampling

the Fisheries Resource Management Laboratory and the Aquatic Ecology Laboratory, Department of Fisheries, Gadjah Mada University (Fig. 1).

Sample Collection and Handling

Samples of Tinfoil barb (*Barbonymus schwanefeldii*) were collected from catches made using Wadhong gandul fishing gear in the waters around the Kamijoro Dam. The collected fish were stored in a cool box filled with ice to maintain their quality during transport to the laboratory. Next, the fish were measured for total length (TL) to 0.1 cm precision with a ruler and weighed on a digital scale. The fish were then dissected to determine sex based on gonad observation. The otolith samples from the right and left sides were morphometrically similar.

The asteriscus otoliths are oval, elongated, and have a regular surface (Kantun *et al*., 2024).

Fish Size Class Grouping

Size class grouping based on total fish length used the Sturges (1926) formula to determine the optimal number of classes, calculated as:

$$K = 1 + 3.3 \log n$$

n = Total number of samples

Based on the calculation results, the class interval obtained was 6.83 cm (rounded to 7 cm). The fish were grouped into three size classes: small (8.5 – 14.9 cm; juvenile phase), medium (15.0 – 18.9 cm; subadult phase), and large (19.0 – 29.0 cm; adult phase). The classification of size classes into three categories is based on a general approach in otolith morphometric research that accounts

Table 1. Morphometric indices of otolith shape

Shape Index	Formula	Description
Roundness (R_O)	$4O_A/\pi O_L^2$	Compares the otolith shape with a perfect circle. $R_O = 1$ indicates a perfect circular shape.
Form Factor (F_F)	$4\pi O_A/O_P^2$	Indicates the level of surface regularity of the otolith. $F_F = 1$ indicates a regular surface $F_F < 1$ indicates an irregular surface
Rectangularity (R_t)	$O_A/(O_L.O_W)$	Indicates the variation in otolith length and width relative to the area. $R_t = 1$ indicates a perfectly rectangular otolith.
Circularity (C)	O_P^2/O_A	Compares the otolith shape with a perfect circle. C = 0 indicates a perfect circular shape. Determines the otolith shape.
Aspect ratio (A_R)	O_L/O_W	$A_R > 1$ indicates an elongated otolith shape.
Ellipticity (E)	$\frac{OL - OW}{(OL + OW)}$	Indicates the occurrence of proportional changes in axes. E < 1 indicates an oval-shaped otolith.

for variations in fish body size across growth phases, such as juvenile, subadult, and adult. Based on the calculation results, the class interval obtained was 6.83 cm (rounded to 7 cm). The fish were grouped into three size classes: small (8.5 – 14.9 cm; juvenile phase), medium (15.0 – 18.9 cm; subadult phase), and large (19.0 – 29.0 cm; adult phase). The classification of size classes into three categories is based on a general approach in otolith morphometric research that accounts for variations in fish body size across growth phases, such as juvenile, subadult, and adult. This statement is supported by otolith studies showing that otolith structure and morphology change as individuals grow from juveniles to adults (Tonheim *et al*., 2020).

Otolith Extraction

Extraction of sagitta-type otoliths was performed using the ventral method through the gill cavity (up-through-the-gills method), as described by Secor *et al*. (1992). The fish were placed with their ventral side facing upward, and the gill arches were placed with their ventral side facing upward, and the gill arches were incised to expose the opercular cavity. The shiny white sagitta otolith was removed from the otic capsule behind the eye socket using fine-tipped forceps. The otolith was then cleaned of attached tissues with bleach (Bayclin), dried at room temperature, and stored in a labeled, sealed plastic cup.

Otolith Imaging and Morphometric Measurements

Otolith images were captured using a cell phone camera and a mini photobox with a black paper background to optimize contrast. The otoliths were placed on graph paper as a calibration scale, with the sulcus acustucis oriented upward. Otolith morphometric parameters were measured using ImageJ software, including: otolith length (OL; cm), otolith width (Ow; cm), otolith area (OA; cm^2) and otolith perimeter (OP; cm). Otolith weight (OWt; g) was measured using an analytical balance with a precision of 0.0001 g.

Figure 2. Morphology of Tinfoil barb (*Barbonymus schwanefeldii*)
(source: FishBase, 2025)

Otolith Shape Indices

Six otolith shape indices were calculated from the morphometric parameters using formula from Tuset *et al*. (2003) and Kontas & Bostanci (2015) (Table 1).

Data Analysis

The data were statistically analyzed using OriginPro 2026 software. Descriptive statis-tics (minimum, maximum, mean, and standard deviation) were presented for all otolith morphometric parameters based on variations in body size, sex, and otolith location (left and right). The Shapiro-Wilk test was used to assess the normality of the data. Since the data were not normally distributed ($p < 0.05$), comparisons were made using nonparametric approaches: the Kruskal-Wallis test to compare morpho-metric differences among fish size groups, and the Wilcoxon Signed-Rank test to compare left and right otoliths and to assess differences between sexes. Effect size (r) was calculated to assess the practical significance of the fdings. According to Mesa *et al*. (2020), the otolith morphology analysis model is highly dependent on the species. From the existing models, the K-nearest neighbor model can be considered the best.

Analysis of the relationship between fish body length and otolith morphometric parameters was performed using simple linear regression with the equation $y = a + bx$, where y is the otolith morphometric para-meter, a is the intercept, b is the slope, and x is the fish body length. The coefficient of determination (R^2) was used to assess the proportion of variation in otolith size explained by fish body length (Cohen, 2016).

Result

A total of 300 Tinfoil barb (*Barbonymus schwanefeldii*) (Figure 2) were successfully caught, consisting of 161 males and 139 females. A total of 267 pairs of otoliths were collected, comprising 143 pairs from males and 124 pairs from females. Data grouping revealed 132 small, 99 medium, and 36 large individuals. The data indicate that the Tinfoil barb population in the Kamijoro Dam during the study period was dominated by small to medium-sized individuals.

Morphological Characteristics of Tinfoil Barb Otolith

The otoliths used are of the sagitta type, the largest otoliths in fish and most commonly used in studies of morphology, age, and identification. Observations of Tinfoil barb otoliths reveal anterior, dorsal, ventral, and posterior regions. The anterior region has two projections: the elongated, pointed rostrum and the shorter antirostrum. Between these two sections lies a gap known as the excisura. The notch is a shallow identation along the dorsal margin, while the posterior margin features an irregular, serrated edge. The core marks the starting point of otolith formation, and the primordium is an irregular ring surrounding the core. There is also the sulcus acusticus, which consists of two parts: the ostium at the anterior end and the cauda at the posterior end. Upon observation, the otolith of the Tinfoil barb is asymmetrical and relatively irregular, with a heterosulcoid sulcus acusticus (Figure 3.).

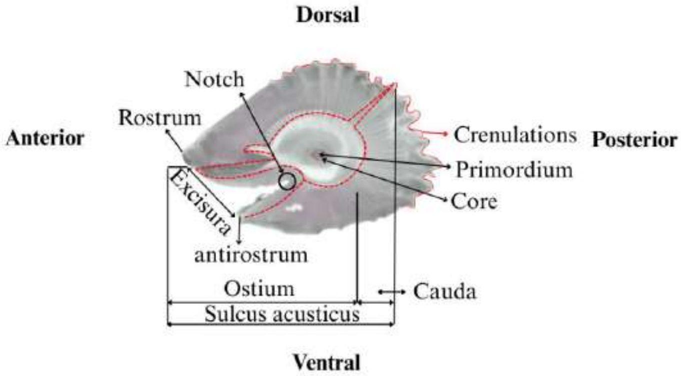

Figure 3. Morphology of the otoliths of the Tinfoil barb

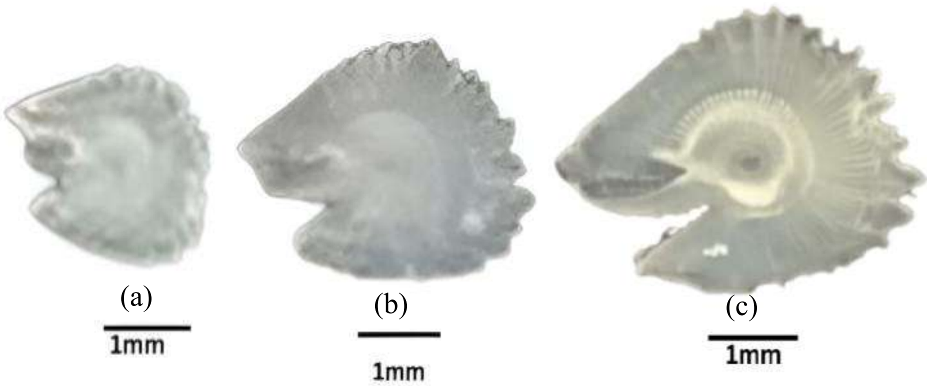

Figure 4. Variations in the otoliths of Tinfoil barb
(a) small-sized otolith (8.5 – 14.9 cm TL), (b) Medium-sized otolith (15.0 – 18.9 cm TL),
(c) Large-sized otoliths (19.0 – 29.0 cm TL)

Table 2. Morphometric averages of Tinfoil barb otolith

Parameters	Measurement results		
	Min	Maks	Mean±SD
Otolith length (OL/cm)	0.188	0.802	0.337±0.097
Otolith width (OW/cm)	0.169	0.567	0.254±0.065
Otolith area (OA/cm^2)	0.022	0.271	0.060±0.040
Otolith perimeter (OP/cm)	0.611	2.764	1.128±0.354
Otolith weight (OWt/g)	0.0009	0.016	0.004±0.002

Table 3. Morphometric averages of Tinfoil barb otoliths based on size variation

Para-meters	Measurement results								
	Small size			Medium size			Large size		
	Min	Maks	Mean±SD	Min	Maks	Mean±SD	Min	Maks	Mean±SD
OL/cm	0.188	0.388	0.282±0.044	0.242	0.443	0.352±0.037	0.339	0.802	0.504±0.152
OW/cm	0.169	0.308	0.219±0.030	0.204	0.310	0.261±0.021	0.239	0.567	0.365±0.107
OA/cm²	0.022	0.078	0.042±0.012	0.035	0.083	0.060±0.010	0.051	0.271	0.127±0.076
OP/cm	0.611	1.322	0.933±0.149	0.856	1.459	1.176±0.125	1.115	2.764	1.741±0.574
OWt/g	0.0009	0.0038	0.002±0.001	0.0027	0.0065	0.004±0.001	0.0032	0.016	0.007±0.003

Variations in fish body size provide the basis for examining the otolith morphology of the Tinfoil barb. Otoliths from small fish show an early stage of development, with the rostrum and antirostrum not yet having undergone significant elongation, crenulation on the posterior and ventral surface still not very distinct, and the sulcus acusticus not very clear. Medium-sized otoliths show quite noticeable differences: the rostrum and antirostrum begin to elongate, the crenulation becomes more distinct, and the excisura begins to deepen. Large fish otoliths exhibit a more complex shape, with a clearly visible and elongated rostrum and antirostrum, a deeper excisura, more pronounced crenulation, a thicker, denser, and more opaque otolith, and an acoustic sulcus that is recognizable with clear boundaries (Figure 4).

Morphometric Characteristics of Tinfoil Barb Otoliths

Morphometric analysis of otoliths in Tinfoil barb was conducted to assess variation in body size, sex, and otolith location. The overall results of the otolith morphometric measurements showed an average otolith length (OL) of 0.337 ± 0.097 cm, otolith width (OW) of 0.254 ± 0.065 cm, otolith area (OA) of 0.006 ± 0.040 cm^2, otolith perimeter (OP) of 1.128 ± 0.354 cm, and otolith weight (OWt) of 0.004 ± 0.002 g (Table 2).

Morphometric measurements of otoliths based on variations in fish body size increased. The small classes showed an average OL of 0.282 ± 0.044 cm. OW 0.219 ± 0.030 cm. OA 0.042 ± 0.012 cm². OP 0.933 ± 0.149 cm and OWt 0.002 ± 0.001 g.. The medium-sized class had an average OL of 0.352 ± 0.037 cm. OW 0.261 ± 0.021 cm. OA 0.060 ± 0.010 cm². OP 1.176 ± 0.125 cm; OWt 0.004 ± 0.001 g. The large size class showed an average OL of 0.504 ± 0.152 cm. OW 0.365 ± 0.107 cm. OA 0.127 ± 0.076 cm². OP 1.741 ± 0.574 cm; OWt 0.007 ± 0.003 g (Table 3).

Based on sex, the morphometric values of male fish otoliths were slightly larger than those of female fish otoliths for some para -

Table 4. Morphometric analysis of Tinfoil barb otoliths by sex.

Parameters	Male (n = 143)			Famale (n = 124)		
	Min	Maks	Mean±SD	Min	Maks	Mean±SD
OL/cm	0.188	0.802	0.346±0.118	0.221	0.717	0.327±0.065
OW/cm	0.169	0.567	0.260±0.079	0.170	0.493	0.247±0.042
OA/cm²	0.023	0.271	0.064±0.049	0.022	0.231	0.055±0.023
OP/cm	0.611	2.764	1.161±0.242	0.693	2.635	1.091±0.246
OWt/g	0.0009	0.0153	0.004±0.002	0.0012	0.0166	0.004±0.002

Table 5. Otolith morphometrics based on location

Parameter	Left (n=267)			Right (n=267)		
	Min	Maks	Mean±SD	Min	Maks	Mean±SD
OL/cm	0.185	0.801	0.336±0.098	0.191	0.810	0.338±0.097
OW/cm	0.160	0.571	0.253±0.065	0.167	0.563	0.255±0.065
OA/cm²	0.020	0.271	0.059±0.039	0.022	0.271	0.060±0.040
OP/cm	0.601	2.690	1.116±0.355	0.601	2.839	1.140±0.358
OWt/g	0.0008	0.0167	0.004±0.002	0.0008	0.0165	0.004±0.002

meters; however. The average otolith weight was the same for both sexes (Table 4). Morphometric measurements based on otolith location revealed very small differences and showed that the left and right otoliths were relatively similar (Table 5).

The results show that the morphometric characteristics of the left and right otoliths differ only slightly and are generally similar. To support this finding, statistical tests were conducted using OriginPro 2026 software. Therefore, a normality test was performed first as a prerequisite for the statistical tests.

Normality Test

A normality test is conducted to determine whether the data are normally distributed. The results of this normality test will be used to determine which statistical test to use in the subsequent analysis: a parametric test if the data are normally distributed, or a non-parametric test if they are not. The normality of the data representing differences in morphometric values between the left and right otoliths was assessed using the Shapiro-Wilk test.

The result of the normality test using the Shapiro-Wilk test showed that, of the five parameters, only one parameter was normally distributed, while the rest were not normally distributed because they had p-values less than 0.05 ($p < 0.05$). A p-value smaller than the significance level of 0.05 indicates that the data do not meet the requirements for a normal distribution, so parametric statistical analysis cannot be used. Therefore, the analysis of differences between the left and right otoliths was performed using the nonparametric Wilcoxon signed-rank test. This is a statistical method for comparing two paired samples when the data are normally distributed.

Wilcoxon Signed-Rank Test

The test results showed significant differences in all otolith morphometric parameters, except for otolith weight, which did not differ significantly. Based on the effect size (r), the parameters of length, width, and circumference fall into the small effect category, otolith area into the moderate effect category, while weight shows no effect. Although statistically significant, the diffe-rences are biologically classified as small to moderate. In line with the study's focus on fish size variation, further analysis used only the left otolith as a representative sample to ensure consistency (Table 6).

Table 6. Wilcoxon signed-rank

Parameters	W	Z	*p-value*	Effect Size (r)	Category
OL/cm	13776.5	-2.62686	0.00862	0.1607	Small*
OW/cm	12603	3.26214	0.00111	0.1996	Small*
OA/cm²	6329	-6.04088	<0.0001	0.3696	Moderate**
OP/cm	12210	-4.1689	<0.0001	0.25513	Small*
OWt/g	0	0	1	0	No effect***

*small: $0.10 \leq r < 0.30$
**moderate: $0.30 \leq r < 0.50$
***no effect: $r = 0$

Table 7. Otolith shape index results based on size variation

Shape index	Small size	Medium size	Large size	Description
Roundness (R_o)	0.666±0.04	0.652±0.029	0.642±0.027	The less rounded
Form factor (F_F)	0.617±0.114	0.558±0.089	0.516±0.066	The edges are more complex
Rectangularity (R_t)	0.663±0.07	0.62±0.062	0.596±0.047	They deviate from a rectangle
Circularity (C)	21.242±5.045	23.098±3.745	24.76±3.137	Less and less round
Aspect ratio (A_R)	1.289±0.096	1.347±0.098	1.376±0.088	More and more elongated
Ellipticity (E)	0.125±0.036	0.146±0.035	0.157±0.031	More and more elliptical

Morphometric Differences in Otoliths Among Fish Size Groups

The results of the Kruskal-Wallis test showed that all otolith parameters differed sig-nificantly among fish size groups (*p*-value < 0.0001). The median values of all parameters increased consistently with increasing fish size classes. The median otolith length increased from 0.280 cm in the small size group to 0.424 cm in the large size group. Increases were also observed in otolith width (0.216 cm to 0.302 cm), otolith area (0.040 cm² to 0.081 cm²), otolith circumference (0.909 cm to 1.365 cm), and otolith weight (0.0022 g to 0.0065 g).

Otolith Shape Index

Analysis of the otolith shape index revealed variation in values across fish size classes. The descriptors roundness (R_o), Form factor (F_F), and Rectangularity (R_t) showed a decrease in values as fish size incre-ased: R_o from 0.666 ± 0.04 to 0.642 ± 0.027; F_F from 0.617 ± 0.114 to 0.516 ± 0.066; and R_t from 0.663 ± 0.07 to 0.596 ± 0.047. Conversely, the values of the circularity (C), aspect ratio (A_R), and Ellipticity (E) increased: C from 21.242 ± 5.045 to 24.76 ± 3.137; A_R from 1.289 ± 0.096 to 1.376 ± 0.088; and E from 0.125 ± 0.036 to 0.157 ± 0.031 (Table 7).

The Relationship Between the Length of Tinfoil Barb and Otolith Morphometry

The results of the linear regression analysis showed a positive relationship between the body length of Tinfoil barb and all otolith morphometric parameters, such that each increase in body length, width, area, perimeter, and weight of the otolith was associated with an increase in body length. The coefficient of determination (R^2) values for these five parameters ranged from to 0.50707 to 0.081368, indicating that most of the variation in otolith size can be explained by variations in fish body length. Quan-titatively, every 1 cm increase in otolith length with R^2 = 0.64369 (63.37%), while the

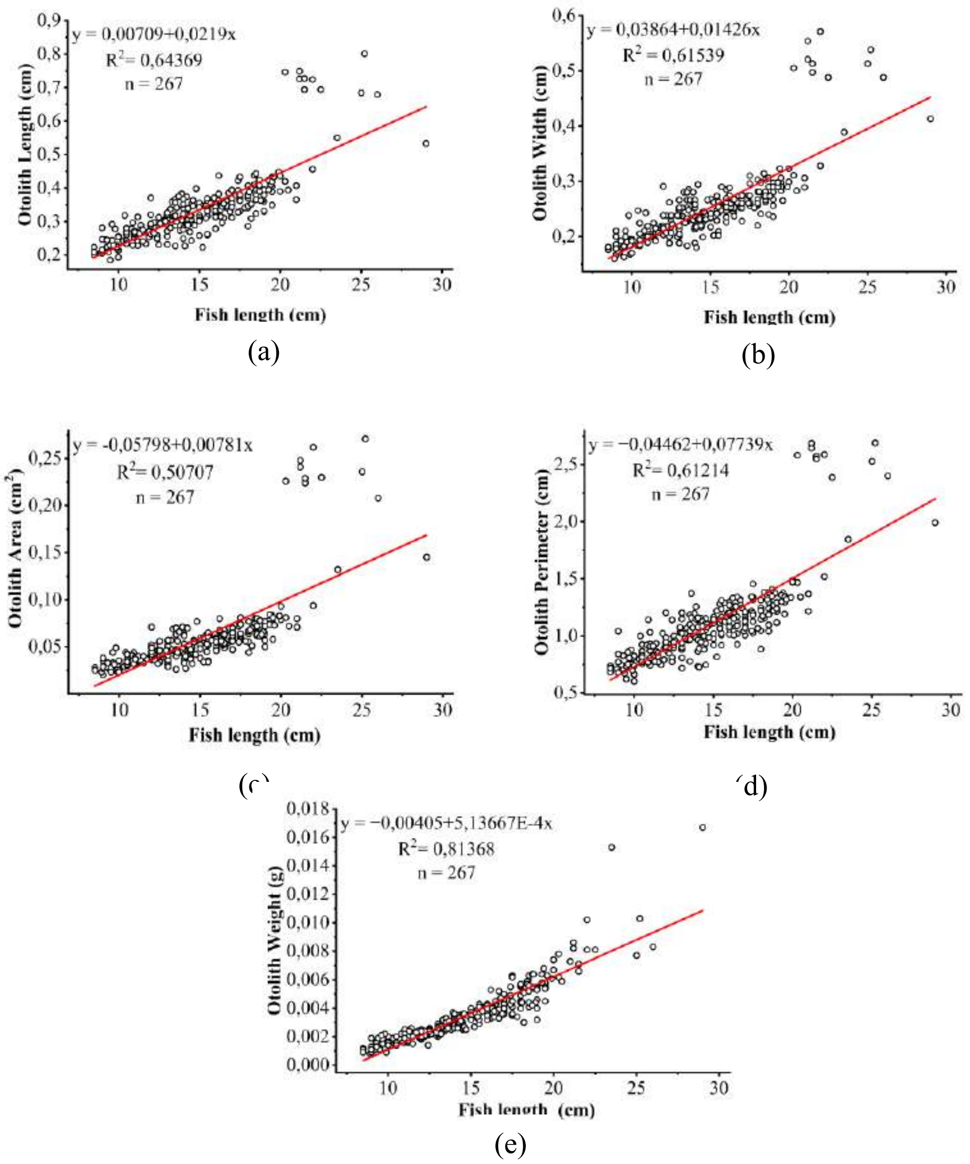

Figure 5. Relationship between the length of Tinfoil barb and otolith morphometric parameters: (a) otolith length, (b) otolith width, (c) otolith area, (d) otolith perimeter, and (e) otolith weight.

R^2 values for otolith width, area, perimeter, and weight are, respectively, 0.61539 (61.54%), 0.50707 (50.71%), 0.61214 (61.21%), and 0.81368 (81.37%). Thus, these values con-firm that otolith morphometric growth occurs in tandem with the growth of the fish's body length.

Discussion

The sagitta otolith of the Tinfoil barb exhibits an asymmetrical elliptical shape with a heterosulcoid acoustic sulcus, which is characteristic of the Cyprinidae family (Lombarte & Cruz, 2007). The presence of an elongated rostrum, antirostrum, excisura, notch, and crenulation on the posterior margin indicates an uneven pattern of calcium carbonate deposition throughout growth (Campana, 2004). Morphological development from small to large sizes reflects a complex biomineralization process that occurs throughout the fish's life. At small size, the otolith remains transparent and has a simple structure because daily deposition of aragonite crystals is still in its early stages (Mille *et al*., 2016). This lack of otoliths biomineralization process of fish knowledge, it can lead to misinterpretation of the different types of signals (e.g., optical or chemical) that provide basic data for research in fish ecology, fisheries management, and species conservation (Pontual *et al*, 2024). As the fish grows, the otolith becomes denser, more opaque, and more complex, with distinct annular lines that record daily or annual growth (Kang *et al*., 2025). These changes are consistent with the findings of Tuset *et al.* (2008) that otolith morphology evolves with age and body size. Meanwhile, according to Hasugian *et al*. (2021), Tinfoil Barb is classified as an omnivore based on analysis of food types and the ratio of intestinal length to total length.

All otolith morphometric parameters (length, width, area, perimeter, weight) increased significantly with fish body size ($p < 0.001$). This indicates positive allometric growth between the otolith and the body, a finding supported by studies on other Cyprinidae fish (Nimesh *et al*., 2021; Kontas & Bostanci, 2015). The increase in median values from small to large sizes indicates continuous calcium carbonate deposition along the otolith margins throughout the fish's lifespan (Campana, 2004). The results study by Fatiqin *et al*., 2022 showed that the morphometric measurements of *Barbodes schwanenfeldii* obtained in the Rupit River waters were smaller than those of Barbodes schwanenfeldii fish found in other river waters because these waters had experienced heavy metal pollution.

Sex differences were relatively small, suggesting that otolith size is more influenced by somatic growth than by reproductive factors. These results are consistent with the findings of Musaa *et al*. (2023) on *Barbonymus schwanefeldii* in Lake Kenyir, Malaysia. Similarly, the differences between the left and right otoliths were statistically significant but had a small to moderate effect size, making them biologically insignificant. Lychakov (2013) added that low bilateral asymmetry supports optimal hearing and balance function. For sexual maturity conditions, the results of research by Kusmini *et al*. (2023) showed that male tinfoil barb fish reached sexual maturity at a standard length of 16.01±1.18 cm, while females at 15.79±1.23 cm.

Changes in the otolith shape indices from small to large sizes show a clear ontogenetic pattern. Decreases in roundness, form factor, and rectangularity, and increases in circularity, aspect ratio, and ellipticity, indicate that the otoliths change from a round shape to a more elongated, elliptical, and complex shape as the fish grow. This is cause by uneven calcium carbonate deposition along different axes, resulting in the edges of the otolith developing more prominently in the longitudinal direction (Tuset *et al*., 2003). These changes are also related to the development of sensory function; larger, more elongated otoliths can alter the mechanical response to sound vibrations and linear acceleration (Popper & Lu, 2000). These findings are consistent with studies on *Barbus tauricus* (Kontas & Bostanci, 2015) and *Rhodeus amarus* (Saygin *et al*., 2020), which show that the otolith shape index is sensitive to ontogenetic growth and environmental conditions.

Linear regression analysis revealed a strong positive relationship between total fish length and all otolith morphometric parameters, with R^2 values ranging from 0.507 to 0.814. The highest R^2 value for otolith weight (0.814) indicates that biomineral accumulation during growth is closely linked to increases in body size. Otolith weight is the most appropriate parameter for estimating fish size, as has also been reported in other species (Bhakta *et al*., 2020; Ankita & Khan, 2022). This relationship reinforces the notion that otoliths are structures that grow throughout an individual's lifetime and reflect its growth history (Campana, 2004; Andrialovanirina *et al*., 2026). Overall, the study's results confirm that Tinfoil barb otoliths exhibit specific morphological and morphometric characteristics, vary ontogenetically, and can serve as indicators of growth and population identification. This study provides a scientific basis for the management of Tinfoil barb resources at the Kamijoro Dam.

Conclussion

The sagittal otoliths of the Tinfoil barb (Barbonymus schwanefeldii) at the Kamijoro Dam are asymmetrical, elliptical, and exhibit a heterosulcoid sulcus pattern, a characteristic feature of the Cyprinidae family, and their structural complexity increases with body size. Morphometrically, all parameters (length, width, area, perimeter, and otolith weight) showed a highly significant positive correlation with total fish length, with otolith weight being the most reliable parameter for estimating somatic growth. Shape index analysis revealed distinct ontogenetic changes, characterized by decreases in roundness, form factor, and rectangularity, and increases in circularity, aspect ratio, and roundness, form factor, and rectangularity, and increases in circularity, aspect ratio, and ellipticity, reflecting a transformation in shape from round in small fish to elongated and complex in large fish. These results confirm that Tinfoil barb otoliths serve as an effective biological archive for estimating body size and for studying population dynamics, thereby contributing to sustainable fisheries management in tropical reservoir ecosystems.

References

Akmal, Y., M. Yunus., H. Plumeriastuti., Y. Dhamayanti, M. Radhi., I. Irfannur., and F. M. Nur. 2025. Growth patterns, condition factors, and morphological variations in *Barbonymus schwanefeldii* from Indonesia. Biosystems Diversity. 33(2): e2533.

Andrialovanirina, N., E. P. Caillault., and K. Mahé. 2026. Relationship between Otolith and Fish Sizes: Validation Using Their 3D Shape Analysis. Open Journal of Marine Science. 16 : 27-38.

Ankita, M., and Khan, S. 2022. Relationships between length-weight, length-length, and fish length to otolith morphometry in *Rita rita* (Hamilton, 1822). Zoology and Ecology. 32(1): 49-55.

Apriani, J., M. Muslim, R. Irawan, dan Karolina, A. 2025. Morfometrik-Meristik Ikan Lampam (*Barbonymus schwanenfeldii*) asal Lebak Guci Kecamatan Sungai Pinang, Kabupaten Ogan Ilir Sumatera Selatan. Jurnal Perikanan Perairan Umum. 4(1): 25-35.

Bhakta, D., S.K. Das., B.K. Dasb., S.Behera and T.S. Nagesha. 2020. Relationship between otolith morphometry and fish size of Otolithoides pama (Hamilton, 1822) from Hooghly-Matlah estuary, India. Indian Journal of Geo Marine Sciences: 49 (10), October 2020,1636-1642 pp

Batubara, A. S., Z. A. Muchlisin, D. Efizon, R. Elvyra, N. Fadli, dan M. Irham. 2018. Morphometric variations of the genus *Barbonymus* (Pisces, Cyprinidae) harvested from Aceh waters, Indonesia. Fisheries & Aquatic Life. 26(4):231-237.

Bostancı, D., and S. Yedier. 2018. Discrimination of invasive fish *Atherina boyer*i (Pisces: Atherinidae) populations by evaluating the performance of otolith morphometrics in several lentic habitats. Fresenius Environmental Bulletin. 27(6): 4493-4501.

Breton, A. R., J. A. Hawkins., and D. L. Winkelman. 2013. Correcting length-frequency distributions for imperfect detection. North American Journal of Fisheries Management. 33(6): 1216–1227.

Campana, S.E. 2004. Photographic atlas of fish otoliths of the Northwest Atlantic Ocean. Canadian Special Publication of Fisheries&Aquatic Sciences. 133:1–284.

Campana, S. E., and S. R. Thorrold. 2001. Otoliths, increments, and elements: keys to a comprehensive understanding of fish populations. Canadian.Jourl of Fisheries&AquaticSci,58(1):30-38.

Chalupnicki, M. A., and D. E. Dittman. 2016. Alternative method of removing otoliths from sturgeon. Journal of visualized experiments: JoVE. (112): 54316.

Cohen, J. 2013. Statistical power analysis for the behavioral sciences. Second Edition, Lawrence Erlbaum Associates, Publishers. ISBN 0-8058-0283-5. Printed in the USA, New York. 40 p.

D'Iglio, C., M. Albano., S. Famulari., A. Carnevale, S. Savoca., N. Spano, and G. Capillo. 2024. Intra-population variability of the saccular, utricular and lagenar otoliths of the garfish *Belone belone* (Linnaeus, 1760) from South-Western Ionian Sea (Central Mediterranean Sea). BMC Ecology and Evolution. 24(31): 31. https://doi.org/-10.1186/s12862-024-02219-0

Dahruddin, H., A. Sholihah, T. Sukmono, S. Sauri, U. Nurhaman, D. Wowor, dan N. Hubert. 2021. Revisiting the diversity of Barbonymus in Sundaland using DNA-based species delimitation methods. Diversity. 13(7) : 283.

De Pontual, H., K. M. MacKenzie., H. Tabouret., F. Daverat., K. Mahé., C. Pecheyran., and K. Hüssy. 2024. Heterogeneity of otolith chemical composition from two-dimensional mapping: Journal of Fish Biology. 104(1): 20-33. Wiley Online Library.

Efizon, D., A. S. Batubara, Z. A. Muchlisin, R. Elvyra, S. Rizal, dan M.N. Siti-Azizah. 2021. Reproductive aspects of naleh fish (*Barbonymus* sp.): A native species from Nagan river, Aceh Province, Indonesia. Biodiversitas Journal of Biological Diversity. 22(5): 2554-256

Erzini, K. 1990. Sample size and data grouping for length-frequency analysis. Fisheries Research. 9(4): 355-366.

Fatiqin, A., R.H.T. Amallia, dan A.B. Dhani. 2022. Karakter Morfometrik Barbodes schwanenfeldii di Sungai Rupit Sumatera Selatan. BIOSAPPHIRE: Jurnal Biologi dan Diversitas. 1(1): 34-41.

Froese, R., A. C. Tsikliras., and K. I Stergiou. 2011. Editorial note on weight–length relations of fishes. Acta Ichthyologica et Piscatoria. 41(4): 261-263.

Froese, R. and D. Pauly. Editors. 2025. FishBase. World Wide Web electronic publication. www.fishbase.org, version

Green, B.S., B.D. Mapstone., G. Carlos., and G. A. Begg. 2009. Tropical Fish Otoliths: Information for Assessment, Management and Ecology, Reviews: Methods and Technologies in Fish Biology and Fisheries 11, DOI 10.1007/978-1-4020-5775-5_1, © Springer Science+Business Media B.V. 2009

Hasugian, F.K., E.Yusni, V. R. Manurung, dan R. Rambey. 2021. Feeding habits of Tinfoil barb, *Barbonymus schwenenfeldii* in the Tasik River, South Labuhanbatu, North Sumatra, Indonesia. Biodiversitas: Journal of Biological Diversity. 22(4).

Kang, Z., D. Song., H. Zhang., L. Liang., C. Zhang., T. Jiang., and Y. Xiong. 2025. Exploring the drivers of otolith Sr/Ca during the early life stages of Larimi-chthys polyactis: insights from cultured and wild populations. Fron-tiers in Marine Sci. 12. 1513070.

Kantun, W., S. A. Sapa., and S. Wulandari. 2024. Analisis Indeks Morfometrik Otolith asteriscus Ikan swanggi (*Priacanthus tayenus* Ricardson, 1846) dari Perairan Selat Makassar. Jurn Riset Diwa Bahari (JRDB), Vol 2(2): 86-90.

Kartamihardja, E. S., K. Purnomo., C. Umar. 2009. Sumber daya ikan perairan umum daratan di Indonesia terabaikan. Jour Kebijakan Perik. Indonesia. *1*(1):1-15.

Kementerian PUPR. 2015. Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat Nomor 27/PRT/M/2015 tentang Ben-dungan. Jakarta. Kementerian Pekerjaan Umum dan Perumahan Rakyat. 70 p.

Kontas, S., and D. Bostancı. 2015. Morphological and biometrical charac-teristics on otolith of Barbus tauricus Kessler, 1877 on light and scanning electron microscope. International Journal of Morphology. 33(4): 1380-1385.

Kruskal, W. H., and W. A. Wallis. 1952. Use of ranks in one-criterion variance analysis. Journal of the American statistical Association. 47(260): 583-621.

Kusmini, I. I., W. Cahyanti., R. Gustiano., S. Sundari, A. Iskandar, A., D. Radona., and S. Subaryono. 2023. First generation reproductive performance and second-generation larval production on the domesticated tinfoil barb, *Barbonymus schwanefeldii* (Bleeker, 1854). *Indonesian Aquaculture Journal*. *18*(2): 97-104.

La Mesa, M., S. Guicciardi., F. Donato., E. Riginella., L. Schiavon., and C. Papetti. 2020. Comparative analysis of otolith morphology in icefishes (Channichthyidae) applying different statistical classification methods. Fisheries Research. 230: 105-668.

Lombarte, A., and A. Cruz. 2007. Otolith size trends in marine fish communities from different depth strata. Journal of Fish Biology. 71(1): 53-76.

Lychakov, D. V. 2013. Behavioral lateralization and otolith asymmetry. Journal of Evolutionary Biochemistry and Physiology. 49(4): 441-456.

Mille T., K. Mahé, M. Cahera, M.C. Villanueva, H. de Pontual, and B. Ernande. 2016. Diet is correlated with otolith shape in marine fish. Marine Ecology Progress Series, 555:167-184

Musaa, M., Mamatb, R., Musac, N., Piaha, R. M., Kamala, A. M., Musaa, N., Sarid, L. A., & Chowdhurye, A. J. K. 2023. Eco-biology of tinfoil barb Barbonymus schwanefeldii in tropical Lake Kenyir, east coast Malaysia. Desalination and Water Treatment, 315, 500–514.

Nimesh, N., S. Jain., R. Kang., and M. Nimesh. 2021. Otolith morphometry-Total fish length relationship in the population of Rasbora daniconius (Hamilton, 1822) (Cyprinidae).Uttar Pradesh Journal Of Zoology. 42(24): 958-964.

Oktavia, N., V. A. Prakoso, M. M. Kamal, O. Z. Arifin, J. Subagja, K. Kurniawan, and R. Gustiano. 2024. A study on the growth and physiological response of juvenile tinfoil barb *Barbonymus schwanefeldii* (Bleeker, 1854) under the influence of pH changes. Indonesian Aquaculture Journal. 19(1): 35-44.

Popper, A. N. and R. R. Fay. 2011. Rethinking sound detection by fishes. Hear.-Res. 273: 25–36.

Popper, A. N., & Z. Lu. 2000. Structure–function relationships in fish otolith organs. *Fisheries research*. *46*(1-3): 15-25.

Popper, A. N., J. Ramcharitar., and S. E. Campana. 2005. Why otoliths? Insights from inner ear physiology and fisheries biology. Marine and freshwater Research. 56(5): 497-504.

Rai, D., and A. Rani. 2022. Comparative otolith morphology and morphometry of cyprinid fishes from Indian waters. Biology Bulletin. 49(2): 113-121.

Samuel, P. D., D. G. R Wiadnya., M. C. Anam., A. Setyanto., N. Khamidah., D. A. Yasmin., and S. S. Astuti. 2025. Kladistik Genera Famili Leiognathidae melalui Penelusuran Morfologi Eksternal dan Otolith: Cladistic Genera of Family Leiognathidae Based on External Morphology and Otolith. JFMR (Journal of Fisheries and Marine Research). 9(1): 152-162.

Sari, D. M., R. M. Putra, R. M., and W. Windarti. 2022. Comparison of meristic characteristics of *Barbodes schwanefeldii* living around the floating net cage area and in the area with no floating net cage in the koto panjang dam Riau Province. Asian Journal of Aquatic Sciences. 5(1): 105-113.

Saygın, S., M. Özpiçak., S. Yılmaz., and N. Polat. 2020. Otolith shape analysis and the relationships between otolith dimensions–total length of European Bitterling, *Rhodeus amarus* (Cyprinidae) sampled from Samsun Province, Turkey. Journal of Ichthyology. 60(4): 570-577.

Scott, D.W., 2009. Sturges' rule. *WIREs Computational Statistics* Journal, 1(3): 303-306, November/December 2009. https://doi.org/10.1002/wics.35

Secor, D. H., J. M. Dean., and E. H. Laban. . 1992. Otolith removal and preparation for microstructural examination. Otolith microstructure examination and analysis. Canadian special publication of fisheries and aquatic sciences. 117: 19-57.

Secor, D. H., J. M. Dean., and E. H. Laban. 1991. Manual for otolith removal and preparation for microstructural examination. Electric Power Research Institute.

Shapiro, S. S., and M. B. Wilk. 1965. An analysis of variance test for normality (complete samples). Biometrika. 52(3-4): 591-611.

Tonheim, S., A. Slotte., L. Andersson., A. Folkvord., and F. Berg. 2020. Comparison of otolith microstructure of herring larvae and sibling adults reared under identical early life conditions. Frontiers in marine science.7: 529.

Tuset, V. M., I. J. Lozano., J. A. González., J. F. Pertusa., and M. M. García-Díaz. 2003. Shape indices to identify regional differences in otolith morphology of comber, *Serranus cabrilla* (L., 1758). Journal of Applied Ichthyology. 19(2): 88-93.

Tuset, V. M., A. G. J. A. Lombarte., J. A. González., J. F. Pertusa., and M. A. J. Lorente. 2003. Comparative morphology of the sagittal otolith in *Serranus* spp. Journal of fish biology. 63(6): 1491-1504.

Tuset, V. M., A. Lombarte., and C. A. Assis. 2008. Otolith atlas for the western Mediterranean, north and central eastern Atlantic. Scientia Marina. 72(1): 7 - 198.

van der Laan, R., and R. Fricke. 2023. Freshwater fish list. 2-9-2024. Forty-second Edition. ISSN: 2468-9157

Wilcoxon, F. 1945. Individual comparisons by ranking methods. Biometrics bulletin.1(6): 80-83.

Biodiversity of Ichthyofauna in The Pabelan River, Magelang Regency

Astuti*[1], Ainun Rodhiyah Nurhayati[1], Maryam Tirta Nuur[1], Navida Vinca Hanif[1], Nurul Azizah Puteri Rahma Dewi[1], Namastra Probosunu[1], Eko Hardianto[1]

[1]Departement of Fisheries, Faculty of Agriculture, Universitas Gadjah Mada,
Jl. Flora, Bulaksumur, Yogyakarta, 55281, Indonesia
*Author: astuti2004@mail.ugm.ac.id

Recieved: January 7, 2026; Accepted: February 25, 2026

Abstract

Pabelan River is one of the most important rivers in Magelang Regency. This research aims to determine the diversity and composition of the ichthyofauna in the Pabelan River, Magelang Regency. The research was conducted from August to October 2025 at three observation stations selected through purposive sampling. Fish were caught using nets with a mesh size of ¾ inch and a diameter of 4 meters. Sampling was conducted over eight weeks, twice a week, from 08.00-14.00 WIB, for two hours at each research station. Data analysis was conducted using the Shannon-Wiener diversity index (H'), Evenness uniformity index (E), and Simpson dominance index (C). The results show that there are 13 fish species classified into 8 families and 4 orders, with the order Cypriniformes being the most dominant. *Ancistrus multispinis* is recorded as the overall dominant species (RA 43.6%), but it was only found at the settlement station. The average length distribution of the fish was dominated by small fish (<10 cm), accounting for more than 50%. Meanwhile, the average weight percentage of fish sized <10 gs was more than 38%. The diversity index value (H') obtained ranged from 0.81 to 1.73, the evenness index (E) from 0.35 to 0.83, and the dominance index (C) from 0.20 to 0.65. Environmental parameters indicate temperatures of 25.9–26.7 °C and a pH of 7.25–7.49, within the range that supports freshwater fish life. Meanwhile, the physical conditions of the water show a current speed of 0.31–0.73 m/s, a brightness of 8.8–11.6 cm, a depth of 43–59 cm, and a width of 17.3–29.2 m. Overall, the diversity of ichthyofauna in the Pabelan River is classified as moderate, with environmental conditions that still support freshwater fish.

Keywords: composition, diversity, ichthyofauna, Pabelan River.

Introduction

The Pabelan River originates on the slopes of Mount Merapi in Magelang Regency, Central Java, and flows into the Progo River. This river is 31.7 kilometers long and has three tributaries: the Trising River, the Apu River, and the Senowo River *(Aprilian et al.*, 2023). It also carries volcanic material from Mount Merapi following the 2010 eruption (Fauziyah *et al.*, 2018). As a waterway influenced by volcanic activity, it has a substrate dominated by sand and volcanic rock from upstream to downstream, with moderate to strong currents. The specific geomorphological conditions of this tropical river theoretically provide ecological niches for various native Indonesian fish species, particularly those from the families Cyprinidae, Gobiidae, and Balitoridae, which possess morphological adaptations to strong currents. However, these conditions also trigger human activities such as sand mining and the construction of sabo dams along the river course, which may alter aquatic habitat characteristics and affect fish diversity (Fauziyah *et al*., 2018; Gob *et al*., 2016).

Despite the pressures of human activities, rivers-as freshwater ecosystems-play a vital role in supporting biodiversity, including fish communities that can reflect the condition of aquatic ecosystems through the variety of habitats they possess. According to Dudgeon (2019), diverse river conditions and varied habitats drive the high number of species and freshwater biodiversity worldwide. Previous research conducted on river sections with varied substrate habitats (sand and rock) and anthropogenic disturbances includes a study on the Progo River. The study by Jailani & Mujtahidah (2021) revealed that the Progo River hosts fish fauna comprising 23 species across 5 orders and 11 families, with the Cyprinidae family as the dominant group. The highest relative abundance was found in the balar fish (*Barbonymus balleroides*), while the lowest relative abundance was observed in the kekhel fish (*Glyptothorax platypogon*). The Pabelan River, located in the same province and flowing into the Progo River, is also of research interest and has the potential for high biodiversity, similar to the Progo River but with different structures and compositions due to variations in the local hydrology of its waters.

Despite this ecological potential, research on the composition and diversity of ichthyofa-na in the Pabelan River remains relatively limited compared to that of the Progo River. Therefore, this study was conducted to determine the diversity and composition of the ichthyofauna in the Pabelan River, Magelang Regency, to provide baseline information on the condition of the local aquatic ecosystem. This study is expected to serve as baseline data to guide the sustainable management of aquatic resources. Additio-nally, the results of this study can support efforts to conserve ichthyofaunal biodiversity, inform policy development, and empower communities living along the Pabelan River to use natural resources responsibly.

MATERIAL AND METHODS

Study site

This study was conducted from August to October 2025 along the Pabelan River in Magelang Regency, Central Java Province. Sampling was conducted at three main stations across two subdistricts: Sawangan Subdistrict (Station 1 in Krogowanan Village and Station 3 in Gondowangi Village) and Dukun Subdistrict (Station 2 in Banyudono Village). Sampling locations were determined using purposive sampling, which involves selecting sites based on specific criteria. In, sampling is done intentionally based on certain criteria that allow researchers to focus on the groups or individuals most relevant to the research objectives The primary criteria used for site selection in this study were the distribution along the Pabelan River, which encompasses

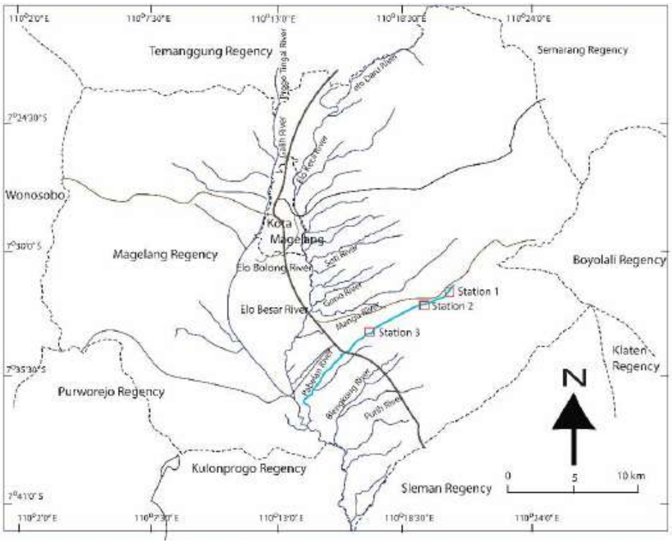

Figure 1. Map of the study area along the Pabelan River (red box). The brown lines indicate national and provincial roads. The broken line marks district boundaries.

habitat variations (separated by dams, sand mining intensity, and surrounding environmental conditions); administrative differences between villages to ensure regional representation; and locations actively used by the community for fishing. A map of the study locations is shown in Figure 1. Details on the location and specific environmental characteristics of each research station are provided in Table 1.

Research Procedures

The study was conducted in several stages, including fish sampling, measurement of water parameters, and data analysis. Fish sampling was carried out over eight weeks, with samples collected twice weekly and assistance from local fishermen. Sampling took place in the morning and afternoon from 8:00 AM to 2:00 PM local time, with two hours allocated at each location.

Table 1. Coordinates and conditions of research stations

Station	Coordinates	Notes
1	7.538104º32' LS, 110.333065º19' BT	Garden/forest area, Krogowanan, Sawangan District, Magelang Regency, Central Java. Elevation: 605 meters above sea level. There is a tomato farm; the vegetation is sparse. Large-scale mining operations (heavy machinery).
2	7.539208º21' LS, 110.328791º19' BT	Karang, Banyudono, Dukun District, Magelang Regency, Central Java. Elevation: 579 meters above sea level. Surrounded by dense vegetation. Moderate sand mining activity (with a significant amount of manual labor).
3	7.557051º33' LS, 110.287797º17' BT	Gijayan, Gondowangi, Sawangan District, Magelang Regency, Central Java Elevation: 439 meters above sea level. Near residential areas, with fairly dense vegetation. Small-scale sand mining activity (visible to a limited extent).

Fish were caught using a net with a mesh size of ¾ inch (1.905 cm) and a diameter of 4 m. A net was chosen because it can catch fish of relatively diverse sizes and species compared to other gear commonly used at the study site. Each caught fish was then identified, counted, placed in a sample bag, and stored in a cold box filled with ice to maintain freshness before being transferred to a freezer for unidentified samples. Taxonomic identification was performed visually, referencing identification guides and the FishBase database. Physical characteristics of the fish, such as total length, were measured with a ruler to 0.5 mm precision, while body weight was measured with a digital scale to 0.1 g precision and recorded with a smartphone camera.

Water quality and river hydrological parameters were measured directly in triplicate at each station, including temperature, pH, turbidity, current velocity, depth, width, and the types of substrate and surrounding vegetation. Station coordinates were determined using GPS on mobile devices and the Timemark app. Water temperature was measured with a digital thermometer, and pH with a pH meter calibrated with a buffer solution. Water turbidity was measured using a Secchi disk lowered into the water column until the black and white marks were no longer visible (d1), then slowly raised until they reappeared (d2), and calculated using the formula: $Transperency = \frac{(d1+d2)}{2}$. Current velocity is measured manually by releasing a ping-pong ball 10 m downstream and recording the elapsed time using a stopwatch. River depth is measured using a weighted rope lowered until it touches the riverbed, while river width is measured using a linear measurement tool. The type of substrate and surrounding vegetation is analyzed visually through direct observation at each observation station. All data obtained is then recorded in a notebook as primary data.

Data Analysis

The collected data on fish species will then be presented in tabular form, along with the number of individuals for each species, to facilitate assessment of species abundance, diversity, evenness, and dominance.

The relative abundance (RA) of fish species in a given area can be calculated using the following formula:

$$RA = \left(\frac{ni}{N}\right) x\ 100\%$$

Note: ni = number of individuals of species i; N = total number of individuals of all species

The fish diversity index for an ecosystem or region can be calculated using the following formula:

$$H' = -\sum\left(\frac{ni}{N}\right)\ln\left(\frac{ni}{N}\right)$$

The diversity index value obtained will indicate the level of ichthyofauna diversity in an ecosystem. The higher the diversity index value, the more diverse the ichthyofauna. The scale or range of diversity index values includes H’ ≤ 1 (low category), 1 < H’ ≤ 3 (moderate category), and H’ ≥ 3 (high category).

Table 2. Environmental parameters at the sampling station on the Pabelan River

Parameter	Station 1	Station 2	Station 3
Temperature (°C)	25.90	26.20	26.70
pH	7.25	7.35	7.49
Current Speed (m/s)	0.73	0.31	0.43
Transparency (cm)	11.70	10.30	8.83
Depth (cm)	48.50	59	43
Width (m)	17.30	25.20	29.20
Substrate	Rocks, sand	Rocks, sand	Rocks, sand
Vegetation	Grasses, banana trees, shrubs	Grasses, shrubs	Grasses, banana trees, shrubs

The evenness index of the ichthyofauna in an ecosystem or region can be calculated using the following formula:

$$E = \frac{H'}{ln\ S}$$

Note: H' = diversity index; S = number of species

The resulting evenness index value indicates the degree of evenness of the ichthyofauna in an ecosystem. The higher the evenness index value, the greater the degree of balance. The scale or range of evenness index values includes $E < 0.4$ (low category), $0.4 < E < 0.6$ (moderate category), and $E > 0.6$ (high category) (relatively uniform).

The species dominance index for an ecosystem or region can be calculated using the following formula:

$$C = (\frac{ni}{N})^2$$

The dominance index value obtained indicates the degree to which one species dominates others within an ecosystem. The dominance index is inversely proportional to the evenness index; thus, the higher the dominance index, the lower the degree of ecosystem balance as species dominantes.

The dominance index ranges from 0 to 1; the closer the value is to 1, the more evident the presence of a dominant species in that community, and vice versa.

RESULT

Environmental Conditions

Environmental parameters at each station are presented in Table 2. Environmental conditions were relatively uniform, with variations in the water's physical parameters. Temperature and pH tended to increase from Station 1 to Station 3, but the ranges did not differ significantly. Station 1 has the highest flow velocity, while Stations 2 and 3 have relatively lower flow velocities. Water clarity decreases progressively down-stream, indicating an increase in suspended particles in the water column. From Station 1 to Station 3, the river width increases, while water depth varies between stations without a clear pattern. The bottom substrate at all three stations is dominated by rocks and sand, along with riparian vegetation consisting of grasses, shrubs, and a few banana trees. These conditions indicate that the three stations share a relatively homogeneous habitat type,

Table 3. Types of fish fauna caught in the Pabelan River, Magelang Regency

No.	Ordo	Family	Types of ichthyofauna		
			Species	Local Name	Total
1	Anabantiformes	Channidae	*Channa gachua*	Gabus	3
2	Cypriniformes	Balitoridae	*Homaloptera ocellata*	Hiu Mbelan	30
3		Cyprinidae	*Barbodes binotatus*	Wader Cakul	66
4			*Barbonymus gonionotus*	Beles	1
5			*Mystacoleucus obtusirostris*	Kepek	51
6			*Neolissochilus soroides*	Mangur	41
7			*Osteochilus vittatus*	Nilem	1
8			*Rasbora argyrotaenia*	Wader Pari	70
9		Nemacheilidae	*Nemacheilus chrysolaimos*	Uceng	1
10	Perciformes	Cichlidae	*Oreocromis niloticus*	Nila	4
11	Siluriformes	Clariidae	*Clarias batrachus*	Lele	2
12		Loricariidae	*Ancistrus multispinis*	Sapu-sapu	264
13		Sisoridae	*Glyptothorax platypogon*	Kekhel	72

with the primary differences lying in the hydrological characteristics of the water.

Fish Composition

The ichthyofauna collected from the Pabelan River in Magelang Regency comprises 13 species across 8 families and 4 orders. The species are dominated by the order Cypriniformes, which comprises three families: Cyprinidae, Balitoridae, and Nemacheilidae. The family Cyprinidae is the most species-rich, with 6 species. Meanwhile, the orders Perciformes and Anabantiformes have the fewest species, each represented by a single species. In detail, the types of ichthyofauna caught during the study are shown in Table 3.

A total of 606 fish individuals were captured during the study period, dominated by Ancistrus multispinis with a relative abundance of 43.6%, while the species with the lowest abundance were *Barbonymus gonionotus, Osteochilus vittatus*, and *Nemacheilus chrysolaimos,* of which only one

Table 4. Composition of the fish fauna caught in the Pabelan River, Magelang Regency

No	Species	Local Name	Station			Total	RA (%)
			Station 1	Station 2	Station 3		
1	*Ancistrus multispinis*	Sapu-sapu	-	-	264	264	43.6
2	*Barbodes binotatus*	Wader Cakul	21	23	22	66	10.9
3	*Barbonymus gonionotus*	Beles	1	-	-	1	0.2
4	*Channa gachua*	Gabus	1	1	1	3	0.5
5	*Clarias batrachus*	Lele	-	2	-	2	0.3
6	*Glyptothorax platypogon*	Kekhel	40	5	27	72	11.9
7	*Homaloptera ocellata*	Hiu Mbelan	2	20	8	30	5.0
8	*Mystacoleucus obtusirostris*	Kepek	4	45	2	51	8.4
9	*Nemacheilus chrysolaimos*	Uceng	-	-	1	1	0.2
10	*Neolissochilus soroides*	Mangur	19	20	2	41	6.8
11	*Oreocromis niloticus*	Nila	4	-	-	4	0.7
12	*Osteochilus vittatus*	Nilem	-	-	1	1	0.2
13	*Rasbora argyrotaenia*	Wader Pari	47	20	3	70	11.6
	Total		139	136	331	606	100

individual each was found (0.2%). Other species had relative Other species had relative abundances ranging from 0.3% to 11.9%. Details of the number of each species at each station are shown in Table 4.

Length and Weight Distribution

The length and weight distribution of the fish collected during the study are shown in Table 5. More than 50% of the average length of the caught fish was <10 cm, and more than 38% of the average weight of the caught fish was <10 g. Clarias batrachus was the largest species compared to others, with an average length of 20.5 cm and an average weight of 74.5 g. The largest Clarias batrachus specimen measured 23.0 cm in length and weighed 80 g. Meanwhile, Glyptothorax platypogon was the smallest fish species, with an average length of 6.55 cm within a length range of 5.0–9.5 cm, while Barbodes binotatus was the lightest species, with an average weight of 3.98 g within a weight range of 2.0–8.0 g.

Community Structure

Community structure can be assessed basedon the diversity, evenness, and dominance indices presented in Table 6. The diversity index (H') values range from 0.81 to 1.73, indicating a low to moderate category. The evenness index (E) ranges from 0.35 to 0.83. An evenness value close to 1 indicates a relatively even distribution of individuals across species, while a lower value indicates an imbalance in the number of individuals among some species. Meanwhile, the dominance index (C) ranges from 0.20 to 0.65, indicating variations in species dominance levels across observation stations.

DISCUSSION

The dominance of the order Cypriniformes in the study results indicates that the Pabelan River still provides a suitable habitat for freshwater fish. According to Kuchta *et al*. (2020), Cypriniformes is one of

Table 5. Length and weight of the captured fish

No.	Species	Total	Size			
			Leght		Weight	
			Total Length (cm)	Average Length (cm)	Total weight (gr)	Average Weight (g)
1	*Ancistrus multispinis*	264	4.5 – 12.2	9.18	0.5 – 26.0	10.87
2	*Barbodes binotatus*	66	5.0 – 17.0	6.96	2.0 – 8.0	3.98
3	*Barbonymus gonionotus*	1	15.4	15.40	70.0	70.00
4	*Channa gachua*	3	9.5 – 17.5	14.66	6.0 – 41.0	25.00
5	*Clarias batrachus*	2	18.0 – 23.0	20.50	69.0 – 80.0	74.50
6	*Glyptothorax platypogon*	72	5.0 – 9.5	6.55	1.0 – 6.0	10.87
7	*Homaloptera ocellata*	30	6.5 – 14.0	11.03	3.0 – 17.0	9.36
8	*Mystacoleucus obtusirostris*	51	5.0 – 12.0	8.56	2.0 – 19.0	7.23
9	*Nemacheilus chrysolaimos*	1	8.5	8.50	4.0	4.00
10	*Neolissochilus soroides*	41	5.5 – 28.5	13.16	2.0 – 232	35.95
11	*Oreocromis niloticus*	4	5.3 – 10.5	8.85	3.0 – 22.0	15.75
12	*Osteochilus vittatus*	1	18.0	18.00	63.0	63.00
13	*Rasbora argyrotaenia*	70	4.5 – 11.3	7.95	0.5 – 11.0	4.60

Table 6. Diversity, evenness, and dominance indices by sampling station

Note	Station		
	Station 1	Station 2	Station 3
Total	139	136	331
Diversity indeks (H')	1.62	1.73	0.81
Evenness index (E)	0.74	0.83	0.35
Dominance index (C))	0.24	0.20	0.65

the freshwater fish groups with a wide geographic distribution and high species diversity. This dominance is primarily exemplified by the family Cyprinidae, which comprises six species. This family is a highly diverse group of freshwater fish that is widely distributed across regions worldwide and exhibits relatively high environmental tolerance to variations in habitat conditions (Kotellat *et al*., 1993). In addition to the dominance of certain orders and families, the ichthyofauna community in the Pabelan River also exhibits dominance at the species level, specifically *Ancistrus multispinis.*

A total of 13 fish species were identified during the study. This number is relatively small compared to the fish communities typically found in the lower reaches or estuaries of rivers and is likely related to the study location, which is situated in the upper to middle reaches of the river. The upper reaches generally feature stronger currents, narrower habitats, and more selective environmental conditions, thereby limiting the presence of certain fish species. These conditions align with the concept of environmental filtering, in which specific environmental characteristics can support only species with appropriate adaptations (Liu *et al.,* 2025). A similar pattern was also reported in the Opak River system by Djumanto & Probosunu (2011) and by Yudha *et al*. (2020), who demonstrated an increase in species richness with river size toward the lower reaches and the estuary.

In addition to variations in species composition, the study results also indicate differences in length and weight among species. These size variations reflect differences in biological characteristics as well as strategies for utilizing habitats and available resources in the water. Small species such as B. *binotatus*, G. *platypogon*, M. *obtusirostris*, N. *chrysolaimos*, and R. *argyrotaenia* generally utilize small organisms as a food source, whereas larger species such as C. *gachua* and C. *batrachus* occupy higher trophic levels by feeding on small fish, shrimp, and insects.

To gain a more comprehensive understanding of the fish community, catch data were analyzed using the Shannon-Wiener diversity index (H'), the evenness index (E), and the dominance index (C). The diversity index values at all three stations fell into the low-to-moderate range, indicating that the ichthyofauna communities at the study sites have not yet fully stabilized. These conditions may be influenced by habitat variation and anthropogenic activities in surrounding waters, which affect the distribution of individuals across species. These results are consistent with a study by Aziz *et al*. (2021), which shows that changes in environmental conditions and human activities can affect fish community diversity.

Differences in fish community structure were observed at each observation station. Station 1 exhibits moderate diversity, relatively high evenness, and low dominance. These conditions indicate a fairly even distribution of individuals across species, with no single species conspicuously dominating the community. According to Erika *et al*. (2018), low dominance values generally indicate a more balanced community and relatively good habitat conditions.

Unlike Station 1, Station 3 had the lowest diversity and the highest dominance. This was primarily due to the high abundance of A. multispinis compared to other species. The dominance of a single species causes uneven individual distribution, thereby reducing diversity even when the number of species is relatively high. This phenomenon is consistent with Sofian *et al*. (2024), who state that diversity tends to decrease when most individuals in a community belong to the same species.

Station 2 exhibits the most balanced community structure, with the highest diversity and evenness values and the lowest dominance. Despite anthropogenic disturbance from sand mining, the uneven substrate is believed to create microhabitat variations, including depressions, shallow areas, and differences in current velocity. This habitat heterogeneity can increase the availability of space and resources for species with different ecological preferences, thereby forming a more proportional community (Shi & Czerniawski, 2025).

The distribution patterns of species at each station also provide insight into the fish's ability to adapt to different habitat conditions. Several species, such as G. *platypogon*, R. *argyrotaenia*, C. *gachua*, M. *obtusirostris*, N. *soroides*, B. *binotatus*, and H. *ocellata*, were found at all observation stations. The presence of these species indicates relatively good adaptive capacity to variations in environmental conditions along the Pabelan River. Most are common river fish found in flowing habitats with rocky and sandy substrates and possess a fairly wide tolerance to changes in water physical conditions (Trijoko *et al*., 2016). This is also consistent with the statement by Kusuma et al. (2024), regarding the adaptive capacity of species from the genus Channa across various habitat types, as well as the study by Muhtadi *et al*. (2017), which notes that rocky river habitats with moderate to strong currents provide an environment conducive to the presence of diverse fish communities in the river.

However, some fish species were found only in very low numbers at certain stations. Species such as O. *niloticus* and B.

gonionotus were found only in limited numbers at Station 1. The low abundance of O. *niloticus* is thought to be related to its preference for calmer and warmer waters, although this species is known to have high environmental tolerance (Cahyanti & Awalina, 2022). Meanwhile, the low abundance of B. *gonionotus* is suspected to be related to unfavorable habitat conditions resulting from disturbances to the aquatic substrate. The species C. *batrachus* was also found only at Station 2 in small numbers. According to Wiharti & Hanik (2022), this species possesses additional respiratory organs that allow it to survive in low-oxygen conditions, but generally prefers calm habitats with softer substrates.

The species composition indicates that native freshwater fish still dominate the fish community in the Pabelan River. Of the 13 species recorded, only two were non-native: O. *niloticus* and A. *multispinis*. The low abundance of O. *niloticus* suggests that this species has not yet had a significant impact on the local community structure. In contrast, A. *multispinis* exhibited relatively high abundance, particularly at Station 3. The high abundance of this species is likely related to habitat characteristics, specifically hard substrates that support foraging activities and self-protection. As a benthic fish in the family Loricariidae, A. multispinis possesses morphological adaptations that enable it to effectively use rock surfaces and other hard substrates (Mattos *et al.,* 2018). Additionally, this species exhibits a high degree of adaptability to various environmental conditions (Wahyudewantoro et al., 2024). The high abundance of this species indicates successful adaptation to specific habitats in the Pabelan River and suggests the potential to influence the structure of the local fish community. However, the invasive status of A. *multispinis* cannot yet be definitively determined because this study has not evaluated its distribution patterns or ecological impacts on the local community. According to Bernery *et al*. (2024), a species can be categorized as invasive if it has undergone introduction, successfully established itself, spread widely, and caused impacts on the ecosystem it inhabits. Therefore, further research is needed to evaluate the potential spread and ecological impacts of this species in the Pabelan River.

CONCLUSION

In general, the ichthyofauna diversity in the Pabelan River, Magelang Regency, is classified as moderate, comprising 13 species across 8 families and 4 orders. The Shannon-Wiener diversity index indicates that the ichthyofauna community structure is not yet fully stable and varies across observation stations. Native freshwater species dominate the fish community, although two non-native species were identified that could potentially influence the community structure under certain conditions. The Pabelan River's habitat conditions, which currently support ichthyofauna, must be preserved through sustainable management and conservation efforts, including the monitoring of activities that could alter the water body's characteristics. Furthermore, the presence of the non-native species *Ancistrus multispinis* warrants attention due to its potential impact on local fish communities. Further research encompassing a wider range of locations, observation periods, and sampling methods is also required to obtain more comprehensive information regarding fish diversity and distribution in the Pabelan River.

References

Aprilian, Z., Harlan, D., Soentoro, E. A., Zahroni, A., Bandung, I. T., Ganesa, J., 10, N., Siliwangi, L., Coblong, K., Bandung, K., & Barat, J. 2023. Analisis Agradasi, Degradasi dan Sedimentasi di Sungai Pabelan Pasca Erupsi Gunung Merapi 2010. *Journal on Education*, *05*(03).

Aziz, Md. S. Bin, Hasan, N. A., Mondol, Md. M. R. Alam, Md. M., & Haque, M. M. 2021. Decline in fish species diversity due to climatic and anthropogenic factors in Hakaluki Haor, an ecologically critical wetland in northeast Bangladesh. *Heliyon*, *7*(1), e05861. https://doi.org-/10.1016/j.heliyon.2020.e05861

Bernery, C., Bellard, C., Courchamp, F., Brosse, S., & Leroy, B. 2024. A global analysis of the introduction pathways and characteristics associated with non-native fish species introduction, establishment, and impacts. *Ecological Processes*, *13*(1), 22. https://doi.org/10.1186/-s13717-024-00495-8

Cahyanti, Y., & Awalina, I. 2022. Studi Literatur : Pengaruh Suhu terhadap Ikan Nila (Oreochromis niloticus). *Panthera : Jurnal Ilmiah Pendidikan Sains Dan Terapan*, *2*(4), 224–235. https://doi.org/-10.36312/pjipst.v2i4.110

Djumanto, & Probosunu, N. 2011. Biodiversitas sumber daya ikan di hulu Sungai Opak. *Jurnal Iktiologi Indonesia*, *11*(1), 1–10.

Dudgeon, D. 2019. Multiple threats imperil freshwater biodiversity in the Anthropocene. *Current Biology*, *29*(19), R960–R967. https://doi.org/10.1016/-j.cub.2019.08.002

Erika, R., Kurniawan, K., & Umroh, U. 2018. Keanekaragaman Ikan Di Perairan Sungai Linggang, Kabupaten Belitung Timur. *Akuatik: Jurnal Sumberdaya Perairan*, *12*(2), 17–25. https://doi.org/10.33019/-akuatik.v12i2.697

Fauziyah, R., Agus Kironoto, B., & Legono, D. 2018. Kajian Angkutan Sedimen Di Sungai Pabelan, Kabupaten Magelang, Jawa Tengah. *Semesta Teknika*, *21*(1). https://doi.org/10.18196/st.211210

Gob, F., Gautier, E., Virmoux, C., Grancher, D., Tamisier, V., Primanda, K. W., Wibowo, S. B., Sarrazin, C., de Belizal, E., Ville, A., & Lavigne, F. 2016. River responses to the 2010 major eruption of the Merapi volcano, central Java, Indonesia. *Geomorphology*, *273*, 244–257. https://doi.org/10.1016/-j.geomorph.2016.08.025

Jailani, A. Q., & Mujtahidah, T. 2021. Study of Iktiofauna Biodiversity Based on Geographical Information Systems (GIS) in the Progo River, Magelang, Central Java. *Journal of Aquaculture Science*, *6*(1), 38–47. https://doi.org/10.31093/-joas.v6i1.136

Kotellat, M., Whitten, A. J., Kaartikasari, S. N., & Wirjoatmodjo, S. 1993. *Freshwater Fishes Of Western Indonesia and Sulawesi.* Pepiplus Edition.

Kuchta, R., Řehulková, E., Francová, K., Scholz, T., Morand, S., & Šimková, A. 2020. Diversity of monogeneans and tapeworms in cypriniform fishes across two continents. *International Journal for Parasitology*, *50*(10–11), 771–786. https://doi.org/10.1016/j.ijpara.2020.06.005

Kusuma, W. E., Widyawati, Y., Dailami, M., Kholil, K. N. A., Paricahya, A. F., Sufaichusan, I., & Wiadnya, D. G. R. 2024. Posisi Filogenetik Ikan Kotes (*Channa gachua* (Hamilton, 1822)) dan Ikan Kutuk (*Channa striata* (Bloch, 1793)) dari Jawa Timur Berdasarkan Urutan DNA Mitokondria Cytochrome C Oxidase Subunit I. *Berita Biologi*, *23*(2), 269–283. https://doi.org/-10.55981/-beritabiologi.2024.2733

Liu, Z., Wu, Y., You, W., Li, S., Shi, G., & Zhang, C. 2025. Revealing the Structure and Biodiversity Patterns of Fish Communities in River Networks Based on Environmental DNA. *Fishes*, *10*(4), 175. https://doi.org/10.3390/-fishes10040175

Mattos, T. M., Carvalho, D. R., de Brito, M. S., & Araújo, F. G. 2018. Occurrence of phoresy between Ancistrus multispinis (Actinopterygii: Siluriformes) and Ichthyocladius sp. (Diptera: Chironomidae) in Atlantic forest streams, Southeastern Brazil. *Zoologia*, *35*, 1–6. https://doi.org/-10.3897/zoologia.35.e13255

Muhtadi, A., Dhuha, O. R., Desrita, D., Siregar, T., & Muammar, M. 2017. Kondisi habitat dan keragaman nekton di hulu Daerah Aliran Sungai Wampu, Kabupaten Langkat, Provinsi Sumatera Utara. *Depik*, *6*(2), 90–99. https://doi.org/10.13170/-depik.6.2.5982

Shi, X., & Czerniawski, R. 2025. Habitat Heterogeneity and Channelization of Small Rivers and Streams: Fish Community Responses to Ecological Gradients. *Ecology and Evolution*, *15*(9). https://doi.org/10.1002-/ece3.72092

Sofian, Humairani, & Syaputra, A. 2024. Keanekaragaman jenis ikan di perairan pasang surut Sungai Musi, Kecamatan Muara Telang, Kabupaten Banyuasin. *Jurnal Ilmu-Ilmu Perikanan Dan Budidaya Perairan*, *19*(1), 55–65.

Trijoko, T., Yudha, D. S., Eprilurahman, R., & Pambudi, S. S. 2016. Keanekaragaman Jenis Ikan di Sepanjang Sungai Boyong – Code Propinsi Daerah Istimewa Yogyakarta. *Journal of Tropical Biodiversity and Biotechnology*, *1*(1), 21. https://doi.org/10.22146/jtbb.12930

Wahyudewantoro, G., Dina, R., Larashati, S., Lukman, L., & Akhdiana, I. 2024. New record of bristlenose catfish, Ancistrus chagresi Eigenmann & Eigenmann, 1889 and Ancistrus sp., in Ciliwung Watershed, Indonesia. *BioInvasions Records*, *13*(4), 1021–1032. https://doi.org/10.3391/-bir.2024.13.4.15

Wiharti, T., & Hanik, N. R. 2022. Identification of Types of Fish Captured by Fishermen at TPI Wuryantoro, Wonogiri, that are Consumed by the Community. *Jurnal Biologi Tropis*, *22*(4), 1177–1187. https://doi.org/-10.29303/jbt.v22i4.4137

Yudha, D. S., Trijoko, T., Eprilurahman, R., Nugraha, R., Suranto, R. D. P., Abida, F. U., Tobing, V. F., Fathiya, R. F., & Nopitasari, S. 2020. Keanekaragaman jenis ikan di sepanjang Sungai Opak Provinsi Daerah Istimewa Yogyakarta, Indonesia. *Biota : Jurnal Ilmiah Ilmu-Ilmu Hayati*, 81–91. https://doi.org/-10.24002/biota.v5i2.2939

Fish Species Diversity in The Krasak River Srumbung Subdistrict Magelang Regency Central Java

Maryam Tirta Nuur*[1], Ainun Rodhiyah Nurhayati[1], Astuti[1],
Navida Vinca Hanif[1], Tony Budi Satriyo[1], Mukti Aprian[1]

[1]Department of Fisheries, Faculty of Agriculture, Universitas Gadjah Mada, Jl. Flora, Bulaksumur, Sleman, Special Region of Yogyakarta 55281, Indonesia
*Author: maryamtirtanuur2004@mail.ugm.ac.id

Recieved: January 8, 2026; Accepted: February 26, 2026

Abstract

This research aims to explore the diversity of fish species in the Krasak River, Central Java, where information on fish composition is still limited, in contrast to the Progo River and Elo River, which have been studied by several researchers. This river, originating from the slopes of Mount Merapi, has water characteristics with volcanic material and variations in current and substrate. The research was conducted from October to November 2025 at three observation locations using purposive sampling. All the fish caught were identified to the species level, counted for their individual numbers, and analysed using the Diversity Index (H'), Evenness Index (E), Dominance Index (D), and Relative Abundance (RA). Environmental parameters, including temperature, pH, current, depth, brightness, and substrate, were also measured as supporting data. The results show that the fish community in the Krasak River comprises 221 individuals across 12 species and 6 families. The Diversity Index shows low values (0.647-0.882), and the Evenness Index is also low (0.260-0.355), indicating an uneven distribution of individuals among species. The species *Mystacoleucus obtusirostris* became the dominant species, accounting for 53.39% of the total individuals captured. This study provides an initial overview of fish diversity in the Krasak River and is expected to be useful for fisheries resource management and further research.

Keywords: Abundance, Community, Diversity, Krasak River

Introduction

Rivers in Magelang Regency are located within the Progo and Bogowonto River Basins (DAS) (BAPPEDALIT-BANGDA, 2021). The Krasak River is one of the rivers that flows along the border between Sleman Regency and Magelang Regency. The upper reaches of the Krasak River are situated on the slopes of Mount Merapi, specifically in Ngablak Village, Magelang Regency, and Ngargomulyo Village, Sleman Regency. The lower reaches of the river are located in Blingo Village, Magelang Regency, and Banyurejo Village, Sleman Regency (Rohman *et al*., 2024).

The Krasak River watershed covers an area of 30.152 km², and the river is approximately 24 km long (Rohman *et al*., 2024). As part of the Progo River watershed, this river should serve as a habitat for various local fish species. A study on fish diversity in the Progo River conducted by Jailani & Mujtahidah (2021) showed that the fish caught were dominated by the Cyprinidae family, such as *Osteochilus vittatus* (nilem), *Mystacoleucus obtusirotris* (kepek), *Barbonymus balleroides* (balar), *Barbodes binotatus* (wader cakul), *Rasbora argyrotaenia* (wader pari), and others. Furthermore, another study by Mulyasari *et al*. (2023) reported that 23 fish species from

11 families were caught in the Progo River. Furthermore, a study on the Elo River in Magelang reported the presence of 6 families, 9 genera, and 9 fish species in both the upper and lower reaches of the river, with the Cyprinidae family being the most dominant (Darma & Putra, 2020).

The Krasak River has a unique characteristic: a high sediment content from volcanic material, which affects both water flow and water clarity (Suhendar *et al*., 2022). These conditions naturally lead to changes in the composition of the fish inhabiting the river (Taufik *et al*., 2021). In addition, there is active sand mining around the Krasak River. This is evidenced by numerous sand depots, the use of excavators to dig and dredge material, and trucks transporting it, all of which clog the main access roads around the river. These activities directly alter habitat conditions, affecting the composition and abundance of fish in the Krasak River (Fauzan *et al*., 2025).

Therefore, research on fish species diversity in the Krasak River is necessary to evaluate and analyze the current structure of the fish community. The results of this evaluation are expected to provide baseline data on the condition of the fish community in the Krasak River. The findings of this study are expected to support future conservation and river management efforts.

MATERIALS AND METHODS

Study Site

Fish species diversity was sampled along the Krasak River using purposive sampling. This method was chosen because of the varying environmental conditions and the differing vegetation and habitat surrounding the river at each sampling site. There were three sampling stations. The first station was located in Kranggan Lor Hamlet, Srumbung Subdistrict, Magelang Regency. The second location was in Kranggan Kidul Hamlet, Srumbung Subdistrict, Magelang Regency.

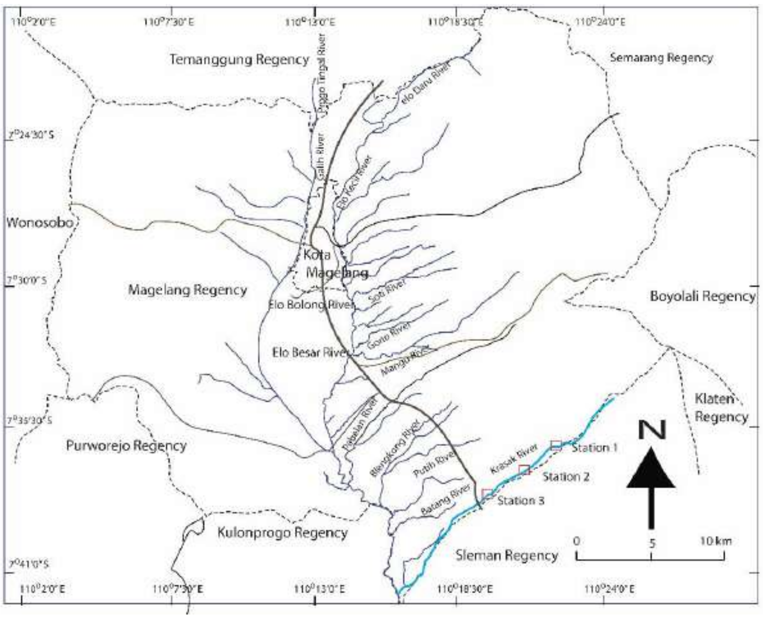

Figure 1. Map of sampling station locations on the Krasak River

Table 2. Research Map Location

Station	Description
1. Kranggan Lor Hamlet, Sudimoro Village, Srumbung Subdistrict.	The station is located at coordinates 7°37'27.5"S 110°20'53.0" E elevation of 452 meters above sea level. This station is characte by slightly brown water with a moderate to calm current. Chi farms and agricultural land surround the station. The riverbed coı of rock and sandy silt. The vegetation around the station is very d
2. Kranggan Kidul Hamlet, Sudimoro Village, Srumbung Subdistrict.	The Kranggan Kidul Station is located at coordinates 7°37'4(110°20'22.7" E at an elevation of 409 meters above sea level. A Kranggan Kidul Station, there is a waterfall that produces a strong current. The riverbed substrate is hard, dominated by r gravel, but the water is not very deep. The water is the clearest a station compared to the other stations. There are farm fields ar the station, so the water is used for irrigation. Additionally, the st features dense and diverse vegetation.
3. Sempon Hamlet, Sudimoro Village, Srumbung Subdistrict.	The Sempon Station is located at coordinates 7°38'2: 110°19'44.1"E at an elevation of 365 meters above sea level a situated near the Krasak River Dam. This station is characterize turbid water with a calm current. The riverbed consists of rock soft mud. In the vicinity of this station, there is intensive dredging activity, and it is the closest station to the highway. vegetation growing along the riverbanks is very dense. It is very to encounter people fishing here.

The final sampling location was in Sempon Hamlet, Srumbung Subdistrict, Magelang Regency. These sampling locations were also determined based on information from local fishermen. The location map for each station is shown in Figure 1, while the characteristics of each observation station are presented in Table 1.

Fish Sampling

Fish sampling was conducted from October through November 2025, once a week in the morning from 7 AM to 11 AM. Sampling at each station lasted 1 hour along a 100-meter stretch. Fish caught using cast nets were collected, cleaned, and placed in plastic bags labeled with their origin. The number of individuals caught at each station was counted. The fish were then transferred to a cooler box to keep the samples fresh. The collected fish were measured for total length The collected fish were measured for total length using a measuring tape and weighed using a digital scale. Each specimen was documented for archival purposes and to verify identification. After measurement and documentation were complete, all samples were transferred to a freezer to maintain their freshness prior to further analysis.

The identification and measurement data were then compiled into a table listing the number of individuals per species, as well as the fish's length and weight. Next, the samples were identified using the identification guides by Haryono *et al*. (2024), Kottelat *et al*. (1993), and Sukmono & Margaretha (2017), and cross-referenced with the latest literature on the identified species. The identification results were grouped by family, genus, species, and local name in tabular form. Photographs of the caught fish are included.

Environmental Condition Measurements

As supporting data, environmental parameters were measured at each sampling point simultaneously with fish collection. The parameters measured included river width (m), water temperature (°C), depth (cm), water clarity (cm), and current velocity ($m\ det\ -1$), each of which was measured three times. In addition, the data were supplemented with observations of water color, riverbed substrate, and vegetation around the sampling sites. The data obtained from ecological index calculations and environmental parameter measurements were then analyzed and presented in tables and graphs. The results of this analysis were subsequently discussed to determine the structure of the fish community, the level of diversity, species dominance, and their relationship to the environmental conditions of the Krasak River.

Ecological Index

Fish data collected from three observation stations were then analyzed to determine the structure of the fish community in the Krasak River. The analysis was conducted using an ecological index approach, consisting of:

a. Shannon-Wiener Diversity Index (H’) (Odum, 1994).

$$H' = -\Sigma pi\ In\ pi$$

Notes:
H’= Shannon-Wiener diversity index
Pi = Ratio of the number of individuals of species (i) to the total number of individuals (ni/N)
Ni = Number of individuals of species i
N = Total number of individuals of all species

b. Dominance Index (D) (Odum, 1998).

$$D = \Sigma(\frac{ni}{N^2})$$

Notes:
D = Dominance Index
Ni = Number of individuals of species i
N = Total number of individuals of all species

c. Evenness Index (E) (Odum,1993).

$$E = \frac{H'}{H\ maks}$$

Notes:
E = Evenness Index
H’= Diversity Index
S = Number of species in the community

d. Relative Abundance Index (RAI) (Krebs,1989)

$$RAI = \frac{ni}{N} x100$$

Notes:
RAI = Relative Abundance Index (ind/m^2)
Ni = Number of individuals of species i
N = Total number of individuals of all species

Result

Fish Species Diversity

Fish catches recorded at three sampling stations along the Krasak River from early October 2025 through November 2025 revealed a fairly wide range of species diversity. A total of 221 fish were caught, representing 4 orders, 6 families, and 12 species. The variation in fish species at each sampling station reflects similarities due to the even distribution of certain species across all stations. Data on the identified fish species are presented in Table 2.

Table 3. Fish Species in the Krasak River by Order, Family, and Species

No	Ordo	Family	Types of ichthyofauna		N (Indiv.)
			Species	Local Name	
1	Anabantiformes	Channidae	Channa striata	Gabus	1
2	Cypriniformes	Cyprinidae	Barbodes binotatus	Wader Cakul	33
3			Tor sp. / Neolissochilus sp.	Mangur	2
4			Mystacoleucus obtusirostris	Kepek	118
5			Osteochilus vittatus	Nilem	21
6		Danionidae	Rasbora argyrotaenia	Wader Pari (A)	2
7			Rasbora lateristriata	Wader Pari (B)	36
8		Nemacheilidae	Nemacheilus chrysolaimos	Uceng	2
9	Cyprinodontiformes	Poeciliidae	Poecilia reticulata	Guppy	3
10			Poecilia wingei	Endler Guppy	1
11	Siluriformes	Sisoridae	Glyptothorax major	Lele Sungai	1
12			Glyptothorax platypogon	Kehkel	1

The fish species caught during the study belonged to four orders, with Cypriniformes being the most dominant. This order was represented by a composition of 7 species distributed across 3 families: Cyprinidae, Danionidae, and Nemacheilidae. The family with the highest species diversity was Cyprinidae, with 4 species, followed by Danionidae with 2 species. Meanwhile, the family Nemachelidae is represented by only one species.

Distribution of Caught Fish

The composition of individual presence at each sampling station varies in terms of both number and percentage, as shown in Table 3.

Based on the table, Cypriniformes is the order with the most species, namely 7. On the other hand, the family with the highest species diversity is Cyprinidae, which consists of 4 species. The data in the table show the distribution of fish caught at each station.

Table 3. Distribution and percentage composition of individual attendance

No	Scientific Name	Local Name	Kranggan Lor	Kranggan Kidul	Sempon	Number	RA (%)
1	Barbodes binotatus	Wader Cakul	10	10	3	33	14.93
2	Channa striata	Gabus	1	0	0	1	0.45
3	Glyptothorax major	Lele Sungai	0	1	0	1	0.45
4	Glyptothorax platypogon	Kehkel	1	0	0	1	0.45
5	Mystacoleucus obtusirostris	Kepek	36	52	30	118	53.39
6	Nemacheilus chrysolaimos	Uceng	2	0	0	2	0.90
7	Tor sp. / Neolissochilus sp.	Mangur	0	2	0	2	0.90
8	Osteochilus vittatus	Nilem	3	9	9	21	9.50
9	Poecilia reticulata	Guppy	0	1	2	3	1.36
10	Poecilia wingei	Endler Guppy	0	1	0	1	0.45
11	Rasbora argyrotaenia	Wader Pari (A)	0	1	1	2	0.90
12	Rasbora lateristriata	Wader Pari (B)	19	9	8	36	16.29
	Total		72	86	53	221	53

This distribution demonstrates that *Mystacoleucus obtusirostris* has a strikingly high abundance percentage of 53.39%. This number accounts for more than half of the total individuals caught. At Sempon Station, 30 individuals were found; at Kranggan Kidul Station, 52; and at Kranggan Lor Station, 36. Thus, the total number of kepek fish is 118. This indicates that the kepek fish is the most abundant species found across all sampling locations.

To provide a clearer visualization of differences in species numbers across stations, the data are presented as a bar graph in Figure 2. Furthermore, details on variations in fish species composition across all study sites are summarized in Figure 3.

The community structure at each sampling station can be analyzed using ecological index parameters. The results of the ecological index calculations are presented in Table 4.

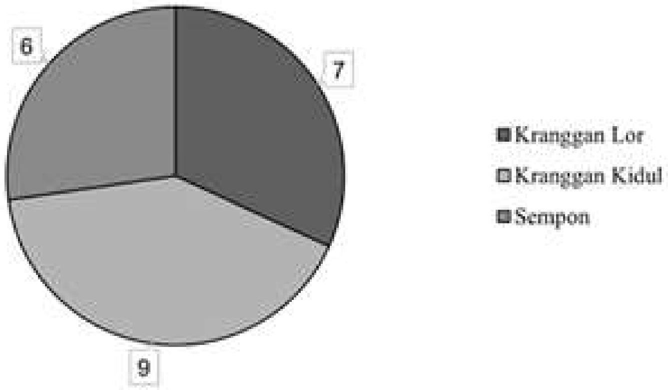

Figure 2. Number of fish species at each station

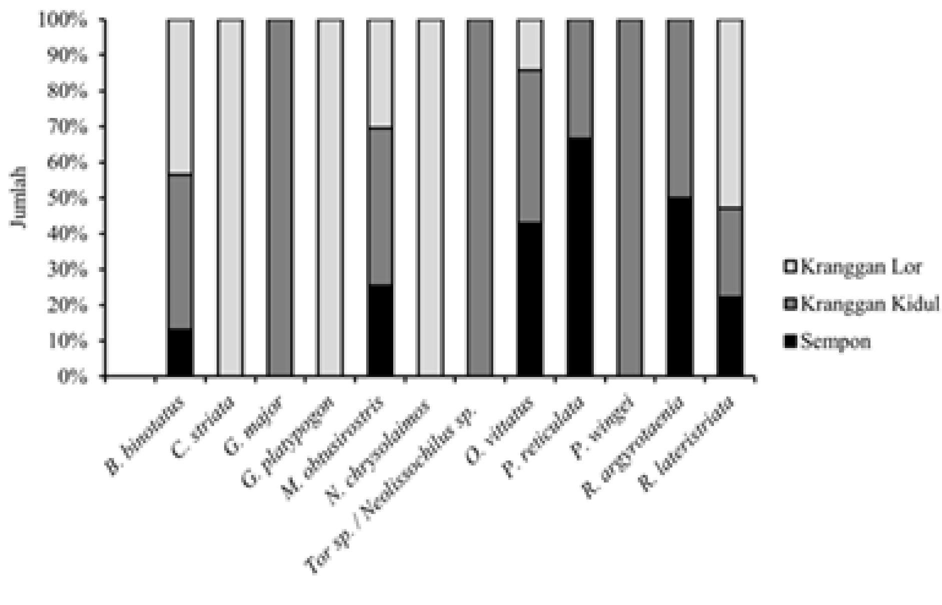

Figure 3. Percentage of each fish species at each station

Table 4. Diversity (H'), Evenness (E), and

Description	1 (Kranggan Lor)	2 (Kranggan Kidul)	3 (Sempon)
Number of Fishes (n)	72	86	53
Diversity Index (H')	0.796	0.882	0.647
Evennes Index (E)	0.321	0.355	0.2603
Dominance Index (D)	0.073	0.061	0.0217

Based on the calculations performed at all sampling stations, the highest H' value was 0.882 at the Kranggan Kidul Station, while the lowest value was recorded at the Sempon Station at 0.647, followed by the Kranggan Lor Station at 0.796. The number of fish species found was only 6 at Sempon Station, 9 at Kranggan Kidul Station, and 7 at Kranggan Lor Station. Furthermore, the fish species composition also confirmed a very strong dominance by M. obtusirostris, with 118 individuals—accounting for 53.39% of all fish caught. Meanwhile, most other species were found in only small numbers; in fact, some species were found in as few as 1–2 individuals, such as *C. striata*, *G. major*, and *G. platypogon*.

The evenness index (E) is a value that represents the abundance and evenness of species within an aquatic ecosystem. If the uniformity index approaches 0, it indicates a tendency toward the dominance of a particular species in that ecosystem; conversely, if the index approaches 1, the ecosystem is in a relatively stable condition with an even distribution of species (Setyobudiandi *et al*., 2009). Table 4. shows that the evenness index (E) values at the Sempon, Kranggan Kidul, and Karangan Lor stations range from 0.2603 to 0.355. A low E value indicates that the distribution of individuals across species is uneven, with most individuals concentrated in one or two dominant species. The dominance index (D) values at the research stations ranged from 0.0217 to 0.073, with the highest value recorded at the Kranggan Lor Station. Although the dominance index values are numerically still very low, the presence of a single species with very high relative abundance indicates a tendency toward biological dominance within the fish community. As supporting data clarifying the structure of the fish community, details on the body size of each fish species found are provided in Table 5.

Table 5 shows the distribution of length and weight of fish caught at all stations, with the average fish length ranging from 2 to 25.5 cm and the average weight ranging from 2 to 114 g. Based on these data, the majority of the fish caught were small. Approximately 88.69% of the total population consisted of individuals less than 10 cm in length, dominated by the species *M. obtusirostris* and *R. lateristriata*. Meanwhile, individuals measuring 10–15 cm accounted for only 1.36% of the total catch, and those larger than 15 cm accounted

Table 5. The species and body size of each type of fish caught at all stations

No	Scientific name	N (Indv.)	Total Length (cm)	Weight		
				Average (cm)	Weight (g)	Average (g)
1	*Barbodes binotatus*	33	6-6.7	6.90	2-15	4.21
2	*Channa striata*	1	25.5	25.50	114	114
3	*Glyptothorax major*	1	13.8	13.8	15	15
4	*Glyptothorax platypogon*	1	6	6	3	3
5	*Mystacoleucus obtusirostris*	118	5-12	7.66	2-17	5.37
6	*Nemacheilus chrysolaimos*	2	7.2-7.3	7.25	2-3	2.5
7	Tor sp. / Neolissochilus sp.	2	11.1-14.7	12.9	10-20	15
8	*Osteochilus vittatus*	21	27.3-13	18.54	18-381	79.19
9	*Poecilia reticulata*	3	3.2-4.1	3.67	0	0
10	*Poecilia wingei*	1	2.2	2.2	0	0
11	*Rasbora argyrotaenia*	2	6.2-7.3	6.75	0-4	2
12	*Rasbora lateristriata*	36	3.1-9.5	7.19	0-7	3.43

for 9.95%, driven by the presence of *O. vittatus*. Analysis of fish weight showed a pattern similar to that of length distribution. Species in the weight category below 10 g also contributed to the population with the same percentage, namely 88.69%. The dominant species were *M. obtusirostris* and *R. lateristriata*. In contrast, the group of fish weighing over 50 g accounted for only 9.95%. The species in this weight category are O. vittatus and C. striata. Meanwhile, the percentage of fish weighing between 10 and 50 g is only 1.36%. The presence of many small fish indicates that the study site serves as a habitat for juvenile fish.

Aquatic Environmental Conditions

The physical environmental conditions of the water at all sampling stations showed differences in characteristics between stations; for example, the Kranggan Lor Station is located near residential areas, chicken farms, and areas where sand is dredged using heavy machinery. The Kranggan Kidul Station is situated near a waterfall and chili pepper farms, while the Sempon Station is located near a sand dredging area where heavy machinery is used. Other factors affecting water quality include river width, river depth, water color, bottom substrate type, and riparian vegetation. It is important to examine these variations in order to understand the distribution patterns and community structure of the fish caught. Detailed results of environmental parameter measurements are presented in Table 6.

The water temperature range is 25–26°C. The depth values at all stations range from 40.7 to 85 cm. Furthermore, current speeds at the three sampling stations range from 0.19 to 0.90 m/s. The strongest current is at the Kranggan Kidul Station because it is located beneath a waterfall. Conversely, the Sempon Station has the slowest current. This is consistent with Tambunan (2013), who classified current speeds into four categories: slow currents ranging from 0 to 0.25 m/s,

Table 6. Environmental Quality at Each Sampling Station

Parameter	1 (Kranggan Lor)	2 (Kranggan Kidul)	3 (Sempon)
Temperature (°C)	26,73	25,07	25,97
pH	7,79	7,86	8,21
Current Speed (m/s)	0,44	0,9	0,19
Water Clarity (cm)	22,5	37,17	13,0
Depth (cm)	85	40,7	50
River Width (m)	18,9	26,86	7,48
Water Color	Light brown	Slightly brown	Murky brown
Substrate	Silt, sand, and rocks	Gravel and rocks	Rocks and silt
Surrounding Vegetation	Banana, coconut, bamboo, keladi, putri malu, beringin, grasses, sengon, waru	Banana, coconut, beringin, grasses, ketul, waru, sengon	Banana, bamboo, grasse ketapang, beringin, lamtoro, sengon

moderate currents ranging from 0.25 to 0.50 m/s, fast currents ranging from 0.5 to 1 m/s, and very fast currents exceeding 1 m/s. In addition, the Sempon Station has the narrowest river width, while the Kranggan Kidul Station has the widest.

Water conditions are also reflected in the water's color. The water color observed across all stations tends to be brown, with the clearest water at the Kranggan Kidul Station and the murkiest at the Sempon Station. The bottom substrate at the Kranggan Lor Station consists of mud, sand, gravel, and large rocks. At the Kranggan Kidul Station, the substrate is predominantly coarse. In contrast, at the Sempon Station, the substrate consists of mud, with many rocks covered by fine sediment. This type of substrate also causes the gaps between the rocks to fill with mud. The riparian vegetation growing at all stations is quite diverse and dense.

Discussion

The structure of fish communities in rivers is closely linked to the physical conditions of their habitat. Fish do not simply occupy random areas; rather, they select habitats that are most suitable for their survival, foraging, and reproduction. When viewed through the lens of the most fundamental factor—temperature—conditions in the Krasak River are highly conducive to biological productivity. Based on temperature measurements ranging from 25–26°C, this range falls within the optimal temperature for fish feeding, which is between 22–29°C (Manunggal *et al*., 2018). Below this temperature, fish can still survive but experience a decrease in appetite. Temperature variations affect physical, chemical, and biological factors in the water body, such as the metabolic activity of organisms and the growth of aquatic biota.

Ideal temperature alone is not sufficient; the structure of fish communities in rivers is also influenced by the riverbed substrate. Rivers with muddy bottoms tend to have lower fish abundance due to instability in fish habitat structure (Nuryanto *et al*., 2015).

Soft mud mixed with rocks causes the gaps between the rocks to be filled with fine sediment. This condition can reduce the availability of microhabitats—such as the spaces between rocks and open rocky bottoms—that fish typically use for foraging and as shelter from predators. On the other hand, very calm water currents result in food particles being poorly distributed. In fact, river fish generally rely on water currents to obtain natural food sources such as detritus, periphyton, and other small organisms. Under calm current conditions, fish tend to move to sections of the river with more dynamic flow. This is because fish are dynamic animals that constantly migrate, both to forage and to spawn. Furthermore, in sufficiently deep rivers, fish must expend more energy to move around in search of food, so not all species are capable of doing so.

Based on the observations, the Kranggan Lor station has the greatest depth, which provides a larger volume of water for fish to move vertically. This explains why relatively large fish, such as *C. striata* and *O. vittatus*, were found at that station. Furthermore, the discovery of *M. obtusirostris* in large numbers indicates that this fish has a broad habitat tolerance and good swimming ability in waters ranging from calm to fast-flowing currents. This habitat preference is particularly evident at stations with stronger currents. According to Cahyono *et al*. (2018), several species in the Cyprinidae family have torpedo-shaped (streamlined) bodies, which allow them to withstand high current speeds by minimizing drag at high flow velocities. This finding aligns with the data presented in Table 4.2, which shows that the most frequently caught fish belong to the family Cyprinidae. Furthermore, fish from the Cyprinidae family can swim against the current—a trait known as rheophilic (Lujan & Conway, 2014).

Different conditions were observed at stations with moderate currents, such as Kranggan Lor Station. Moderate currents still allow fish to forage, though not as effectively as in fast-flowing currents. According to Suryaningsih *et al*. (2018), rivers with moderate currents and a mixed substrate of rocks and sandy silt tend to support moderate populations of generalist fish communities. However, they rarely support high abundance compared to rivers with rocky substrates and strong currents.

On the other hand, the increased proportion of *R. lateristriata* at the Kranggan Lor Station aligns with the findings of Prasetyo & Retnoaji (2020), which showed that *R. lateristriata* tends to be more sedentary and active in waters with weak to moderate currents compared to fast-flowing currents. This is because less intense currents allow the fish to conserve energy while swimming and foraging. Research by Sentosa & Djumanto (2010) further supports the finding that *R. lateristriata* prefers shallow riverbank areas with sandy and gravelly substrates to facilitate foraging and enhance reproductive success. Based on this, the presence of *R. lateristriata* indicates that the habitat characteristics at the Kranggan Lor Station are suitable for this species.

In addition to current and substrate type, dense riparian vegetation plays a key role in increasing *R. lateristriata* abundance. Riparian vegetation serves as a gathering place for detritus and microorganisms, which are the primary food sources for small fish such as *R. lateristriata*. According to Suryaningsih *et al*. (2018), small fish from the Cyprinidae family tend to be more abundant in river segments with good riparian vegetation and high habitat heterogeneity.

Although all stations had dense riparian vegetation, an interesting phenomenon was observed: species were caught only in very limited numbers. Species caught in very small numbers in the Krasak River included Channa striata, *Glyptothorax major*, *Glyptothorax platypogon*, *Nemacheilus chrysolaimos*, *Tor sp. / Neolissochilus sp.*, and *Poecilia wingei*. The presence of these species is likely due to habitats that were underrepresented at the sampling stations.

Each species has different morphological, behavioral, and habitat preferences. For example, *C. striata* naturally inhabits waters with muddy, rocky, or sandy bottoms, as well as those rich in plant roots and tree roots. These types of substrates serve as hiding places for juvenile fish, whether to hunt for prey or to seek shelter from predators (Sirodiana & Irawan, 2020). The discovery of *C. striata* at the Kranggan Lor Station—in relatively deep waters with rocky and sandy-mud substrates, as well as dense riparian vegetation—provides both shelter and a food source for *C. striata*. As an opportunistic predator, this species preys on a wide range of aquatic organisms, including small fish, crustaceans, aquatic insects, and benthic organisms (Rosita & Monalisa, 2026). However, because the current at this station is moderate and sand dredging continues near the river, the habitat is not yet stable enough to support a resident population. This statement is supported by Rosita and Monalisa (2026), who note that the natural habitat of *C. striata* includes slow-flowing rivers, lakes, swamps, canals, and seasonal pools. Thus, the presence of a single *C. striata* individual at the Kranggan Lor Station more accurately reflects a temporary presence due to movement along the river, rather than a stable local population.

C. striata is a fish species equipped with an additional respiratory organ that allows it to breathe directly from the air, enabling it to survive in various habitats, such as swamps, rivers, lakes, and even flooded rice fields (Zega, 2025). Morphologically, *C. striata* has a long, slender body. This characterizes its rapid swimming movements and predatory behavior, as it lies in wait among vegetation for prey until it comes within striking distance (Kottelat *et al*., 1993). However, in terms of habitat preference, this species tends to choose waters with slow currents and dense vegetation to facilitate its hunting. Therefore, the presence of this fish indicates that at the Kranggan Lor Station, *C. striata* uses the area as a hiding place, given that this station is the deepest one. Additionally, the limited number of these fish is likely due to their solitary and territorial nature. On the other hand, fishing gear has limited ability to reach *C. striata*'s habitat among the vegetation. This is further supported by similar research on the decline in swimming endurance of snakehead fish in fast-flowing waters. High current speeds cause the fish to swim faster, leading to exhaustion due to increased energy expenditure (Nofrizal *et al*., 2011).

Small benthic species such as *N. chrysolaimos* also exhibit limited populations. *N. chrysolaimos* prefers habitats with moderately strong water currents and a substrate of small rocks. In addition to substrate factors, organic inputs from nearby aquaculture activities around the study site may also influence this fish's habitat preferences, given that *N. chrysolaimos* prefers fresh water with good environmental quality (Yudha & Hamdani, 2024). Furthermore, Kottelat *et al*. (1993) noted that Nemacheilus inhabits shallow riverbanks and riverbeds with sandy-gravel substrates and that this species can swim against the current. *N. chrysolaimos* uses the sandy gravel riverbed for self-defense when threatened (Keskar *et al*., 2014). When viewed in terms of habitat suitability, this species is indeed poorly suited to the physical characteristics of the Kranggan Lor Station, which is dominated by soft substrates, and thus cannot provide the habitat required by the fish to cling to rocks or forage on the riverbed. This is supported by Yudha *et al*. (2018), who noted that this fish is a demersal species with adhesive pectoral fins that enable it to attach to rocks on the riverbed and avoid being swept away by the current. Additionally, this fish has a subterminal mouth, which correlates with its feeding habits in the river. Consequently, very few individuals have been found. This habitat limitation is also a constraint for species that depend on fast-flowing water with hard substrate.

The presence of *G. platypogon* at the Kranggan Lor Station is likely due to the fish migrating to sections of the river with calmer currents for specific activities, such as foraging or temporarily avoiding very strong currents. However, because the substrate at the Kranggan Lor Station is dominated by soft, sandy mud, this habitat cannot sustain a Glyptothorax population over the long term. Very small numbers of *G. major* and *N. soroides* were also found at Kranggan Kidul Station. Fish of the genus Glyptothorax are also known as obligate rheophilic fish, meaning they prefer very strong water currents and rocky substrates (Ng & Kottelat, 2016). This is due to their bodies being equipped with a ventral adhesive apparatus, also known as the Thoracic Adhesive Apparatus (Kottelat *et al*., 1993). This apparatus consists of fine skin folds that help the fish attach firmly to rocks in extremely fast-flowing currents and in areas with better water quality (Maizul, 2020). These fish are active on the riverbed and typically hide beneath rocks. In addition, this rocky substrate serves as a feeding habitat. The presence of a waterfall in Kranggan Kidul—with its very strong current and a substrate of rocky gravel—indicates a suitable habitat for *G. major*. However, the limited number of individuals captured was due to the fish's tendency to hide among the rocks and the extremely strong current at this station.

An interesting finding in this study is the variation in species numbers across all stations. This variation will directly affect the water body's ecological index value. The quality of an aquatic ecosystem can be interpreted through the ecological index values obtained. The diversity value depends on the variation in individuals within each captured species; thus, the more species and the greater the variation in the number of individuals per species, the greater the diversity in that ecosystem (Sriwidodo, 2013). According to Magurran (2004), diversity indices are classified into three levels: if the diversity index (H') is greater than 3, the diversity is considered high; if H' is less than 1, the diversity is low. The analysis results show that the diversity index value for the Krasak River ranges from low to moderate.

In this study, a unique distribution pattern was observed, with the highest diversity index values—both in individual abundance and species richness—concentrated at the Kranggan Kidul Station. This phenomenon contrasts with the findings of Arunkumar & Manimekalan (2018), who studied freshwater fish fauna and concluded that fish species diversity and abundance decrease with increasing elevation. In contrast, in this study, Sempon Station—which has the lowest elevation—recorded the fewest individuals and species. The low species diversity at Sempon Station is likely due to substrate instability from intensive sand dredging and proximity to a highway. On the other hand, the high species richness at Kranggan Kidul Station can be explained by the river's wider dimensions. The river's width is positively correlated with the number of microhabitats and the total area. Thus, it can be inferred that longer and wider rivers are inhabited by more species than smaller ones (Nuryanto *et al*., 2015). A larger area naturally contains a greater number of microhabitats, and thus is more likely to be inhabited by a wider variety of fish species (Kottelat *et al*., 1993). Additionally, Kranggan Kidul features a variety of microhabitats, ranging from areas near waterfalls (riffles) to deeper sections (pools), enabling it to support a greater number of species.

Research by Sriwidodo *et al*. (2013) revealed that fish diversity in areas with strong currents is higher than in areas with slow currents; current velocity significantly influences the habitat and environmental conditions of river ecosystems—including both biotic and abiotic factors—resulting in greater fish diversity. This demonstrates that the Kranggan Kidul station, which has the strongest current velocity, exhibits the highest diversity value. Cahyono *et al*. (2018) also found that stations with higher current velocities account for 91% of the variation in fish diversity. Furthermore, the high species diversity in the upstream zone confirms the findings of a study by Titik & Agus (2019), which showed that fish species richness in the upper reaches of the Luk Ulo River in Kebumen Regency is higher than in the lower reaches—a difference attributed to extensive human activities, overfishing, and land-use practices. These factors ultimately alter the river's characteristics, leading to a decline in the population and diversity of river biota. Thus, this confirms the presence of environmental pressure at the Sempon Station, triggered by intensive sand dredging activities.

Intensive sand dredging activities can lead to excessive sedimentation and water turbidity. Meanwhile, conditions at the Kranggan Kidul and Kranggan Lor stations—which are slightly farther from mining activities—show slightly higher biodiversity values. This is also consistent with the statement by Kadim & Pasisingi (2024) that low H' values and low evenness in rivers are associated with habitat disturbance caused by anthropogenic activities. This disturbance leads to the dominance of a single species that can adapt to the habitat conditions in the Krasak River. The dominance of a single species across all stations causes the fish community to become unbalanced. This condition is consistent with anthropogenic activities along the Krasak River, namely intensive sand mining. Sand mining around the river is physically correlated with the riverbed substrate and water clarity parameters at the study site (Bhattacharya *et al*., 2019). Furthermore, variations in water clarity affect photosynthesis and aquatic productivity (Mardani *et al*., 2013).

Thus, it can be concluded that *M. obtusirostris* has successfully survived in these waters. The dominance of *M. obtusirostris* at the study site indicates that this species possesses a high adaptive capacity to stressed river environmental conditions. The high relative abundance of this fish, accounting for more than 50% of the total individuals caught, suggests that this species can survive and thrive in waters with declining habitat quality. Furthermore, *M. obtusirostris* is a river fish species characterized by a relatively fast growth rate and a fairly high natural mortality rate, though this is offset by a recruitment pattern that occurs almost year-round (Djumanto *et al*., 2014). These characteristics allow the population to recover more quickly, even under environmental stress or habitat disturbance, enabling it to remain dominant in the fish community of disturbed rivers. Saprudin *et al*. (2022) and Suryaningsih *et al*. (2018) noted that fish from the family Cyprinidae tend to dominate in river segments subjected to anthropogenic pressures, such as changes in river morphology and sedimentation resulting from sand mining. This pattern is similar to that of this study, in which the species *M. obtusirostris* was found at all sampling stations due to its high adaptability.

Sand dredging activities can increase sedimentation and water turbidity. Both of these factors are less favorable for fish that require rocky substrates or clear water, but they are still tolerable for *M. obtusirostris*. The resilience of *M. obtusirostris* is also driven by its very broad feeding pattern. The kepek's ability to survive is also linked to its ecological flexibility in utilizing habitats and food sources. The kepek reaches its asymptotic length quickly, resulting in high growth rates. This high growth rate is due to the kepek fish's broad dietary range (euryphagous), enabling it to prey on both animal and plant matter in its surroundings (Djumanto *et al*., 2014). The main diet of the kepek fish consists of worms, crustaceans, insects, aquatic plants, phytoplankton, and detritus (Froese & Pauly, 2014). Consistent with these findings, Bainiyah *et al*. (2020) note that the Cyprinidae family is indeed known as the primary inhabitants of several rivers and swamps.

Consequently, the dominance of the kepek fish at the study site represents an ecological response to environmental pressures in the river. The combination of high environmental tolerance, good growth rates and recruitment, and flexibility in habitat use and foraging makes *M. obtusirostris* a species capable of surviving and dominating in disturbed river ecosystems, particularly those affected by human activities such as dredging or sand mining. The low uniformity index reflects an unstable community that is sensitive to environmental changes. A similar pattern was reported by Wahyuningsih *et al*. (2022) in the Logawa River, Central Java, where sand mining activities altered the physical conditions of the water, in turn leading to low aquatic organism diversity. Odum (1993) explains that in disturbed ecosystems, dominance values tend to increase because only a few species are able to adapt and thrive. This aligns with the findings of Pramono *et al*. (2018) on the Klawing River in Central Java, who reported that the increased dominance of fish from the Cyprinidae family was associated with human activity pressures around the river. A similar pattern was observed at this study site, where fish distribution was uneven and showed signs of community simplification in response to ongoing environmental disturbances.

Thus, the uneven distribution of fish among stations, the dominance of highly tolerant species, and the limited distribution of sensitive species indicate that the fish community structure at the study site is under ecological stress. This distribution pattern reinforces the results of the diversity, evenness, and dominance index analyses and indicates that human activities around the river—particularly dredging and sand mining—play a significant role in shaping the spatial distribution of the fish community.

Conclussion

A Total of 12 fish species belonging to 6 families were found. A total of 12 fish species belonging to 6 families were found. The Cyprinidae family was the most dominant group, with the species *Mystacoleucus obtusirostris* (kepek fish) having the widest distribution across all sampling sites. The distribution of fish species showed an uneven pattern, though this was not particularly significant. The Diversity Index (H') ranged from 0.647 to 0.882, falling into the low category. Differences in H' values are closely related to habitat variations among stations. The Evenness Index (E) ranged from 0.260 to 0.355, indicating low values. This is evidenced by the uneven distribution of individuals across species, with the majority concentrated in a single species. Furthermore, the Dominance Index (D) is reflected in the Relative Abundance (RA) values, in which the number of Mystacoleucus obtusirostris individuals that accounted for >50% of the total catch is shown. This demonstrates the species' high adaptive capacity compared to other species. The aquatic environmental conditions in the Krasak River—particularly current velocity, bottom substrate type, and turbidity levels—are the primary limiting factors for fish distribution. Differences in environmental characteristics at each station also influenced the composition of the species found. In addition, sand dredging activities around the stations are suspected to have contributed to changes in substrate conditi-ons and water turbidity levels, which in turn affected fish distribution.

References

Bainiyah, R., K. Salim, & E. Utami. 2020. Struktur komunitas ikan di perairan Sungai Mendo Kabupaten Bangka. Akuatik: Jurnal Sumberdaya Perairan, 14(1): 67-73.

BAPPEDALITBANGDA Kabupaten Mage-lang. 2021. Kajian Sosial Budaya Di Kecamatan Borobudur Kabupaten Magelang. Magelang : BAPPEDALIT-BANGDA Kabupaten Magelang.

Bhattacharya, R. K., N. Das Chatterjee, & K. Das. 2019. Geomorphic response to riverine land cover dynamics in a quarried alluvial River Kangsabati, South Bengal, India. Environmental Earth Sciences, 78(22): 633.

Cahyono, R. N., A. Budiharjo, & S. Sugiyarto. 2018. Keanekaragaman dan kekerabatan ikan Famili Cyprinidae pada ekosis-tem Bendungan Colo Sukoharjo Jawa Tengah. EnviroScienteae, 14(2): 137-146.

Djumanto, D., M. I. P. Devi, I. F.Yusuf, & E. Setyobudi. 2014. Kajian dinamika populasi ikan kepek, *Mystacoleucus obtusirostris* (Valenciennes, in Cuvier & Valenciennes 1842) di Sungai Opak Yogyakarta. Jurnal Iktiologi Indonesia, 14(2): 145-156.

Froese R, D. Pauly. Editors. 2014. FishBase. World Wide Web electronic publication. www.fishbase.org, ver-sion (08/2013).

Haryono, Y. Hikmayani, Wahyudewantoro, R. Gustiano, Aisyah, I. Hidayatullah, & Y. Y. P. Jaya. 2024. Panduan

Identifikasi Jenis Ikan Perairan darat. Jakarta: Kementerian Kelautan dan Perikanan.

Kadim, M. K., & N. Pasisingi. 2024. Kondisi habitat fisik dan keanekaragaman makroinvertebrata sebagai indikator pencemaran di sungai Bone Gorontalo. Jurnal Kesehatan Lingkungan Indonesia, 23(3): 301-310.

Keskar, A., Padhye, A., & Dahanukar, N. 2014. Fighting against all odds: the struggle for existence among hill stream loaches of northern Western Ghats. Min-Newsletter of FFSG, 2: 25-29.

Kottelat, M., T. Whitten, S. N. Kartikasari, & S. Wirjoatmodjo. 1993. Freshwater Fishes of Western Indonesia and Sulawesi. Singapore: Periplus Editions.

Krebs, C.J. 1989. Ecological Methodology. Harper and Row Inc Publiser, New York.

Lujan, N. K., & K. W. Conway. 2014. Life in the fast lane: a review of rheophily in freshwater fishes. Extremophile fishes: Ecology, evolution, and physiology of teleosts in extreme environments, 107-136.

Maizul, R. 2020. Mengenal ikan kekel (*Glyptothorax platypogon* Valenciennes, 1840), ikan asli dari Pulau Jawa. Warta Iktiologi. 4(2): 21-26

Magurran, A. E. 2004. Measuring Biological Diversity. Oxford: Blackwell Publishing.

Manunggal, A., R. Hidayat, S. Mahmudah, D. Sudinno, & A. Kasmawijaya. 2018. Kualitas air dan pertumbuhan pembesaran ikan patin dengan teknologi biopori di lahan gambut. Jurnal Penyuluhan Perikanan dan Kelautan, 12(1): 11-19.

Mardani, M., A. Mangalik, Y. Jagau, & J. Hadie. 2013. Inventarisasi Jenis Ikan yang Tertangkap di Beberapa Perairan Danau di Wilayah Kecamatan Kamipang Kabupaten Katingan Kalimantan Tengah. Enviro Scienteae, 9(2), 85-99.

Mulyasari, T. M., J. Mukono, and Y. Sincihu. 2023. The presence of microplastics in the Indonesian environment and its effects on health. Journal of Public Health in Africa. 14(2): 8.

Ng, H. H., & M. Kottelat. 2016. The glyptothorax of Sundaland: a revisionary study (Teleostei: Sisoridae). Zootaxa, 4188(1): 1-92.

Nofrizal, N., M. Ahmad, & I. Syofyan. 2011. Daya tahan dan kecepatan renang ikan selais (Kryptopterus sp.)[Swimming endurance and speed of catfish (Kryptopterus sp.)]. Jurnal Iktiologi Indonesia, 11(2): 99-106.

Nuryanto, A., D. Bhagawati, M. N. Abulias, & I. Indarmawan. 2015. Fauna ikan di Sungai Cikawung Kabupaten Cilacap Jawa Tengah. Jurnal Iktiologi Indonesia, 15(1): 25-37.

Odum, E.P. 1993. Dasar-dasar Ekologi. Diterjemahkan dari Fundamental of Ecology oleh T. Samingan. Gadjah Mada University Press. Yogyakarta

Odum, E.P. 1994. Dasar-dasar Ekologi. Edisi-3. Terjemahan Tjahjono Samingan. Gadjah Mada Univ. Press. Yogyakarta.

Odum, E. P. 1998. Dasar-dasar Ekologi. Diterjemahkan dari Fundamental of Ecology oleh T. Samingan. UGM Press. Yogyakarta.

Prasetyo, A., & B. Retnoaji. 2020. Migration biomodelling of wader pari fish (*Rasbora lateristriata* Bleeker, 1854) toward varied current direction and substrate type. In AIP Conference Proceedings (Vol. 2260, No. 1, p. 030005). AIP Publishing LLC.

Pramono, T. B., D. Arfiati, M. S. Widodo, & U. Yanuhar. 2018. Iktiofauna di hilir Sungai Klawing Kabupaten Purbalingga, Jawa Tengah. Samakia: Jurnal Ilmu Perikanan, 9(2): 65-69.

Rohman, F., Ikhsan, J., & Hairani, A. 2024. Prediksi Dampak Endapan Sedimen

Hasil Erupsi 2023 terhadap Karakteristik Banjir Lahar di Kali KrasakMenggunakanSIMILAR. Konst ruksia, 15(2), 39-48.

Rosita, S. P., S. S. Monalisa, & S. Pi. 2026. Parasit Protozoa pada Ikan Gabus (*Chana striata*). Uwais Inspirasi Indonesia. 101 p.

Sentosa, A. A., & D. Djumanto. 2010. habitat pemijahan ikan wader pari (*Rasbora lateristriata*) Di Sungai Ngrancah, Kabupaten Kulon Progo [Spawning habitat of *Rasbora lateristriata* in Ngrancah River, Kulon Progo Regency]. Jurnal Iktiologi Indonesia, 10(1): 55-63.

Setyobudiandi I, Sulistino, Ferdinan Y, Kusuma C, Hariadi S, Damar A, Sembiring A dan Bahtiar. 2009. Sampling dan Analisis Data Perikanan dan Kelautan Terapan Metode Pengam-bilan Contoh di Wilayah Pesisir dan Laut. Fakultas Perikanan dan Ilmu Kelautan. IPB

Sirodiana, S., & D. Irawan. 2020. Pemeliharaan benih ikan gabus (*Channa striata*) di kolam dengan substrat dasar pasir. Buletin Teknik Litkayasa Akuakultur, 18(1): 25-28.

Sriwidodo, D. W. E., A. Budiharjo, & S. Sugiyarto. 2013. Keanekaragaman jenis ikan di kawasan inlet dan outlet Waduk Gajah Mungkur Wonogiri. Bioteknologi Biotechnological Studies, 10(2): 43-50.

Suhendar, A., R. Dwi, & I. Maulana. 2022. Dampak aktivitas penambangan pasir pada kualitas air S.Krasak, Magelang. Jurnal Lingkungan & Sum-berdaya Alam Indonesia, 10(3): 142–152.

Sukmono, T. & M. Margaretha. 2017. Ikan Air Tawar di Ekosistem Hutan Sumatera dan Frankfurt Zoological Society. Yayasan Konservasi Ekosistem Hutan Sumatera & Frankfurt Zoological Society.

Suryaningsih, E., A. K. Zakaria, & I. S. Rohyani. 2018. Distribusi longitudinal ikan di Sungai Klawing, Jawa Tengah. JII, 18(2): 129–140.

Tambunan, J. M. 2013. Strategi Pengelolaan Lingkungan Pantai Tanjung Pesona Kabupaten Bangka untuk Pengembangan Wisata. UNDIP. Program Pasca Sarjana.

Taufik, M., D. Rahmadani, & A. Syamsuddin. 2021. Pengaruh aktivitas manusia pada kualitas air dan keanekaragaman biota sungai. J. Ilmu Lingkungan Lestari, 18(2): 97–107.

Titik. T. W and Agus Z. 2018. Keanekaragaman Ikan di Sungai Luk Ulo Kabupaten Kebumen. Biosfera Vol 35, No 1 Januari 2018 : 23 - 28 DOI: 10.20884/1.mib.2018.35.1.592

Wahyuningsih, E., N. L. Rahayu & M. Zaenuri. 2022. Pengaruh penambangan batu terhadap komunitas makrozoobentos di S. Logawa. Jurnal Multidisiplin Madani, 2(2), 1047-1066.

Yudha, D. S., & Hamdani, F. N. 2024. Keanekaragaman morfologis *Nemacheilus fasciatus* di Perairan S.Bogor, Temanggung dan Blitar. J.Biologi Papua, 16(2): 114-121.

Yudha, I. G. N. A. P., I. W. Arya, dan S. A. M. P. Suryani, 2018. Studi identifikasi keragaman jenis, feeding habit dan food habit ikan demersal pada bagian Hilir Sungai Yeh Sungi, Tabanan, Bali. Gema Agro, 23(2): 114-123.

Zega, A., B. V. Telaumbanua, D. Laoli & R. D. Zebua, 2023. Physical water quality parameters in Boyo River Onowaembo Village, Gunungsitoli Subdistrict. J.Perikanan Tropis, 10(2):43-52.

Zega, H.V. 2025. Meristik ikan gabus. Ju Zega, H.V. 2025. Meristik ikan gabus. Jurnal Ilmu Pertanian&Perikanan, 2(3): 58-65

Diet Composition and Feeding Habits of the Gobiid Fish *Eleotris fusca* in the Ummiding River, Polewali Mandar, West Sulawesi

Adiara Firdhita Alam Nasyrah[1], Muhammad Nur[1], Azmiatul Khairat[2], Tikawati[1], Sri Winda Amaliah[3]

[1)]Aquatic Resources Study Program, Department of Fisheries, Sulawesi Barat University
Jl. Prof Baharuddin Lopa, Majene, West Sulawesi 91412
[2)]Aquaculture Study Program, Department of Fisheries, Sulawesi Barat University
Jl. Prof Baharuddin Lopa, Majene, West Sulawesi 91412
3)Aquatic Research Management, IPB University, West Java, Indonesia
e-mail: adiarafirdhita.alamnasyrah@unsulbar.ac.id

Recieved: December 6, 2025; Accepted: February 7, 2026

Abstract

Eleotris fusca is one of the amphidromous goby fishes lives in Ummiding river, West Sulawesi. Amphidromous goby has a complex life cycle compared to other fishes. The adults lives in river for growth and reproduction, meanwhile the eggs and larvae are transported downstream to the estuary. After completing their larval development, they migrate back to freshwater. The presence of prey strongly influences the migration and growth of *E. Fusca* in nature. This study aims to reveal the diet composition and feeding habits of *E. Fusca*. Sample collected using an electrofishing unit in Ummiding river, West Sulawesi, throughout three months from October to December 2023. A total of 90 fishes captured with total length range 32-81 mm. The diet composition of *E. fusca* consisted in three types of prey, such as insect larvae, phytoplankton and zooplankton. Ratio of length intestinal explained *E. fusca* category as carnivorous and tends to has feeding strategy in generalist with the dominant prey Hemiptera from insect larvae.

Keywords: amphidromous goby, carnivorous, *E. fusca*, Ummiding river, Hemiptera

Introduction

The Mandar River is one of the major river systems in West Sulawesi Province, originating in the mountainous Tutar District and flowing through several districts of Polewali Mandar Regency before discharging into Mandar Bay. At approximately 150 km, it is one of the longest rivers in West Sulawesi (Tasrif *et al.* 2022). The river provides diverse freshwater habitats that support a rich fish community dominated by amphidromous gobies (Nur et al. 2021; Nurjirana *et al.* 2020; Nasyrah *et al.* 2025). A key habitat for gobies in West Sulawesi is the Ummiding River, Pao-pao Village, Alu District, Polewali Mandar Regency (Tikawati *et al.* 2024; Nasyrah *et al.* 2025).

Amphidromous gobies were very commercially in West Sulawesi especially post larval stage, locally known as *penja.* This seasonal fishery plays an important socio-economic role, as *penja* is widely harvested, consumed, and marketed in both fresh and dried forms by local communities (Nur *et al.* 2018). These fishes exhibit a complex amphidromous life cycle in which adults inhabit rivers for growth and reproduction, while eggs and larvae are transported downstream to estuarine and marine environments. After completing larva develop-ment in the sea, juveniles migrate back into freshwater habitats (Simanjuntak, *et al.* 2021; Hasan, 2022). During the migration to river, post larvae was intensively exploited by local fishers. This case makes penja a high economic value for fisheries resources, but also raises concerns regarding the long-term sustainability of wild goby populations.

Eleotris fusca is one of the dominant species in Ummiding River (Nasyrah *et al.* 2024). *E. fusca* is not just a commercially valuable food fish it also has significant potential as an ornamental species due to it's appealing morphology and color. Given its economic significance and conservation issues, the domestication of *E. fusca* stands out as a viable approach to establishing a new aquaculture product while aiding conser-vation via a captive breeding and restocking initiative in West Sulawesi. However, the success of domestication depends on a comprehensive understanding. Maeda and Tachihara (2004) described the instream distribution and feeding habits of *E. fusca* in the Teima River, Okinawa, while Mennesson *et al.* (2015) revealed its amphi-dromous life cycle using otolith analyses. In West Sulawesi, studies have investigated the reproductive biology (Nasyrah *et al*. 2025) and habitat characteristics (Nasyrah *et al.* 2024) of *E. fusca*. Information on the diet composition and feeding habits of *E. fusca* in the Ummiding River is still lacking. Therefore, this study aims to fill the gap from previous research on the effort to domesticate goby in West Sulawesi to support the conser-vation and domestication of this species.

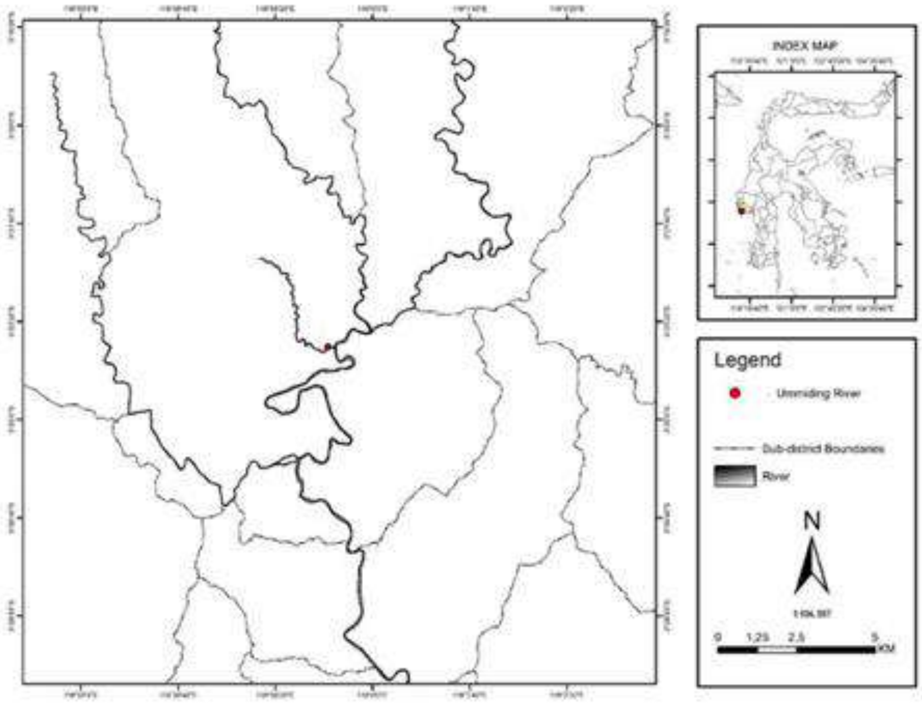

Figure 1. Map of sampling site in Ummiding River

Materials and methods

Study sites

E.fusca were sampled each month from October to December 2023 in the Ummiding River, Pao-pao Village, Alu Regency, Polewali Mandar, West Sulawesi (Figure 1). Meanwhile, sampling analysis started from May to June 2024 in the Fisheries Laboratory, UPA Integrated Laboratory, Sulawesi Barat University

Sampling collection

This research uses an exploratory survey method by purposively selecting three locations along the Ummiding River, which is suspected to have a high abundance of *E. fusca*. Sampling was conducted using a backpack electrofishing unit. The fish caught were preserved in sample bottles containing a 10% formalin solution for further analysis in the laboratory.

Measurements and dissection of fish samples

E. fusca samples were measured for length using a caliper with an accuracy of 0.1 mm and weighed using a digital scale with an accuracy of 0.0001 g. Samples were then cleansed from formalin using running water, dried with tissue, and dissected. Dissection start from the anus to the upper abdomen, up to the rear of the operculum, and then from the ventral side to the lower abdomen.

Diet composition analysis

Each dissected digestive tract was preserved in a clip plastic bag containing 4% formalin. The digestive tract samples were analyzed to determine the fish's diet. To determine the ratio of intestinal length, the length of the digestive tract is measured. The measured digestive tract then placed in petri dish to examine the contents.

The volume of the contents from digestive tract is measured to determine the total contents volume using the syringe method. The digestive tract contents were identified under a monocular microscope with 4x10 magnification, referring to Needham and Needham (1962), Pennak (1978), Clifford (1991), and Vuuren et al. (2006). After identification, the contents were counted and the volumes measured for further analysis.

Data analysis

Ratio of intestinal length

Feeding habits were determined the fish as herbivore, carnivore, and omnivore based on the correlation between the ratio of intestinal length and total length, referring to the formula described by Muthiah (2021) :

$$RIL = \frac{\text{Intestine length}}{\text{Total length}}$$

RIL = intestine length/fish total length; fish belonged to carnivore if RIL < 1, herbivore if RIL> 3, and omnivore if RIL = 1–3.

Diet Composition

The diet composition was analyzed using the index of preponderance based on the following formula Natarajan and Jhingran (1961). Where V_i is the percentage volume of

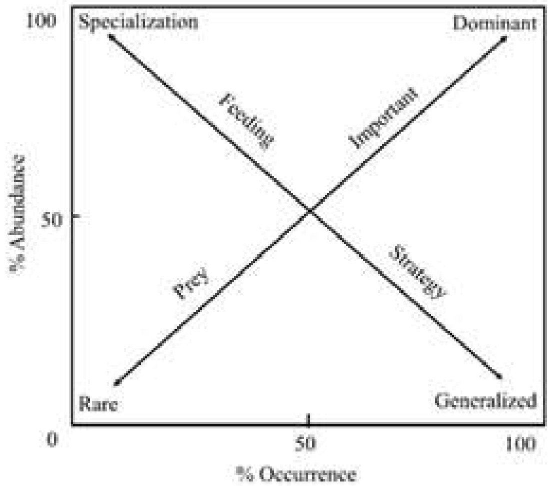

Figure 2. Feeding strategy plot modified from Coestello by Amundsen (1996)

the specific prey (%) and O_i is the percentage occurrence of the specific prey (%).

$$Ii = \frac{\text{Vi x Oi}}{\sum \text{Vi x Oi}} \text{ x } 100\ \%$$

Feeding Strategy

Feeding strategy were obtained by linking a specific percentage of the abundance of food organisms and the percentage frequency of occurrence using charts Costello (1990) modified Amundsen (1996) (Figure 2).

The plot provides information on the prey's importance and feeding strategy. Frequency occurrence and prey abundance using the formula Masuda *et al.* (1984).

$$\text{Pi} = \frac{\sum \text{Si}}{\sum \text{St}} \text{ x } 100\%$$

where Pi is the prey-specific abundance of prey *i*; S_i is the stomach content composed of prey *i*, and S_{ti} is the total stomach content in only those fish with prey *i* in their stomachs.

Results

Ratio of intestinal length E. fusca

A total of 90 individuals *E. fusca* from Ummiding river from October to December 2023 were collected during the sampling time. Total length of *E. fusca* was 32 – 81 mm with the ratio of intestinal length (RIL) being 0.42 – 0,53 mm, indicating a carnivore inclination RIL < 1). The ratio of intestinal length com-position of distribution is shown in Table 1.

Table 1. Ratio of intestinal length E. fusca in Ummiding river

Sampling time	Total length ranges (mm)	Intestinal length ranges (mm)	Total length average (mm)	Intestinal length average (mm)	Ratio of intestinal length
October	32 - 81	5 - 40	54,6 ± 12,5	23,5 ± 10,5	0,4178
November	49 - 80	11 - 62	60,8 ± 8,9	32,7 ± 9,6	0,5341
December	42 - 78	10 - 60	55 ± 8	25 ± 9	0,4602

Table 2. Diet composition of E. fusca in Ummiding river

Category	Food organism	Sampling time		
		October	November	December
Insect larvae	Hemiptera	+	+	+
	Lepidoptera	+	+	+
	Trichoptera	+	+	+
	Ephemeroptera	+	+	+
	Diptera	+	+	+
	Coleoptera	-	+	-
	Hirudinae	+	+	+
	Oligochaeta	+	-	-
	Insect fragments	+	+	+
Phytoplankton	*Phormidium*	+	+	+
	Gomphonema	+	-	-
	Meridion	+	-	-
	Oscillatoria	+	-	-
	Naviculla	+	+	+
	Coelosphaerium	+	-	-
	Aphanizomenon	+	+	+
	Microthamnion	+	+	-
	Cyclotella	-	+	-
	Dinoflagellata	-	+	-
	Ceratium	-	+	+
	Diatoma	-	+	-
	Lyngbya	-	+	-
	Straurastrum	-	+	-
	Synedra	-	+	+
	Rhizoclonium	-	+	-
	Melosira	-	+	-
	Periphyton	+	-	-
Zooplankton	*Cladocera*	+	+	+
	Ostracoda	+	-	-
	Tricladida	+	-	-
	Arthropoda	+	-	-

Note: + present, - absent

Table 3. The preponderance index (IP) of diet composition E. fusca in Ummiding river

Category	IP (%)		
	October	November	December
Insecta larvae	69,90	94,62	90,28
Phytoplankton	19,45	5,08	6,79
Zooplankton	10,66	0,30	2,93
Total	100	100	100

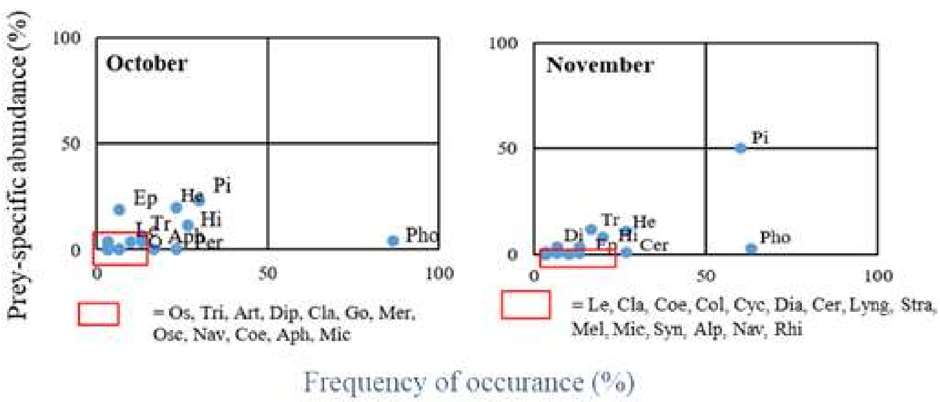

Figure 3. The feeding strategy of E. fusca in Ummiding river from October to November 2023

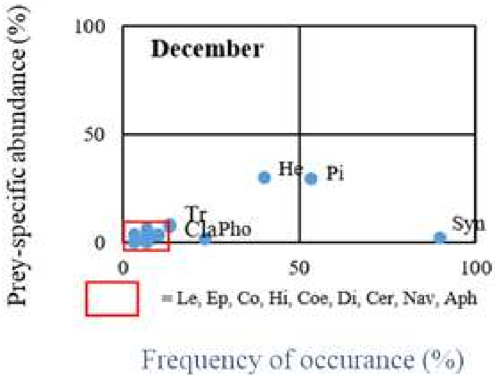

Figure 4. The feeding strategy of E. fusca in Ummiding river in December 2023

Note: *Hemiptera* (He), *Oligochaeta* (Ol), *Lepidoptera* (Le), *Tricoptera* (Tr), *Ephemeroptera* (Ep), *Ostracoda* (Os), *Tricladida* (Tr), *Arthropoda* (Art), *Diptera* (Dip), Insecta fragments (Pi), *Cladocera* (Cla), *Hirudinea* (Hi), *Phoridium* (Pho), *Gomphonema* (Go), *Meridion* (Mer), *Oscillatoria* (Osc), *Navicula* (Nav), *Coelosphaerium* (Coe), *Aphanizonemon* (Aph), *Microthamnion (*Mic), Perhypiton (Per), *Coleoptera* (Col), *Cyclotella* (Cyc), Diatoma (Dia), *Lyngbia* (Lyng), Staurastrum (Stra), *Melosira* (Mel), *Synedra* (Syn), *Rhizoclonium* (Rhi), *Ceratium* (Cer)

Diet composition

The various food items of *E. fusca* in Ummiding river from October to December 2023 were identified and listed in Table 2

Index Preponderance

The preponderance index value of diet composition *E. fusca* in Ummiding river shown in Table 3

Feeding strategy

The feeding strategy of *E. fusca* in Ummiding river from October to December 2023 shown in Figure 3 & 4

Discussion

The research results the RIL value of *E. fusca* collected in Ummiding river ranges from 0,42 to 0,53 mm, which means it has carnivorous feeding habits (RIL <1), based on the statement by Zuliani *et al.* (2016), where fish with RIL <1 are generally carnivorous, RIL = 1–3 are omnivorous, and RIL >3 indicate herbivorous traits. Similarly, Maeda & Tachihara (2004) studied the feeding habits of *E. fusca* in the Teima River, Okinawa Island, Japan, and categorized it as carnivorous. Analysis of the digestive tract contents shows *E. fusca* consumes three prey groups of organisms throughout three months in Ummiding river. The three prey items were insect larvae, phytoplankton and zooplankton. Insect aquatic larvae such as Ephemeroptera, Trichoptera, Lepidoptera, Diptera, Hemiptera and Coleoptera, as well as the Annelida group (Oligochaeta and Hirudinea). The phytoplankton group was Bacillariophyceae (*Gomphonema, Meridion, Navicula, Cyclotella, Diatoma, Synedra, Melosira*), Chlorophyta (*Microthamnion, Staurastrum, Rhizoclonium*), Cyanobacteria (*Phormidium, Oscillatoria, Coelosphaerium, Aphanizomenon, Lyngbya*), and Dinoflagellata (*Ceratium*). In addition, several zooplankton groups, such as *Cladocera*, *Ostracoda*, *Tricladida*, and

Arthropoda, were also found in the digestive tract. Similar findings were reported of *E. fusca* in Cisolok and Cimandiri estuaries, Palabuanratu, were phytoplankton in Bacillariophyceae (*Cymbella*, *Navicula, Nitzschia, Surirella, Synedra*) and zooplankton in Rotifera (*Notholca*) that benthic were identified in its gut contents and commonly found on the bottom or in the water column (Prabowo, 2022). In another estuary in Palabuhanratu, Cimaja estuary, Amaliah *et al.* (2022) explained amphidromous gobies using benthic Bacillariophyceae such as *Tabellaria* and *Surirella* as main prey. Furthermore, Khartiono *et al.* (2024) also described goby in Biak river, Central Sulawesi as a benthic feeder, such as Bacillariophyceae (*Cymbella* and *Bacillaria*) found in their gut contents.

The presence of benthic organisms indicates that *E. fusca* utilizes food resources both in the bottom water as well as in the water column. The diversity of phytoplankton indicates that although *E. fusca* has a short intestine, it also consumes a certain amount of plant-based food sources thus, it can be classified as an omnivore with a carnivorous tendency. The benthic prey consumed by *E.fusca* were certainly in line with the habits of these fish, where during the migration process to the estuary, the first thing they do is settle on the bottom of the water before moving upstream (Maeda and Tachihara, 2005; Prabowo, 2022). This statement is supported by the fact gobies are commonly found on the bottom of water bodies, whether on rocky substrates (Keith *et al.* 2014) with clear waters using their pelvic fins (Khartino *et al.* 2024). Additionally, Jabbar *et al.* (2025) and Nasyrah *et al.* (2024) reported the Ummiding river is a fast-flowing river with substrates dominated by rocky sand and crystal clear water, emphasizing that the Ummiding river became a suitable habitat for *E. fusca.*

The diet composition is an important aspect in understanding fish ecology because it reflects food preferences, resource availability in the habitat, and adaptation strategies used to support its growth and survival (Nasyrah *et al.* 2024). Index of Preponderance (IP) was used to determine the categories of main, secondary, and additional foods, allowing us to identify the dominant types of food in the feeding habits of *E. fusca.* Based on the IP value of the diet composition, the findings showed that insect larvae constituted the bulk of food consumed (84,93%), phytoplankton (10,44%), and zooplankton showed the least-consumed diets (4,63%). The dominance of insect larvae, particularly from Hemiptera, in the digestive tract indicates a match between the fish's diet and the abundance of food in its environment. Aisyah (2025) described that insect larvae is many in Ummiding River, West Sulawesi. Furthermore, it's also suspected that the abundance of vegetation on both sides of the river serves as a habitat that supports the abundance of insects, making it the main food source for *E. fusca.*

On the other hand, phytoplankton is used as a secondary food with a lower IP value, indicating phytoplankton was not the main food, rather, it is believed to be merely ingested along with other organisms or consumed as an additional energy source when the availability of insect larvae decreases. Meanwhile, zooplankton were found at the lowest value in the diet composition of *E. fusca*, indicating these organisms were occasionally consumed. Based on the results of this research *E. fusca* was carnivorous with omnivorous tendencies, indicated by insect larvae as the primary food, and the result of the ratio intestinal length (RIL) value obtained that *E. fusca* is classified as a carnivore.

E. fusca from October to December 2023 in Ummiding river develops a generalist feeding strategy. Various types of food were found in the digestive tract, but there was a tendency for particular foods to be more dominant in specific months (Figure 3&4). In October, phytoplankton genus *Phormidium* were more frequently consumed, while in November, the most common food was insect fragments. Afterwards, in December the food was dominated by Hemiptera and insect fragments. This different dominated prey each month indicate the food availability in Ummiding river. *E.fusca* tends has strategy as generalists preference, with the dominant prey Hemiptera. A similarly, in Amaliah *et al.* (2022) findings, gobies in Cimaja estuary, Palabuanratu have a feeding strategy that tends to be generalist. The larval amphidromous that migrate to freshwater have adaptations to adjust the prey availability, using the prey as energy to migrate to upstream and grow. The presence of benthic organisms, plankton, and unidentified prey in their diet composition indicates these fish do not rely on a specific type of food. Fish with various types of prey named as opportunistic, with adaptations to adjust the food availability in nature (Amaliah *et al*. 2022), according to Effendie (2002), they are more easily adapted to artificial feed during the domestication process. In line with it, Prabowo (2022) describes *E.fusca* in Cisolok and Cimandiri estuarine, Palabuanratu tends to has opportunistic feeding strategy belongs to prey availability. The opportunistic and flexible feeding pattern of *E. fusca* provides opportunities in domestication efforts.

Conclusions

A total of 90 individuals of *E.fusca* were collected in Ummiding river throughout three months from October to December 2023. The diet composition of the *Eleotris fusca* comprised three prey items such as insect larvae, phytoplankton and zooplankton. The ratio of intestinal length explained *E.fusca* to categorized as carnivorous and the feeding strategy tends to generalist with dominant prey insect larvae, Hemiptera.

References

Aisyah. 2025. Studi kualitas air habitat Ikan Gobi (*Eleotris fusca* Forster, 1801) di Sungai Ummiding, Polewali Mandar sebagai dasar domestikasi ikan asli (*Skripsi*) Universitas Sulawesi Barat.

Amaliah SW, Affandi R, Simanjuntak CPH, Baihaqi F, Annida SB, Prabowo T, Romdon A. 2022. Diet composition and feeding strategy of larvae and juveniles of green riffle goby, *Stiphodon elegans* in Cimaja Estuary, Indonesia. *2ND-ISARM-2022. IOP Conf. Series: Earth and Environmental Science* 1260 (2023) 012009.

Amundsen PA, Gabler HM, Staldvik FJ. 1996. A new approach to graphical analysis of feeding strategy from stomach contents data modification of the Costello (1990) method. *Journal of Fish Biology.* 48(4): 607–614.

Clifford HF. 1991. *An Illustrated Guide Aquatic Invebrates of Alberta*. The University of Alberta Press.

Costello MJ. 1990. Predator feeding strategy and prey importance: a new graphical analysis. *Journal of Fish Biology*. 36(2): 261–263.

Effendie MI. 2002. *Biologi Perikanan*. Yayasan Pustaka Nusatama, Yogyakarta

Jabbar FBA, Yuniati D, Mahfud CR, Samudra B, Rahmawati, Aulia R, Imran M, Isra M, Annisa N. 2025. Physicochemical water quality of *Macrobrachium asperulum* natural habitats in Ummiding and Batetangnga Rivers, West Sulawesi, Indonesia: a baseline study for aquaculture development. *The 1st International Animal Science and Fisheries Conference (IASFC 2025). IOP Conf. Series: Earth and Environmental Science* 1603 (2026) 012046

Hasan V. 2022. Mengenal Ikan Gobi air tawar. *Artikel Ilmiah Populer Universitas Airlangga*. https://unair.-ac.id/mengenal-ikan-gobi-air-tawar/

Khartiono LD, Gani A, Wuniarto E, Herjayanto M, Ndobe S, Bakri AA, Nurijana, Senggagau B, Wisto, Ali W. 2024. Food habits of Blue Neon Goby *Stipodhon semoni* Weber, 1895 (Gobii-formes:Gobiidae) in Biak River Bang-gai Regency, Central Sulawesi. *JPPI.* 30(1): 1-6.

Keith P, Hoareau TB, International R, Consultants W, Lord C, Gimonneau G. 2014. Characterisation of post-larval to juvenile stages , metamorphosis and recruitment of an amphidromous goby, *Sicyopterus lagocephalus* (Pallas) (Teleostei: Gobiidae: Sicydiinae) Characterisation of post-larval to juvenile stages, metamorphosis and r. January 2008. doi:10.1071/MF08116.

Maeda K, Tachihara K. 2005. Recruitment of amphidromous sleepers *Eleotris acanthopoma, Eleotris melanosoma, and Eleotris fusca* into the Teima River, Okinawa Island. *Ichthyol Res.* 52(4):325–335. doi:10.1007/s10228005-0289-z.

Maeda K, Tachihara K. 2004. Instream distributions and feeding habits of two species of sleeper, *Eleotris acanthopoma and Eleotris fusca*, in the Teima River, Okinawa Island. *Ichthyological Research*, 51(3), 233–240. https://doi.org/10.1007/s10228-004-0224-8

Masuda H, Amaoka K, Araga C, Uyeno T, Yoshino T. 1984. *The fishes of the Japanese Archipelago* (1st ed.). Tokai University Press.

Mennesson MI, Tabouret H, Pécheyran C, Feunteun É, Keith P. 2015. Amphidromous life cycle of *Eleotris fusca* (Gobioidei: Eleotridae), a widespread species from the Indo-Pacific studied by otolith analyses. *Cybium : Revue Internationale d'Ichtyologie*. 32: 249-260.

Muthiah LI. 2021. Identifikasi saluran pencernaan dan jenis makanan Ikan Lempuk (*Gobiopterus* sp.) di Ranu Grati, Kecamatan Grati, Kabupaten Pasuruan, Jawa Timur (Skripsi). Universitas Brawijaya.

Nasyrah AFA, Lestari D, Nur F, Nur M, Aisyah, Rahmat, Putri AK, Amaliah SW. 2024. Habitat Study of Goby (*Eleotris fusca* Forster, 1801) in Ummiding River Waters, Polewali Mandar as a basis for domestication. Seminar Nasional PKP. 182-189.

Nasyrah AFA, Lestari D, Nur F, Nur M. 2025. The reproductive biology of Goby Amphidromous Dusky Sleeper (*Eleotris fusca* Forster, 1801) in Ummiding River, Polewali Mandar, West Sulawesi. *Jurnal Ilmiah AgriSains*, *26*(3), 141–152. https://doi.org/10.22487/-jiagrisains.v26i3.2025.141-152

Natarajan AV, Jhingran AG. 1961. Index of preponderance—a method of grading the food elements in the stomach analysis of fishes. *Indian Journal of Fisheries*. 8(1), 54–59.

Needham JG, Needham PR. 1962. *A Guide to the Study of Freshwater Biology*. Holden Day, Inc, San Francisco.

Nur M, Fajriani, Tenriware, Simanjuntak CPH, Nasyrah A-FA, Kautsari N. 2021. Fish fauna of the Batetangnga River, West Sulawesi, Indoneisa. *E3S Web Conf.,* 322: 1-6.

Nur M, Omar SBA, Dahlan MA. 2018. Struktur ukuran dan tipe pertumbuhan ikan penja di Perairan Sungai Karema, Provinsi Sulawesi Barat. *Jurnal SAINTEK Peternakan dan Perikanan*. 2(1):43–47.

Nurjirana, Afrisal M, Sufardin, Haris A, Burhanuddin AI. 2020. Diversity and distribution freshwater ichthyofaunal of West Sulawesi. *IOP Conference Series: Earth and Environmental Science*. 486, 1 (2020),012079. DOI: https://doi.org/-10.1088/1755-1315/486/1/012079.

Pennak RW. 1978. *Freshwater Invertebrates of the United States* (2nd Ed.) John Wiley & Sons, New York.

Prabowo T. 2022. Komposisi spesies, kelimpahan dan ekologi makanan larva dan yuwana ikan amphidromous di Estuari Cisolok dan Cimandiri Teluk Palabuhanratu (Tesis). Bogor: IPB University.

Simanjuntak CPH, Baihaqi F, Prabowo T, Annida SB, Sulistiono, Ervinia A. 2021. Pola rekrutmen ikan amfidromus air tawar (Pisces: Gobiidae, Eleotridae) di Muara Sungai Cimaja, Teluk Palabuhanratu. *Jurnal Iktiologi Indonesia*. 21(3):321-337. https://-doi.org/10.32491/jii.v21i3.595

Tasrif AA, Lopa RT, Maricar F. 2022. Zooning regulation in the Mandar River Buffer Zone, Tinambung Subdistrict, Polewali Mandar Regency. *Jurnal RAB Construction Research.* 7(2): 104–115.

Tikawati, Omar SBA, Nur M. 2024. Length-weight relationship and condition factor of threadfin goby *Sicyopterus longifilis* de Beauford, 1912 (Teleostei: Sicydiinae) at Ummiding and Matama Rivers, West Sulawesi, Indonesia. *Biodiversitas,* 25: 2074-2085.

Vuuren JV, Pieterse S, van den Berg AJH, Rensburg JVP. 2006. *Easy identification of the most common freshwater algae*. Department of Water Affairs and Forestry.

Zuliani, Z., Z. A. Muchlisin, N. 2016. Nurfadillah. Kebiasaan Makanan dan Hubungan Panjang Berat Ikan Julung - Julung (*Dermogenys* Sp.) di Sungai Alur Hitam Kecamatan Bendahara Kabupaten Aceh Tamiang. *Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah,* 1 (1): 12-24.

Reproductive Biology of the Goby *Sicyopterus longifilis* from the Matama River, West Sulawesi, Indonesia

Tikawati[1], Sharifuddin Bin Andy Omar[2], Muhammad Nur[1] Rasti Sapri[1]
Adiara Firdhita Alam Nasyrah[1]

[1]Derpartment of Aquatic Resource, Faculty of Fisheries, Universitas Sulawesi Barat,
Majene 911412, West Sulawesi, Indonesia
Jl.Prof Baharuddin Lopa, Majene, West Sulawesi 91412
[2]Department of Fisheries, Faculty of Marine Science and Fisheries, Universitas Hasanuddin,
Makassar 90245, South Sulawesi, Indonesia
Jl. Perintis Kemerdekaan Km 10, Makassar 90245, South Sulawesi, Indonesia
e-mail: tikaw5256@gmail.com

Recieved: December 6, 2025; Accepted: February 7, 2026

Abstract

Sustainable fisheries management depends heavily on the reproductive biology of amphidromous fishes, yet little is known about *the reproductive traits of Sicyopterus longifilis*. In this study, *we determined gonad development stages in S. longifilis from the Matama River in West Sulawesi, Indonesia, macroscopically, following Effendie (1979), and calculated GMI* **from gonad weight and total body weight.** From July to December 2023, we sampled fish monthly using an electric shocker. We measured egg diameter with an ocular micrometer under a compound microscope, evaluated fecundity using the gravimetric method, determined gonad development stages macroscopically according to Effendie (1979), and computed GSI from gonad and body weight. A total of 758 specimens, comprising 281 male and 477 females, were examined. Throughout the investigation, we found five gonad maturity stages (I-V), indicating ongoing reproductive growth. The peak reproductive activity occurred in July, and female GMI increased with gonadal development, reaching its highest value at GMS IV. Egg diameter varied from 0.20 to 0.44 mm, and fecundity varied from 43 to 7,887 eggs, with an average of 1,702 ± 2,551 eggs. *S. longifilis* appears to have a complete spawning strategy based on the unimodal distribution of egg diameter. The relationships between fecundity and total length, body weight, and gonad weight were relatively weak, indicating that reproductive output is influenced not only by fish size but also by environmental conditions and physiological status. These findings provide the first comprehensive information on the reproductive biology of *S. longifilis* in the Matama River and contribute essential baseline data for the conservation and sustainable management of amphidromous goby populations in West Sulawesi.
.

Keywords: amphidromous goby, egg diameter, fecundity, gonad maturity stage, gonadosomatic index

Introduction

Diadromous fish have a unique life cycle; they spawn in freshwater, larvae migrate to the sea after hatching, and young fish return to rivers to grow until they reach maturity. Consequently, future climate warming is expected to alter recruitment dynamics and population persistence in amphidromous fishes. However, the life cycle of amphidromous fish depends heavily on connectivity between rivers and the sea, making this group highly sensitive to habitat fragmentation, hydrological changes, water quality degradation, dam construction, and climate change. As a result, amphidromous fish are widely used as indicators of tropical river ecosystem health. They are also an important group for freshwater biodiversity conservation and fisheries management

(McDowall, 2007; Keith *et al.*, 2011; FishBase, 2016).

Studies of amphidromous species also show that oceanographic conditions during the larval phase greatly influence population dynamics. Teichert *et al*. (2021) demonstrated that water temperature strongly influences the early development and survival of Sicyopterus lagocephalus larvae. Increasing water temperature significantly reduced larval survival and affected critical developmental processes, highlighting this amphidromous species' sensitivity to thermal conditions during early life stages. Larvae developing at higher sea temperatures have faster growth rates, shorter pelagic durations, and smaller sizes at recruitment; thus, climate change is expected to increase. *S. longifilis* is one of the amphidromous species that has significant ecological and economic value in Indonesia. In West Sulawesi, this species is called goby fish, or "penja," in the postlarval phase and is a highly profitable seasonal fishery commodity for coastal communities and those along river flows. In addition to generating income, this species has ecological benefits as an important part of the fast-flowing river fish community. Tikawati *et al.* (2024) found that the physicochemical characteristics of the water suitable for growth are still present in the habitat of *S. longifilis* in the Ummiding River and Matama River. However, increased fishing activities, land-use changes, and habitat disturbances can affect the population structure and sustainability of fish resources, so managing *S. longifilis* requires more comprehensive biological information.

Reproduction is one of the most important biological parameters in fish resource management because it indicates the population's ability to maintain stock sustainability in nature and produce offspring. Gonad Maturity Stages (GMS), Gonad Maturity Index (GMI), fecundity, and egg diameter can be used to determine spawning season, size at first gonadal maturity, reproductive energy investment strategy, and population recruitment potential. This data is used to formulate management policies, including minimum catch size, closed seasons, and spawning habitat protection (Kudsiah *et al*., 2024). Furthermore, West (1990) explains that although macroscopic observation and gonad indices suit surveys of very large populations, histological methods are most accurate for determining fish reproductive phases.

Brown-Peterson *et al.* (2011) proposed standardized terminology for fish reproductive phases that can be applied across various teleost groups, reflecting advances in fish reproductive biology research. They divide reproductive development into immature, developing, spawning-capable, regressing, and regenerating phases. This classification allows for more consistent comparisons of research results between species. This standardization is very important because several previous studies used different gonad classification systems, making the interpretation and synthesis of research findings difficult.

Studies on the reproduction of Gobiidei fish have developed very rapidly. Cole and Parenti (2022) describe the reproductive morphology of Rhyacichthys aspro, a basal gobiid. They describe typical gobioid reproductive characteristics, such as asynchronous spawner-type ovaries and reproductive tract structures crucial for spawning success. This study provides an important foundation for understanding the evolution of goby fish reproduction, but it has not yet addressed quantitative reproductive elements such as fecundity and gonadal maturation dynamics in amphidromous species utilized by the community.

Studies on goby reproduction remain very limited in Indonesia. Kudsiah *et al.* (2024) found that Glossogobius giuris in Lake Sidenreng has four stages of ovarian maturity. In addition, females have a higher ovarian maturity index than males, and the size at first ovarian maturity differs between the sexes. This study provides a foundation for managing goby reproduction in the freshwater waters of South Sulawesi. However, the research findings cannot be directly applied to *S. longifilis* because the two species have different habitats, lifestyles, and migration patterns.

Previous research shows that most studies focus on reproductive morphology, standardization of gonadal development classification, or reproductive aspects of non-swimming goby species. Currently, little data exist on the reproductive biology of *S. longifilis*, particularly gonadal maturity levels, gonadal maturity indices, fecundity, and egg diameter in its natural population in West Sulawesi. Nevertheless, this information is crucial for understanding the reproductive strategies of this species, determining the spawning season, estimating the potential population increase, and formulating fisheries management policies based on scientific data. Accordingly, to support the management and conservation of amphidromous species in the Matama River, West Sulawesi, this study aims to analyze the reproductive aspects of *S. longifilis,* including gonadal maturity levels, gonadal maturity indices, fecundity, and egg diameter.

Materials and Methods

The study was conducted from July to December 2023 in the Matama River, Polewali Mandar Regency, West Sulawesi Province. Sampling was conducted periodically at several stations representing the main habitat of *S. Longifilis*

Fish reproduction analysis was conducted at the Biology Laboratory, West Sulawesi University. Figure 1 shows the study locations. Fish samples were collected monthly using an electric shocker set to 12 volts and 9 A. The operator used the electric shocker to capture fish by following a zigzag pattern against the river current (moving upstream). The capture was conducted over 200 meters at 30-minute intervals. We then

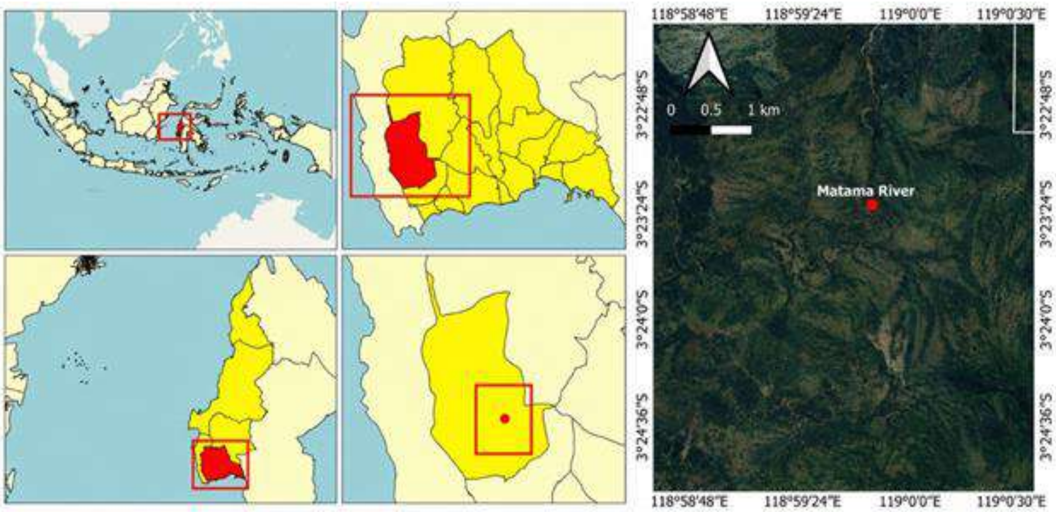

Figure 1. Research Map of the Matama River *Sampling collection*

separated the fish caught in the Matama River by species and counted them. We preserved the separated fish in 1000 ml sample bottles containing 10% formalin, labeled with the location and collection date. After 2-3 hours, the fish were washed thoroughly with running water and transferred to a container containing 70% alcohol for laboratory analysis.

Data Analysis

Gonad Maturity Stages (GMS) is analyzed by grouping data based on the proportion of fish that have not and have matured gonads. The Classification of Gonad Maturity Stages (GMS) *S. longifilis* refers to Effendie (1979) as shown in Table 1.

Table 1. Classification of fish gonadal maturity levels (Effendie, 1979)

GMS	Male	Female
I	Testes are thread-like, shorter (limited in length), and their tips are visible in the body cavity. They are clear in color.	The ovaries are thread-like and extend to the front of the body cavity. They are clear in color and have a smooth surface.
II	The testes are larger, with a milky white color. Their shape is more distinct than in gonadal maturity stage I.	The ovaries are larger and have a darker, yellowish color. The eggs are not yet clearly visible to the naked eye.
III	The surface of the testes appears serrated; the color becomes whiter, and the testes grow larger. When pressed, they break easily.	The ovaries are yellow. Morphologically, the eggs begin to appear as visible granules to the naked eye.
IV	As in gonadal maturity stage III, the features are more clearly visible. The testes become increasingly firm.	The ovaries are getting larger; the eggs are yellow and can be easily separated. Oil droplets do not appear to fill ¼–? of the abdominal cavity, and the intestines are displaced.
V	The posterior part of the testes is deflated, while the part near the ejaculatory duct is still filled.	The ovaries are wrinkled, with thick walls; residual eggs are present near the oviduct opening, and there are many eggs similar to gonadal maturity stage II.

Gonadal Maturity Index

The gonadal maturity index (GMI) is calcul-ated using the following formula (Effendie, 2002):

$$IKG = \frac{Bg}{Bi} 100\%$$

Explanation:

GMI = gonadal maturity index (%),
Bg = gonad weight (g),
Bi = fish weight (g).

Fencudity

Observations of fecundity and egg diameter were determined from fish samples with GMI stages III, IV, and V. Total fecundity was calculated using the gravi-metric method (Andy Omar, 2013) with the following formula:

$$F = \frac{G\ x\ f}{g}$$

Explanation:

F = Total number of eggs in the gonads (fecundity, eggs)
G = Gonad weight (g)
g = Weight of a portion of the gonads (subsample, g)
f = Number of eggs from the gonad subsample (eggs)

Next, the relationship between fecun-dity and total fish length was calculated using the following formula (Effendie, 2002):

$$F = aL^b$$

Explanation:
F = Fecundity (eggs)
L = Total fish length (mm)
a dan b = Constants

The relationship between fecundity and fish body weight was calculated using the following formula (Effendie, 2002):

$$F = a + bW$$

Explanation:
F = Fecundity (eggs)
L = Total fish weight (g)
a dan b = Constants

The relationship between fecundity and fish gonad weight is calculated using the formula (Effendie, 2002) as follows:

$$F = a + bG$$

Explanation:
F = Fecundity (eggs)
G = Gonad weight (g)
a dan b = Constants

Egg Diameter

Egg diameter measurements were performed using an ocular microscope equipped with an ocular micrometer. Egg diameter was calculated using the following equation Andy Omar, 2010):

$$\mathrm{Ds} = \sqrt{\mathrm{Dh} \times \mathrm{dv}}$$

Explanation:
Ds = Actual egg diameter (mm);
Dh = Horizontal egg diameter (mm);
Dv = Vertical egg diameter (mm).

The data on gonadal maturity levels are presented in graphs and descriptive tables. The analysis of fecundity, gonadal maturity index, and egg diameter is conducted using descriptive statistics, which include mini-mum, maximum, average, and standard deviation values. Simple linear regression analysis was also used to examine the relationship between fecundity and total length and body weight. Statistical software IBM SPSS version 26 and Microsoft Excel 2021 were used to perform the statistical analysis. To show the reproductive charac-teristics of *S. longifilis* in the Matama River, the analysis results are presented in the form of descriptions, tables, and graphs.

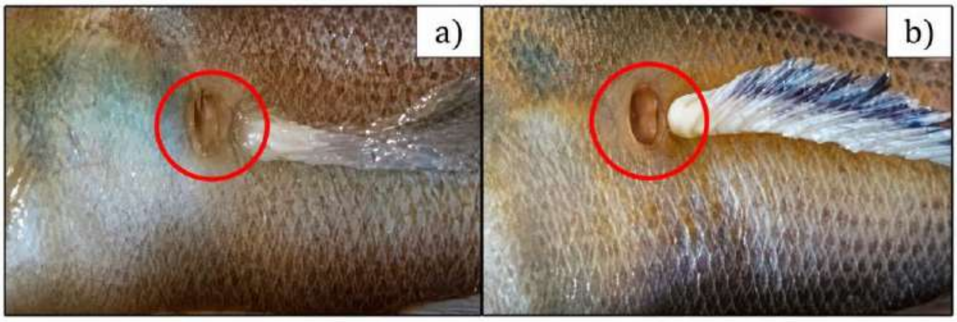

Figure 2. Sexual dimorphism in the goby fish *S. longifilis*. Description: a) Papilla in male goby fish, b) Papilla in female goby fish

Results

Gonadal Maturity Stage (GMS)

The gonadal maturity Stage (GMS) is the stage of fish gonad development from before, during, to after spawning. The goby fish (*S. longifilis*) in the Matama River exhibit sexual dimorphism that can be distinguished based on the shape of the urogenital papilla. Male fish have a triangular and somewhat pointed papilla, while female fish have a round and bifurcated papilla (Figure 2).

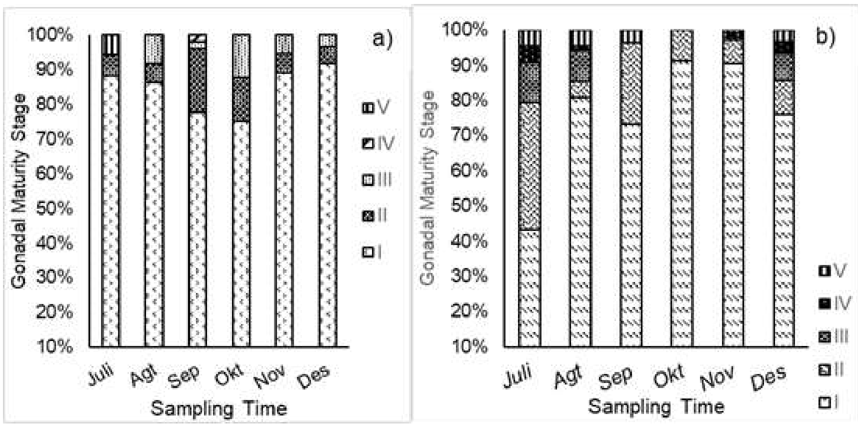

Figure 3. Frequency (%) of gonadal maturity levels of *S. longifilis* goby fish observed based on the sampling time in the Matama River

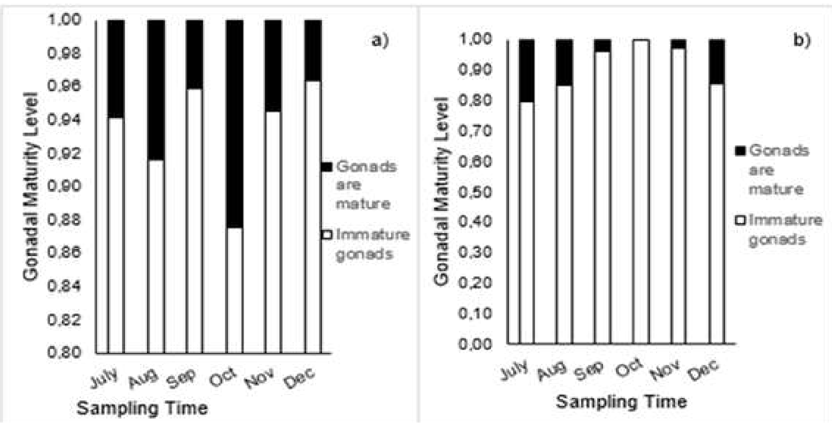

Figure 4. Frequency (%) of Gonad maturity stage of *S. longifilis* Goby Fish Observed Based on Fish with Matured and Immature Gonads at Each Sampling Time in the Matama River: a) Male, b) Female

Table 2. Distribution of gonadal maturity stages of *S. longifilis* in the Matama River

Gonadal Maturity Stage	Male		n (Individuals)	Female		n (Individuals)
	Range	Mean±SD		Range	Mean±SD	
I	24,01-95,28	55,7936± 15,0997	246	0,049-9,656	52,9608± 52,9660	370
II	41,7-89,99	64,6757± 13, 7180	23	47,2-108,63	64,1921± 13,3890	62
III	67,42-91,86	79,0983± 6,6805	12	49,6118,9	73,6326± 16,4002	23
IV	0	0	0	44,7-88,61	77,6762± 15,5499	8
V	0	0	0	54,3-127,49	90,5857± 23,5087	14
Total			281			477

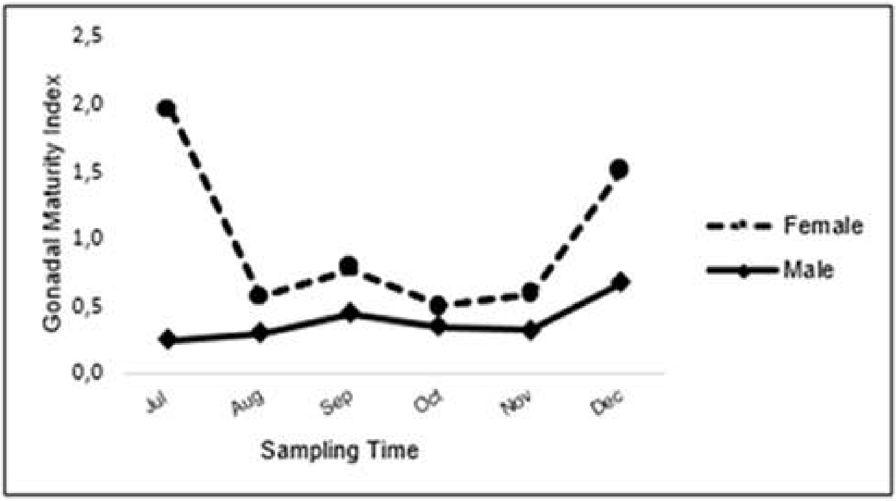

Figure 5. Gonad maturity index (GMI) of *S. longifilis* goby fish in the Matama River

The differences in urogenital papilla morphology provide a clear external characteristic for distinguishing the sex of *S. longifilis*. This sexual dimorphism is particularly useful for assessing gonadal maturity because it allows identification of males and females before detailed examination of gonadal development.

Gonadal Maturity Index (GMI)

The gonadal maturity index (GMI) of goby fish (*S. longifilis*) in the Matama River shows a pattern of change over the Observation period (Figure 4). The GMI varied by gonadal maturity stage and sampling month, reflecting changes in gonadal development throughout the reproductive cycle. In female fish, the GMI increases and peaks in July, then gradually decreases from August to December. The distribution of gonadal maturity index values based on the level of gonadal maturity can be seen (Figure 4), while the distribution of the gonadal maturity index can be seen in Table 3.

Table 3. Gonadal maturity index of the goby fish *S. longifilis* based on gonadal maturity stages in the Matama River

Gonadal maturity index	Male		n (Individuals)	Female		n (Individuals)
	Range	Mean±SD		Range	Mean±SD	
I	0.0111-2.8571	0.15084±0.2833	246	0.0041-2.1739	0.1132±0.1883	370
II	0.01467-2.3178	0.8079±0.6064	23	0.0678-4.7692	0.8136±0.8216	62
III	0.3021-3.1854	1.6917±0.8431	12	0.0189-7.8461	2.8075±2.0677	23
IV	0	0	0	0.0109-11.3636	6.8034±3.5579	8
V	0	0	0	0.2202-7.2043	2.3809±2.0330	14
Total			281			477

Table 4. Range and average fecundity of the goby fish *S. longifilis* based on the sampling time in the Matama River

Sampling time	Range of total body length (mm)	Body weight range (g)	Fekundity range (Eggs)	Mean ±SD
July	49.60-118.90	1.300-22.700	558-3,766	2.488±1.191
August	58.66-122.51	3.123-23.990	43-7,887	1.702±2.551
September	111.09-119.41	20.735-25.755	33-34	33.5 ±0.707
October	0	0	0	0
November	78.94-90.25	6.666-9.109	1,285-3,144	11.620±1.717
December	68.41-88.64	4.733-9.188	594-1,648	3.144±3.620

The highest GMI value was obtained in female individuals with GMS IV, while the lowest value was found in GMS I. The increase in GMI value indicates a higher proportion of gonad weight to body weight during the gonad maturation process.

Fecundity

The fecundity of goby fish (*S. longifilis*) in the Matama River was analyzed in 39 female fish with gonadal maturity levels (GML) III, IV, and V. The research results showed that the fecundity of goby fish in the Matama River varied, with the number of eggs ranging from 43 to 7,887 at total lengths of 58.66 to 122.51 mm, with an average value of 1,702 ± 2,551 eggs (Table 4).

August had the highest fecundity. The relationship between fecundity and total length, body weight, and gonad weight showed a low correlation (Figure 5), indicating that fecundity varies not only with body size but also with environmental factors and the fish's reproductive condition. Table 5. Fecundity of *S. longifilis* in the Matama River. The relationship between fecundity and total length and body weight shows a positive trend: larger individuals produce more eggs.

Egg Diameter

The diameter of goby fish eggs (*S. longifilis*) in the Matama River ranges from 0.20-0.44 mm during GMS III, IV, and V (Figure 7).

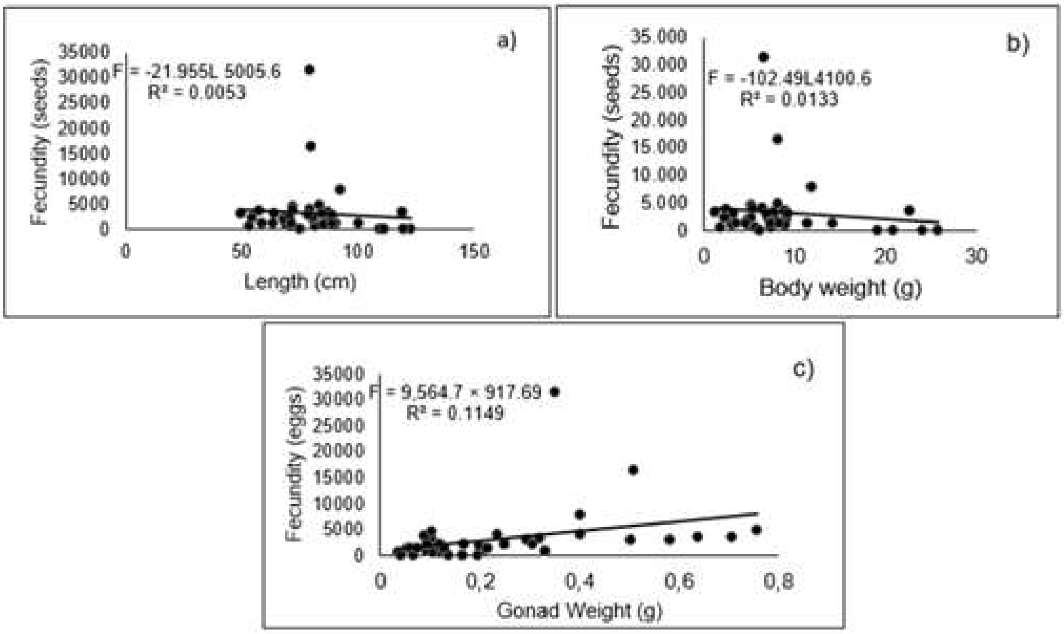

Figure 6. Relationship between fecundity and total body length (a) between fecundity and body weight (b), and between fecundity and gonad weight (c) of Matama River Gobies

Table 5. Range and average gonadal maturity stage of the goby fish based on the sampling time in the Matama River

Gonadal Maturity Stage	N	Total body range (mm)	Body weight range (g)	Fecundity range (seeds)	Mean ±SD
III	19	49.60-118.90	1300-22700	558-31448	4,570±7490
IV	7	64.41-88.61	3300-9188	973-4,777	3042±4777
V	13	54.30-122.51	2300-25755	33-3976	1472±1357

The variation in egg diameter indicates differences in the developmental stages of oocytes during the gonad maturation process. Differences in egg diameter can occur within the same species or between different species, influenced by environmental factors, particularly the availability of food sources that support gonad development. The distribution of goby fish egg diameters in the Matama River shows a single highest modal value at each stage of gonadal maturity, indicating that *S. longifilis* has a total spawner spawning pattern.

Table 6. Distribution of egg diameter of *S. longifilis*.

Discussion

Gonad Maturity Stage

The gonadal maturity Stage (GMS) is a stage of gonadal development before and after spawning that describes the sexual maturity level of fish. In this phase, most of the fish's metabolic output is utilized for gonad development (Iskandar, 2024). GMS can be observed morphologically through changes in gonad shape, size, color, and texture

Table 6. Spawning Seasons of Several Goby Fish Species

Spesies	Spawning Season	Location	References
Neogobius caspius	April and May	Noor Beach	Mahdipour *et al.*, 2020
Glossogobius matanensis	March-April and October-December	Towuti, South Sulawesi	Sulistiono *et al.*, 2007
Glossogobius giuris	July though August	Ujung Pangkah Waters	Sulistiono 2012
Glossogobius giuris	September through November	Tempe Lake	Eragradhini, 2014
Syciopterus lagocephalus	May	River Cibareno	Ambarwati *et al.*, 2023
Sicyopterus lagocephalus	November though May	Reunion	Bielsa *et al.*, 2003
Sicyopterus japonicus	September though October	Shuang-Chi River, Taiwan	Shen and Tzeng 2002
Glossogobius matanensis	October and March	Towuti Lake	Mamangkey and Nasution, 2012

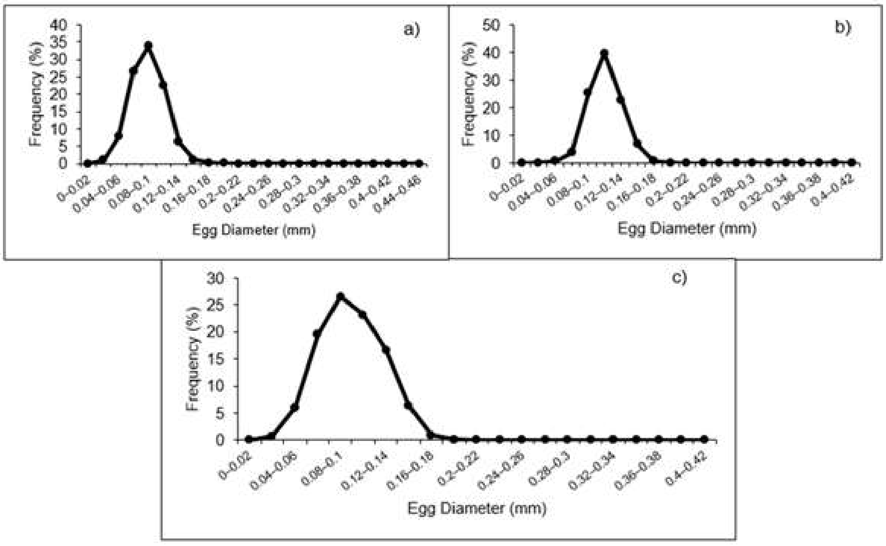

Figure 7. Distribution of the diameter of *S. longifilis* goby fish eggs observed at each stage of gonadal maturity during the study in the Matama River. Note: a) (GSI III), b) (GSI IV), and c) (GSI V).

Macroscopic observations of the goby fish (*S. longifilis*) in the Matama River show that the gonads develop into two reproductive organs, namely testes in male fish and ovaries in female fish (Figure 2). According to Sulistiono et al. (2007), the level of gonadal maturity can be used to estimate the reproductive status of fish, the size and age at which gonads first mature, the proportion of the fish stock that has matured reproductively, and to provide information on the reproductive cycle of a population. In addition, GMI can be used to estimate a species' spawning period.

The determination of the gonadal maturity stages (GMS) of the goby fish (S. longifilis) in the Matama River was conducted thru macroscopic observation based on the modification of Salvanes *et al.* (2018), which divides gonadal development into five stages: GMS I (not developed), GMS II (early developing), GMS III (developing), GMS IV (mature), and GMS V (post-spawning). The research results show that all stages of gonadal maturity (GMS I-V) were found in the goby fish population in the Matama River during the study period.

Gobies that have not yet matured their gonads (GMS I and II) were found in every month of observation, from July to December, in both male and female fish. This indicates that recruitment occurs continuously, resulting in a population dominated by individuals in the early stages of gonad development. Meanwhile, goby fish with mature gonads (GMS III, IV, and V) were found in July, August, September, November, and December. The absence of fish in GMS III, IV, and V in October indicates that during that month, most of the population is in the reproductive rest phase or has completed the previous spawning process (Figure 4 and Table 2).

The presence of individuals in GMS V (post-spawning) indicates that spawning occurred in the Matama River. Based on the distribution of gonadal maturity levels during the study, it is suspected that the spawning activity of the goby fish (*S. longifilis*) in the Matama River took place in July (Figure 5). This assumption is reinforced by the discovery of post-spawning individuals after that period, indicating that gamete release has occurred. According to Lelono *et al.* (2023), food availability and environmental conditions strongly influence gonad development. Under normal conditions, the weight of the female fish's gonads can reach 10–25% of their body weight, while for male fish it ranges from 5–10% of their body weight during the gonadal maturation phase.

The presence of all levels of gonadal maturity (Gonadal Maturity Stages I-V) in the Matama River indicates that the habitat supports the continuity of the goby fish (*S. longifilis*) reproductive cycle. Information on the distribution of these gonadal maturity levels is crucial for understanding reproductive patterns, determining spawning seasons, and formulating sustainable management and conservation strategies for goby fish resources in the Matama River (Sulistiono *et al*., 2007; Iskandar, 2024; Lelono *et al*., 2023).

Gonad Maturity Index

The gonad maturity index (GMI) of *S. longifilis* increased with increasing gonadal maturity and reached its highest value at GMS IV, followed by a decline at GMS V. This pattern reflects the increase in gonad weight during gonadal development and its subsequent reduction following spawning. Based on the research results in the Matama River, the gonad maturity index of female goby fish (*S. longifilis*) peaks in July, then begins to decline from August to December (Figure 6). This pattern indicates that gonad development reaches maturity in July, followed by spawning, which causes a decrease in gonad weight. This is consistent with the spawning season of the goby fish Glossogobius giuris in the waters of Ujung Pangkah as reported by Sulistiono *et al.* (2007).

The gonadal maturity index of female goby fish in the Matama River is higher compared to male goby fish. This differen-ce indicates that female gonadal develop-ment is more intensive due to yolk forma-tion and accumulation (vitellogenesis) in the ovaries. Barbieri *et al.* (2023) reported that GMI values increase over time as long as the gonads are still developing. The dec-rease in GMI value occurs when the gonad weight rapidly decreases during the spawn-ing process until the end of spawning (Asriyana and Halili, 2021). The increase in GMI value is directly proportional to time, which is suspected to be due to ongoing gonad development.

The increase in gonad weight during reproductive development occurs as a result of the accumulation of yolk precursors in the ovaries. Hara *et al.* (2016) mentioned that the increase in gonad weight is the result of the accumulation of yolk deposition during the gonad development process. This causes female gonad weight to be greater than that of male fish, resulting in higher GMI values. According to Gustomi *et al.* (2016), the average gonadal maturity index value of female fish is greater than that of male fish because the gonad weight of female fish is larger than that of male fish.

The pattern of changes in the Gonad Maturity (GMI) of goby fish in the Matama River, which increased in July and then decreased from August to December, indicates that reproductive and spawning activities occur during that period. Tropical freshwater fish generally exhibit.

High GMI values indicate that the gonads are in the mature phase, whereas a subsequent decrease in GMI may indicate spawning and post-spawning conditions.. Thus, the gonadal maturity index can be used as an indicator to determine the breeding season of the goby fish (*S. longifilis*) in the Matama River, as explained by Sulistiono *et al.* (2007) that the GMI is one of the effective parameters in estimating the spawning season of fish.

Fecundity is the total number of eggs present in the ovaries and the potential to be released during spawning. Fecundity in goby fish can vary even among individuals of the same species because of environ-mental factors and the availability of food nutrients (Jan & Jan, 2017). Fecundity analysis was conducted to estimate the reproductive potential of the goby fish *S. longifilis* in the Matama River. Fecundity calculations were performed on female goby fish at gonadal maturity stages (GMS) III, IV, and V. According to Winemiller *et al.* (2008), fecundity values and egg sizes vary.

The research results show that the fecundity of goby fish in the Matama River ranges from 43 to 7,887 eggs with a total length of 58.66-122.51 mm, while the average fecundity value reaches 1,702 ±

2,551 eggs. August had the highest fecundity (Table 4). Variation in egg production indicates differences in reproductive capacity among individuals, likely related to body size, gonadal maturity, and aquatic environmental conditions.

Different environmental conditions can cause differences in egg numbers among fish populations (Langroudi & Sabet, 2016). In addition, variations in fecundity are also influenced by the size composition of the captured fish (Jan, 2017). Intrinsic factors, such as body size, age, and parental physiological condition, along with environmental factors such as temperature, food availability, and habitat conditions, can influence variation in fish fecundity. Reproductive success (Lowerre-Barbieri *et al*., 2023; Alix *et al*., 2020; Bhat *et al*., 2025). Another factor that also influences is the geographical location and the timing of sample collection (Wagle, 2014). Puspaningdiah *et al*. (2014) also explain that fecundity is closely related to age, body weight, body length, and food availability. The better the fish's growth, the higher its reproductive capacity, resulting in more eggs produced.

The fecundity value of goby fish in the Matama River is still within the range of tropical freshwater fish fecundity, which is generally lower compared to marine fish or migratory fish. Yonvitner *et al*. (2018) reported that the fecundity of freshwater fish is generally lower compared to the fecundity of marine fish or migratory fish. In addition, Jega *et al.* (2018) stated that food availability, fish size, salinity, temperature, and genetic factors influence variations in fecundity and reproductive potential.

The relationship between fecundity and the total length of female goby fish with mature gonads in the IV and V stages of maturity in the Matama River follows the equation F= -21.95L+5005.6 (Figure 6). The equation shows a relationship between total fish length and egg production, indicating that body size is one factor affecting fecundity. In general, fish with larger body sizes have higher reproductive capacity because they are able to produce a greater number of eggs, as reported in various other fish species. The com-

Egg Diameter

An egg is the final product of gametogenesis after the oocyte undergoes a growth phase influenced by hormonal activity (Mylones *et al.,* 2010). Larger eggs generally contain more yolk, resulting in larvae with a larger initial size and higher energy reserves. Larvae use yolk reserves as a nutritional source during early life before they can obtain food from the environment. Thus, egg diameter is a reproductive strategy that increases the chances of larval survival under fluctuating environmental conditions.

Based on the observations, the diameter of goby fish eggs (*S. longifilis*) in the Matama River ranges from 0.20-0.44 mm (Figure 7). The variation in egg diameter indicates that the observed oocytes are at different stages of development, ranging from early vitellogenesis to near maturity. The larger the diameter of the egg, the higher the level of oocyte development and the closer it is to spawning time.

The results of this study are consistent with Iskandar (2024), who stated that egg diameter can affect larval growth and development in the early stages of life. The diameter of the egg is also an indicator of the amount of nutrients stored within the egg, so the larger the diameter of the egg, the greater the reserve of nutrients available to support the growth of the embryo and larva after hatching.

The increase in egg diameter occurs due to the accumulation of yolk during the oocyte development process. Suhenda *et al.* (2016) explain that the increase in egg diameter is caused by the formation of yolk deposits and the distribution of yolk granules, which are used as an energy source during embryo development.

The process occurs thru the stages of vitellogenesis, which is the process of synthesis, transport, and absorption of vitellogenin into the developing oocyte (Hara et al., 2016). According to Song et al. (2020), vitellogenin is the main phospholipid-glycoprotein component of the yolk that continues to accumulate in the oocyte, leading to an increase in egg dia-meter until reaching the gonadal maturity stage.

The success of the vitellogenesis process is influenced by various factors, both internal and external. Cleveland et al. (2019) reported that vitellogenin synthesis is influenced by the physiological condition of the female, while Marzuqi et al. (2015) stated that nutritional adequacy is one of the important factors determining the success of yolk formation. Therefore, the variation in egg diameter found in goby fish in the Matama River is suspected to be influenced not only by the level of gonadal maturity but also by the aquatic environmental conditions and the availability of food that support the reproductive process.

Table 7. Fecundity in several freshwater fish species

Spesies	Fecundity (eggs)	Location	Reference
Neogobius caspius	400-1800	Noor Beach	Mahdipour et al., 2020
Glossogobius giuris	10640-150639	Ujung Pangkah Waters	Sulistiono, 2012
Glossogobius giuris	14505-181981	Lake Tempe	Eragradhini, 2014
Sicyopterus lagocephalus	24320-73810	Cibareno River	Ambarwati et al., 2023
Sicyopterus lagocephalus	14304-232475	River Marsouins, Reunion Island	Teichert et al., 2014
Sicyopterus japonicus	11000-18000	Shung-Chi River, Taiwan	Shen and Tzeng 2008
Glossogobius matanensis	20667-178133	Towuti Lake, South Sulawesi	Sulistiono et al., 2007
Boleophthalmus dussumieri	15223-37963		Ridho et al., 2021
Periophthalmodon schlosseri	13693-25863		
Glossogobius matanensis	25447-56907	Lake Towuti	Mamangkey and Nasution, 2012

Table 8. Egg Diameter of Freshwater Goby Fish

Spesies	Egg Diameter (mm)	Spawning Pattern	Location	Reference
Glossogobius matanensis	0.04-0.65	-	Towuti Lake, South Sulawesi	Sulistiono et al., 2007
Sicyopterus lagocephalus	0.20-0.22 mm	*Total spawner*	Cibareno River, Sukabumi, West Java	Ambarwati et al., 2023
Glossogobius giuris	49-372 µm	-	Ujung Pangkah, Waters	Sulistiono 2012
Glossogobius giuris	49-372 µm 32-150	- -		Eragradhini, 2014
Sicyopterus japonicus	72-103		Shuang-Chi River, Taiwan	Shen & Tzeng 2008
P. chrysospilos	0.051-0.069	-	Musi River Estuary	Ridho et al., 2021
B. dussumieri	0.034-0.04			
P. chrysospilos	0.051-0.069	-		

Information regarding the diameter of goby fish eggs (*S. longifilis*) in the Matama River provides an overview of the reproductive strategy of this species in producing offspring capable of surviving the early stages of their life. Comparison of egg diameters among several species of goby fish is presented in Table 8.

Conclusions

The reproductive biology of *S. longifilis* in the Matama River, West Sulawesi, revealed five gonadal maturity stages (GMS I–V) in both males and females, with July showing the highest reproductive activity. Egg diameter ranged from 0.20 to 0.44 mm, while fecundity ranged from 43 to 7,887 eggs. The unimodal distribution of egg diameter suggests that *S. longifilis* exhibits a total spawning pattern. These findings provide baseline information to support sustainable conservation and fisheries management of amphidromous gobies in tropical river ecosystems and contribute to a better understanding of the reproductive strategy of *S. longifilis*.

Acknowledgement

The authors greatly appreciate the research facilities and laboratory support provided by Universitas Sulawesi Barat during this investigation. We also thank Universitas Sulawesi Barat's Biology Laboratory for helping with sample processing and reproductive analysis. We would like to express our profound gratitude to the local residents and field workers in the Matama River, Polewali Mandar Regency, whose help during specimen collecting and field sampling was crucial. We also acknow-ledge the academic advice and scientific assistance provided by the Department of Fisheries, Faculty of Marine Science and Fisheries, Universitas Hasa-nuddin, during the execution of this study.

References

Alix, M., Kjesbu, O. S., & Anderson, K. C. (2020). From gametogenesis to spawning: How climate-driven warming affects teleost reproductive biology. Journal of Fish Biology, 97(3): 607-632.

Andy Omar, S. Bin. (2010). Aspek reproduksi ikan nilem, Osteochilus vittatus (Valenciennes, 1842) di Danau Sidenreng, Sulawesi Selatan. Jurnal Iktiologi Indonesia, 10(2), 111-112.https://doi.org/10.32491/jii.v10i2.163 Andy Omar, S. Bin. (2013). Buku Ajar Biologi Perikanan. Makassar (ID): Universitas Hasanuddin.

Asriyana, A., Halili, H. (2021). Reproductive traits and spawning activity of striped eel catfish (plotosidae) in kolono bay, indonesia. Biodiversitas. 22(7): 3020-3028.

Bhat, I. A., Rather, M. A., Ahmad, I., Ahmad, I., Mir, I. N., & Hussna. (2025). Impact of shifting abiotic factors in aquaculture on fish breeding and reproduction: a review. Blue Biotechnology, 2(1):3.

Brown-Peterson, N. J., Wyanski, D. M., Saborido-Rey, F., Macewicz, B.J., & Lowerre-Barbieri,S.K.(2011).A standardized terminology for describing reproductive development in fishes. Marine and Coastal Fisheries, 3(1):52-70.

Cleveland, BM. Leeds TD. Picklo MJ. Brentesen, C.Frost J.Biga PR.2019. Supplementing rainbow trout (*Oncorhynchus mykiss*) broodstock diets with choline andmethionine improves growth in offspring. *Journal Of the World Aquaculture Society*, 51:266-281.

Cole, K. S., & Parenti, L. R. (2022). Gonad morphology of *Rhyacichthys aspro* (Valenciennes, 1837), and the diagnostic reproductive morphology of gobioid fishes. *Journal of Morphology*, *283*(3): 255-272.

Effendie MI, (2002). Fisheries Biology. Yayasan Pustaka Nusatama. Yogyakarta. 163 pp.

Effendie, M.I., (1979). Fisheries Biology Methods. Yogyakarta: Yayasan Pustaka Nusatama. 112 pp.

Eragradhini, A. (2014) Reproductive biology of the tank goby (Glosso-gobius giuris, Hamilton Buchanan 1822) in Lake Tempe, South Sula-wesi. 1-72.

FishBase (2016). FishBase: A Global Information System on Fishes.

Gustomi, A, Sulistino & Yonvitner.(2016). Reproduction of the Fish Belida Notopterus Pallas, 1769) in the Kolong-Bendungan Simpur, Pulau Bangka

Hutagalung.Hara, A., Hiramatsu, N & Fujita, T. (2016). Vitellogénesis y coreogénesis en peces. Ciencia de los Peces. 82: 187-202. DOI: 10.1007-/s12562-015-0957-5.

Iskandar, A. (2024) Curcumin supplementation and hormonal induction to improve the reproductive performance of red-eyed fish (Systomus orphoides): 1-97.

Jan, M., Jan, N. (2017). Estudios sobre la fecundidad (F), el índice gonadosomático (GSI) y el índice hepatosomático (HIS) de Salmo trutta fario (trucha marrón) en la piscifactoría de truchas de Kokernag, Anantnag, Jammu y Cachemira. Revista International de Estudios de Pesca y Acuicultura, 5(6): 170-173.

Jega, I.S., Miah, M.I., Huda N.A., Rahman, M.A., Fatema, M.K., Haque, M.M. & Shahjahan, M. (2018). Biología reproductiva del pez gato menoda amenazado, Hemibagrus menoda (Hamilton, 1822) en el río Kangsha, Bangladés. Revista de ciencias pesqueras y acuáticas. 13 (1): 39-48. DOI: 10.3923/jfas.2018.39.48.

Kudsiah, H., Suwarni, B. S. P., & Rahim, S. W. (2024). Nivel de Madurez Gonadal e Índice del Pez Gobi de Tanque (Glossogobius Giuris) en las Aguas del Lago Sidenreng, Sulawesi del Sur. Entorno y Ecología, 12(6): 591-600.

Langroudi FH, Sabet MH. (2016). Biología reproductiva del lotak, Cyprinion macrostomum Heckel, 1843 (Pisces:

Cyprinidae), del drenaje del río Tigris. Revista Iraní de Ciencias de la Pesca. 17(2):288-299. DOI:10. 22092/IJFS.-2018.115479.

Lelono, T.D., Bintoro, G., Harlyan, L.I., Kamilah, I. (2023). Crecimiento, mortalidad, consumo de alimentos y estado de explotación del atún de aleta negra Auxis rochei (Risso, 1810) capturado en las aguas de Prigi, Trenggalek, Java Oriental. Acuicultura, Acuario, Conservación y Legislación. 16(3): 1418-1429.

Lowerre-Barbieri, S. K., Brown-Peterson, N. J., Wyanski, D. M., Moncrief-Cox, H. E., Kolmos, K. J., Menendez, H. S.,& Friess, C. (2023). Un marco unificado y una terminología para los rasgos reproductivos integrales para comprender la productividad de las poblaciones de peces. Pesquerías Marinas y Costeras, 15(6): e210276.

Mamangkey, J.J & Nasution, S.H. (2012). Reproduction of the endemic butini fish (Glossogobius matanensis Weber 1913) based on depth and time in Lake Towuti, South Sulawesi. Indonesian Journal of Biology. 8(1): 31-34.

Marzuqi M, Giri Ina, Setiadharma T, Andamari R, Andriyanto W, Astuti Nww. 2015. The use of prematuration feed to enhance gonadal development in prospective broodstock of milkfish (Chanos chanos Forsskal). Aquaculture research journal. 10(4): 519-530. Doi: 10.15578/Jra.10.4.2015.519-530.

McDowall, R.M. (2007). Sobre la anfidromía, una forma distinta de diadromía en organismos acuáticos. Peces y Pesquerías 8 (1): 1-13. DOI: 10.1111/-j.1467-2979.2007.00232.x

Mylonas, C.C., Fostier, A., Zanuy S. (2010). Manejo de reproductores y manipulaciones hormonales de la reproducción de peces. Endocrinología General y Comparativa. 165:516-534.

Puspaningdiah, M., Solichin, A. & Ghofar, A. (2014). Biological aspects of the snakehead fish *(Ophiocephalus striatus*) in the waters of Rawa Pening, Semarang Regency, Management of Aquatic Resources Journal, 3(4): 75-82.

Salvanes, A.G.V., Christiansen, H., Taha, Y., Henseler, C., Seivag, M.l., Kjesbu, O.S., Folkvord, A., Utne-Palm, A.C., Currie, B., Ekau, W., Anja, K., Plas, V.D., Gibbons, M.J. (2018). Variation in growth, morphology and reproduction of the bearded goby (*Sufflogobius bibar-batus*) in varying oxygen Environ-ments Of Northern Benguela. Jour-nal Of Marine Systems, 2-17. DOI: 10.1016/J.Jmarsys.2018.04.003.

Song, Y., Zheng, W., Zhang, M., Cheng, X., Cheng, J., Wang, W., Li, Y. (2020). Técnicas de reproducción artificial fuera de temporada de la lenguado hembra cultivada (Cynoglossus semi-laevis): gestión de reproduc-tores, métodos de administración de terapia hormonal y fertilización artificial. Acuicultura. 518: 734866. DOI: 10.1016/J.Aquaculture.2019.-734866.

Suhenda, N., Samsudin, R., Kristanto, A.H. (2016). The role of dietary fat in supporting embryo development, egg hatching rate, and larval survival of the baung fish (Mystus nemurus). Journal of Aquaculture Research. 4(2): 201-211. DOI: 10.15578/Jra.-4.2.2009.201-211.

Sulistiono, A., Firmansyah, S., Sofiah, M., Brojo, R., Affandi, J., Mamangkey. 2007. Biological aspects of the butini fish (Glossogobius matanen-sis) in Lake Towuti, South Sulawesi. Journal of Aquatic Sciences and Fisheries of Indonesia, 14(1): 13-22.

Sulistiono. (2012). Reproduction of beloso fish (Glossogobius giuris) in the waters of Ujung Pangkah, East Java. Indonesian Aquaculture Journal. 11 (1): 64-75.

Teichert, N., Valade, P., Fostier, A., Lagarde, R., Gaudin, P. (2014). Biología reproductiva de un gobio anfídromo, *Sicyopterus lagoce-*

phalus, en la isla de Union. Hydrobiologia, 726: 123-141. DOI: 10.1007/S10750-013-1756-6.

Tikawati, T., Omar, S. B. A., Nur, M., Said, M., & Sapri, R. (2024, December). Sex Ratio and Size at First Gonadal Maturity of Gobi Fish (*S. longifilis* de Beauford, 1912) in the Matama River, Polewali Mandar Regency, West Sulawesi. In the National Seminar on Animal Husbandry, Marine, and Fisheries, 1(1): 221-229).

Wagle, S.K. (2014). Estudios sobre el Índice Gonadosomático, Fecundidad y Tasa de Eclosión del Stock de Domesticación de Asala Schizothorax richardsonii (Gray) del Río Nallu del Distrito de Lalitpur. Nuestra Naturaleza, 12(1): 19-27.

West, G 1990. Métodos de Evaluación del Desarrollo Ovarico en Peces: Una Revisión. Australian Journal of Marine and Freshwater Research,. 41:200-222.

Winemiller KO, Angelo AA, Caramaschi ÉP. (2008). Ecología de los peces en arroyos tropicales. San Diego (USA): Academic Press. 107-140 p.

Yonvitner, Setyobudiandi, I., Ernawati, Y.,Zairion, Mashar, A., Akmal, G.S. (2018.) Fish Biology. IPB Press, Bogor

Acknowledgment

The Editorial Board of Jurnal Iktiologi Indonesia (the Indonesian Journal of Ichthyology) would like to express its sincere appreciation to the following peer reviewers for their valuable time, expertise, and thoughtful contributions in reviewing and evaluating the manuscripts published in Volume 23, Number 1, February 2026. Their constructive comments and professional assessments have greatly contributed to maintaining the scientific quality of the journal, namely:

1. Prof. Dr. Teguh Peristiwadi - Research Center for Biosystematics and Evolution, National Research and Innovation Agency (BRIN), Indonesia
2. Prof. Dr. O.D. Subhakti Hasan - Polytechnic of Fisheries, Ministry of Marine Affairs and Fisheries (KKP), Indonesia
3. Dr. Tedjo Sukmono - Faculty of Science and Technology, Universitas Jambi, Indonesia
4. Dr. Nyoman Dati Utami - Faculty of Marine Science and Fisheries, Universitas Udayana, Indonesia
5. Dr. Lenny S. Syafei - Indonesian Ichthyological Society, Bogor, Indonesia

INSTRUCTION for AUTHORS

The Jurnal Iktiologi Indonesia (JII) publishes original research articles encompassing all aspects of fish (Pisces) inhabiting freshwater, brackish, and marine environments. The scope includes biology, physiology, taxonomy and systematics, genetics, and ecology, as well as their applications in fisheries, aquaculture, fisheries management, and conservation. Manuscripts submitted to JII must report the complete results of original scientific research.

JII also accepts book reviews relevant to the journal's scope. In addition, review articles addressing significant and current topics may be published upon invitation from the Editorial Board. Comments on, and responses to, articles previously published in JII are also welcome and may be considered for publication.

JII is published three times annually, in February, June, and October. The final issue of each volume contains the table of contents, author index, and subject index for the entire volume.

Manuscripts must be written in English and must not have been previously published or be under consideration for publication elsewhere. The Editorial Board reserves the right to accept or reject manuscripts based on their relevance to the scope of JII. Accepted manuscripts may be edited or condensed for clarity, consistency, and adherence to journal style, without altering their scientific content. The views expressed in published articles are solely those of the authors and do not necessarily reflect those of the Editorial Board or the publisher.

Unless otherwise specified, the first author will be considered the corresponding author. Authors whose manuscripts are accepted for publication agree to transfer copyright to the publisher, the Masyarakat Iktiologi Indonesia (Indonesian Ichthyological Society). Page proofs will be sent to the corresponding author for review. Corrected proofs, along with the signed copyright transfer agreement, must be returned to the Editorial Board within one week.

Authors reporting novel findings or inventions are strongly encouraged to secure appropriate intellectual property protection, including patent applications where applicable, prior to publication in JII.

Manuscript Submission

Manuscripts may be submitted at any time by sending a soft copy to the JII Editorial Board through the journal website:

jurnal-iktiologi.org

All submitted manuscripts will be evaluated by the Editorial Board and subsequently reviewed by two competent anonymous peer reviewers. The peer-review process is intended to provide constructive evaluations and to ensure that manuscripts published in JII meet a high scientific standard.

The following guidelines are intended to assist authors in preparing manuscripts for submission to JII. Manuscripts prepared in accordance with these instructions will facilitate and expedite the review and editorial process.

Manuscript Preparation

Authors should ensure that their manuscripts are prepared clearly and consistently by following the guidelines below.

- Use A4 paper size with margins of 3 cm on all sides. Pages should be numbered consecutively at the bottom right corner.
- The manuscript should be formatted in a single-column layout throughout.
- Manuscripts should be prepared using Microsoft Word for Windows, typed in Times New Roman, 12-point font, with 1.5-line spacing. Different fonts may be used in figures where appropriate.
- Text should be left-aligned only (do not justify the text).
- Use a single space (not double spaces) after punctuation marks (periods, commas, colons, and semicolons).
- Use the International System of Units (SI) for all measurements and weights.
- Scientific names of organisms must follow the appropriate international nomenclatural codes (e.g., the International Code of Zoological Nomenclature). Genus and species names must be written in italic type.
- Do not use the slash symbol (/) to indicate "per" in units. Instead, use negative

exponents, for example, write 9 m s^{-1} instead of 9 m/s.

- Avoid abbreviations unless they are defined at their first occurrence. The full term should be written out first, followed by the abbreviation in parentheses.
- Dates should be written in the format day month year, for example, 12 September 2010. In tables and figures, month names should be abbreviated using the first three letters (e.g., Feb, Jun, Oct).
- Maps must include latitude and longitude references and indicate the source of the data.
- Photographs or illustrations of organisms or their anatomical parts must include a scale bar or other appropriate indication of scale.
- Ensure that all figures are numbered consecutively in the order in which they are cited in the text. Figure numbers and captions should be placed below the figures.
- Ensure that all tables are numbered consecutively according to their citation in the text. Table numbers and titles should be placed above the tables. Table titles should be clear, complete, and informative. Data sources and explanatory notes should be placed below the table. Vertical lines should not be used in tables. Horizontal lines should be limited to those above and below the column headings and at the bottom of the table.
- Authors are solely responsible for the accuracy of all references cited. JII uses the author–year citation system. In the text, citations should be presented as Rahardjo & Simanjuntak (2007) or (Rahardjo & Simanjuntak 2007) for one or two authors, and Sjafei et al. (2008) or (Sjafei et al. 2008) for three or more authors. Multiple references cited together should be arranged chronologically, for example: (Gonzales et al. 2000; Stergiou & Moutopoulos 2001; Khaironizam & Norma-Rashid 2002; Abdurahiman et al. 2004; Frota et al. 2004; Tarkan et al. 2006). References published in the same year should be arranged alphabetically by the first author's surname. Multiple publications by the same author(s) in the same year should be distinguished by lowercase letters following the publication year, for example: Syafei 2018a and Syafei 2018b.

Manuscript Structure

Title

The title should be centered, concise, accurate, and informative, clearly reflecting the content of the manuscript. The main title should be presented in bold, 13-point font

Authors and Affiliations

Authors' names should be written in regular, 12-point font. Affiliations should be presented in regular, 9-point font, including the full name and address of the institution, together with the postal code. The e-mail addresses of all authors must be provided.

Abstract

The abstract must be written in English, with a maximum length of 250 words. It should briefly describe the objective of the study, the methods employed, the principal results, and the main conclusion. Avoid the use of abbreviations and references. The abstract should consist of a single paragraph.

Keywords

Provide up to seven keywords in English, arranged alphabetically.

Introduction

The Introduction should clearly explain the background and rationale of the study. Previous relevant studies (the current state of knowledge) should be concisely reviewed to establish the context of the research. The research objectives should be clearly stated.

Materials and Methods

This section should describe the materials and methods in sufficient detail to allow the study to be reproduced. The study location, period of research, and specifications of equipment used should be clearly stated.

Results

Present the findings clearly and objectively based on the methods employed. This section should contain only the results of the study and should not include references to the literature.

Discussion

The scientific value of a manuscript is largely determined by the quality of its discussion. Interpret the findings in relation to previous studies and support the interpretations with appropriate evidence and relevant references. Unexpected findings or anomalies should be adequately explained. Authors are strongly encouraged to cite recent primary literature, preferably published within the last 10 years.

Conclusion

The conclusion should be concise, clearly stated, and directly address the objectives of the study.

Acknowledgements (if applicable)

This section should recognize institutions, funding agencies, or individuals who have made significant contributions to the research or the preparation of the manuscript.

References

References should be arranged alphabetically according to the surname of the first author. Ensure that every reference cited in the text appears in the reference list, and that every reference listed has been cited in the text.

Journal Articles

Write the full title of the article. Capitalize only the first word of the title and proper nouns. The journal title should be written in full (not abbreviated) and in italic, followed by the volume number, issue number (if applicable), and page range in roman type.

Example:

Lauer TE, Doll JC, Allen PJ, Breidert B, Palla J. 2008. Changes in yellow perch length frequencies and sex ratios following closure of the commercial fishery and reduction in sport bag limits in southern Lake Michigan. Fisheries Management and Ecology, 15(1): 39–47.

Books

Book titles should be written in italic. Capitalize the principal words of the title, except articles, conjunctions, and prepositions. Include the publisher, place of publication, and total number of pages.

Example:

Berra TB. 2001. Freshwater Fish Distribution. Academic Press, San Francisco. 640 p.

Translated Books

For translated books, include the name of the translator.

Examples:

Nikolsky GV. 1963. The Ecology of Fishes. Translated from Russian by L. Birkett. Academic Press, London and New York. 352 p.

Steel GD, Torrie JH. 1981. Prinsip-prinsip dan Prosedur Statistika. Translated by Bambang Sumantri. PT Gramedia Pustaka Utama, Jakarta. 747 p.

Chapters in Edited Books or Conference Proceedings

References to chapters in edited books or conference proceedings should include the author(s), year of publication, chapter title, editor(s), title of the book or proceedings (in italic), publisher, place of publication, and page numbers.

Examples:

Bleckmann H. 1993. Role of lateral line in fish behaviour. In: Pitcher TJ (ed.). Behaviour of Teleost Fishes. Chapman and Hall, London. pp. 201–246.

Simanjuntak CPH, Zahid A, Rahardjo MF, Hadiaty RK, Krismono, Haryono, Tjakrawidjaja AT (eds.). 2011. Prosiding Seminar Nasional Ikan VI. Bogor, 8–9 June 2010. Masyarakat Iktiologi Indonesia, Cibinong. 612 p.

Unpublished Material

Limited citations of unpublished results, manuscripts in preparation, submitted manuscripts, or personal communications should be cited only in the text and should not be included in the References.

In Press Publications

Articles and books that have been accepted for publication but have not yet been published should be designated as "in press."

Other Types of Contributions

Review articles, book reviews, and comments or responses to previously published articles are not required to follow the manuscript structure described above.

Jurnal Iktiologi Indonesia
Volume 23 Number I February 2026

9 771693 033002