# Trophic ecology of silver barb (*Barbonymus gonionotus*) in Serayu Movable Weir, Central Java, Indonesia, following the 2022 mass-mortality event

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https://doi.org/10.67784/1022

**Abstract**. Trophic adaptation following major ecological disturbances is essential for evaluating ecosystem recovery and species resilience. Therefore, this study aimed to examine trophic ecology of silver barb (*Barbonymus gonionotus*) in Serayu Movable Weir, Central Java, Indonesia, following a mass-mortality event in 2022 using morphological, digestive, and dietary analyses. Feeding morphology was evaluated based on mouth position and related structural traits, while digestive characteristics were assessed using relative intestine length as an indicator of trophic adaptation. Stomach contents were identified and quantified to determine the composition and relative contribution of dietary items. The results showed that the species possessed a herbivorous trophic strategy, combining generalized feeding morphology with strong phytoplanktivorous specialization. The terminal mouth and intermediate relative intestine length (2.29-4.82) indicated broad feeding capability and adaptation to plant-based resources. However, stomach content analysis showed a highly specialized realized diet dominated by phytoplankton (99.99%), with zooplankton contributing only 0.01%, indicating environmental resource availability rather than morphological constraints. Dietary diversity (H′ = 2.39) and electivity analysis further indicated selective feeding on particular phytoplankton taxa, suggesting efficient resource optimization. These results showed the high trophic plasticity of *B. gonionotus*, enabling effective exploitation of primary production in regulated tropical rivers. As a phytoplanktivorous omnivore, the species played an important role in energy transfer and nutrient cycling, showing ecological significance and resilience to environmental disturbance.
**Keywords**: dam, ecological disturbance, Indonesia, trophic plasticity, tropical river.

**Introduction**. Freshwater ecosystems are essential for supporting exceptional biodiversity and providing various services such as fisheries production, nutrient cycling, water regulation, and habitat maintenance. Despite their ecological and socioeconomic importance, freshwater ecosystems are undergoing rapid global degradation caused by anthropogenic pressures, including hydrological alteration, pollution, habitat fragmentation, invasive species, fisheries, recreation, and climate change (Reid et al., 2019; Tickner et al., 2020; Albert et al., 2021). Among these stressors, river regulation by dams and reservoirs constitutes a dominant driver of ecological change through the modification of natural flow regimes, sediment transport, habitat connectivity, and aquatic community structure (Chen & Olden, 2017; Foley et al., 2017; Wang et al., 2017).

Reservoir sedimentation has become a major challenge for regulated rivers, particularly in tropical catchments where intense rainfall, land-use change, and watershed degradation accelerate sediment delivery. The accumulation of sediment reduces reservoir storage capacity and hydropower efficiency, thereby threatening the long-term sustainability of water infrastructure (Ren et al., 2021; Wenhong, 2022). To address this challenge, sediment flushing is increasingly implemented to restore reservoir

function. However, rapid downstream mobilization can generate severe ecological disturbances by increasing suspended sediment concentrations and turbidity, reducing underwater light availability, altering nutrient dynamics, and degrading aquatic habitats (Espa et al., 2019; Noe et al., 2020). These changes can impair fish respiration, feeding efficiency, reproduction, and survival, potentially disrupting aquatic food-web processes and ecosystem functioning (Grimardias et al., 2017; Schenk & Bragg, 2021; Quadroni et al., 2024).

Tropical rivers are particularly vulnerable to sediment-driven disturbances due to their exceptional biodiversity and the limited understanding of species-specific resilience mechanisms. Increased sediment loading can also alter primary production, reduce benthic habitat complexity, and modify energy pathways within aquatic ecosystems. Since fish integrate environmental changes through patterns of resource acquisition and energy allocation, trophic ecology provides an effective framework for assessing ecological responses to disturbance. Species capable of dietary flexibility, trophic niche adjustment, and resource switching may maintain populations under rapidly changing environmental conditions by exploiting alternative energy pathways (Laske et al., 2018; McMeans et al., 2019; Neves et al., 2021, 2023). However, the mechanisms underlying trophic resilience following acute sediment disturbances remain insufficiently explored, particularly in tropical regulated regions such as Serayu River (Wibowo et al., 2024).

Serayu River in Central Java, Indonesia, is a regulated tropical river system affected by the operation of PB Soedirman Reservoir. Progressive sediment deposition caused by watershed erosion and the expansion of intensive floating-cage aquaculture has prompted the need for periodic sediment flushing to preserve reservoir functionality (Andriyani et al., 2018). In April 2022, a large-scale flushing event transported accumulated sediments downstream and was associated with extensive fish mortality in Serayu Movable Weir area, accounting for approximately 61 km downstream of the reservoir. The event caused substantial deterioration of water quality, characterized by elevated suspended solids, increased turbidity, altered nutrient concentrations, and reduced dissolved oxygen, indicating severe ecological disturbance (Wibowo et al., 2022; Nuryanto et al., 2026). Therefore, understanding how fish respond trophically to disturbances is critical for predicting ecosystem recovery and improving river management. Omnivorous fishes often show greater resilience to environmental disturbance because their broad trophic niches enable rapid shifts in prey use and energy pathways in changing resource conditions. However, there is limited empirical evidence on trophic responses of tropical freshwater fishes to sediment-flushing disturbances (Sabater et al., 2018).

Silver barb, *Barbonymus gonionotus* (Bleeker, 1849), is an economically important cyprinid widely distributed across Southeast Asian freshwater ecosystems. The herbivorous feeding strategy, rapid growth, and tolerance to environmental variability make *B. gonionotus* an appropriate model for investigating trophic responses to disturbance (Rahman et al., 2024). The species exploits diverse food resources, including algae, aquatic macrophytes, detritus, phytoplankton, insects, and other aquatic invertebrates, indicating substantial dietary plasticity (Ain et al., 2021; Rahman et al., 2024). Therefore, this study aims to evaluate trophic response of *B. gonionotus* following the sediment-flushing disturbance that occurred during the 2022 operation at the PB. Soedirman Dam. Changes in dietary composition, feeding strategy, trophic niche characteristics, and resource use are also explored through stomach-content analysis and quantitative dietary indices, while integrating environmental variables that describe habitat alteration. The results provide novel insights into fish trophic resilience and contribute to ecological management strategies for sediment-disturbed tropical-regulated rivers.

## Material and Method

***Study area.*** This study was conducted from May to November 2025 in Serayu Movable Weir area, Central Java, Indonesia (Figure 1), located approximately 61 km downstream from PB Soedirman Reservoir. Serayu River is a regulated tropical river system

influenced by upstream reservoir operations, irrigation activities, aquaculture development, and watershed-derived sediment inputs. PB Soedirman Reservoir, located in Banjarnegara Regency, has experienced progressive sediment accumulation due to high erosion rates within the watershed. Sediment flushing activities were implemented periodically to restore reservoir storage capacity. However, the large-scale flushing event in April 2022 caused substantial downstream sediment transport and was associated with mass fish mortality in Serayu Movable Weir region.

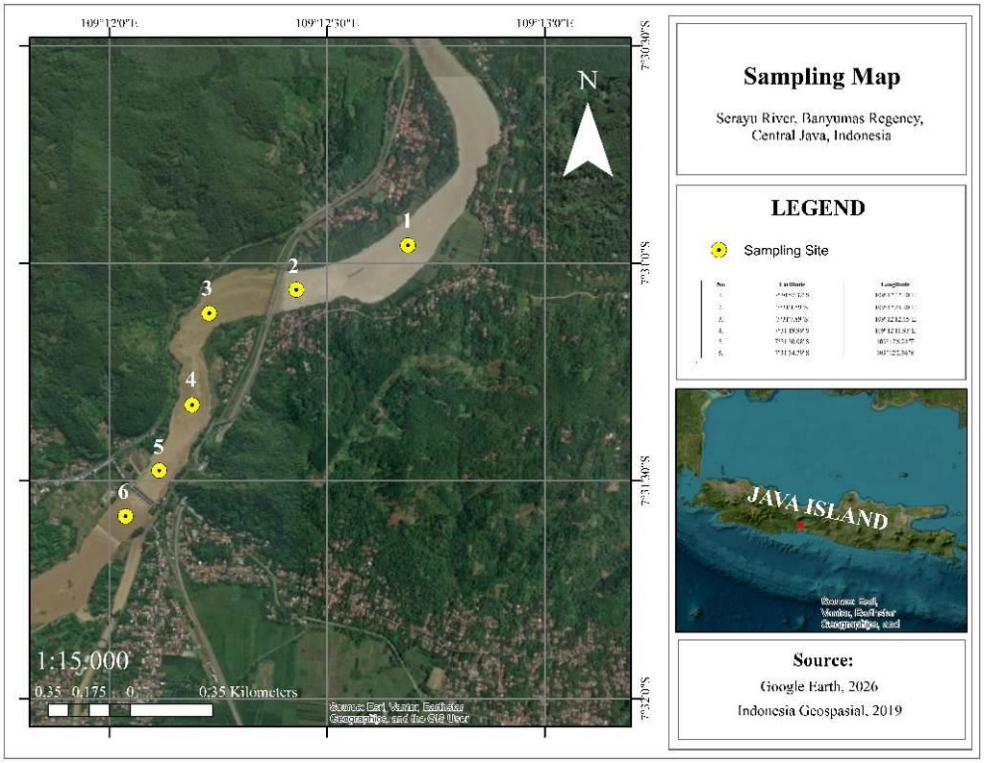



Figure 1. Study areas with sampling stations in Serayu Movable Weir, Central Java, Indonesia.

***Fish sampling and biological measurements***. Sampling was carried at six (6) sampling sites covering upstream of the weir and one site below the weir. These sites were chosen to expand the sampling area within the dam, thereby increasing the likelihood of obtaining *B. gonionotus* samples. Samples of *B. gonionotus* (Figure 2) were collected using standardized fishing gears such as experimental gill nets (mesh sizes 1-2 inches), cast nets, or electrofishing equipment depending on local regulations and habitat conditions. Fish sampling was conducted during the post-disturbance recovery period following the 2022 sediment flushing event. A total number of 33 *B. gonionotus* specimens were collected to evaluate their dietary characteristics.




Figure 2. General features of *B. gonionotus* collected from Serayu Movable Weir, Central Java, Indonesia.

Captured fish were immediately preserved using ice and transported to the laboratory for biological analysis. Each individual was measured for total length (TL, cm), standard length (SL, cm), and body weight (BW, g). This was followed by dissection, and the digestive tract was removed and weighed. Stomach samples were preserved in 70-96% ethanol for subsequent dietary analysis.

***Environmental parameter measurements***. Physicochemical parameters were measured simultaneously during fish collection, which included water pH, water temperature (°C), water transparency (cm), dissolved oxygen (DO) (mg $L^{-1}$), and total dissolved solids (TDS) (mg $L^{-1}$). These parameters were determined using standard limnological procedures (Table 1), and the results were used to characterize habitat quality and primary productivity.

Table 1

The method for water quality parameter measurement in Serayu Movable Weir, Central Java, Indonesia

| *Parameter* | *Unit* | *Measurement method* | *References* |
|---|---|---|---|
| pH | - | pH meter | (APHA, 2005) |
| Temperature | °C | Mercury thermometer | (APHA, 2005) |
| Water transparency | cm | | (APHA, 2005) |
| Dissolved oxygen (DO) | mg $L^{-1}$ | Winkler method | (APHA, 2005) |
| Total dissolved solids (TDS) | mg $L^{-1}$ | Gravimetry | (APHA, 2005) |

***Tropical ecology evaluation***. Various parameters related to tropical ecology of *B. gonionotus* were measured and evaluated. These included food availability in the environment, mouth position, relative intestine length (RIL), and stomach content.

For plankton sampling and identification, plankton samples were collected using a net with a 25-µm mesh size, a 30-cm mouth diameter, and a 75-cm net length. At all six sampling stations, 100 L of water was collected by filtering 10 samples of 10-L buckets through the plankton net. The sampling efforts were carried out with two replicates. The concentrated plankton sample was transferred from the 50-mL collection bottle into a labeled sample bottle and preserved with 4% formalin and two drops of Lugol's iodine solution following Sastranegara et al. (2020).

Before analysis, each sample was homogenized by gently inverting the bottle. A drop of the homogenized sample was placed on a glass slide, covered with a coverslip, and examined under a binocular light microscope at 400× magnification (10× objective × 40× eyepiece) following Sachlan (1982). Plankton taxa were identified using the taxonomic keys of Sachlan (1982) and Davis (1995). For each sample, observations were conducted across 20 fields of view by systematically scanning the slide in a zigzag pattern (10 fields to the right, 1 field upward, and 10 fields to the left). Plankton abundance was calculated according to the method described by Sachlan (1982):

$$\text{Abundance} = [(A/B) \times (C/D) \times (E/F)] \text{ individual/liter}$$

where: A = water volume in bottle sample (mL);
B = water volume observed (mL);
C = cover glass width ($mm^2$);
D = view field number (20);
E = number of plankton individuals;
F = total volume of filtered water (100 L).

The mouth position was determined based on relative position to the body median or the snout tip. Meanwhile, relative intestine length (RIL) was measured by comparing intestine length and standard body length (Figure 3). The calculation was based on the following formula (Alabssawy et al., 2019; Wibowo et al., 2022):

$$\text{RIL} = [\text{IL (cm)}/\text{SL (cm)}]$$

where: RIL = relative intestine length;
IL = intestine length;
SL = standard length.



Figure 3. Body and intestine length of *B. gonionotus*.

Stomach contents were analyzed to evaluate diet composition of *B. gonionotus*. Fish dissection was performed by making an incision from the anus to the posterior end of the operculum. Blunt scissors were carefully inserted into the body cavity to minimize the risk of damaging the digestive tract and other internal organs. The volume of the digestive organs was determined using the water displacement method by immersing the organs in a measuring cylinder containing a known volume of water. Organ volume was calculated as the difference between the initial and final water volumes after immersion. Subsequently, the digestive tract contents were removed, transferred into labeled sample bottles, and preserved with a 4% formalin solution until the material was completely submerged.

For microscopic examination, the stomach contents were initially homogenized. Larger food items were identified using a hand lens, while smaller particles were examined under a binocular microscope. A drop of the homogenized stomach content was placed on a microscope slide for observation. Each sample was examined across 20 fields of view with five replicates. Food items were identified according to the taxonomic references of Sachlan (1982) and Davis (1955), which were primarily used for the identification of natural food organisms, specifically plankton. Diet composition served as an essential parameter to estimate the feeding habits of the fish using dietary diversity index (H'), index of preponderance (IP), and electivity index (EI). In this study, dietary diversity was assessed using the Shannon-Wiener diversity index, following the formula expressed below:

$$H' = -\sum pi \times \ln pi;$$

where: pi = represents the proportion of each food category.

Index of preponderance (IP), providing an estimate of stomach fullness and the relative importance of different food items, was calculated using the formula proposed by Natarajan and Jhingran, as cited in Gupta & Banerjee (2014).

$$IP = (Vi \times Oi) / (\Sigma(Vi \times Oi)) \times 100$$

where: IP = index of preponderance;
Vi = percentage of $i^{th}$ plankton;
Oi = frequency of $i^{th}$ plankton.

Electivity Index (EI) was used to assess the food preferences of the species by comparing the relative availability of food items in the environment with their occurrence in the diet. The index was calculated according to the method described by Ageili et al (2013):

$$EI = (ri - pi) / (ri + pi)$$

where: EI = electivity index;
ri = relative number of organisms that are eaten;
pi = relative number of organisms in the water.

***Data analysis***. Mouth morphology was analyzed descriptively by comparing observational data with published literature. Feeding habits were interpreted descriptively using the results of stomach content analysis and compared to relevant literature.

## Results

***Ecological parameters***. A total of five ecological parameters were measured during the field trips, with values presented in Table 2.

Table 2
Average values of four water quality parameters in Serayu Movable Weir, Central Java, Indonesia

| *No* | *Parameter* | *Unit* | *Range* | *Average±SD* |
|---|---|---|---|---|
| 1 | pH | - | 6.01-7.17 | 6.50±0.44 |
| 2 | Temperature | °C | 25.8-29.8 | 27.69±1.85 |
| 3 | Water transparency | cm | 8.5-41 | 20.00±12.54 |
| 4 | Dissolved oxygen (DO) | mg $L^{-1}$ | 7.49-9.64 | 8.67±0.79 |
| 5 | Total dissolved solids (TDS) | mg $L^{-1}$ | 85.2-100.6 | 91.99±5.70 |

***Plankton diversity and abundance***. Microscopic observation and plankton identification on the water samples collected from Surayu Movable Weir showed phytoplankton, zooplankton, and protists. A total of 77 plankton taxa were identified, comprising 69 phytoplankton species, 6 zooplankton species, and 2 species of protist (Table 3).

Table 3
Plankton species identified in water samples collected from Serayu Movable Weir, Banyumas, Central Java, Indonesia

| *Taxa* | *Station (cell $L^{-1}$)* | | | | | | *Total (cell $L^{-1}$)* | *Mean±SD* |
|---|---|---|---|---|---|---|---|---|
| | *1* | *2* | *3* | *4* | *5* | *6* | | |
| **Bacillariophyta** | | | | | | | | |
| *Amphipleura pellucida* | 20 | 44 | 13 | 8 | 13 | 105 | 203 | 17±37.13 |
| *Amphora praelata* | 15 | 0 | 0 | 0 | 13 | 23 | 51 | 7±9.89 |
| *Amphora* sp. | 13 | 0 | 29 | 18 | 35 | 20 | 115 | 19±12.29 |
| *Cocconeis pediculus* | 0 | 52 | 24 | 0 | 26 | 0 | 102 | 12±21.08 |
| *Cyclotella comta* | 13 | 28 | 29 | 0 | 0 | 0 | 70 | 7±13.98 |
| *Cyclotella costei* | 11 | 10 | 37 | 0 | 0 | 0 | 58 | 5±14.35 |
| *Cyclotella* sp. | 74 | 106 | 13 | 0 | 0 | 20 | 213 | 17±44.09 |
| *Cymbella affinis* | 13 | 0 | 52 | 24 | 0 | 50 | 139 | 19±23.36 |
| *Cymbella cistula* | 11 | 13 | 21 | 11 | 20 | 0 | 76 | 12±7.61 |
| *Cymbella naviculiformis* | 0 | 54 | 18 | 29 | 0 | 13 | 114 | 16±20.42 |
| *Cymbella* sp. | 28 | 23 | 20 | 13 | 33 | 0 | 117 | 22±11.74 |
| *Diatoma elongata* | 0 | 0 | 31 | 0 | 0 | 0 | 31 | 0±12.66 |
| *Diatoma elongatum* | 0 | 11 | 55 | 63 | 10 | 0 | 139 | 11±28.23 |
| *Diatoma linearis* | 15 | 0 | 52 | 23 | 26 | 13 | 129 | 19±17.49 |
| *Diatoma* sp. | 21 | 26 | 26 | 31 | 10 | 13 | 127 | 24±8.18 |
| *Fragilaria capucina* | 31 | 101 | 13 | 34 | 34 | 67 | 280 | 34±31.83 |
| *Fragilaria construens* | 0 | 0 | 0 | 20 | 29 | 13 | 62 | 7±12.40 |
| *Fragilaria* sp. | 101 | 88 | 73 | 70 | 34 | 106 | 472 | 81±26.21 |
| *Gyrosigma* sp. | 15 | 38 | 68 | 34 | 0 | 11 | 166 | 25±24.40 |
| *Melosira italica* | 36 | 23 | 28 | 20 | 0 | 13 | 120 | 22±12.47 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Melosira* sp. | 20 | 13 | 11 | 50 | 18 | 11 | 123 | 16±14.92 |
| *Navicula cuspidata* | 28 | 18 | 37 | 0 | 11 | 63 | 157 | 23±22.18 |
| *Navicula elegans* | 62 | 0 | 91 | 41 | 0 | 23 | 217 | 32±36.02 |
| *Navicula gracilis* | 20 | 54 | 21 | 13 | 7 | 44 | 159 | 21±18.43 |
| *Navicula lanceolata* | 78 | 24 | 42 | 20 | 28 | 18 | 210 | 26±22.72 |
| *Navicula placentula* | 24 | 60 | 76 | 50 | 69 | 0 | 279 | 55±29.12 |
| *Navicula radiosa* | 76 | 11 | 0 | 20 | 28 | 75 | 210 | 24±32.73 |
| *Navicula* sp. | 68 | 193 | 65 | 38 | 45 | 57 | 466 | 61±57.66 |
| *Neidium affine* | 11 | 60 | 0 | 55 | 20 | 10 | 156 | 16±25.26 |
| *Nitzschia acicularis* | 13 | 11 | 0 | 28 | 0 | 10 | 62 | 11±10.33 |
| *Nitzschia actinastroides* | 0 | 0 | 10 | 23 | 0 | 20 | 53 | 5±10.59 |
| *Nitzschia fasciculata* | 15 | 11 | 20 | 20 | 18 | 20 | 104 | 19±3.67 |
| *Nitzschia filiformis* | 68 | 73 | 24 | 10 | 8 | 37 | 220 | 31±28.27 |
| *Nitzschia frustulum* | 42 | 156 | 0 | 0 | 0 | 29 | 227 | 15±60.59 |
| *Nitzschia longissima* | 10 | 24 | 0 | 20 | 20 | 34 | 108 | 20±11.73 |
| *Nitzschia philippinarum* | 0 | 35 | 0 | 13 | 26 | 13 | 87 | 13±13.98 |
| *Nitzschia recta* | 29 | 55 | 63 | 0 | 20 | 15 | 182 | 25±24.25 |
| *Nitzschia sigma* | 0 | 0 | 37 | 0 | 91 | 0 | 128 | 0±37.20 |
| *Nitzschia subrostrata* | 24 | 13 | 52 | 68 | 38 | 20 | 215 | 31±21.04 |
| *Nitzschia vermicularis* | 0 | 13 | 91 | 0 | 10 | 26 | 140 | 12±34.52 |
| *Nitzschia* sp. | 76 | 78 | 26 | 0 | 34 | 54 | 268 | 44±30.45 |
| *Pinnularia gibba* | 13 | 47 | 0 | 0 | 20 | 91 | 171 | 17±35.17 |
| *Pinnularia nobilis* | 0 | 75 | 0 | 60 | 13 | 28 | 176 | 21±31.67 |
| *Pinnularia* sp. | 0 | 31 | 0 | 41 | 0 | 0 | 72 | 0±18.86 |
| *Stauroneis anceps* | 13 | 119 | 0 | 0 | 10 | 55 | 197 | 12±46.88 |
| *Surirella biseriata* | 24 | 11 | 28 | 0 | 0 | 54 | 117 | 18±20.57 |
| *Surirella elegans* | 54 | 52 | 0 | 28 | 13 | 23 | 170 | 26±21.38 |
| *Surirella robusta* | 21 | 0 | 11 | 47 | 0 | 29 | 108 | 16±18.26 |
| *Surirella striatula* | 0 | 20 | 0 | 18 | 13 | 0 | 51 | 7±9.59 |
| *Synedra acus* | 66 | 176 | 52 | 107 | 24 | 98 | 523 | 82±53.06 |
| *Synedra affinis* | 39 | 63 | 39 | 96 | 18 | 0 | 255 | 39±33.80 |
| *Synedra capitata* | 10 | 13 | 13 | 11 | 11 | 11 | 69 | 11±1.22 |
| *Synedra fasciculata* | 23 | 91 | 0 | 13 | 0 | 50 | 177 | 18±35.38 |
| *Synedra lanceolata* | 23 | 0 | 18 | 49 | 31 | 101 | 222 | 27±35.22 |
| *Synedra radians* | 23 | 10 | 0 | 50 | 0 | 0 | 83 | 5±19.90 |
| *Synedra tabulata* | 0 | 96 | 37 | 56 | 23 | 28 | 240 | 33±32.97 |
| *Synedra ulna* | 70 | 99 | 34 | 72 | 68 | 44 | 387 | 69±22.98 |
| *Synedra* sp. | 44 | 54 | 18 | 97 | 24 | 50 | 287 | 47±28.05 |
| *Tabellaria fenestrata* | 13 | 0 | 20 | 29 | 0 | 15 | 77 | 14±11.37 |
| **Charophyta** | | | | | | | | |
| *Closterium* sp. | 13 | 40 | 41 | 0 | 24 | 20 | 138 | 22±15.82 |
| **Cyanobacteriophyta** | | | | | | | | |
| *Merismopedia convoluta* | 0 | 0 | 11 | 15 | 0 | 13 | 39 | 6±7.23 |
| *Oscillatoria limosa* | 10 | 13 | 44 | 20 | 11 | 18 | 116 | 16±12.71 |
| *Oscillatoria* sp. | 26 | 24 | 13 | 39 | 0 | 11 | 113 | 19±13.67 |
| *Spirulina major* | 50 | 0 | 23 | 0 | 31 | 0 | 104 | 12±20.92 |
| *Spirulina* sp. | 0 | 26 | 0 | 0 | 40 | 34 | 100 | 13±18.79 |
| **Chlorophyta** | | | | | | | | |
| *Microspora* sp. | 65 | 46 | 0 | 13 | 0 | 49 | 173 | 30±28.01 |
| *Pediastrum simplex* | 18 | 34 | 0 | 13 | 0 | 36 | 101 | 16±15.78 |
| *Pediastrum* sp. | 33 | 0 | 13 | 0 | 23 | 24 | 93 | 18±13.56 |
| *Ulothrix zonata* | 24 | 0 | 0 | 0 | 18 | 24 | 66 | 9±12.25 |
| **Protista** | | | | | | | | |
| *Ophrydium versatile* | 13 | 13 | 11 | 20 | 0 | 10 | 67 | 12±6.49 |
| *Tinntinopsis* sp. | 41 | 36 | 10 | 13 | 13 | 0 | 113 | 13±16.04 |
| **Zooplankton** | | | | | | | | |
| *Astramoeba radiosa* | 13 | 59 | 13 | 23 | 23 | 33 | 164 | 23±17.22 |
| *Brachionus plicatilis* | 22 | 0 | 0 | 10 | 16 | 18 | 66 | 13±9.36 |
| *Brachionus* sp. | 26 | 20 | 37 | 11 | 18 | 0 | 112 | 19±12.64 |
| *Centropyxis aculeata* | 0 | 3 | 8 | 0 | 23 | 15 | 49 | 6±9.24 |
| *Cyclops* sp. | 10 | 0 | 0 | 10 | 0 | 33 | 53 | 5±12.81 |
| *Keratella cochlearis* | 34 | 105 | 57 | 49 | 0 | 20 | 265 | 42±36.13 |

***Mouth position***. According to visual observation, the mouth of *B. gonionotus* is located at the front tip of its head, or terminal mouth (Figure 3). The terminal mouth is also characterized by similar or approximately similar length between upper (maxilla) and lower (mandibula) jaws (blue box).

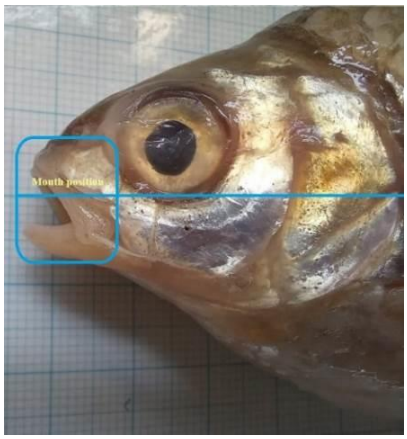



Figure 3. Mouth position of *B. gonionotus* (Bleeker, 1849).

***Relative intestine length***. RIL of *B. gonionotus* samples collected during the sampling in Serayu Movable Weir ranged from 2.29 to 4.82 (Table 4).

Table 4

Relative intestine length of *B. gonionotus* samples from Serayu Movable Weir, Central Java, Indonesia

| *No* | *Total body length (cm)* | *Standard body length (cm)* | *Intestine length (cm)* | *Relative intestine length (RIL)* |
|---|---|---|---|---|
| 1 | 17.5 | 14 | 42 | 3.00 |
| 2 | 16.3 | 13 | 36.5 | 2.81 |
| 3 | 16.4 | 13 | 41.5 | 3.19 |
| 4 | 15.5 | 12.3 | 37.5 | 3.05 |
| 5 | 15.3 | 12.2 | 38.5 | 3.16 |
| 6 | 16.5 | 13 | 34 | 2.62 |
| 7 | 15 | 11.7 | 38 | 3.25 |
| 8 | 15.2 | 12 | 39.5 | 3.29 |
| 9 | 25 | 20.7 | 84.5 | 4.08 |
| 10 | 27 | 22.6 | 87 | 3.85 |
| 11 | 14.6 | 11.5 | 47 | 4.09 |
| 12 | 15.8 | 12.5 | 40.5 | 3.24 |
| 13 | 14.2 | 11.2 | 44.5 | 3.97 |
| 14 | 16.5 | 13 | 37.5 | 2.88 |
| 15 | 14.3 | 10.5 | 35 | 3.33 |
| 16 | 25 | 20.6 | 94.5 | 4.59 |
| 17 | 17.4 | 14 | 32 | 2.29 |
| 18 | 17.1 | 12.6 | 41.5 | 3.29 |
| 19 | 15.5 | 12.5 | 39 | 3.12 |
| 20 | 16.7 | 13.2 | 40 | 3.03 |
| 21 | 14.5 | 11.3 | 44 | 3.89 |
| 22 | 27.7 | 22.3 | 86 | 3.86 |
| 23 | 20.5 | 16.5 | 61.5 | 3.73 |
| 24 | 26 | 21 | 54 | 2.57 |
| 25 | 24.5 | 19.5 | 65.5 | 3.36 |
| 26 | 23 | 18 | 50 | 2.78 |
| 27 | 18.7 | 14.2 | 68.5 | 4.82 |
| 28 | 22 | 17 | 48 | 2.82 |
| 29 | 21 | 16.3 | 57 | 3.50 |
| 30 | 17.5 | 13 | 48 | 3.69 |
| 31 | 18 | 14 | 58 | 4.14 |
| 32 | 18.6 | 14.3 | 53.5 | 3.74 |
| 33 | 17.3 | 13.5 | 47.5 | 3.52 |
| Range value of RIL | | | | 2.29-4.82 |

***Dietary diversity***. A total of 33 individuals of *B. gonionotus* were examined to evaluate dietary diversity (H'). Stomach content analysis and diet identification observed 32 species, comprising 31 phytoplankton species and 1 zooplankton species (Table 5). Dietary diversity analysis using Shannon-Wiener index produced H' value of 2.39.

Table 5

Diet of *B. gonionotus* collected in Serayu Movable Weir, Central Java, Indonesia

| *Plankton* | *Station (fish individual)* | | | | | | *Presence* | *N* | *Frequency* |
|---|---|---|---|---|---|---|---|---|---|
| | *1* | *2* | *3* | *4* | *5* | *6* | | | |
| **Bacillariophyta** | | | | | | | | | |
| *Achnanthes clevei* | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 32 | 0.063 |
| *Achnanthes lanceolata* | 0 | 0 | 3 | 0 | 0 | 3 | 6 | 32 | 0.188 |
| *Amphora* sp. | 1 | 4 | 0 | 3 | 3 | 0 | 11 | 32 | 0.344 |
| *Cocconeis* sp. | 2 | 2 | 0 | 1 | 0 | 0 | 5 | 32 | 0.156 |
| *Cyclotella* sp. | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 32 | 0.031 |
| *Cymbella* sp. | 4 | 5 | 5 | 3 | 3 | 7 | 27 | 32 | 0.844 |
| *Diatoma elongatum* | 1 | 0 | 0 | 2 | 2 | 0 | 5 | 32 | 0.156 |
| *Fragilaria capucina* | 0 | 0 | 0 | 2 | 0 | 2 | 4 | 32 | 0.125 |
| *Gyrosigma* sp. | 0 | 0 | 3 | 0 | 0 | 7 | 10 | 32 | 0.313 |
| *Melosira granulata* | 0 | 0 | 0 | 1 | 2 | 3 | 6 | 32 | 0.188 |
| *Melosira varians* | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 32 | 0.031 |
| *Melosira* sp. | 1 | 0 | 0 | 4 | 4 | 0 | 9 | 32 | 0.281 |
| *Navicula gastrum* | 2 | 5 | 5 | 0 | 0 | 0 | 12 | 32 | 0.375 |
| *Navicula placentula* | 0 | 5 | 0 | 0 | 0 | 8 | 13 | 32 | 0.406 |
| *Navicula* sp. | 0 | 5 | 0 | 4 | 4 | 0 | 13 | 32 | 0.406 |
| *Neidium affine* | 1 | 0 | 0 | 1 | 2 | 0 | 4 | 323 | 0.125 |
| *Nitzschia actinastroides* | 0 | 0 | 0 | 2 | 2 | 0 | 4 | 32 | 0.125 |
| *Nitzschia filiformis* | 2 | 3 | 0 | 0 | 0 | 0 | 5 | 32 | 0.156 |
| *Nitzschia recta* | 2 | 3 | 0 | 0 | 0 | 0 | 5 | 32 | 0.156 |
| *Nitzschia subrostrata* | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 32 | 0.031 |
| *Nitzschia vermicularis* | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 32 | 0.063 |
| *Pinnularia* sp. | 5 | 0 | 4 | 0 | 0 | 2 | 11 | 32 | 0.344 |
| *Rhopalodia* sp. | 0 | 0 | 0 | 1 | 2 | 0 | 3 | 32 | 0.094 |
| *Synedra tabulata* | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 32 | 0.063 |
| *Synedra* sp. | 0 | 5 | 0 | 0 | 0 | 0 | 5 | 32 | 0.156 |
| **Charophyta** | | | | | | | | | |
| *Closterium* sp. | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 32 | 0.030 |
| **Chlorophyta** | | | | | | | | | |
| *Actinastrum* sp. | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 32 | 0.063 |
| *Microspora* sp. | 0 | 0 | 0 | 4 | 4 | 0 | 8 | 32 | 0.250 |
| *Scenedesmus longispina* | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 32 | 0.031 |
| **Cyanobacteriophyta** | | | | | | | | | |
| *Chroococcus* sp. | 1 | 0 | 2 | 0 | | 4 | 7 | 32 | 0.219 |
| **Dinophyta** | | | | | | | | | |
| *Peridinium* sp. | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 32 | 0.031 |
| **Zooplankton** | | | | | | | | | |
| *Centropyxis aculeata* | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 32 | 0.031 |

***Index of preponderance***. Based on the food component observed inside the stomach, phytoplankton accounted for 99.99% of the diet of *B. gonionotus*, while zooplankton was 0.01%. This showed that *B. gonionotus* diet was strongly dominated by phytoplankton.

***Electivity index***. The food habits of *B. gonionotus* from Serayu Movable Weir, Central Java, were analyzed based on an electivity index (EI). EI values were negative for several species of phytoplankton and zooplankton, although some phytoplankton species showed positive values (Table 6).

Table 6
Electivity index of food items consumed by *B. gonionotus* in Serayu Movable Weir post mass-mortality event in 2022

| *Food items* | *Ei* |
|---|---|
| **Bacillariophyta** | |
| *Achnanthes clevei* | 1.00 |
| *Achnanthes lanceolata* | 1.00 |
| *Amphora* sp. | 0.23 |
| *Cocconeis* sp. | -0.77 |
| *Cyclotella* sp. | -0.96 |
| *Cymbella* sp. | 0.73 |
| *Diatoma elongatum* | -0.40 |
| *Fragilaria capucina* | -0.33 |
| *Gyrosigma* sp. | 0.56 |
| *Melosira granulata* | 1.00 |
| *Melosira varians* | 1.00 |
| *Melosira* sp. | 0.08 |
| *Navicula gastrum* | 1.00 |
| *Navicula placentula* | -0.56 |
| *Navicula* sp. | -0.01 |
| *Neidium affine* | -0.85 |
| *Nitzschia actinastroides* | -0.85 |
| *Nitzschia filiformis* | -0.70 |
| *Nitzschia recta* | -0.87 |
| *Nitzschia subrostrata* | -0.94 |
| *Nitzschia vermicularis* | -0.80 |
| *Pinnularia* sp. | 0.46 |
| *Rhopalodia* sp. | 1.00 |
| *Synedra tabulata* | -0.98 |
| *Synedra* sp. | -0.48 |
| **Charophyta** | |
| *Closterium* sp. | -0.80 |
| **Chlorophyta** | |
| *Actinastrum* sp. | 1.00 |
| *Microspora* sp. | -0.90 |
| *Scenedesmus longispina* | 1.00 |
| **Cyanobacteriophyta** | |
| *Chroococcus* sp. | 1.00 |
| **Dinophyta** | |
| *Peridinium* sp. | 1.00 |
| **Zooplankton** | |
| *Centropyxis aculeata* | -0.84 |

**Discussion**. This study shows that *B. gonionotus* has trophic strategy characterized by herbivory with strong phytoplanktivorous specialization. Although the species possesses generalized feeding morphology, reflected by the terminal mouth and intermediate relative intestine length (2.29-4.82), stomach content analysis shows overwhelming reliance on phytoplankton (IP = 99.99%). This indicates that realized feeding ecology is strongly influenced by environmental resource availability rather than morphological constraints alone. The significant difference between potential trophic niche and realized trophic niche is increasingly recognized as a central concept in modern trophic ecology, where morphology defines feeding capability, while resource abundance and behavioral selection determine actual diet (Izzo et al., 2016; Toussaint et al., 2018).

The terminal mouth observed in *B. gonionotus* provides mechanical flexibility for exploiting food particles suspended in the water column while simultaneously allowing grazing on submerged substrates. This generalized cranial morphology is characteristic of trophic generalists that allows for efficient use of diverse food resources without specialization for benthic, pelagic, or surface feeding. Functional morphological studies have shown that mouth orientation is one of the strongest predictors of trophic niche breadth in freshwater fishes. This is because feeding mechanics directly influence prey

encounter rate, capture efficiency, and habitat utilization (Burress, 2016; Villeger et al., 2017). Consequently, the generalized feeding apparatus of *B. gonionotus* provides the anatomical foundation for dietary plasticity under fluctuating environmental conditions.

Digestive morphology further supports this interpretation. The relatively broad range of RIL indicates considerable intraspecific variation in digestive investment, showing long-term adaptation to differences in dietary composition among individuals. Comparative analyses across hundreds of fish species show that intestinal length increases predictably with greater reliance on plant-derived resources because digestion of cellulose-rich material requires prolonged retention time, increased absorptive surface area, and enhanced microbial fermentation (Duque-Correa et al., 2024). Therefore, the high RIL values observed in this study indicate substantial adaptation toward herbivory while retaining sufficient digestive flexibility to process occasional animal prey, supporting classification of *B. gonionotus* as an omnivore with pronounced herbivorous tendencies rather than an obligate herbivore.

Despite the morphological versatility, stomach content analysis indicates significant dietary specialization under the prevailing environmental conditions. Based on the results, phytoplankton accounted for approximately the entire diet (99.99%), while zooplankton represented only incidental consumption (0.01%). This dominance suggests that Serayu Movable Weir provides abundant algal resources capable of satisfying most nutritional requirements of *B. gonionotus*. River impoundments commonly increase hydraulic residence time, reduce current velocity, and enhance phytoplankton production, thereby shifting food-web structure toward greater dependence on autochthonous primary production (Zhu et al., 2013; Patil et al., 2018). Under these conditions, herbivorous fishes maximize energetic efficiency by directly exploiting highly available algal biomass rather than investing additional energy searching for less abundant animal prey.

The moderate dietary diversity (H’ = 2.53) further shows that specialization on phytoplankton does not imply dependence on a single food resource. However, *B. gonionotus* consumed numerous phytoplankton taxa, indicating resource diversification within a single trophic level. Contemporary food-web theory suggests that consumers showing broad dietary diversity within functional resource groups possess greater ecological resilience because of the ability to reduce dependence on individual prey taxa while maintaining stable energy intake despite seasonal variation in community composition (Burress, 2016; Albertson et al., 2018). This within-level dietary diversification contributes to the ecological success of *B. gonionotus* across heterogeneous freshwater environments in Southeast Asia.

Electivity analysis provides additional evidence that feeding behavior is governed by selective resource utilization rather than passive filtration. Positive EI values for several phytoplankton taxa indicate active preference despite the availability of numerous alternative food resources. Meanwhile, negative values suggest avoidance of nutritionally inferior, morphologically defended, or less digestible prey. Selective herbivory has become increasingly recognized as a major determinant of freshwater ecosystem dynamics because consumers preferentially remove highly profitable taxa while allowing resistant species to persist. This condition influences phytoplankton succession, nutrient cycling, and ecosystem productivity (Schneider et al., 2016; Albertson et al., 2018; Stamou et al., 2019; Serandour et al., 2023; Taniguchi & Menden-Deuer, 2023; Taniguchi et al., 2023). Consequently, the selective feeding observed in *B. gonionotus* shows optimization of nutritional gain rather than indiscriminate grazing.

The integration of morphology, digestive anatomy, and diet shows the significant trophic plasticity of *B. gonionotus*. Plasticity is increasingly considered one of the principal mechanisms enabling freshwater fishes to persist under anthropogenic environmental change, including habitat modification, hydrological regulation, and altered resource availability (Burress, 2016; Izzo et al., 2016). Rather than showing fixed trophic specialization, *B. gonionotus* appears capable of adjusting dietary composition according to environmental conditions while maintaining relatively stable trophic function. This flexibility explains successful establishment in rivers, reservoirs, floodplains, and aquaculture systems in tropical Asia.

From an ecosystem perspective, the predominance of phytoplanktivory places *B. gonionotus* at a critical position relating primary production with higher trophic levels. Herbivorous fishes mediate carbon transfer from phytoplankton into fish biomass while simultaneously accelerating nutrient recycling through excretion, thereby stimulating primary productivity and strengthening benthic–pelagic coupling (Vanni, 2002; Li et al., 2021). In regulated rivers, where altered hydrology often increases phytoplankton biomass, abundant herbivorous fishes may exert significant top-down control on algal communities and contribute to internal nutrient regeneration. Consequently, trophic role of *B. gonionotus* extends beyond simple resource consumption to include regulation of ecosystem functioning and energy flow.

Trophic evidence indicates that *B. gonionotus* should be regarded as a selective herbivore with considerable functional plasticity. Generalized feeding morphology provides broad trophic potential, elongated intestines facilitate efficient digestion of plant material, and behavioral selectivity allows preferential exploitation of nutritionally profitable phytoplankton. This combination of morphological versatility and dietary specialization represents an adaptive strategy enabling the species to maintain high feeding efficiency under fluctuating environmental conditions characteristic of tropical regulated rivers such as Serayu Movable Weir.

**Conclusions**. Trophic biology of *B. gonionotus* shows that the species is functionally herbivorous with strong phytoplanktivorous specialization. Integrated evidence from feeding morphology, relative intestine length, stomach contents, dietary diversity, index of preponderance, and electivity indicates possession of broad trophic capability. However, the realized niche is dominated by selective consumption of phytoplankton. This trophic strategy enhances energetic efficiency, promotes resilience to environmental variability, and positions *B. gonionotus* as an important mediator of primary production, nutrient recycling, and energy transfer within regulated tropical freshwater ecosystems.

**Acknowledgements**. The authors are grateful to local fishermen and students for their assistance during field sampling and laboratory work. Furthermore, the authors are grateful to the Research and Community Services Institute (LPPM) and the Faculty of Biology for administrative support and facilitating the study permit.

**Authors Contributions**. DNW conceived and designed the study, conducted the data analysis, and led the manuscript writing; NS was responsible for data collection and contributed to data interpretation; NLR was responsible for plankton identification; AN critically reviewed the manuscript for important scientific content, assisted in the literature review, and provided substantial feedback during the manuscript processing. The authors read and approved the final manuscript and agreed to be accountable for all aspects of the work.

**Conflict of Interest**. The authors declare that there is no conflict of interest.

**Data Availability**. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

**Funding**. This research received financial support from Universitas Jenderal Soedirman with the contract number 14.584/UN23.34/PT.01/V/2025.

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Received: 16 August 2026. Accepted: 28 September 2026. Published online: 18 November 2026.
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How to cite this article:
Wibowo, D. A., Setyaningrum, N., Rahayu, N. L., & Nuryanto, A. (2026). Trophic ecology of silver barb (*Barbonymus gonionotus*) in Serayu Movable Weir, Central Java, Indonesia, following the 2022 mass-mortality event. *Aquaculture, Aquarium, Conservation & Legislation, 19*(6), 2741-2756. https://doi.org/10.67784/1022