

# A study on habitat preference of the hill stream loach *Mesonoemacheilus triangularis* (Day, 1873) from a forested stream of Pamba river in southern Kerala

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## ABSTRACT

The physical structure and various environmental features of an aquatic ecosystem determine the diversity, abundance, habitat preference and functional ecological guilds of the ichthyofauna. *Mesonoemacheilus triangularis* is an endemic loach regularly used for the aquarium trade. Hence, knowledge regarding their habitat selectivity is helpful for proper conservation and management. The habitat availability and preference of *M. triangularis* were conducted from January to December 2019 in a stream of the Pamba river in southern Kerala. Water depth, stream width, pH, water temperature, TDS, total hardness, dissolved oxygen, water flow velocity, BOD and COD were determined every month. The visual estimate of substrate composition was made using a sampling quadrat. An underwater camera is employed for observing species interaction in the habitat. *M. triangularis* preferred stream habitats- riffles and pools with pebbles, cobbles, sand and boulder undercut as they provide hiding, feeding and spawning ground. During late post-monsoon and summer, they were seen restricted to pool habitats. Average pH, water temperature (°C) and water flow velocity (m/s) were recorded as  $6.3 \pm 0.38$ ,  $25.77 \pm 1.37$  and  $1.25 \pm 2.13$ , respectively. The maximum length of *M. triangularis* collected from its habitat is 5.6 cm. They showed high predatory behaviour in the stream environment. The nearest neighbour of this benthic guild member is *Garra mullya*. Seasonal and size related shift in habitat use by *M. triangularis* is also recorded.

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## 1. Introduction

The hill streams of the Western Ghats are characterized by diverse flow regimes, varying substrate types, meandering nature, the extent of canopy closure and the availability of mesohabitat (Srivastava and Sarkar, 2000). Fishes need healthy living space for their growth and survival (Engstrom-Ost *et al.*, 2007; MacNeill, 2010; Nunn *et al.*, 2011). Physical structure and various environmental features of an aquatic environment influence habitat selection by the ichthyofaunal community. Habitat selection is a behavioural process that ensures the individual's fitness level (Fretwell and Lucas, 1969). It depends on stream geomorphology, climate, water quality, and extent of predation and competition. Habitat preference studies of fishes are important in water quality management and conservation activities. Various life stages of fish require different physical habitats, spawning habitats, juvenile feeding habitats, and adult habitats, which vary among species (Suman *et al.*, 2021). Hence, understanding the relationship between fish and their habitat helps improve the human community's use and exploitation of fishery resources (Bergmann *et al.*, 2005). The wellbeing of the fish assemblages always depends upon the health of freshwater ecosystems and habitat availability (Johnson *et al.*, 2012).

*Mesonoemacheilus triangularis*, commonly called Zodiac loach, is a fish endemic to the Western Ghats belonging to the order Cypriniformes and the family Nemacheilidae. It is regularly captured for the aquarium trade (Gopalakrishnan and Ponniah, 2000; Anoop *et al.*, 2017). The primary objective of the current study is to understand the habitat availability and preference of the hillstream loach *M. triangularis* in the tributary stream of the Pamba river.

## 2. Materials and Methods

### 2.1 Description of study area

The study area Chorakakki is a hill stream tributary of the Pamba river that belongs to the Ranni forest division. The stream is located at an altitude of 163 mAMSLL with geographical coordinates 9.304 N and 77.054 E in the pristine forests of the Western Ghats. Falls, glides, cascades, pools, riffles, rapids and runs characterize the perennial stream. An intermittent stream confluences with the respected stream in the sampling reach.

### 2.2 Monitoring Strategy

The study site was surveyed to monitor habitat availability and usage by the endemic loach *M. triangularis* from January to December 2019 on a monthly basis. A 100 m length stream stretch was used for the purpose. Target fish specimens were collected by Scoop net and preserved in 10% Formalin for further studies. The preserved specimens were identified with the help of standard manuals of Talwar and Jhingran (1991) and Jayaram (1999). Visual estimation of substrate composition in the habitat patch was made using a sampling quadrat adapted from Simonsen (1993). The modified Wentworth scale (Bain *et al.*, 1985) was used for classifying substrate categories along the stream reach. The stream habitat inventory method described by Armantrout (1998) was followed for measuring habitat parameters. Water temperature, pH, Total Dissolved Solids (TDS), Conductivity, Total hardness, Dissolved Oxygen (DO) and water flow velocity were analyzed at the sampling point. Stream depth and width were measured using a graduated wading rod and measuring tape, correspondingly. A pygmy current meter was employed for recording water flow velocity. Pen type pH meter was used for analyzing water

p<sup>H</sup>. Methods of APHA (2005) were followed for estimating Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), DO and Total hardness. A spherical densiometer was utilized for estimating riparian shade across the stream reach.

### 3. Results and Discussion

#### 3.1 Habitat availability and environmental variables

The present study examined seven habitat variables (Table 1) and nine physicochemical properties of the stream water (Table 2).

The habitat availability in the stream consists of different mesohabitat and substrate types. The maximum width of the hill stream was 8.27 m recorded during June. The highest noted water column depth was 1.2 m. Deep pool, boulder edge, overhanging, aquatic macrophytes, leaf litter deposits and woody debris were the major instream cover across the stream channel. The right and left banks of the respected stream were protected by riparian vegetation of shrubs and trees that allow only minor erosion. This minor erosion of the bank was usually associated with monsoon and post-monsoon. The studied stream reach usually had an open canopy with coverage of 39.7±9.9%, elevating stream temperature, especially during the summer. The upmost water temperature marked was 28.6°C in May. The p<sup>H</sup> of the stream starts to decrease at the onset of summer, making it more acidic. Almost neutral p<sup>H</sup> (7.1) is observed in October. Low TDS, total hardness and conductivity were seen in the monsoon periods.

The water turns stagnant throughout summer, and pools are the only available mesohabitat along the stream reach. The maximum water flow velocity recorded was 7.27 m/s. The highest total hardness of 21 mg/l and minimum of 5.6 mg/l were noted in March and August, respectively. BOD

of the water plays an important role in the productivity of aquatic ecosystems. As the stream is a high altitude stream, negligible BOD and COD concentrations are seen. Maximum BOD and COD were only about 1.2 mg/l and 5 mg/l, respectively.

#### 3.2 Habitat preference of the hill stream endemic loach *Mesonoemacheilus triangularis*

The *M. triangularis* was observed in the upper and middle parts of the investigated stream reach. They tended to be frequent in mesohabitat structures of pools and riffles. The pool had the highest abundance among the habitat types, followed by riffle. The flow velocities across the riffles were 0.06 – 0.35 m/s. The fish community was strongly associated with a 12.5 – 81 cm channel depth with instream cover of boulder edge, overhanging, aquatic macrophytes and leaf litter deposits (Fig. 1). Substrate types can be important for fish spawning and feeding behaviour, and influences fish distribution (Quist *et al.*, 2005; Tabatabaei *et al.*, 2015). Hatchlings use crevices of rocks and cobbles as a cover for escaping from the turbulent stream water. A study conducted by Ruby and Raju (2021) in the same stream reach found that the highly structured substrates provide shelter to the aquatic insects, and the substrate composition in the entire stream ecosystem is 42% of bedrock, followed by large and small boulders (35%), cobble (13%), gravel (6%) and sand and silt (4%). However, the substrate composition in the preferred habitat of *M. triangularis* was of boulder, cobble, pebble and sand. The number of *Mesonoemacheilus* individuals associated with the pebble substrate was higher, when compared to those associated with sand and cobble (Fig. 2). The fish is always associated with the rocky substrata and, therefore, forms an important member of the stream benthic guild along with *Garra mullya*. The water temperature ranged between 24.1°C and

**Table 1.** Habitat availability and preference of the hillstream loach *Mesonoemacheilus triangularis* inhabiting Chorakakki, the forested stream of the Pamba river in Kerala

Habitat Variable	Habitat Availability	Habitat Preference
Habitat Types	Falls, Rapids, Cascades, Riffles, Pools, Glides and Run	Riffle and Pool
Stream Width	8.27 m (Maximum)	6 m
Stream Depth	1.2 m (Maximum)	12.5 cm – 81 cm
Substrate Types	Bed rock, Boulder, Cobble, Pebble, Gravel, Sand and Silt	Boulder, Cobble, Pebble and Sand
Instream Cover	Deep pool, Boulder edge, Overhangings, Aquatic macrophytes and Leaf litter	Deep pool, Boulder undercut, Aquatic macrophytes, Leaf litter
Bank Stability	Good	Good
Riparian Shade	Less than 40%	Mostly in well-lit area with less canopy closure

**Table 2.** Physico-chemical properties of the Chorakakki, the forested hillstream of the Pamba river in Kerala (Minimum, Maximum, Mean and Standard deviation of variables)

Physico-chemical Parameters	Min	Max	Mean	SD
pH	5.9	7.1	6.3	0.38
Water Temperature (°C)	24.1	28.6	25.77	1.37
TDS (ppm)	9	21	13.25	3.83
Conductivity (µS/cm)	13.38	31.23	19.71	5.69
Total Hardness (mg/l)	5.6	21	10.45	3.6
DO (mg/l)	7	9.2	7.8	0.49
Water flow velocity (m/s)	0	7.27	1.25	2.13
BOD (mg/l)	0.2	1.2	6.71	0.29
COD (mg/l)	0.4	5	2.13	1.24



**Fig. 1.** Instream habitat of *Mesonoemacheilus triangularis* at Chorakakki, a forested hill stream of the Pamba river in Kerala

28.6°C, and the pH from 5.9 – 7.1. The dissolved oxygen (DO) was very high, recorded between 7 to 9.2 mg/l.

The fish *M. triangularis* differed in habitat selection based on season and their life stage. Juveniles were associated with sandy and pebble substrate near to the right bank with the lowest depth (12 cm – 28.2 cm). Adult fish occurred mostly at pools with larger depths (30 cm – 81 cm) (Fig. 3). Similar size related habitat uses by fishes were reported by Schiemer *et al.*, (1991) and Jurajda *et al.*, (2002). Juveniles are always observed a few distances away from their shelter compared to adults. Adult *M. triangularis* was noted about 50 cm to 2 m away from their prescribed shelter- a large boulder undercut for their various biological activities. They always prefer well-lit areas in the stream reach for resting. Habitat heterogeneity is found to be reduced during the late post-monsoon and summer seasons. Hence in these seasons, all the fishes are confined to the pools.

The healthy stream Chorakakki contained rich benthic fauna and submerged aquatic plants like *Podostemum ceratophyllum* and *Fissidens adianthoides*. The submerged and emergent plants act as a nursery for growing *Mesonoemacheilus* individuals and provide oxygen as a byproduct of photosynthesis. It also ensures the availability of different food resources to the fish inhabitants. *M.*

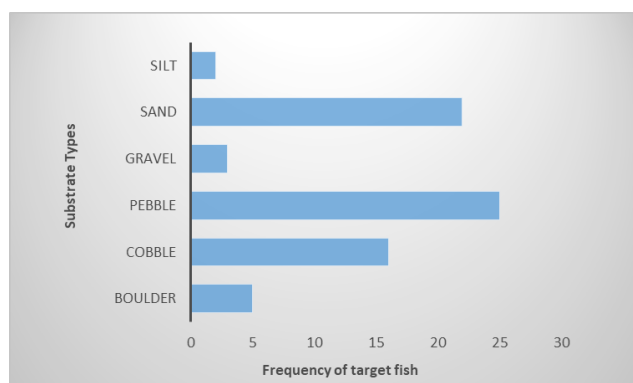
*triangularis* is highly predatory in nature in the aquatic environment. The maximum standard length of the fish collected from its habitat is 5.6 cm. The stream provides a good habitat choice for the growth and survival of the endemic ornamental fish *M. triangularis*.

**4. Conclusion**

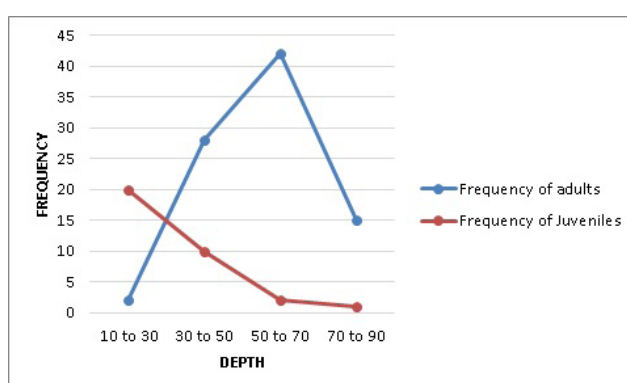
Habitat heterogeneity across spatial scales is positively related to species richness and trophic ecology structuring of the fishes. The current study reveals that the availability of suitable mesohabitat (riffles and pools) with the proper substrate, leaf litter deposition in the bottom, food resources and optimum physico-chemical parameters supports the *M. triangularis* population along the stream. In order to maintain the healthy habitat characteristics as such, continuous monitoring of the stream environment is essential.

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**Fig. 2.** Association of *Mesonoemacheilus triangularis* individuals with substrate categories



**Fig. 3.** Variation in depth preference by adult and juveniles of *Mesonoemacheilus triangularis*

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