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Aquatic Floral Abundance on Ichthyofaunal Community in a Forested Stream of Pamba River in the Western Ghats

Ruby Thomas, Raju Thomas K.

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ABSTRACT

Aquatic macrophytes are essential to the fish community because they offer food, protection from predators and shelter. The present study deals with the influence of the distribution and abundance of aquatic macrophytes on stream fishes. Twenty-one species of aquatic plants and 13 associated fish species were identified during the study period of January-December 2019. In the study stream, the abundance of aquatic flora positively impacted the fish community. Certain aquatic macrophytes were highly preferred by individual fish species in the area. The Podostemonads formed a major plant group along the stream. Emergent plants, especially *Lagenandra toxicaria* played an important role in maintaining the composition of the fish community. *Hypselobarbus kurali* is a known genus of food fish, and they exhibited affinity to the area covered with *Lagenandra toxicaria*. *Hydrilla verticillata*, the submerzed plant showed extensive growth during monsoon and supported a large number of *Haludaria fasciata*.

Ruby Thomas[1]*, Dr Raju Thomas K.[2]
[2]Assistant Professor
[1,2]Department of Zoology, Mar Thoma College, Tiruvalla 689103, Kerala, India
Email : rubythomas92@gmail.com
*Corresponding author

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INTRODUCTION

The Western Ghats is recognized both nationally and internationally for their ecological and cultural values. This important biogeographic zone of our nation is known for its characteristic perennial water towers and helps in maintaining various climatic factors. Most of the headwater stream systems are situated in these pristine forests. They support various life forms ranging from the plankton community to large mammals. Bryophytes (mosses, hornworts and liverworts) can be found in a variety of, often harsh, habitats; and are the most common plants in pristine erosive streams, together with the Podostemonads in the tropics (Crooks 2021). Aquatic plants play an important role in determining the species composition, abundance, and size of fishes. Upon decay, they supply organic detritus for the aquatic food web and have typically been thought to represent the foundation of aquatic food webs (Kurbatova *et al.* 2014, Prast *et al.* 2014, Ramirez and Fonseca 2014). The amount, biomass and species diversity of higher aquatic plants were evaluated in aquatic habitats (especially in microcosms), and the results showed significant effects on the fish community (Nohner *et al.* 2018, Cunha *et al.* 2019, Carniatto *et al.* 2020, Kurbatova and Yershov 2020, Thomaz 2021, Aleixo *et al.* 2022). Jinqing *et al*. (2013) analyzed the relationship between environmental factors, aquatic vegetation and fish assemblages.

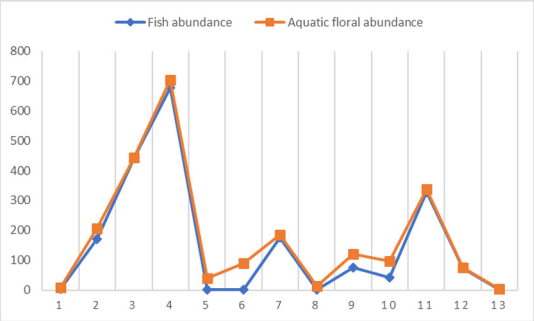

Fig. 1. Effect of aquatic floral abundance on ichthyofauna in the forested stream of Pamba river.

This paper describes the influence of aquatic vegetation abundance on ichthyofaunal diversity. The main objective is to determine the diversity, distribution and functional uses of aquatic plants to the fish community in a forested stream of Pamba river.

MATERIALS AND METHODS

The study focuses on the forested stream Nilackal Kaduvappara Thodu, a tributary of the holy river Pamba in the Western Ghats. The stream is located at an altitude of 225 m AMSL and flows through the Ranni Forest Division. Sampling was conducted along 100m of stream stretch. The collections were made from January to December 2019 on a monthly basis. A frame quadrat having a sampling area of 60 cm^2 was used for the diversity assessment of aquatic flora. Observations were done by simply wading through the stream. Photographs of submerged plants were taken using an underwater camera. Samples of emergent plants and algae were collected and their morphological features were analyzed for identification. The identification of aquatic plants was carried out with the help of Cook and Rutishauser (2001), and Gamble (2008). The abundance is usually measured by counting the plant species in the sampling quadrate. The plant species counted more than 20 are categorized as abundant (A), 11-20 as moderately abundant (MA), 6-10 as less abundant (LA), and 1-5 as rare (R). The interactions of fishes with the aquatic plants were observed. The fish were collected using a cast net and scoop net based on the water column depth. After thorough washing, the specimens were preserved in 10% formalin. The fishes were identified using the standard keys of Talwar and Jhingran (1991), Jayaram (1999), and Eschmeyer *et al.* (2019). The fish abundance is also noted while the sampling process. The graphical representation is made using MS Excel.

RESULTS AND DISCUSSION

A total of 21 species of aquatic plants belonging to 21 genera and 11 families were observed during the study. These include members belonging to algal, fern, and angiosperm communities (Table 1). *Spirogyra* species was the only green algae found along the forested stream during summer. Four families represented the ferns community- Fissidentaceae, Marattiaceae, Pallaviciniaceae, and Polypodiaceae. Plant families such as Araceae, Cyperaceae, Hydrocharitaceae, Podostomaceae, Scrophulariaceae, and Onagraceae formed the angiosperm representatives along the stream stretch. *Hydrilla verticillata* was the only member belonging to Hydrocharitaceae, which showed extensive growth during monsoon. *Fissidens adianthoides* and *Microsorum pteropus* preferred both submerged and emergent conditions. *Spirogyra* species, *Hydrilla verticillata*, and the common Podostemonads constituted the submergent vegetation. The river weed family (Podostomaceae) was composed of eight species namely *Castelnavia princeps*, *Cladopus hookeriana*, *Dalzellia ceylanica, Farmeria metzgerioides, Indotristicha trifaria, Podostemum ceratophyllum, Polypleurum stylosum,* and *Zeylanidium lichenoides.* They are strictly aquatic angiosperms that grow in fast-flowing streams. *Actinoscirpus grossus*, *Cyperus rotundus* and *Hypolytrum nemorum* were the most common and abundant species during the post-monsoon period. *Angiopteris evecta* was observed within the stream channel. It formed a rare member in the area. *Lagenandra toxicaria* is a perennial plant, often abundant along the stream stretch. Among the aquatic angiosperms, *Lagenandra toxicaria, Torenia bicolor*, and *Cladopus hookeriana* were endemic to the Western Ghats. *Ludwigia octovalvis* is a member of the Onagraceae family, which possesses air sacs for floating. Bunch *et al.* (2015) reported that macrophyte environments can shift from dynamic, species-rich communities to dense, monotypic communities, which can alter the physico-chemical environment in which fish can live.

Table 1. Abundance and diversity of aquatic vegetation observed in the stream stretch A- Abundant, LA-Less Abundant, MA-Moderately Abundant, R-Rare.

Category	Scientific name	Abundance
Algae		
Family: Zygnemataceae	*Spirogyra* Link,1820	LA
Ferns and other allies		
Family: Fissidentaceae		
	Fissidens adianthoides Hedw.,1801	AB
Family: Marrattiaceae	*Angiopteris evecta* (J.R. Forst) Hoffm.,1796	LA
Family: Pallaviciniaceae	*Pallavicinia lyelli* (Hook) Gray,1821	AB
Family: Polypodiaceae	*Microsorum pteropus* (Bl.) Copel,1929	AB
Flowering plants		
Family: Araceae	*Lagenandra toxicaria* Dalz,1852	AB
Family: Cyperaceae	*Actinoscirpus grossus* (L.f.) Goetgh and D.A.Simpson,1991	MA
	Cyperus rotundus L.,1839	MA
	Hypolytrum nemorum (Vahl) Spreng, 1825	AB
Family: Hydrocharitaceae	*Hydrilla verticillata* (L.f.) Royle, 1960	AB
Family: Podostomaceae	*Castelnavia princeps* Tul. and Wedd, 1849	LA
	Cladopus hookeriana (Tul.) C. Cusset, 1973	R
	Dalzellia ceylanica (Gard.) Wight, 1995	LA
	Farmeria metzgerioides (Trim.) Willis, 1902	MA
	Indotristicha trifaria Spreng, 1970	MA
	Podostemum ceratophyllum Michx, 1803	LA
	Polypleurum stylosum (Wight) Hall, 1971	LA
	Zeylanidium lichenoides (Kurz) Engl., 1930	MA
Family: Scrophulariaceae	*Lindernia rotundifolia* (L.) Alston, 1931	LA
	Torenia bicolor Dalz, 1851	MA
Family: Onagraceae	*Ludwigia octovalvis* (Jacq.) P.H. Raven, 1962	MA

The abundance of aquatic flora showed a positive impact on the fish community in the study stream (Fig 1). Looby *et al.* (2021) reported that the composition of fish community changes with an increase in submerged aquatic vegetation patch size, and differences in abundance with aquatic vegetation is varied by fish species. Thirteen species of fish collected from the study site (Table 2) showed a preference for aquatic macrophytes; as they provide shelter, food, and coverage from predators. The cover of *Hydrilla verticillata* was widely used by *Haludaria fasciata*, during monsoon season. The branched *Hydrilla* protected the prey fishes from predators, and the extensive cover was observed to control the current velocity of the stream stretch during monsoon season. They also provided shelter for juvenile fishes in the stream column. Evangelista *et al.* (2014) described *H. verticillata* as the second most studied invasive aquatic macrophyte after *Myriophyllum spicatum*. Increased *H. verticillata* increased juvenile populations and year-class strength (Allen *et al.* 2003, Nagid *et al.* 2015) and reduced *H. verticillata* decreased recruitment, fishing effort, and catch of trophy-sized fish (Johnson *et al*. 2014). Others, however, showed that *H. verticillata* had no effect on the fish community measures (Hoyer *et al*. 2008). Emergent plants such as *Lagenandra toxicaria* and *Angiopteris evecta* provided a habitat for the *Hypselobarbus genus*. *Haludaria fasciata* also used these aquatic plant beds as cover. The stems, leaves, and twigs constituted structurally complex habitats for the *Haludaria* fingerlings. Most of the Podostemonads formed foundation species in the aquatic system, as they provided a habitat for macroinvertebrates. *Garra mullya* scraped on the algal matter on the submerged rocks. Hence, in the study site, *Garra mullya* showed a high affinity to

Table 2. List of fish species associated with aquatic plant bed.

Sl. No.	Species	Food	Ornamental	Larvicidal
	Belonidae			
1	*Xenentodon cancila* Hamilton 1822	+	+	-
	Cyprinidae			
2	*Dawkinsia filamentosa* Valenciennes 1844	+	+	-
3	*Garra mullya* Hamilton 1822	-	+	-
4	*Haludaria fasciata* Jerdon 1849	-	+	-
5	*Hypselobarbus curmuca* Hamilton 1822	+	+	-
6	*Hypselobarbus kurali* Menon and Rema Devi 1995	+	+	-
	Danionidae			
7	*Barilius bakeri* Day 1865	+	+	-
8	*Barilius gatensis* Valenciennes 1844	+	+	-
9	*Devario aequipinnatus* McClelland 1839	+	+	+
10	*Devario malabaricus* Jerdon 1849	+	+	+
11	*Rasbora daniconius* Valenciennes 1844	+	+	+
	Nemacheilidae			
12	*Mesonemacheilus triangularis* Day 1865	-	+	-
13	*Mesonemacheilus guentheri* Day 1867	-	+	-

habitat with rubble substrate. Macrophyte diversity was important for the preferred food items of the fish, with stomach contents shifting from higher plants, algae, and detritus to insects with increasing macrophyte (Quirino *et al.* 2022). *Microsorum pteropus* and *Fissidens adianthoides* provided hiding place for indigenous ornamental fish *Mesonemacheilus triangularis* in the stream channel. Xu *et al.* (2016) revealed that the decrease in macrophyte cover will result in a decrease in the area of active and juvenile fish living areas for sinking mucilaginous egg-producing fishes. Stahr and Kaemingk (2017) reported the existence of variation in the macrophyte stretch use among fish species.

Among the listed fishes, *Hypselobarbus curmuca* and *H. kurali* have formed commercially important food fishes. *Rasbora daniconius*, *Devario aequipinnatus*, and *D. malabaricus* showed larvicidal activity. All the collected fishes were found to be used as indigenous ornamental fishes.

The present study discloses that the aquatic plant beds in the stream stretch provide spawning and nesting sites to the resident fishes. Hence the plant community determines the distribution, composition, and abundance of fish in the aquatic environment. They also supply organic matter, thereby regulating water chemistry.

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