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A comparative study on Ichthyofaunal diversity of two pristine streams of Achenkovil River in Southern Kerala with open and closed canopy

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Abstract

The ichthyofaunal diversity of two streams of the Achenkovil River with open and closed canopy were studied. Thirteen species were recorded from stream with open canopy and nine from closed canopy stream. The preferential levels of light, water temperature and availability of both illuminated and shady areas across the stream supported high species richness. Canopy closure plays a major role in regulating the species richness, water temperature and light intensity of the stream ecosystem.

Keywords: Canopy Closure, Ichthyofaunal Diversity, Light Intensity, Water Temperature, Streams

Introduction

Streams play a major role in the biogeochemical cycle and are an integral part of biodiversity. The freshwater stream form a complex ecosystem, based on balanced interactions between biological, physical and chemical processes. Species distribution in a natural stream depends on the multidimensional set of environmental characteristics. Distribution of species depends on environmental factors such as velocity, depth, temperature and availability of food and space. Animals such as fishes, insects, amphibians, molluscs, birds and mammals use the stream for their complete lifecycle or certain events in the lifecycle (Gebrekiros, 2016).

Distributions of stream fishes are determined by their ability to withstand unfavourable conditions and their interaction patterns (Schlosser, 1982). Various types of disturbances play a major role in structuring the macro benthos. As the range of habitat diversity increases, that stream will be able to support more species. Fishes are not only used for protein or ornamental purpose but also a strong indicator of the health of an aquatic ecosystem (Gebrekiros, 2016). A study on fish-habitat relationship is essential for the management and conservation of fishes.

Canopy closure is an important habitat feature, that influence many ecological processes of the stream and provides shade and protection to stream inhabitants. The study on fish diversity in relation to physical and chemical parameters are widely conducted in India (Patra *et al.*, 2011; Murugan & Chandrasekharan, 2012; Sanalkumar *et al.*, 2013; Shetty *et al.*, 2015; Samal *et al.*, 2016). Studies on the relationship between fish diversity and canopy closure have been conducted in the Amazon regions. Montag *et al.* (2018) conducted a study on 71 streams of eastern Amazon. Bojsen & Barriga (2002) carried out a study on 12 streams of Ecuadorian Amazon. Mendonca *et al.* (2005) conducted study on streams of Manaus and Cervia *et al.,* (2005) conducted study on Solimoes River, both are rivers of Amazonas State in Brazil. Arantes *et al.,* (2017) also conducted studies on streams of Amazon River in Varsea, Para State of Brazil. The present study aims to understand the influence of canopy closure on diversity of fishes of two streams of Achenkovil River.

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Material and Methods

Study Area

Two pristine streams of the Achenkovil River were studied from January-December 2019. One stream contains open canopy and the other has closed canopy. Both streams are flowing through the Konni forest division of Achenkovil Reserve Forest, part of the Western Ghats (Figure 1). The reach length of 100 m is selected for the study purpose.

Stream-I Mannarappara Todu (Open Canopy Stream)

Small streams from forest regions Vellamthetti, Kumaramkodi and Cheengakuzhy join to form Mannarappara todu which finally merges with left bank of the Achenkovil River. Study site located between $9^0$14'23.3"N and $76^0$97'57.6"E.

Stream- II Naduvathumoozhi Todu (Closed Canopy Stream)

Naduvathumoozhi todu is fed by several streams originating from the Naduvathumoozhi forest region. One major tributary of the respective stream is Penanga todu. The stream finally joins with the right bank of Achenkovil River. Study site located between $9^0$14'25.1"N and $76^0$97'52.8"E.

Fish Collection, Preservation and Identification

Fishes were collected using cast, scoop and aquarium nets on monthly basis, from January to December 2019. Uniform casting was done in both streams. The collected fish were preserved in 10% formalin and identified using standard fish identification keys of Talwar and Jhingran (1991) and Jayaram (1999) and online database on fish species- The FishBase (www.fishbase.de/summary/13639). Canopy closure, light intensity and water temperature were measured using Spherical densiometer, Light meter, and Digital thermometer respectively.

Results and Discussion

During the present study, stream with low canopy closure, Mannarappara todu showed high species richness than the closed canopy stream, Naduvathumoozhi todu. A total of 16 species belonging to 6 orders and 8 families were collected from the studied streams (Table 1). Species such as *Dawkinsia filamentosa* (Valenciennes, 1844), *Barilius gatensis* (Valenciennes, 1844), *Danio malabaricus* (Jerdon, 1849), *Hypselobarbus curmuca* (Hamilton, 1807), *Salmostoma boopis* (Day, 1874), *Pseudetroplus maculatus*

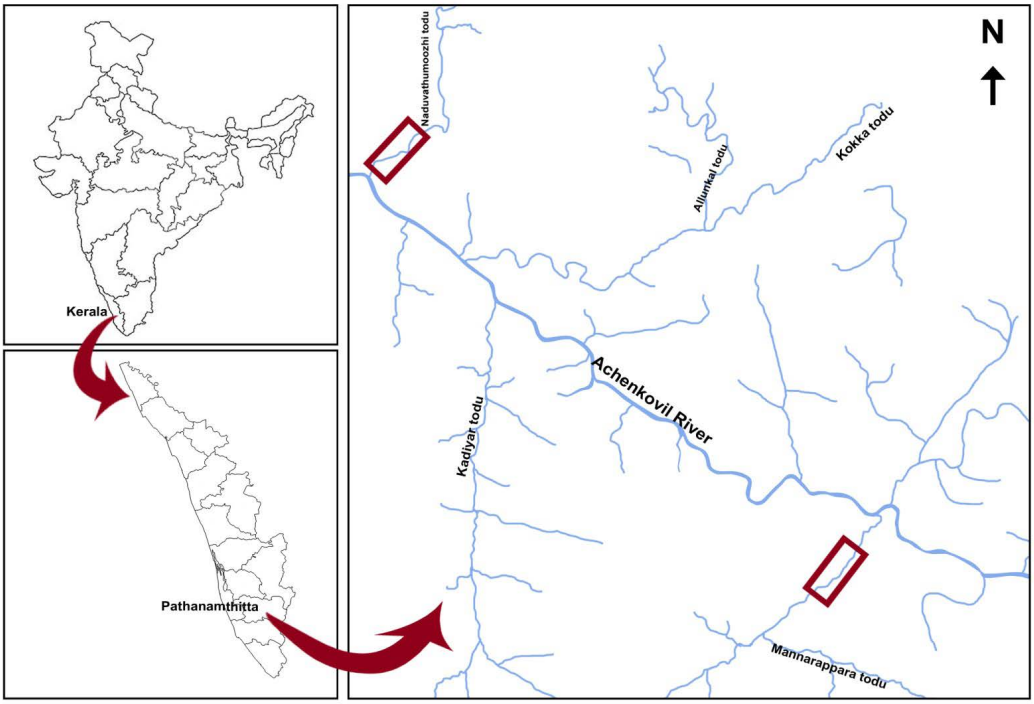


Figure 1. Map of a stretch of Achenkovil river showing the collection sites.

(Bloch, 1795) and *Xenentodon cancila* (Hamilton, 1822) were observed only in the open canopy stream, Mannarappara todu and *Lepidocephalichthys thermalis* (Valenciennes, 1846), *Macrognathus guentheri* (Day, 1865) and *Horabagrus brachysoma* (Gunther, 1864) were found only in the Naduvathumoozhi todu with closed canopy closure.

Haludaria fasciata (Jerdon, 1849), *Barilius bakeri* (Day, 1865), *Garra mullya* (Sykes, 1839), *Rasbora daniconius* (Hamilton, 1822), *Mesonoemacheilus triangularis* (Day, 1865) and *Aplocheilus lineatus*

Table 1. Fish diversity status of Mannarappara todu (open canopy stream) and Naduvathumoozhi todu (Closed canopy stream)

Order	**Family**	**Species**	**Mannarappara thodu (Open canopy stream)**	**Naduvathu-moozhi thodu (Closed canopy stream)**	**IUCN status [Sanalku-mar *et al.*, 2013]**
Cypriniformes	Cyprinidae	*Dawkinsia filamentosa* (Valen-ciennes, 1844)	+	-	LRlc
		Haludaria fasciata (Jerdon, 1849)	+	+	LRnt
		Barilius bakeri (Day, 1865)	+	+	LRnt EWG
		Barilius gatensis (Valenciennes, 1844)	+	-	LRlc EWG
		Danio malabaricus (Jerdon, 1849)	+	-	LRlc
		Garra mullya (Sykes, 1839)	+	+	LRlc
		Hypselobarbus curmuca (Ham-ilton, 1807)	+	-	EN EWG
		Rasbora daniconius (Hamil-ton, 1822)	+	+	LRnt
		Salmostoma boopis (Day, 1874)	+	-	LRlc
	Nemacheilidae	*Mesonoemacheilus triangularis* (Day,1865)	+	+	LRnt EWG
	Cobitidae	*Lepidocephalichthys thermalis* (Valenciennes, 1846)	-	+	LRlc
Synbranchiformes	Mastacembelidae	*Macrognathus guentheri* (Day, 1865)	-	+	LRlc EWG
Siluriformes	Horabagridae	*Horabagrus brachysoma* (Gun-ther,1864)	-	+	EN EK
Perciformes	Cichilidae	*Pseudetroplus maculatus* (Bloch, 1795)	+	-	LRlc
Beloniformes	Belonidae	*Xenentodon cancila* (Hamilton, 1822)	+	-	LRlc
Cyprinodon-tiformes	Apocheilidae	*Aplocheilus lineatus* (Valenci-ennes, 1846).	+	+	LRlc

[**EWG**- Endemic to the Western Ghats, **EK**- Endemic to Kerala, **EN**- Endangered, **LRnt**- Low risk nearly threatened, **LRlc**- Low risk least concern]

Table 2. Canopy closure, Light intensity and Water temperatures of Stream-I [Mannarappara todu (Open canopy stream)] and Stream-II [Naduvathumoozhi todu (Closed canopy stream)]

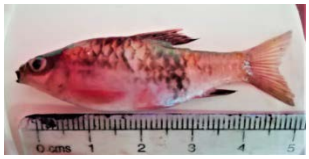
Parameters	Canopy closure (%)		Light intensity (lux)		Water temperature(0C)	
	Stream-I	Stream-II	Stream-I	Stream-II	Stream-I	Stream-II
January	16.63	64.09	19800	12900	27.1	28.6
February	12.31	67.14	16930	11300	28	28.3
March	14.71	74.55	18270	13690	29.3	29.4
April	14.3	73.97	12760	9870	29	29
May	14.25	81.12	18490	13440	29.9	28.8
June	12.34	69.36	18040	15250	27.7	27.3
July	13.58	84.24	18120	10190	26.7	26.5
August	14.56	87.62	18300	9160	26.3	26.2
September	12.15	79.77	9390	7030	26	24.7
October	10.79	84.95	10480	6630	26.3	26.4
November	10.91	83.12	20570	12180	26.4	26.3
December	12.99	74.94	15360	10160	26.1	25.5
Average	**13.29**	**77.07**	**16376**	**10983**	**27.4**	**27.2**

(Valenciennes, 1846) species were found in both streams. In the present study, Cyprinidae with nine species, formed the dominant family. The family represent 56% of the total fish species collected from the study area. The remaining seven families contributed only one species each. Amongst recorded fish species ten species are ornamental (*Haludaria fasciata* (Jerdon, 1849), *Barilius bakeri* (Day, 1865), *Barilius gatensis* (Valenciennes, 1844), *Danio malabaricus* (Jerdon, 1849), *Garra mullya* (Sykes, 1839), *Rasbora daniconius* (Hamilton, 1822), *Salmostoma boopis* (Day, 1874), *Mesonoemacheilus triangularis* (Day, 1865), *Lepidocephalichthys thermalis* (Valenciennes, 1846) and *Aplocheilus lineatus* (Valenciennes, 1846)) and, five are edible (*Hypselobarbus curmuca* (Hamilton, 1807), *Macrognathus guentheri* (Day, 1865), *Horabagrus brachysoma* (Gunther, 1864), *Pseudetroplus maculates* (Bloch, 1795) and *Xenentodon cancila* (Hamilton, 1822).

The average canopy closure in the open canopy stream was 13.29 % and 77.07% in closed canopy stream. The light intensity varied from 9390 lux to 20570 lux in the stream with open canopy while 6630 lux to15250 lux in the closed canopy stream. Water temperature during the study period ranged from 26^{0}C to 29.9^{0}C at open canopy stream and 24.7^{0}C to 29.4^{0}C at closed canopy stream (Table 2). The light penetration, canopy closure and water temperature showed relation. The higher the canopy closure, lower light penetration and water temperature in the stream. The distribution of stream biota is proportional to the light intensity received in the stream. All major events in its life depend on light. *Lepidocephalichthys thermalis* (Valenciennes, 1846), showed preference to closed canopy stream with low light penetration and water temperature. Similarly, *Macrognathus guentheri* (Day, 1865), a species that prefers low water temperature 22^{0}C-25^{0}C (www.aqualog.com, 2020) is found only in low temperature stream, Naduvathumoozhi todu. In the present study, the catfish *Horabagrus brachysoma* (Gunther, 1864) was collected only from Naduvathumoozhi todu with high leaf litter deposition. Ilha *et al.* (2019) also found that catfishes relay submerged leaves as shelter and foraging; and leaf deposition in the stream strongly influences the catfish community structure in Upper Xingu River, South-eastern Amazonia, Brazil.

In Mannarappara todu, an open canopy stream has extremely low leaf deposition and the stream is clear. *Barilius gatensis* (Valenciennes, 1844), *Danio malabaricus*

Plate **Fishes collected from the study streams**

 *Dawkinsia filamentosa* (Valenciennes, 1844)	 *Haludaria fasciata* (Jerdon, 1849)	 *Barilius bakeri* (Day, 1865)	 *Barilius gatensis* (Valenciennes, 1844)
 *Danio malabaricus* (Jerdon, 1849)	 *Garra mullya* (Sykes, 1839)	 *Hypselobarbus curmuca* (Hamilton, 1807)	 *Rasbora daniconius* (Hamilton, 1822)
 *Salmostoma boopis* (Day, 1874)	 *Mesonoemacheilus triangularis* (Day,1865)	 *Lepidocephalichthys thermalis* (Valenciennes, 1846)	 *Macrognathus guentheri* (Day, 1865)
 *Horabagrus brachysoma* (Gunther,1864)	 *Pseudetroplus maculatus* (Bloch, 1795)	 *Xenentodon cancila* (Hamilton, 1822)	 *Aplocheilus lineatus* (Valenciennes, 1846).

(Jerdon, 1849) and *Pseudetroplus maculates* (Bloch, 1795) were seen more often on this clear sand bottom. *Dawkinsia filamentosa* (Valenciennes, 1844), *Hypselobarbus curmuca* (Hamilton, 1807), *Salmostoma boopis* (Day, 1874) and *Xenentodon cancila* (Hamilton, 1822) are fishes which preferred illuminated areas in the stream. So, it is seen in the open canopy. *Haludaria fascia* (Jerdon, 1849), *Barilius bakeri* (Day, 1865), *Rasbora daniconius* (Hamilton, 1822) and *Aplocheilus lineatus* (Valenciennes, 1846) are found in both streams as they are more tolerant of light and water temperature. The fishes *Garra mullya* (Sykes, 1839) and *Mesonoemacheilus triangularis* (Day, 1865) prefer shaded areas with the rocky substratum. The coexistence of these two species is rarely observed in Mannarappara todu, due to its open nature.

Canopy closure is an important factor in the stream as it provides shade and allochthonous materials. The light intensity was observed in both streams in proportion to the canopy closure, a slightly higher water temperature can be recorded in a stream with an open canopy. Shade loving fish species always prefer stream sections with closed canopy. Leaf deposition in the closed canopy stream strongly influences the catfish community structure. The amount of light received in the stream is as important as the shade. Species that prefer light availability and high temperature always choose stream sections with open canopy. According to the present study, both canopy closure and light intensity are factors required for species richness. More fish species were found in the stream with the required shade, light and water temperature.

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