www.envsciarch.com

ENVIRONMENTAL SCIENCE ARCHIVES
ISSN: 2583-5092
Volume IV Issue 2, 2025

RESEARCH PAPER OPEN ACCESS

Diversity of Riparian Vegetation in Pattathipara and Poovanchira Streams of Peechi-Vazhani Wildlife Sanctuary, Kerala

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Received: 2025/08/28
Accepted: 2025/09/21
Published: 2025/09/23

Abstract
Riparian vegetation is found in the margins of streams, rivers and lakes, which significantly contributes to the health of the waterbodies. The current study aims to analyse the riparian vegetation of the Pattathipara and Poovanchira streams in Kerala, which are part of the Peechi-Vazhani Wildlife Sanctuary. The Pattathipara quadrat study included 37 plant species from 28 families, whereas the Poovanchira quadrat survey included 34 plants from 25 families. Euphorbiaceae had the most species (4 spp.) in the Pattathipara region, while Malvaceae, Fabaceae, Rutaceae, and Lamiaceae each had three spp. in the Poovanchira region. The present study examined the relative density, relative frequency, relative basal area, tree importance value indexes and Shannon Weiner Diversity Index (H') in the Pattathipara and Poovanchira regions. Relative frequency, density, and abundance indicated that both area is relatively dominated by deciduous trees. The IVI profile indicated the dominance of *Terminalia elliptica* in Pattathipara and *Wrightia tinctoria* in Poovanchira, which are dry deciduous forest trees.

Keywords: Relative density; Relative frequency; Relative basal area; Importance Value Indexes; Shannon Weiner Diversity Indexes; Riparian

Introduction

Riparian zones are the transition points between terrestrial and aquatic ecosystems. Ecotones are defined as severe gradients in environmental conditions, ecological processes, and plant populations. (Gregory. 1991). Riparian zone vegetation is influenced by regional climate, species diversity, hydrology, geomorphology, and disturbance patterns. (Cooper et al., 2003; Decamps et al., 1995; Naiman et al., 1993; Shafroth et al., 2002.)

Riparian ecosystems exist adjacent to streams, rivers, lakes, and wetlands and have a direct impact on aquatic and wildlife habitat. It is also known as gallery forests or streamside forests (Brinson, 1990). Ecological restrictions filter out species that can establish and persist, leading to unique plant assemblages that differ from nearby terrestrial vegetation (Ellenberg, 1988). Plant distribution in riparian corridors is primarily determined by fluvial and hydrological processes within certain biogeographical zones (Hupp and Osterkamp, 1996; Stromberg et al., 1996). There are certain common components that are unique to riparian ecosystems. Certain plants have evolved to grow, blossom, fruit, disperse seeds, and finish their life cycle close to rivers. While the root system stabilises the bank and filters lateral sediments and nutrient inputs, the riparian canopy controls stream sediment and nutrient dynamics by providing organic matter through litter fall and regulating stream temperature through shadowing.

Materials and methods

The research approach involves a taxonomic/vegetational survey of Poovanchira and Pattathipara streams of Thrissur district and their associated waterfall. The taxonomic survey and qualitative and quantitative ecological assessment are being performed simultaneously to prepare a database. The identification of plant components with standard floras of the region and photographic

documentation are the qualitative analysis and phytosociological method (quadrat method) for quantitative ecological assessment.

Study area

Poovanchira stream is a tributary of the Manali River that flows through the small village of Poovanchira in Ollukkara Block, Thrissur District, Kerala, India. The stream originates in the highlands of the Peechi-Vazhani Wildlife Sanctuary. The vegetation along the riverine forest is predominantly evergreen and deciduous in nature. Furthermore, the surrounding area was dominated by an agricultural environment including rubber and mixed plants. Pattathipara stream is a tributary of the Manali river found in Pananchery village, Ollukkara Block, Thrissur District, Kerala, India. The stream originates in the highlands of the Peechi-Vazhani Wildlife Sanctuary. The vegetation along the riverine forest is predominantly evergreen and deciduous in nature. Furthermore, the surrounding area was dominated by an agricultural landscape of rubber and mixed plants.

A B

Fig. 1. A) Pattathipara waterfalls B) Poovanchira waterfalls (Photo by Author, December 2020)

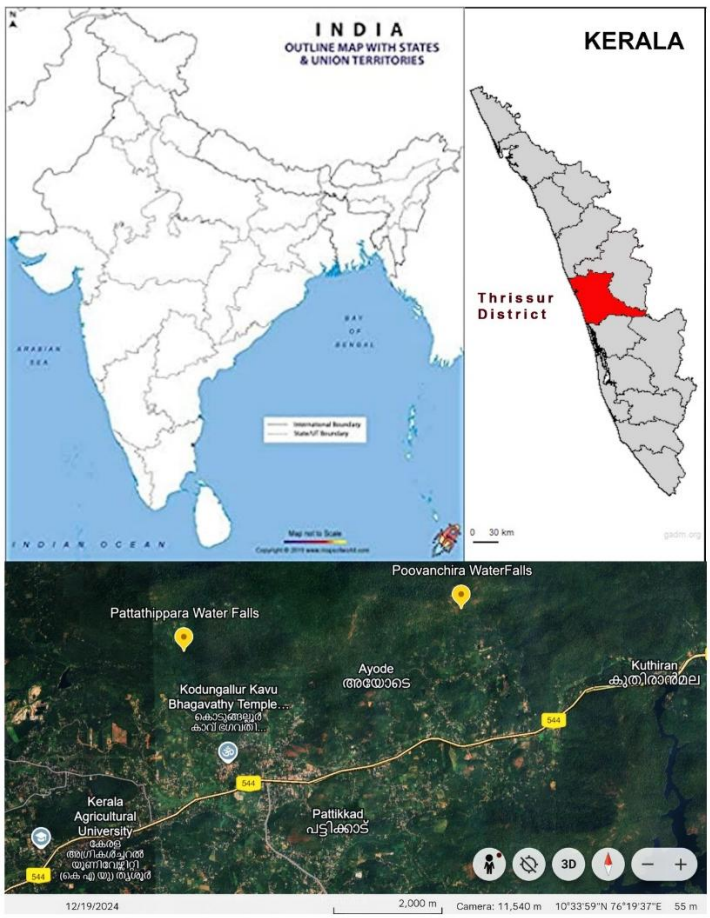

Fig. 2. Map of study area indicating Pattathipara and Poovanchira waterfalls

Qualitative vegetation

The taxonomic survey of the Poovanchira and Pattathipara streams was conducted during October 2020 and November 2020. Riparian plants were identified with standard floras (Hooker 1872-1897, Gamble & Fischer 1915-1936) and nomenclature validation with IPNI (www.ipni.org) and Plants of the World Online. (https://powo.science.kew.org/). Photographs were taken using the OPPO A9 2020 mobile camera.

Quantitative Analysis

The quantitative data were gathered by the nested quadrat method. Quadrats of 10 x 10 m size were employed for trees, 5 x 5 m for shrubs and climbing herbs. Two sites were selected for the quantitative analysis, with a distance of 1 km from the top of the waterfall to the stream, and 4 quadrats of 10 x 10, 5 x 5, and 1x1 m were laid across the stream to collect the riparian species data.

Parameters analysed for quantitative vegetation assessment

For plant diversity and floristic organisation, quantitative metrics like frequency, density, abundance, and diversity indices were computed. Studying the quantitative traits of every single plant in a group is not feasible. Therefore, an approximate estimate of the species content of the community is established based on the sampling technique, which entails the analysis of selected plots or sampling units.

Frequency

Frequency designates the dispersion of species in a community. It is the percentage of sampling units in which a particular species occurs (Joshi et al., 2019). Frequency is calculated using the formula:

$$\text{Frequency} = \frac{\text{Number of quadrats in which the species occurred}}{\text{Total number of quadrats studied}} \times 100$$

Relative frequency

Relative frequency specifies the frequency of a particular species in relation to the total frequency of all the species present in the community (Joshi et al., 2019). Relative frequency is calculated using the formula:

$$\text{Relative frequency (\%)} = \frac{\text{Frequency of species A}}{\text{Total frequency of all the species}} \times 100$$

Density

Density shows the number of individual trees per unit area and it indicates the statistical strength of a species in a community (Joshi et al., 2019). Density is calculated using the formula:

$$\text{Density} = \frac{\text{Total number of individuals of a species}}{\text{Number of quadrats studied}}$$

Relative density

The proportion of density of species with respect to the total density of all the species within an area is referred to as relative density. In other words, it is the numerical strength of a species in relation to the total number of individuals of all species (Joshi et al., 2019). Relative density is calculated using the formula:

$$\text{Relative density (\%)} = \frac{\text{Density of a given species}}{\text{Total density of all species}} \times 100$$

Abundance

It is the study of the number of individuals of different species in the community per unit area (Curtis and McIntosh, 1950). Abundance is calculated using the formula:

$$\text{Abundance} = \frac{\text{Total number of individuals of the species}}{\text{Number of quadrats in which species occurred}}$$

Relative abundance

It is the abundance of a particular species with respect to total abundance of all species and expressed in percentage. Relative abundance is calculated using the formula:

$$\text{Relative abundance} = \frac{\text{Abundance of species A}}{\text{Total abundance}} \times 100$$

Basal area

Basal area refers to the ground actually penetrated by the stems (Hanson and Churchill, 1961). Basal area can be calculated using the formula:

$$\text{Basal area (Sq.cm)} = \frac{\pi \times (dbh)^2}{4}$$

Relative basal area

It is the basal area of a particular species with respect to total basal area of all species and expressed in percentage. Relative basal area is calculated using the formula:

$$\text{Relative basal area (\%)} = \frac{Basal\ area\ of\ species\ A}{Total\ basal\ area\ of\ all\ species} \times 100$$

Diversity index

A quantitative indicator of species diversity within a community is called a diversity index. One of the most important diversity indices is the Shannon Wiener diversity index. As an information statistic index, the Shannon diversity index makes the assumption that every species is represented in a sample and that the sample is drawn at random.

Shannon Wiener index (H')

The species diversity of the forest community was assessed to provide a more quantitative description of the community. (Joshi et al., 2019), using Shannon Wiener index. Shannon Wiener index can be calculated by using the formula:

$$H' = \sum[(pi) \times \ln(pi)]$$

Importance Value Index (IVI)

It can be computed by summing the relative values of the three parameters: density, frequency, and basal area (Joshi et al.,2019). The importance value index can be calculated by using the formula (Curtice, 1959)

IVI = Relative Density + Relative Frequency + Relative Basal Area

Floristic components

The synoptic account of Pattathipara stream and waterfall revealed that there are 37 plants belonging to 28 families. The synoptic account of the Poovanchira stream and waterfall revealed that there are 34 plants belonging to 25 families. Most of the authors have reported the dominance of family Poaceae in the Western Ghats (Arora, 1964; Nayar 1980, 1984, 1996; Karthikeyan 1983, 1996; Parthasarathy 1988; Ahmedullah and Nayar, 1986; Nair and Daniel 1986; Sreekumar and Nair 1991; Vajravelu and Vivekananthan 1996; Venu 1998). In contrast to the above observation, the present study in Pattathipara recorded the dominance of Euphorbiaceae (4 species), followed by Fabaceae (3 species), Rubiaceae (2 species), Acanthaceae (2 species), Astreaceae (2 species), and Moraceae (2 species). The study in Poovanchira recorded the dominance of Malvaceae, Fabaceae, Rutaceae, and Lamiaceae (3 species each) followed by Asteraceae (2 species), Acanthaceae (2 species). The periodic disruptions of the flood plain, which inhibit the establishment of Poaceae and encourage woody plants that can endure the flood currents, are the cause of this change in the vegetation profile (Naiman and Decamps, 1997).

Vegetation profile and community structure

The vegetation profile of Pattathipara stream includes 16 herbs, 2 shrubs, 7 climbers, 3 trees, and 9 saplings. The study area has higher number of herbs followed by saplings, climbers, trees and shrubs. The vegetation profile of Poovanchira stream includes 12 herbs, 8 shrubs, 3 climbers, 6 trees, and 5 saplings. The study area has a higher number of herbs followed by shrubs, trees, saplings and climbers.

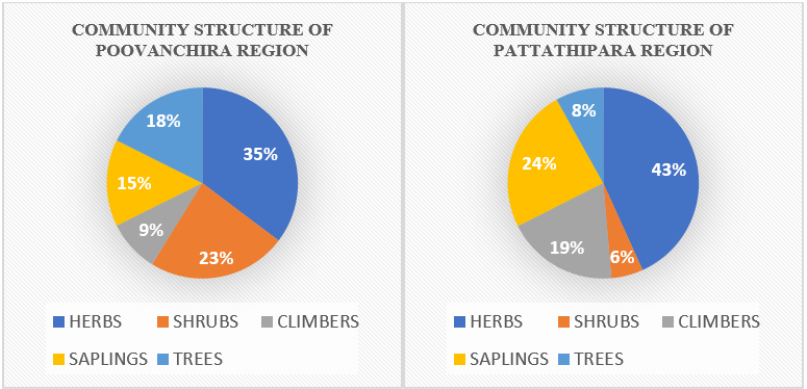

Fig. 2. A) Pie diagram showing the community structure of Poovanchira region **B)** Pie diagram showing the community structure of Pattathipara region.

Results and discussion

Phytosociology & ecology of species

The parameters analysed for phytosociology include frequency, density, and abundance. The most frequent trees that occurred in the Pattathipara region are *Terminalia elliptica* (75%), followed by *Mitragyna parvifolia* and *Bombax ceiba* (50%). The density of trees indicates that *Terminalia elliptica* (0.75), followed by *Mitragyna parvifolia* and *Bombax ceiba* (0.5). This distribution density is typical of a deciduous forest ecosystem. The most frequent trees that occurred in the Poovanchira region are *Wrightia tinctoria* (75%), followed by *Dillenia pentagyna*, *Terminalia* elliptica, Schleichera *oleosa*, *Bombax ceiba, Pongamia pinnata,* and *Lagerstroemia microcarpa* (25%). The density of trees indicates that *Wrightia tinctoria* (0.75), *Dillenia pentagyna*, *Terminalia elliptica*, *Schleichera oleosa*, *Bombax ceiba, Pongamia pinnata,* and *Lagerstroemia microcarpa* (0.25). This frequency distribution of trees indicated that both the area is dominated by deciduous trees. This distribution density is also typical of a deciduous forest ecosystem. The highest abundance value showing trees in the Pattathipara region are *Terminalia elliptica, Mitragyna parvifolia,* and *Bombax ceiba* (1.0). The highest abundance value showing trees in the Poovanchira region are *Wrightia tinctoria, Dillenia pentagyna*, *Terminalia elliptica*, *Schleichera oleosa*, *Bombax ceiba, Pongamia pinnata,* and *Lagerstroemia microcarpa* (1.0). The relative density, relative basal area, and relative frequency (Table 1,2,3, and 4) indicated that a relatively good natural riparian vegetation occurs in the Pattathipara and Poovanchira streams and waterfall areas.

Importance Value Index

The IVI calculated from the trees of the Pattathipara region indicated that *Bombax ceiba* has the highest IVI (52.17), followed by *Terminalia elliptica* (36.89) and *Mitragyna parvifolia* (27.26). The IVI calculated from the trees of the Poovanchira region indicated that *Dellinia pentagyna* (58.26) followed by *Schleichera oleosa* (30.18), *Wrightia tinctoria* (12.63), *Bombax ceiba* (11.46), *Terminalia elliptica* (10.44), *Lagerstroemia macrocarpa* (6.97), *and Pongamia pinnata* (4.78) (Table 1,2,3, and 4).

Table. 1. Relative Frequency, Relative Density, Relative Basal Area, and Importance Value Index of Riparian tree vegetation of Pattathipara, Thrissur.

Botanical name	Relative frequency	Relative Density	Relative Basal area	Importance value index
Mitragyna parvifolia	3.03	1.63	22.59	27.26
Terminalia elliptica	4.54	2.45	29.88	36.89
Bombax ceiba	3.03	1.63	47.50	52.17

Table. 2. Relative Frequency, Relative Density, Relative Basal Area and Importance Value Index of Riparian tree vegetation of Poovanchira, Thrissur.

Botanical name	Relative frequency	Relative Density	Relative Basal are a	Importance value index
Dillenia pentagyna	2.22	1.63	54.39	58.26
Wrightia tinctoria	6.66	4.91	1.05	12.63
Schleichera oleosa	2.22	1.63	26.32	30.18
Terminalia elliptica	2.22	1.63	6.58	10.44
Bombax ceiba	2.22	1.63	7.60	11.46
Pongamia pinnata	2.22	1.63	0.92	4.78
Lagerstroemia microcarpa	2.22	1.63	3.11	6.97

Table. 3. Relative Frequency, Relative Density of herbs, shrubs, climbers and saplings of Pattathipara, Thrissur.

Botanical name	Relative frequency	Relative density
Ziziphus oenoplia	3.03	3.27
Rhynchoglossum notonianum	4.54	5.73
Macaranga peltata	1.51	0.81
Justicia sp.	1.51	1.63
Ruellia tuberosa	4.54	4.09
Selaginella delicatula	6.06	18.85
Hibiscus hispidissimus	3.03	2.45
Acacia pennata	3.03	2.45
Colocasia esculenta	3.03	2.45
Targia involucrata	4.54	4.09
Helicteres isora	3.03	3.27
Dillenia pentagyna	1.51	0.81

Triumfetta rhomboidea	3.03	2.45
Acalypha indica	1.51	0.81
Strychnos nux-vomica	1.51	0.81
Abrus precatorius	3.03	2.45
Naringi crenulata	4.54	4.91
Oplismenus compositus	4.54	5.73
Cissus discolor	3.03	1.63
Chionanthus mala-elangi	3.03	1.63
Mallotus philippensis	4.54	2.45
Metragyna parvifolia	1.51	0.81
Chromolaena odorata	3.03	4.91
Streblus asper	1.51	0.81
Globba sessiliflora	1.51	1.63
Cheliocostus speciosus	1.51	2.45
Ficus arnottiana	1.51	0.81
Vigna unguiculata	1.51	0.81
Leucas biflora	1.51	0.81
Achyranthes aspera	1.51	2.45
Pouzolzia indica	1.51	1.63
Blumea lacera	1.51	2.45
Phyllanthus niruri	1.51	0.81
Dioscorea bulbifera	1.51	0.81
Shannon Weiner index H	**1.44**	

Table. 4. Relative Frequency, Relative Density of herbs, shrubs, climbers and saplings of Poovanchira, Thrissur.

Botanical name	**Relative frequency**	**Relative density**
Helicteres isora	2.22	3.27
Bauchinia sp.	2.22	1.63
Naringi crenulate	4.44	4.91
Chromolaena odorata	4.44	3.27
Triumfetta rhomboidei	6.66	6.55
Imbatiens chinensis	4.44	3.27
Biophytum sensitivum	4.44	4.91
Costus speciosus	6.66	4.91
Deris pentaphylla	4.44	4.91
Curcuma sp.	2.22	1.63
Terminalia elliptica	2.22	1.63
Vitex altissima	2.22	1.63
Barleria sp.	2.22	3.27
Macaranga peltate	2.22	3.27
Canthium rheedi	2.22	4.91
Selaginella delicatula	2.22	4.91
Zanthoxylum rhetsa	2.22	3.27
Hyptis suaveolens	2.22	1.63
Ageratum conyzoides	2.22	1.63
Ludwigia perennis	2.22	1.63
Peperomia pellucidia	2.22	3.27
Vigna unguiculata	2.22	1.63
Ruellia prostrata	2.22	1.63
Commelina diffusa	2.22	3.27
Alternanthera brasiliana	2.22	4.91
Pouzolzia indica	2.22	1.63
Justicia japonica	2.22	1.63
Mukia maderaspatana	2.22	1.63
Shannon Weiner index H	**1.40**	

Diversity indices

The Shannon Weiner diversity index H' of Pattathipara region was 1.44 (Table 3), which indicated that the riparian area has a natural uniform vegetation without much disturbance. The Shannon

Weiner diversity index H' of the Poovanchira region was 1.40 (Table 4), which indicated that the riparian area has a natural, uniform vegetation without much disturbance.

Conclusion

The riparian flora of the Pattathipara river basin is composed of 37 plants belonging to 28 families. In the present study of Pattathipara recorded the dominance of Euphorbiaceae (4 species), followed by Fabaceae (3 species), Rubiaceae (2 species), Acanthaceae (2 species), Astreaceae (2 species), and Moraceae (2 species) from the stream. The riparian flora of the Poovanchira river basin is composed of 34 plants belonging to 25 families. In the present study of Poovanchira recorded the dominance of Malvaceae, Fabaceae, Rutaceae, and Lamiaceae (3 species each), followed by Asteraceae (2 species), and Acanthaceae (2 species). The vegetation profile of Pattathipara stream includes 16 herbs, 2 shrubs, 7 climbers, 3 trees, and 9 saplings. The study area has higher number of herbs followed by saplings, climbers, trees and shrubs. The vegetation profile of Poovanchira stream includes 12 herbs, 8 shrubs, 3 climbers, 6 trees, and 5 saplings. The study area has higher number of herbs followed by shrubs, trees, saplings and climbers. Relative frequency, density, and abundance indicated that both area is relatively dominated by deciduous trees. The IVI profile indicated the dominance of *Terminalia elliptica* in Pattathipara and *Wrightia tinctoria* in Poovanchira, which are dry deciduous forest trees. From the Shannon Weiner diversity index of Pattathipara region (1.44) and Poovanchira region (1.40), it was assumed that both the riparian area has uniform species diversity.

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Author Contributions

PBG: Lead author; conducted fieldwork, data collection, and primary analysis; drafted the initial manuscript. JP: Supervisor; provided guidance during the study and contributed to the interpretation of results.

Acknowledgements

Not applicable.

Funding

Not applicable.

Availability of data and materials

Not applicable.

Competing interest

The authors declare no competing interests.

Ethics approval
Not applicable.

Citation: Gautham PB and Joby Paul (2025) Diversity of Riparian Vegetation in Pattathipara and Poovanchira Streams of Peechi-Vazhani Wildlife Sanctuary, Kerala. Environmental Science Archives 4(2): 669-677.