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Biodiversity Significance of Low-Elevation Riparian Forests in Vazhachal: Conservation and Restoration Implications

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Abstract

The riparian ecosystems are the world's one of the richest in terms of biodiversity and ecological functions in a mountainous landscape. The riparian vegetation of the Chalakkudy River within Vazhachal forests of Western Ghats has been explored for the floral and faunal diversity. Mapping of the riparian vegetation in the river revealed it is of only 4.8 sq. Km in extent, (1%) of the total natural vegetation of the Vazhachal Forest Division and the low-elevation Evergreen Riparian Forest is only 2.38 Sq. K.ms (0.8%) of the available natural vegetation. Irrespective of the extent, this vegetation has great ecological and biodiversity value since they act as an evergreen corridor to connect all the vegetation in the landscape and harbours high biodiversity value. The riparian vegetation alone represents 696 species of angiosperms, of which 254 are endemics and33 are in the threatened category of IUCN. The Shannon diversity value for trees alone is 1.6 comparable to other evergreen forest types. The area recorded maximum fish diversity in these locations, within the highest fish diverse river in Kerala. The riparian forest at Vazhachal is the only sympatric location of three south Indian hornbill species, which is also the lowest elevation record of the nest of Great Hornbill (180m MSL). The latest survey observed 196 species of birds, 131 species of butterflies, 51 species of Odonates of which 70% are from the riparian forests. Maximum diversity and abundance were recorded from the Riparian areas. This provides an insight into the ecological significance of low-elevation riparian forests in the conservation of Biodiversity. The Riparian forest structure and its plant components provide a structural mechanism to provide various Niches for a wide range of unique species of plants and animals. These functional aspects have to be considered seriously during the ecorestoration process. The riparian forests in the area recently proposed for a Hornbill Riparian - Sanctuary, it is one of (Important Bird and Biodiversity Area) IBA and proposed fish breeding area.

Keywords: Conservation, Riparian Biodiversity, Tropical, Western Ghats

1. Introduction

Riparian forests are a unique ecosystem because of humidity, water availability, sedimentation and natural seasonal flooding in the area and it acts as an ecotone that connects terrestrial and aquatic ecosystems (Naiman and Decamps, 1997). According to the latest assessment by FSI (2019) shows the total forest cover of India as 7, 12,249 Sq. Km, which is 21.67% of the total geographic area of the country and Forest Cover in Kerala State is 21,144.29 Sq. Km, which is 54.42% of the State's geographical area, which includes the Riparian forests of 44 rivers of Kerala (State of Forest Report, 2019). "Many of the ecological issues related to land use and environmental quality could be ameliorated with effective riparian corridor management" (Naiman *et al*., 1993). In Coastline areas, Riparian vegetation is necessary for keeping up high water quality in streams, waterways, and lakes and the lower reaches of the riparian forests act as a buffer between the upland and the river (Cherullipadi and Paul, 2016). High odonate diversity and endemism were observed in streams flowing through evergreen forests. Thus, it indicates riparian ecosystem health (Subramanian *et al*., 2008).

Riparian areas may comprise less than 1% of the area in the Western United States, but they are among the most productive and valuable of all lands (Chaney *et al*., 1990). The riparian vegetation of the Chalakkudy River is represented by 4.8 sq. km, i.e. 1% of the total natural vegetation of the Vazhachal Forest division. The most important and threatened is the low elevation evergreen forests. The riparian forest within the Vazhachal forest division is with an extent of 2.83 Sq. Km (0.8%) of the available natural vegetation (Bachan, 2010).

Riparian forests play various ecosystem services including maintain biodiversity, high productivity and provide different bioclimatic regions thou they enhance diverse flora and fauna in these small patches of forests along the river. The riparian area can be considered as the important corridor, Threatened and unique ecosystem. The riparian zone has been reported as some of the most species-rich and most productive systems, and they are more sensitive to human influence and potentially hunted ecosystems (Malanson, 1993). Hydrological alterations and its impacts severely affect the riparian ecosystem and causing biodiversity loss and disturbance in the riparian stretch (Castello and Macedo, 2016).

The studies on riparian forests and its biodiversity are scarce from the Indian region. The present study analyses the floristic richness, faunal diversity and various structural components within the riparian vegetation which provides specific niches for unique biota. This is being examined in comparison with other forest types to elucidate the riparian vegetation as a unique ecosystem based on two-decade-long studies in the riparian vegetation of the Chalakkudy River, Kerala.

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2. Materials and Methods

Floristic enumeration of the riparian vegetation was done from 2001 to 2010 (Bachan, 2010), and it was updated during 2017-2019. All the studies on biodiversity richness of the area were pooled to have an understanding of the biodiversity significance. Photographic evidence of different and unique biota was analysed to understand the presence of unique faunal and floral elements in the low-elevation riparian vegetation. Secondary literature from various sources was pooled to have a comparative account of our observations. Data from systematic sampling location of the riparian area of Chalakkudy River (Bachan, 2003, 2010) also analysed to have an understanding of the species richness and diversity.

A rapid survey was conducted during 2017-2019 in the study area, Vazhachal Forest division, including the low-elevation riparian vegetation areas of Chalakkudy River from Orukombankutty up to the Thumboormuzhi area. The areas were divided into four zones. Zone A is Poringal to Orukombankutty; zone B is Orukombankutty to Vazhachal picnic spot; Zone C is Vazhachal picnic spot to Kannamkuzhi, and zone D is from Kannamkuzhi to Thumboormozhi.

The total study area was gridded into 108 grids, and 20 sampling locations were identified for systematic stratified random sampling of birds, butterflies and Odonata in the area based on percentage data on forest types, land use etc. 2 km transects with 12 point counts at 10 minutes intervals were established in the morning and evening hours (6.45 – 8.45 am and 3.30-5.30 pm). Each transect was covered by a team of 6 people involving one bird expert, one Odonata and butterfly expert, one volunteer or beginner, one forest staff and tribal watchers. The birds were counted along the transects for species and abundance. Care has been taken to avoid duplication of transects and areas, and extra encounters were listed for species diversity.

Rapid assessments of fish habitats were also conducted to understand the impact of the flood on the river ecosystems as well as fish diversity. The flood impacted area of Chalakkudy Main River starting from Orukombankutty up to Athriappilly waterfalls were surveyed systematically for the impact of flood 2018 on various fish habitats in the river. A datasheet was prepared for a rapid assessment, and the survey was conducted November –December 2018. Secondary data (Ajithkumar *et al*., 1999, Raghavan *et al*., 2007, Raghavan *et al*., 2008, Bachan *et al*., 2019 b) were used to substantiate data of other groups such as reptiles, amphibians and fishes etc. along with encounter records from riparian forests with photographs as evidence.

The total extent of riparian vegetation and the low elevation riparian vegetation was elucidated form the maps prepared using QGIS. The extent of vegetation has been used as an important argument for the fragility and unique feature of the low-elevation ecosystem. All the data were examined to understand the diversity and importance of low-elevation riparian vegetation of the Chalakkudy river at Athirapilly-Vazhachal-Orukombankutty region. Structural elements in the low-elevation riparian vegetation providing niches for various unique floristic and faunal elements were listed into a tabular format to understand the unique features of the riparian vegetation. This has been elucidated as an important aspect to consider along with species selection of ecorestoration riparian vegetation.

3. Results and Discussion

The floristic analysis of the angiosperm flora of Chalakkudy River recorded 696 species of angiosperms. They belong to 450 genera under 129 families. Dicotyledons with 534 taxa belonging to 351 genera under 111 families and 162 taxa of Monocotyledons under 99 genera and 18 families. Two hundred fifty-four are endemics, and 33 are threatened category of IUCN, representing 36.5 % endemism. The percentage of endemism is relatively high when compared to Thrissur forest (15.2%) and the entire Kerala (27.18%). Among the endemic species, 149 are endemics of Western Ghats and Sri Lanka Hot Spot, of which 95% (142 species) are confined to the Western Ghats alone, and 89 species are of Southern Western Ghats. Among the endemic species recorded, 30 species were of Peninsular India endemics, 27 species of Peninsular India-Sri Lanka endemics, 17 species of South India-Sri Lanka endemics and four species were endemic to India, within 145 km long Chalakkudy River basin.

Among the representing species, 270 (40%) are indigenous elements, 172 (25%) Indo-Malayan elements, 30 Tropical Asian, 49 Pantropical, 29 Paleotropical, and 22 Tropical and South American. The percentage of plants under RET (Rare, Endangered, Vulnerable and Threatened) category is also high 4.7% (33 species out of 695) when compared to Thrissur forest flora 3% (50 species out of 1645). Poaceae is the dominant family with 48 species followed by Euphorbiaceae (29), Orchidaceae (27), Cyperaceae (26), Acanthaceae (25), Rubiaceae (24), Moraceae (24), Fabaceae (21), Asteraceae (20), Araceae (16), Clusiaceae (14) and Scrophulariaceae (13).

About 350 plant species from 92 families found to occur frequently along the riparian zone. The important riparian plant families are Lecythidaceae, Salicaceae, Sabiaceae, Podostemaceae, Capparaceae, Elaeocarpaceae, Urticaceae, Pandanaceae, Myrsinaceae. Leeaceae, Dipterocarpaceae, Clusiaceae, Myristicaceae, Chloranthaceae, Lentibulariaceae, Hydrocharitaceae, Typhaceae, Cyperaceae, Poaceae, Rhizophoraceae, Avicenniaceae, Acanthaceae, Annonaceae, Flacourtiaceae, Pittosporaceae, Euphorbiaceae, Eriocaulaceae, Araceae, Moraceae, Orchidaceae, Zingiberaceae, Melastomataceae, Rubiaceae, Ulmaceae, Ebenaceae, Polygonaceae, Onagraceae, Balsaminaceae, Butomaceae, Nympaceae, Begoniaceae,

The dominant families with respect to endemic species are Orchidaceae (17), Acanthaceae (15), Rubiaceae (12), Araceae, Melastomataceae, Annonaceae and Poaceae 11 species each, Euphorbiaceae (10), Clusiaceae (10) and Lauraceae (9). The genera *Impatiens* ranks first with a maximum number of endemic species (8). This is followed by *Ficus* (6), *Syzygium* (6), *Strobilanthes* (5), *Garcinia* (5), *Osbeckia* (5) and *Memecylon* (4).

The endangered species include *Desmos viridiflorus* (Bedd.) Safford, *Atuna travancorica* (Bedd.) Kosterm.,

Symplocos macrophylla Wall. ex A. DC. subsp. *rosea* (Bedd.) Nooteb., *Aporosa bourdillonii* Stapf, *Syzygium chavaran* (Bourd.) Gamble, *Bulbophyllum aureum* (Hook. f.) J. J. Smith, *Cryptocarya anamalayana* Gamble, *Syzygium bourdillonii* (Gamble) Rathkr. & Nair and *Ardisia sonchifolia* Mez.

Plants from 'Rare' category include *Mallotus resinosus* (Blanco) Merr., *Trias stocksii* Benth. ex Hook, *Oxytenanthera bourdillonii* Gamble, *Salacia beddomei* Gamble, *Semecarpus travancorica* Bedd., *Sonerila versicolor* Wight, *Dalzellia gracilis* C. J. Mathew, *Willisia selaginoides* (Bedd.) Warming ex Willis, *Dysoxylum malabaricum* Bedd. ex Hiern, *Crotalaria clarkei* Gamble, *Mycetia acuminata* (Wight) Kuntze, *Capparis rheedei* DC., *Oberonia brachyphylla* Blatt. & McCann, *Cyclea fissicalyx* Dunn, *Coscinium fenestratum* (Gaertn.) Colebr. and *Humboldtia vahliana* Wight. The Threatened category includes *Cinnamomum riparium* Gamble, *Impatiens herbicola* Hook., *Syzygium occidentalis* (Bourd.) Gandhi. *Ochreinauclea missionis* (Wall. ex G. Don) Ridsd., *Myristica malabarica* Lam., *Aglaia perviridis* Hiern and *Orophea uniflora* Hook. f. & Thomson. The Threatened category was represented with *Arisaema barnesii* C. E. C. Fisch. The low-elevation river bed is a habitat for endemic and threatened *Willisia selaginoides (Podostemonaceae)* and *Lagenandra nairii (Araceae).* The Athriapilly and Vazhachal is the type locality for the aroid *Lagenandra nairii*.

Among the 196 species of birds recorded during the survey, 117 species were recorded from the riparian vegetation areas. Maximum species diversity for birds was observed in riparian areas are Vazhachal Bridge area (89 species), Orukomban (83 Species), Karamthodu (36 species) and Kannankuzhithodu (80 Species). The data is comparable with other one-time survey records from Vazhachal area 139 species (Nameer and Cheeran, 1996), 130 species (Susanth, 1996) and 167 species (Bachan, 2003).

Among the nine threatened bird species recorded during the survey, five are of great riparian affinity. Three species of Hornbills, the Malabar Grey, Malabar Pied and Great Hornbills are symmetrically nesting in the low elevation riparian forests at Vazhachal. The area is the only available nesting locality of the Malabar Pied Hornbill in Kerala apart from Aralam and Low elevation nesting ground for Great Hornbill 180m MSL (Bachan 2006, 2011).

Among the 51 species of Odonata recorded during the survey, 48 species were recorded from the riparian vegetation areas. Maximum species diversity was observed in riparian areas of Vazhachal Bridge (24), Karamthodu-Vazhachal (11) and Kannamkuzhythodu (13).

Among the 131species of butterflies recorded during the survey, 86 Species were recorded from the riparian vegetation areas. Maximum species diversity was observed in riparian areas of Karamthodu (53) and Vazhachal (33). The data is comparable with other one-time survey records from Vazhachal area 233 species (Susanth, 2012) of which 29 comes under the threatened category, including 21 endemics to the Western Ghats and 8 Near Threatened.

Seventy-two species of fish species were recorded from the riparian vegetation areas. *Sahyadriya chalakkudiensis* is endemic to Chalakkudy River. *Tor khudree*, *Sahyadria denisonii*, *Barbodes carnaticus* are the other species observed in riparian stretches.

The compilation of faunal diversity (Bachan 2019 b) indicates, a total of 71 species of mammals belonging to 25 families were observed in the Vazhachal Forest Division area, of which 34 Mammals species were recorded from the riparian vegetation areas. Thirty-two species of Amphibians and 63 species of reptiles are enumerated from the area.

The photographic evidence shows presence endemic and threatened mammals such as Asiatic elephant, tiger, leopard, wild guar, flying squirrel, lion-tailed macaque, Nilgiri languor, reptiles such as Python, King cobra, monitor lizard, Endangered Cochin forest cane turtle, amphibians such as endangered fossil frog *Nasika batrachus sahyadrensis.*

The table shows that the plant or microhabitat components which provide structural and functional inclusion of important flora and fauna in the low elevation riparian forests of in Vazhachal along the Chalakkudy River. These structural components of the vegetation and the habitats are important in specialised niches for various biota contributing the uniqueness of the riparian vegetation. This also accounts for the importance of the riparian vegetation, making it a specialised ecosystem with high biodiversity value and ecological significance irrespective of its extent.

Fig. 1. Floristic analysis of riparian vegetation

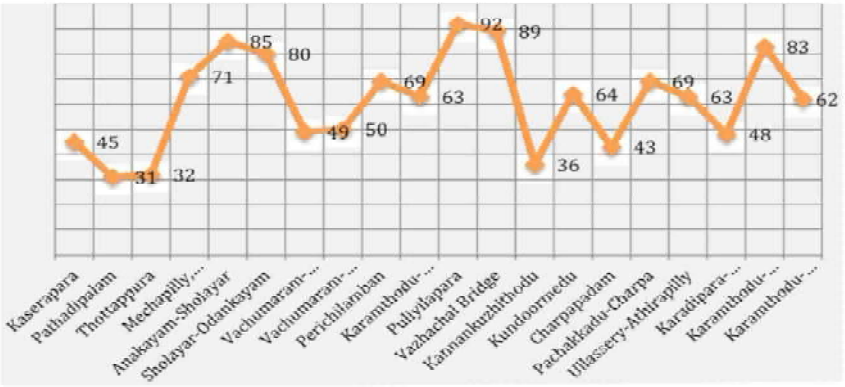

Fig. 2. Bird diversity at different sampling locations in Vazhachal Forests

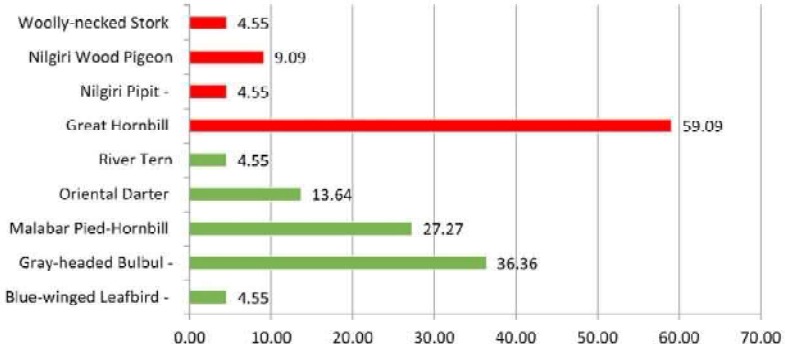

Fig. 3. Frequency of occurrence of threatened birds in Vazhachal Forests

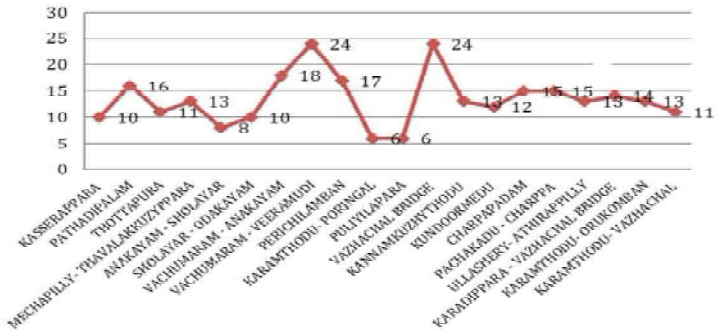

Fig. 4. Odonata diversity at different sampling locations in Vazhachal Forests

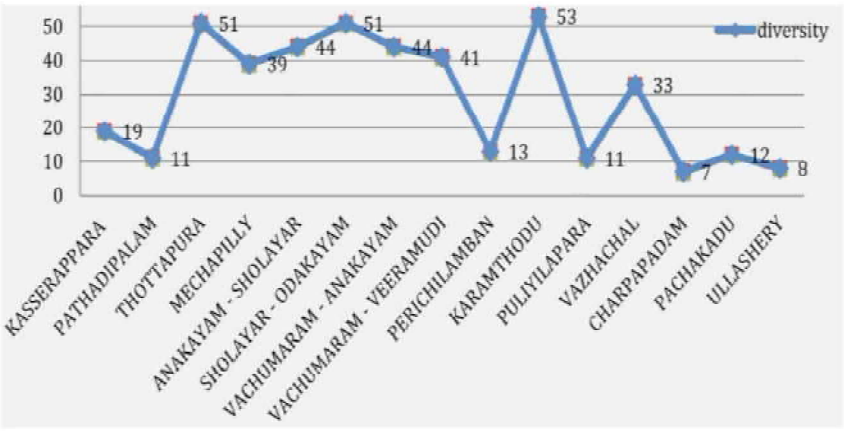

Fig. 5. Butterfly diversity at different sampling locations in Vazhachal Forests

Table 1. Functional aspects of riparian forests in Vazhachal Forests

Sl.No	Functional Aspect	Niche/Related species	Functional Outcome
1	Evergreen Nature	*Vateria indica* L.	Threatened trees
		Dipterocarpus indicus Bedd.,	Threatened trees
		Kingiodendron pinnatum (Roxb. ex DC.) Harms	Threatened trees
2	Rheophytic Habitat	*Lagenandra nairii* Ramamurthy &Rajan	Endemic
		Willisia selaginoides (Bedd.) Warming ex Willis	Endemic
3	Micro habitat in the water environment	Fishes and Odonata	
		Sahyadria chalakkudiensis Menon, Rema Devi & Thobias	Endemic-Chalakkudy river
4	Evergreen Nature	*Vateria indica* L.	Threatened trees
		Dipterocarpus indicus Bedd.,	Threatened trees
		Kingiodendron pinnatum (Roxb. ex DC.) Harms	Threatened trees
5	Rheophytic Habitat	*Lagenandra nairii* Ramamurthy & Rajan	Endemic
		Willisia selaginoides (Bedd.) Warming ex Willis	Endemic
6	Micro habitat in the water environment	Fishes and Odonata	
		Sahyadria chalakkudiensis Menon, Rema Devi &Thobias	Endemic-Chalakkudy river

4. Conclusion

The low-elevation evergreen Riparian forest in Chalakkudy River is having only an extent of 2.38 Sq. Kms (0.8%) of the total available natural vegetation but 62% of the total riparian vegetation available in the river and harbours 70-80 % of flora including many endemics and threatened species. They also support rich biodiversity of birds (117 species), butterflies (Species 86), odonates (48 species), Mammals (71 species), Amphibians (14 species), reptiles (6 endemic species) fishes (72 species). The vegetation provided habitat for many threatened and endemic species of plants and animals. The low elevation riparian vegetation in Chalakkudy to Vazhachal is a classic example of a unique ecosystem, which provides various niches for a different kind of biodiversity components. High biodiversity value, endemism, and depletion in extent and quality indicate the riparian forests as a critical ecosystem for conservation. This has to be given 'Unique Ecosystem Status" as recommended in the Working Plan of Vazhachal Forest Division (Bachan, 2019 a) and it has to be protected as a protected area of Riparian Forests / Hornbills. A recent study on flood impact by Bachan *et al*. (2019 b), reports severe damage happened to the low-elevation riparian forests at Vazhachal downstream to the Poringalkuthu dam. Protection, long-term monitoring and eco-restoration of these threatened habitats are essential. The structural components of the riparian vegetation which provides specific and unique niches for a wide range of endemic and threatened biodiversity have to be taken care of while planning the ecorestoration process.

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