

Larval odonate assemblage structure in a disturbed rainforest stream of the southern Western Ghats, Kerala, India

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ABSTRACT: Larval odonate assemblages were investigated in the Kallar stream system, a perennial hill stream of the southern Western Ghats in Thiruvananthapuram District, Kerala, India. Monthly sampling was conducted at five sites (Darpha-Kalungu, Pottanchira, Kaliyikkal, Meenmutty and Main Kallar) that differed in riparian cover, land use and substrate composition. Larvae were collected from multiple microhabitats including sand, gravel, cobble, boulder and leaf-litter deposits using hand nets and direct substrate examination and were identified using standard taxonomic keys. A total of 3,090 individuals belonging to 12 families and 39 morphospecies were recorded. Dragonfly larvae dominated the assemblage, with Gomphidae showing the highest abundance. Open-canopy sites associated with settlements and plantations were mainly represented by widespread families such as Libellulidae and Gomphidae, whereas shaded forest reaches containing leaf litter and woody debris supported additional families including Platystictidae, Protoneuridae and Euphaeidae. Damselflies were more frequent in shaded stretches, while sandy reaches supported fewer individuals. The results indicate that riparian canopy cover and substrate heterogeneity strongly influence odonate larval distribution and emphasize the importance of maintaining natural riparian vegetation in Western Ghats hill streams.

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KEY WORDS: Damselflies, dragonflies, hill stream, riparian vegetation, substrate, heterogeneity

INTRODUCTION

The order Odonata, comprising Anisoptera (dragonflies) and Zygoptera (damselflies) are one of the fascinating groups of insects. Owing to their amphibious life history, relatively short generation time, high trophic position and diversity, odonates are considered as an important component of freshwater ecosystems as well as good indicators of ecosystem health (Corbet, 1993; Clark and Samways, 1996, Dijkstra *et al.*, 2014; Cheri and

Finn, 2023). They are valuable as indicators of aquatic and terrestrial ecosystem health and play a vital role as prey and predators to maintain the balance of trophic levels of food chain in freshwater ecosystems. Their aquatic larvae constitute a natural biological control over mosquito larvae and thus help to control several epidemic diseases like malaria, dengue, filariasis etc. (Mitra, 2002; Abdullah and Mamat, 2024)). Odonate taxa are ideal models for the investigation of the impact of environmental warming and climate change due to

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their tropical evolutionary history and adaptations to temperate climates (Hassall, 2015; Olsen *et al.*, 2022). Freshwater insects, including odonates, are widely used in biomonitoring studies to evaluate river health and habitat quality (Kalkman *et al.*, 2008; Termaat *et al.*, 2015; Tiple *et al.*, 2019; Chakravarty and Gupta, 2024). The present work was therefore undertaken to evaluate the diversity and abundance of larval stages of odonates of Kallar stream and its tributaries.

MATERIALS AND METHODS

Kallar is a typical tropical rainforest stream located near Ponnudi in Thiruvananthapuram district, Kerala, the southern part of the Western Ghats. In this study five collection sites were selected in which four are the tributaries of Kallar stream and one is the main Kallar. The selected sites are Darpha-Kalungu (S1), Pottanchira (S2), Kaliyikkal (S3), Meenmutti (S4) and main Kallar (S5). Habitat characteristics such as riparian vegetation, canopy cover, substrate composition and human disturbance were recorded at each site to evaluate habitat influence on larval assemblage structure. At each sampling locality, a stretch of 100 m area was chosen for collection (Fig. 1, Table 1). The sampling was done monthly basis for a period of one year using kick net (1m² area, mesh size 200mm) and D-frame net (mesh size 50mm) and preserved in alcohol (70%). In the laboratory, larvae were sorted, identified and counted under stereoscopic microscope using standard keys (McCafferty and Provonsha, 1981; Morse *et al.*, 1984). The biodiversity indices like Margalef's richness index, Shannon-Weiner diversity index and Simpson dominance index were calculated using the software PAST.

RESULTS AND DISCUSSION

A total of 3,090 odonate larvae were collected from five sampling sites along the Kallar stream and its tributaries during the study period. The collection comprised 12 families and 39 morphospecies belonging to the two odonate groups, dragonflies and damselflies. Dragonfly larvae formed the major component of the assemblage. Four families were recorded: Gomphidae, Corduliidae, Libellulidae and

Macromiidae. Gomphidae was the most dominant family and occurred at all sites, with the highest abundance at Site 2 (Pottanchira) and the lowest at Site 4 (Meenmutty). Libellulidae was the second most abundant family and was recorded from all five sites, showing relatively higher abundance at Site 1 (Darpha-Kalungu), an open-canopy reach associated with agriculture and plantations. Corduliidae occurred in moderate numbers with an irregular distribution among sites, whereas Macromiidae was represented by comparatively few individuals (Table 2).

Damselfly larvae collected belonged to eight families: Chlorocyphidae, Euphaeidae, Platystictidae, Lestidae, Chlorolestidae, Protoneuridae, Platycnemididae and Calopterygidae. Euphaeidae showed relatively high abundance at Sites 2 and 5. Chlorolestidae was particularly abundant at Site 3 (Kaliyikkal), a residential reach with open canopy. Platystictidae and Protoneuridae were more frequent in shaded sections of the stream (Sites 4 and 5), where leaf litter and woody debris were present. Chlorocyphidae and Lestidae were recorded in low numbers across all sites. Platycnemididae occurred mainly at Site 3, while Calopterygidae was more abundant at Site 1 and less frequent at Site 5.

Biodiversity indices varied among the sites. The Shannon–Wiener diversity index ranged from 2.14 to 3.10, with the highest value at Site 1 and the lowest at Site 2. Simpson dominance index values ranged from 0.79 to 0.94, indicating variation in dominance patterns among sites. Margalef's richness index ranged from 3.97 to 5.57, with the highest richness at Site 3 and the lowest at Site 5. Overall, dragonfly larvae were numerically more abundant than damselfly larvae at all sampling locations. Sites characterized by shaded canopy, forest cover, and the presence of leaf litter and woody debris (Sites 4 and 5) supported several families associated with structurally complex habitats, whereas open-canopy sites with nearby human settlement or plantations (Sites 1-3) were dominated by widely distributed families (Table 3).

The present study demonstrated clear spatial variation in the composition and diversity of odonate

larvae among the five sampling sites of the Kallar stream system. Differences in larval assemblages were closely associated with habitat characteristics such as canopy cover, substrate composition, altitude and degree of human disturbance. Odonates are known to respond strongly to local habitat structure and riparian conditions, making them reliable indicators of freshwater ecosystem integrity (Corbet, 1999; Kalkman *et al.*, 2008; Harabis and Dolny, 2021).

Anisopteran larvae dominated all sampling sites, particularly members of the family Gomphidae. Gomphid larvae are burrowers that prefer sandy and gravelly substrates in running waters (Corbet, 1999). Such substrates were common at Sites 1, 2 and 3, which were characterized by open canopy and mixed mineral bed material, providing suitable conditions for burrowing forms. Similar associations between gomphid larvae and sandy substrates have been reported in tropical stream systems (Subramanian, 2009; Tiple *et al.*, 2019). In contrast,

Sites 4 and 5 contained greater amounts of leaf litter, cobbles and woody debris, which supported comparatively fewer burrowing larvae.

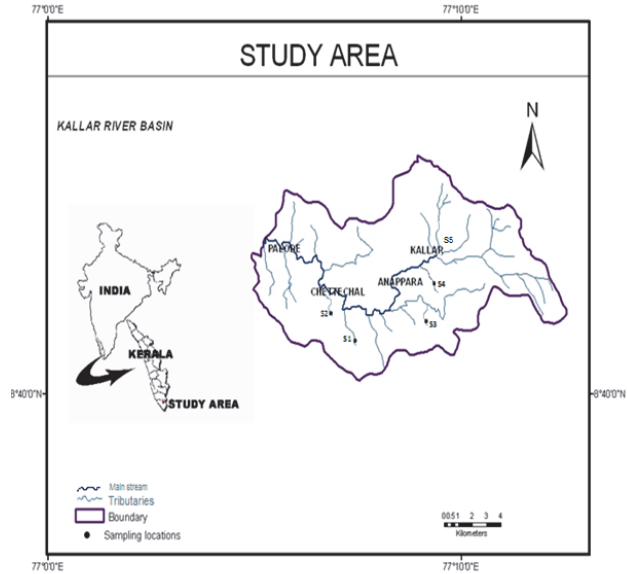


Fig. 1 Location of the study area

Table 1. Habitat characteristics of Kallar stream and its tributaries

No.	Parameter	Site 1 (Darpha-Kalungu)	Site 2 (Pottanchira)	Site 3 (Kaliyikkal)	Site 4 (Meenmutti)	Site 5 (Main Kallar)
1	Latitude	8°402 423N	8°412 313N	8°402 163N	8°422 363N	8°432 423N
2	Longitude	77°042 023E	77°032 093E	77°062 043E	77°072 413E	77°072 373E
3	Altitude (msl)	111	105	116	156	227
4	Flow regime	Perennial	Perennial	Perennial	Perennial	Perennial
5	Riparian vegetation	Mixed riparian vegetation with herbs and grasses	Plantation-associated riparian vegetation	Disturbed riparian vegetation near settlement	Forest riparian vegetation	Dense forest riparian vegetation
6	Land use	Agriculture & plantations	Plantation-Rubber	Residential influence	Forest	Forest
7	Canopy cover	Open (<30%)	Open (<30%)	Open (<30%)	Partially shaded (30–70%)	Shaded (>70%)
8	Water clarity	Clear	Clear	Clear	Clear	Clear
9	Large woody debris	Absent	Absent	Absent	Present	Present
10	Water odour	Odourless	Odourless	Odourless	Odourless	Odourless
11	Human disturbance	Present	Present	Present	Present	Absent
12	Dominant substrate	Sand, gravel, pebble, cobble, small boulders	Sand, gravel, pebble, cobble	Sand, gravel, pebble, cobble	Sand, gravel, cobble, leaf litter	Cobble, boulder, woody debris, leaf litter, rocks

Table 2. Odonates larvae collected from the study sites

Family	Genus	S1	S2	S3	S4	S5
Sub order – Anisoptera (Dragonflies)						
Gomphidae	<i>Gomphidae</i> sp. 1	82	328	85	99	205
	<i>Gomphidae</i> sp. 2	33	131	31	38	73
	<i>Gomphidae</i> sp. 3	8	12	11	14	6
	<i>Gomphidae</i> sp. 4	95	62	62	3	17
	<i>Gomphidae</i> sp. 5	12	5	14	0	6
	<i>Gomphidae</i> sp. 6	16	7	12	3	0
	<i>Gomphidae</i> sp. 7	4	9	1	0	9
	<i>Gomphidae</i> sp. 8	10	1	1	0	0
	<i>Gomphidae</i> sp. 9	0	1	1	0	4
	<i>Gomphidae</i> sp. 10	8	2	5	0	0
	<i>Gomphidae</i> sp. 11	2	1	1	0	0
	<i>Gomphidae</i> sp. 12	0	0	1	0	2
Cordullidae	<i>Cordullidae</i> sp. 1	9	5	7	15	0
	<i>Cordullidae</i> sp. 2	34	4	15	53	5
	<i>Cordullidae</i> sp. 3	0	0	1	5	0
Libellulidae	<i>Libellulidae</i> sp. 1	29	8	29	12	3
	<i>Libellulidae</i> sp. 2	23	1	19	5	0
	<i>Libellulidae</i> sp. 3	12	3	16	3	0
	<i>Libellulidae</i> sp. 4	7	0	2	0	0
	<i>Libellulidae</i> sp. 5	13	0	5	1	0
	<i>Libellulidae</i> sp. 6	3	1	2	0	0
	<i>Libellulidae</i> sp. 7	10	0	2	0	0
	<i>Libellulidae</i> sp. 8	21	2	12	3	0
Macromidae	<i>Macromidae</i> sp.1	3	5	2	3	2
Sub order – Zygoptera (Damselflies)						
Chlorocyphidae	<i>Chlorocyphidae</i> sp.1	0	3	2	0	3
	<i>Chlorocyphidae</i> sp.2	5	0	1	3	5
Euphaidae	<i>Euphaidae</i> sp.1	40	67	60	32	66
	<i>Euphaidae</i> sp.2	15	41	26	4	24
Platystictidae	<i>Platystictidae</i> sp.1	7	7	10	10	16
Lestidae	<i>Lestidae</i> sp.1	5	3	3	1	12
	<i>Lestidae</i> sp.2	1	1	0	1	5
Chlorolestidae	<i>Chlorolestidae</i> sp.1	19	32	56	33	44
	<i>Chlorolestidae</i> sp.2	20	18	37	21	16
Protoneuridae	<i>Protoneuridae</i> sp.1	42	3	54	4	1

Platycnemididae	<i>Platycnemididae</i> sp.1	21	0	24	1	6
	<i>Platycnemididae</i> sp.2	6	1	8	3	4
Calopterygidae	<i>Calopterygidae</i> sp.1	61	35	15	26	6
	<i>Calopterygidae</i> sp.2	7	4	5	20	1
	<i>Calopterygidae</i> sp.3	5	1	0	2	1

SITES: Darpha-Kalungu (S1), Pottanchira (S2), Kaliyikkal (S3), Meenmutti (S4) and main Kallar (S5)

Table 3. Biological indices of odonates

Diversity Indices	Site 1	Site 2	Site 3	Site 4	Site 5
Shannon Weiner index	3.10	2.14	2.99	2.64	2.24
Simpson Index	0.94	0.79	0.93	0.89	0.81
Margalef's richness index	5.20	4.63	5.57	4.47	3.97

Zygopteran families such as Euphaeidae, Platystictidae and Chlorocyphidae were more common in shaded stream sections. These families are typically associated with forested streams having stable flow and well-developed riparian vegetation (Subramanian, 2005; Dijkstra *et al.*, 2014). The relatively higher abundance of these families at Sites 4 and 5 can be attributed to increased canopy cover, organic substrates and reduced disturbance. Shaded habitats buffer temperature fluctuations and provide microhabitats suitable for climbing and clinging larvae (Corbet, 1999; Cheri and Finn, 2023).

The lowest diversity recorded at Site 2 may be related to influence of rubber plantation and greater human activity. Removal or modification of riparian vegetation is known to reduce habitat heterogeneity and shelter availability for aquatic insects (Kalkman *et al.*, 2008; Harabis and Dolny, 2021). In contrast, Site 1 exhibited the highest diversity, possibly due to heterogeneous substrates and moderate disturbance, which often increases niche availability in stream ecosystems.

Altitude also appeared to influence assemblage structure. Site 5, located at higher elevation and surrounded by forest, supported several stream-associated families, indicating relatively stable ecological conditions. Forested headwater streams generally maintain cooler temperatures, higher

dissolved oxygen and increased allochthonous organic input, which favour sensitive odonate larvae (Dijkstra *et al.*, 2014; Olsen *et al.*, 2022).

Overall, dragonfly larvae were more abundant than damselfly larvae across all sites. Dragonflies possess greater dispersal ability and ecological tolerance, enabling them to colonize disturbed habitats more effectively (Corbet, 1999; Kadoya *et al.*, 2004). Damselflies are more habitat-specific and sensitive to environmental alteration, particularly changes in riparian cover and substrate structure (Weir, 1974; Tiple *et al.*, 2019).

The observed distribution pattern supports the use of odonate larvae as effective indicators of freshwater habitat quality. Sites with intact riparian vegetation and heterogeneous substrates supported higher diversity, whereas disturbed locations showed reduced richness and dominance of tolerant groups. Therefore, odonate larval assemblages can serve as a useful tool for ecological monitoring and conservation assessment of tropical hill streams in the southern Western Ghats.

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