



STREAM INSECT DIVERSITY IN A SACRED AND NON-SACRED FOREST OF ANKOLA TALUK, UTTARA KANNADA, KARNATAKA

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ABSTRACT

Stream insects play significant roles in ecosystem functioning like riparian litter decomposition and other nutrient cycle related activities, from the head water to downstream. The sacred groves are hydrologically important places, being associated with perennial streams, springs or other water bodies. The current study on the diversity and functional feeding groups of stream insects in a sacred grove (SG) and a non-sacred grove (NSG) shows that SG stream had higher diversity than NSG stream. Whereas the SG had three Western Ghat endemic taxa (*Petersula*, *Edmundsula* and *Janohyphella*), the NSG had only one (*Petersula* in lower abundance). Among the functional

feeding groups shredders occurred only in SG due to higher litter-fall from denser vegetation. Scrapers were in more quantity in NSG due to richer periphyton promoted by poorer canopy. Pollution intolerant genera *Edmundsula* and *Janohyphella* indicating good health of SG stream were absent in NSG. The abundance of *Hydropsyche*, *psychomyia* and *Simulium* in NSG stream indicated anthropogenic disturbances, mainly agricultural runoff currently. The pristine nature of SG water bodies should be safeguarded from rising human pressures including pilgrimage and tourism.

KEYWORDS: Sacred grove, stream insects, functional feeding group, pollution sensitive taxa

INTRODUCTION

Aquatic insects comprise a taxonomically diverse, ecologically important and interesting group of animals in freshwater system especially of stream ecosystems (Dudgeon, 1999). They are vital for riparian vegetation and flood plain food webs, processing organic matter and cycling of nutrients as they belong to several specialized feeding groups such as shredders, filter feeders, deposit collectors and predators. Their activities can alter water quality and influence energy flow patterns in

different trophic levels; their biological interactions often have significant effects on community structure. In addition to this ecosystem function, they are very good indicators of the anthropogenic impact of running waters. Hence, aquatic insects are considered as keystone organisms and used for bio-monitoring methods in both temperate and tropical regions (Sivaramakrishnan, *et al.*, 1996; Boulton and Lake, 2008; Balachandran *et al.*, 2012).



Documentation of aquatic insects and their diversity assessment are considered essential, these being least explored and due to their indicator value on stream health and the group being least studied one, more so in the Indian Western Ghats.

The tradition of preserving forest patches as sacred, dedicated to deities, was a widespread, worldwide practice once. Such a practice has faded away in most countries today, many parts of India like Western Parts, North-Eastern States, Himalayas, Central India, Eastern Ghats, Aravalis etc. being exceptions. The sacred forests, popularly known as sacred groves, are hydrologically important places, being at the sources of perennial streams and springs and associated with other water bodies. Such groves are known to shelter several sensitive climax and endemic species many of which might have vanished from the local or regional level (Ray *et*

al., 2014 & 2015). Among various ecosystem services rendered by sacred groves are their hydrological services and persistence of various aquatic species, especially faunal elements which require clean and cool waters and associated pristine habitats (Chandran *et al.*, 2010; Umazi *et al.*, 2013). Several studies have been carried out on flora and fauna (especially vertebrates) of the sacred groves of India during last three decades. In such studies, however, the aquatic insects, and in particular stream insects, though indicators of ecosystem health, have received only scanty attention if at all. Therefore the present study is aimed to inventorise the stream insect the stream insect community from a stretch of sacred forest stream in comparison with such a community from an adjoining stream from a non-sacred forest and to fortify issues related to conservation significance of sacred groves.

MATERIALS AND METHODS

Study area: The study was carried out in two neighbouring watersheds with similar topography and almost equal height of the hills, one with a sacred grove (14.59847° N, 74.55096° E) at Vibhuthi Falls and the second without a sacred grove (14.620623° N, 74.546915° E) at Mabgi Village in the Ankola Taluk of Uttara Kannada district, Karnataka. The area of watershed drainage basin of sacred forest and non-sacred forest are spread over 748.06 and 192.6 ha respectively. Both places receive average rainfall 3926.6 mm and the temperature ranges from 15 - 32 °C. The vegetation of the hill is of the tropical evergreen forest with some deciduous trees in areas under current or past disturbances. The NSG forest is more of semi-evergreen nature as it has previous history of slash and burn cultivation until almost a century ago. Ever since the practice stopped fire

factor became insignificant in the case study area, a heavy rainfall zone, promoting regeneration of evergreen species. With increase in such the population of deciduous trees started diminishing. Nevertheless the Mabgi forest has still several deciduous trees amidst regenerating evergreens. Notable of the deciduous are *Dillenia pentagyna*, *Grewia tiliifolia*, *Lagerstroemia microcarpa*, *Terminalia paniculata*, *Vitex altissima*, *Xylia xylocarpa* etc. Among the pioneer evergreens, of which there is good number is *Aporosa lindleyana*, *Holigarna arnottiana*, *Olea dioica*, *Pterospermum diversifolium*, *Syzygium cumini*, *Alstonia sholaris* etc. Of the late successional evergreens noticed are *Garcinia Morella*, *Knema attenuata*, *Polyalthia fragrans*, *Persea macrantha*, *Cinnamomum macrocarpum*, *Litsea* spp. etc. Wherever human disturbances are ongoing early stage pioneers like



Macaranga peltata, *Ervatamia heyneana*, *Lea macrophylla* and numerous weeds and lianas proliferate. Eroded soil surface strewn with rocks is characteristic of NSG forest.

The Vibhuthi-kan SG forest in most places is more intact and the canopy is of predominantly evergreen throughout the year. Of the evergreen trees noticed are *Calophyllum apetalum*, *C. tomentosum*, *Cinnamomum marocarpum*, *Holigarna grahamii*, *Dimocarpus longan*, *Polyalthia fragrans*, *Garcinia talbotii*, *Persea macrantha* and *Knema attenuata*, *Myristica malabarica*, *Syzygium* spp. etc. Isolated occurrence of Endangered tree *Madhuca bourdillonii*, originally recorded from Travancore Western Ghats, was reported by Chandran *et al.* (2008) from a stream bank of case study area. Presence of another rare species from the vulnerable category of IUCN, *Gymnacranthera*

canarica is an indicator of *Myristica* swamps and pristine streams.

Sampling methods: The study was conducted during September, 2014. Both stream sites, stretches measuring about 250 m each, were chosen for collecting insect sampling. At each sampling site, aquatic insects were collected from various substrates such as bedrocks, boulders, cobbles, leaf litter and dead wood. The sampling methodology was adopted from Sivaramakrishnan *et al.* (2000). Collected samples were preserved in 70% ethanol. In laboratory, the specimens were identified up to the best possible taxonomic level using helpful field keys (Dudgeon, 1999; Merritt and Cummins, 1988; Subramanian and Sivaramakrishnan, 2007; Balachandran *et al.*, 2011). Functional feeding categorization of aquatic insects was made in accordance with Dudgeon (1999) and Merritt and Cummins (1988).

RESULTS AND DISCUSSION

We recorded from both streams altogether a total of 33 genera of aquatic insects from 22 families and 7 orders (Table 1). Of these, generic richness of sacred grove (SG) stream was highest (30 taxa) than that of non-sacred grove, NSG (22 taxa). The SG had relative abundances: mayflies (54.53%), caddis flies (11.08%), dragonflies & damselflies (11.07%) and stoneflies (10.2). The NSG had mayflies (52.3%), dipteran flies (16.6%), caddis flies (11.4%) and remaining stream insect communities occupied less than 7 %. Members of the order Ephemeroptera are considered to be sensitive to environmental stress and their presence signified relatively clean conditions (Merritt and Cummins, 1978). Despite the assemblages of mayflies (Ephemeroptera) as predominant group in both streams, the SG was richer (14 genera) than the NSG (10 genera). Of

the 14 genera from SG, three are endemic to Western Ghats (*Petersula*, *Edmundsula* and *Janohyphella*) as shown figure 2. The conspicuous absence of some taxa like *Edmundsula*, *Leptophlebia*, and *Janohyphella* in the NSG, clearly indicates that the differences in vegetation composition and physical nature of landscape elements, relatively less altered in the SG than in the NSG have been decisive in the presence of these endemics in the SG. Caddis flies (Trichoptera) were the second dominant order, represented by 6 genera from 4 families. *Anisocentropus* sp, *Lepidostoma* sp, *Psychomyia* sp, *Parapsyche* sp and *Cheumatopsyche* sp. were recorded in SG stream and *Hydropsyche* sp and *Psychomyia* sp from the NSG stream. The genus *Hydropsyche* is cosmopolitan and tolerant of even toxic heavy metals (Rainbow *et al.*, 2012). The



high abundance of *Hydropsyche* sp and *Psychomyia* sp in the NSG indicate organic pollution and human disturbances related to agricultural runoff into the stream.

A typical aquatic insect community of a natural stream habitat is expected to have functional groups like shredders, collector-gatherers, predators, scappers and macrophyte-piercers. Functional feeding groups among aquatic insects are considered as a strong basis for comparative studies of the biomass and productivity of consumer groups across ecosystems, whereas it is much more difficult (and often less informative) to make such comparisons on a species-by-species basis (Hershey and Lamberti, 2001). The composition of functional feeding groups among the stream insect communities of SG and NSG streams is given in the figure 3. The notable presence of shredder community in the SG stream

alone is a significant difference with the NSG; the shredders are favored by good canopy of the riparian vegetation creating litter fall for them to act upon. On the contrary, the NSG stream has more of scrapper community, specialized in scrapping upon especially algal growth on comparatively well illuminated substratum due to poor tree canopy. Hence, in both the places the insect consumers respond to a situation of the overall forest vegetation composition, a decisive feature for determining functional feeding groups. The current study on aquatic insects in central Western Ghats, admittedly of fleeting nature, nevertheless, underscores the potential for making much more intensive and systematic studies in this underexplored region. Well designed sampling methodology and extended periods of observation will pave way for significant discoveries related to aquatic insect diversity and ecosystem functioning.

CONCLUSION

This study provides first glimpses of aquatic insect diversity of a stream associated with a sacred grove and another passing through a secondary forest which had underwent anthropogenic pressures like shifting cultivation, fire, timber logging etc. in the past and receives runoff from agriculture currently. The SG stream was richer in aquatic insect diversity with some notable Western Ghat endemics and presence of pollution sensitive taxa like *Edmundsula*, *Leptophlebia*, and *Janohyphella*. These aquatic insects, bio-indicators of good stream quality, is absent in the NSG stream which has poor riparian vegetation and past and ongoing anthropogenic pressures. At the same time it needs to be pointed out that these days natural sacred sites are attracting pilgrims and tourists in

increasing numbers, with adverse consequences on associated ecosystems. Dinakaran and Krishnan (1997) reported the disappearance of pollution sensitive taxa of mayflies (*Isca* sp), earlier recorded from Alagar Hills in the Eastern Ghats, a pilgrimage spot dedicated to the local deity Theerthakarai Raakayee Amman (meaning 'mother goddess of sacred water) due to increasing water pollution. Such threat looms large for the pristine stream of Vibhuthi especially from tourists who visit a beautiful waterfall in the stream. Many were found to take bath in the pool using soap and also littering the surroundings which can be detrimental to the pristine nature of the stream calling for promotion of ethical tourism and pilgrimage in natural sacred sites associated with water bodies.



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Table 1: List of aquatic insects inhabiting sacred and non-sacred streams.

Family	Species	VSF	VNS	Functional feeding group
Ephemeroptera				
Leptophlebiidae	<i>Petersula</i>			Collectors-gatherers
	<i>Choroterpes</i>			Collectors-gatherers, Scrapers
	<i>Edmundsula</i>			Collectors-gatherers
	<i>Isca</i>			Collectors-gatherers
	<i>Thraulius</i>			Collectors-gatherers
	<i>Leptophlebia</i>			Collectors-gatherers
Baetidae	<i>Baetis</i>			Scrapers, Collectors - gatherers
	<i>Platybaetis</i>			Scrapers, Collectors - gatherers
	<i>Labiobaetis</i>			Scrapers, Collectors - gatherers
Caenidae	<i>Canis</i>			Collectors-gatherers
Teloganodidae	<i>Teloganodes</i>			Scrapers, Collectors - gatherers
	<i>Janohyphella sp</i>			Scrapers, Collectors - gatherers
Heptageniidae	<i>Thalerosphyrus</i>			Scrapers, Collectors - gatherers
	<i>Epeorus</i>			Collectors - gatherers, Scrapers
Trichoptera				
Calamoceratidae	<i>Anisocentropus sp.</i>			Shredders-deteritivores
Lepidostomatidae	<i>Lepidostoma sp.</i>			Shredders-deteritivores
Hydropsychidae	<i>Parapsyche</i>			Collectors-filterers
	<i>Cheumatopsyche</i>			Collectors-filterers
	<i>Hydropsyche</i>			Collectors-filterers
Psychomyiidae	<i>Psychomyia sp</i>			Scrapers, Collectors - gatherers
Plecoptera				
Perlidae	<i>Neoperla</i>			Predators
Odanata				
Euphaeidae	<i>Euphae sp</i>			Predators
Libellulidae				Predators
Gomphidae				Predators
Coleoptera				
Scirtidae	<i>Unidentified</i>			Scrapers
Elmidae	<i>Stemelis</i>			Scrapers, Collectors - gatherers
Psephenidae	<i>Eubrianax</i>			Scrapers
Diptera				
Athericidae	<i>Unidentified</i>			Predators
Simuliidae	<i>Simulium sp.</i>			Collectors



Heteroptera				
Hebridae	<i>Unidentified</i>			Predators
Gerridae	<i>Gerris sp</i>			Predators
Corixidae	<i>Micronecta sp</i>			Piercers-herbivores, scrapers
Naucoridae	<i>Naucoris sp</i>			Predators

VSF= sacred forest stream (Vibhuthi Hill); VNS= non-sacred forest stream (Mabgi Village Hill); = Presence of taxa.

Figure 1: The present study area map in the Gangavali riverbasin.

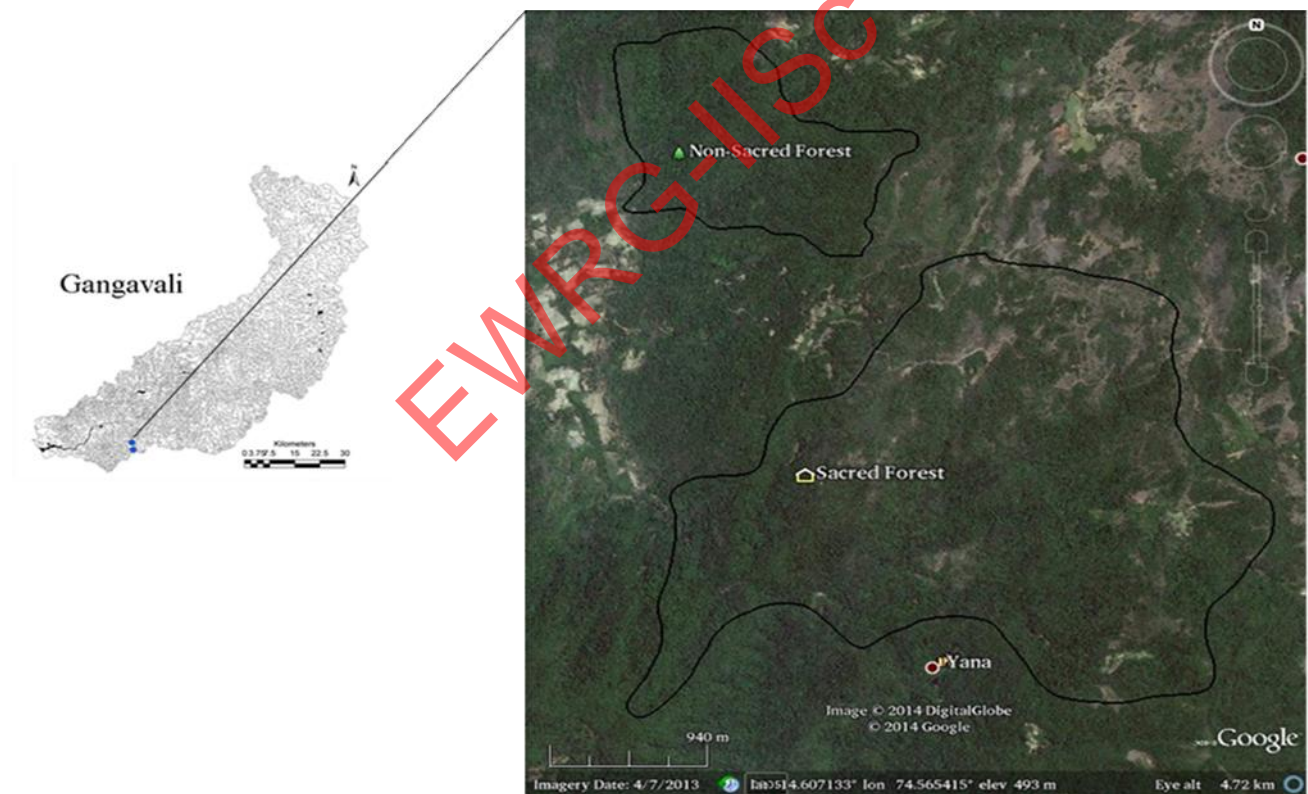


Figure 2: Aquatic insect genera in the SG and NSG stream.

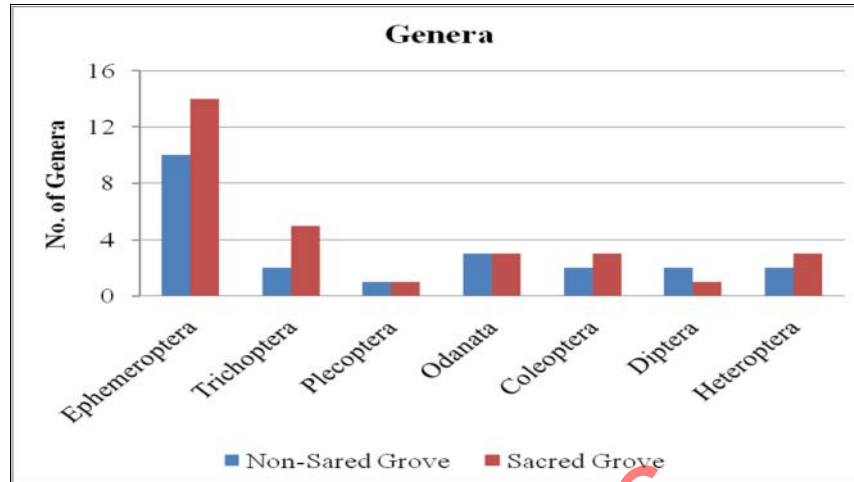


Figure 3: Functional feeding group in the SG and NSG stream

