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# Leaf Litter Degradation by Microbes and Macro Invertebrates in Mid Reaches Stream of Eastern Ghats

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***Abstract:*** The present work implies about the role of microorganisms and macro invertebrates in leaf litter degradation. Five fungal genera and five bacterial genera were isolated from the collected leaf litter samples. *Bacillus* sp and *Aspergillus niger* were as the dominant in bacterial and fungal genera respectively. The leaf litter was associated with the scrapers like *Baetis* sp, *Choroterpes* sp and *Hydropsyche* sp. The decline in microbial population was observed in February and it is due to the increase of the scrapers. The reason for the increase of scrapers is a non-shady environment which normally they tend to live that happens during February. The riparian cover becomes the governing body in controlling the population dynamics of scrapers and microbes. The result implies that fungi were the first one to colonize the leaf litter and it co-exists with bacteria and finally leaf litters are degraded by scrapers.

***Keywords***: Scrapers, Macro invertebrates, Fungi, Leaf litter

The degradation of leaf litter and other organic matters that falls into streams plays a vital role in the functioning of the ecosystem. Thus, examining factors that influence the degradation of leaf material in streams is critical for understanding ecosystems processes in nature (Sparkes et al 2008). Streams are naturally subjected to great spatial and temporal variability, which is likely to affect the distribution and activity of organisms. Various factors such as quality of leaf litter, pH (Dangles and Chauvet 2003), temperature and nutrient concentration regulating the leaf litter decomposition in fresh water habitat. Macro invertebrates being the secondary producers occupies most important place in regulating the energy dynamics of freshwater habitat. Western Ghats being one of the biodiversity hotspot being vastly studied in all sectors of diversity, distribution, spatio-temporal variation, leaf litter degradation and energy dynamics of benthic macro invertebrate community. Microorganisms like heterotrophic fungi and bacteria play a crucial role in decomposition of aquatic leaf litter and degradation of organic material in the freshwater habitat (Nizamydeen et al 2014), but only a little has been emphasized by the aquatic biologists for the community structure of aquatic fungi and bacteria in running waters. The present study can be used to provide information about the role of microorganisms and macro invertebrates in determining the pattern of leaf litter degradation in Sirumalai stream of Eastern Ghats.

## MATERIAL AND METHODS

**Study area:** Sirumalai hills belong to Sholavandhan range of Tamil Nadu forest department of Eastern Ghats (10º 18' N and 78º12'E), which has nine reserve forests extending over an area of 4,4769,74 acres. The main stream is Sathiar which originates from Pidariammanmalai at Manakattur and receives supplies from Sembodai stream and other small streams. Sampling was carried out in Thadaganachi Amman stream, which ultimately joins with Vaigai River (Fig. 1).

**Sampling rationale:** Leaf litter samples were collected for three months viz., October, December and February during 2018-2019. Leaf litter samples were collected in sterile vials and it is brought up to the laboratory and they were refrigerated. Water samples were also collected and physico-chemical parameters were analyzed using APHA guidelines (APHA 2005).

**Microbial analysis:** The leaf litter was soaked in water and serially diluted to $10^{-4}$ dilutions. From this dilution, 0.1ml was transferred to the Petri plates with nutrient agar and potato dextrose agar for bacterial and fungal growth, respectively.

**Enumeration of colonies:** The number of colonies was enumerated in each plate. The total number of microbes was determined per ml of original culture, multiplying the number of colonies by dilution factor.

**Identification of the microorganisms:** The isolated bacterial colonies were identified by Gram's staining method and biochemical characterization. Fungi were identified based on their morphology and spores following Lacto phenol Cotton blue staining method.

**Sampling of aquatic insects:** The most conventional sampling device, kick net of hand screen was used for

**Fig. 1.** Study site

sampling aquatic insects. The size of the net was $1m^2$ and approximately 100 µm mesh size following the methodology adopted by Burton and Sivaramakrishnan (1993) and macro invertebrates were identified with the help of suitable taxonomic literature.

## RESULTS AND DISCUSSION

Five fungal genera and five bacterial genera were isolated from the collected leaf litter samples at $10^{-2}$ and $10^{-3}$ dilutions (Table 1). Five bacterial genera include *Bacillus* sp., *Micrococcus* sp., *Staphylococcus aureus*, *Pseudomonas* sp., *Escherichia coli* and five fungal genera's *Aspergillus niger*, *Penicillium* sp., *Rhizopus* sp, *Sacchromyces* sp., *Cladosporium* sp. These were identified from the discrete colony forming units (cfu) obtained on nutrient agar and potato dextrose agar. The cfu was found to be highest during October and the lowest was recorded in February. In bacterial genera, a maximum of 126 x $10^{-3}$ cfu were produced by *Bacillus* sp in October and minimum of 2.1 x $10^{-3}$ cfu were produced by *Pseudomonas* sp in February. Among fungal genera, *Aspergillus niger* shows maximum cfu (13 x $10^{-2}$ cfu/gm) in October and *Penicillium* sp shows a minimum of 0.6 x $10^{-2}$ cfu/gm. *Aspergillus* and *Penicillium* were the primary colonizers and *Rhizopus* has been reported as one of the colonizers during the advanced stage of decomposition (Shanthi and Vittal 2010). Same trend was also observed in our results, as the *Rhizopus* number started to increase in the December whereas other fungal genera number was highest in October.

The leaf litter was associated with the scraper community macro invertebrates which includes two principal orders of aquatic insects, ephemeroptera and trichoptera of which ephemeroptera includes genera *Baetis* sp. and *Choroterpes* sp, whereas trichoptera includes *Hydropsyche* sp (Table 2), *Baetis* sp. was found to be maximum. The results of the study which also fits in the concept of River Continuum Concept (RCC) because in mid reaches streams,

**Table 1.** Mean number of colony forming units (cfu) of bacteria and fungi colonizing leaf litter

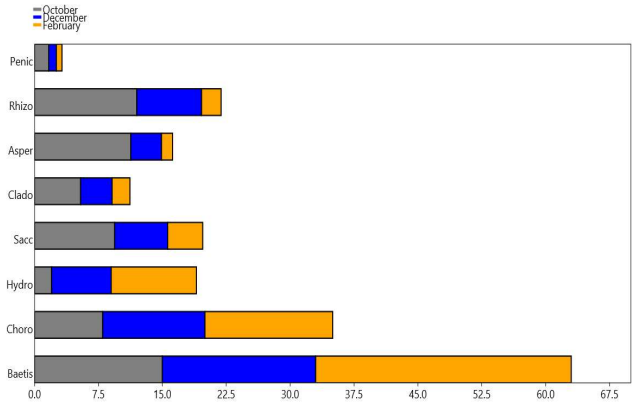
| Organism name | October | December | February |
|---|---|---|---|
| *Sacchromyces* sp. | 9.40 | 6.23 | 4.11 |
| *Cladosporium* sp. | 5.40 | 3.70 | 2.10 |
| *Aspergillus niger* | 11.30 | 3.60 | 1.30 |
| *Rhizopus* sp. | 12.00 | 7.60 | 2.30 |
| *Penicillium* sp. | 1.66 | 0.90 | 0.66 |
| *Bacillus* sp. | 116.33 | 72.00 | 62.60 |
| *Micrococcus* sp. | 44.33 | 22.30 | 11.66 |
| *Staphylococcus aureus* | 10.40 | 6.30 | 4.20 |
| *Pseudomonas* sp. | 7.60 | 6.10 | 2.10 |
| *Escherichia coli* | 17.10 | 14.30 | 11.11 |

**Table 2.** Scraper genera of aquatic insects colonizing leaf litter

| Genera | October | December | February |
|---|---|---|---|
| *Baetis* sp. | 15 | 18 | 30 |
| *Choroterpes* sp. | 8 | 12 | 15 |
| *Hydropsyche* sp. | 2 | 7 | 10 |

due to more influence of allochthonous matter, scraper community was found to be higher than the shredders (Vannote et al 1980). In this study, only scrapers are present so it fits in the concept of RCC as the feeding categorization changes when moves from head water streams to mid reaches streams (Vannote et al 1980). The association by scraper macro invertebrate communities like *Baetis*, *Choroterpes* (Ephemeroptera) and *Hydropsyche* (Trichoptera) along with leaf litter is substantiated by the observation of Anbalagan et al (2012). Fungi are the principal organisms in converting the leaf litter to more palatable form (Pascoal and Cassio 2004). In the present study, bacterial colonies outnumber the fungal colonies. The reduction in the abundance of fungi and increase of bacteria is due to the macro invertebrate interaction. The scraping community is strong enough to control the distribution and abundance of fungi indicating that, the growth of fungal population is inversely proportional to the number of scrapers (Fig. 2)

The decline in microbial population was observed in February and may be due to the end of post monsoon period which made less water flow with low percentage of canopy cover. In contrast to microbial population, macro invertebrate communities are higher in number in February. The reason for the increase of scrapers is because normally they tend to live in a non-shady environment, due to less canopy cover in February (Table 4), which makes suitable for the livelihood of scrapers and this leads to reduction of fungal communities. The riparian cover becomes the governing body in controlling




Penic-*Penicillium* sp, Rhizo-*Rhizopus* sp, Asper-*Aspergillus niger*, Clado-*Cladosporium* sp, Sacc-*Sacchromyces* sp, Hydro-*Hydropsyche* sp, Choro-*Choroterpes* sp, Baetis-*Baetis* sp

**Fig. 2.** Correlation of fungi and macro invertebrates in different months

**Table 3.** Mean physico-chemical parameters of Sirumalai hills

| Physico-chemical parameters | October | December | February |
|---|---|---|---|
| Water temperature (°C) | 30.1 | 29.5 | 28.3 |
| pH | 7.1 | 6.9 | 7.2 |
| Dissolved oxygen (mg/l) | 7.2 | 6.9 | 7.03 |
| Total dissolved solids (ppt) | 0.18 | 0.17 | 0.13 |
| Stream width (m) | 2.8 | 1.9 | 2.1 |
| Stream depth (m) | 0.1 | 0.2 | 0.5 |
| Stream flow (sec/m) | 6.1 | 8.2 | 4.2 |

**Table 4.** Mean habitat parameters for Sirumalai hill

| Parameters | October | December | February |
|---|---|---|---|
| Bedrock (%) | 10 | 8.3 | 60 |
| Boulders (%) | 50 | 27.4 | 20 |
| Pebbles (%) | 11.7 | 50 | 11.7 |
| Gravels (%) | 15 | 3.3 | 1.3 |
| Sand (%) | 13.3 | 11 | 7 |
| Riparian cover (%) | 80.3 | 83 | 60 |

the population dynamics of scraper community of insects. All other physico-chemical parameters fall within normal acceptable range (Table 3). The result predicts that fungi were the first one to start the leaf litter decomposition and it co-exists with bacteria and finally leaf litters are degraded by scrapers.

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## CONCLUSIONS

The leaf litter degradation was primarily done by aquatic fungi and bacteria, subsequently macro invertebrates were the last one to colonize. Poor forest management and forecasted climate change in Eastern Ghats were directly and indirectly influence on leaf litter decomposition. The micro and macro taxa along with riparian coverage can influence the decomposition mechanism of leaf litter in Sirumalai forest. In the future, a more detailed study on microbial biomass, chemistry of leaf litter and the physicochemical parameters of the stream will reveal the fate of the allochthonous energy inputs in running waters and the bioenergetics of the system.

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