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Hierarchical dynamics influence the distribution of immature black flies (Diptera: Simuliidae)

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ABSTRACT

Adult black flies (Simuliidae) are medically important insects and they are the sole vector of *Onchocerca volvulus*. Immature black flies are major components of aquatic macroinvertebrate assemblages in streams and play a vital role in nutrient dynamics. In this study, we examined effect of hierarchical dynamics (spatio-temporal pattern) on the distribution of immature black flies in South Indian streams. The sampling was done in streams of Western Ghats, South India. A total of 16 species belong to two subgenera: *Simulium* (10 species) and *Gowmphostilbia* (6 species) of *Simulium* were observed. Alpha diversity indices were analyzed, which indicate the abundance and species richness between sampling sites. Non-parametric analysis recognized the key environmental variables including latitude and stream order. Subsequently, the monsoon influences the larval assemblages and its association was high in leaf litter as revealed through statistical analyses. Although the members of the immature black fly assemblage with different environmental factors, they are very closely related to spatial and temporal organization and secondarily with other factors prevailing in streams.

1. Introduction

In ecology, the behavior of a species living in precise environmental conditions is termed as ecological niche. Within this general framework, understanding the species delimit is challenging, because many species are not limited and they are distributed in different environments. In this context, assemblage pattern of a species is important to find the specific environmental variables related to the distribution of species. Increasing pollution of the world, relationship between environmental variables and species groups is obligatory and it is most significant if the species is a vector. Consequently, this study focused on the family Simuliidae of the order Diptera, are an important medical and veterinary group of small hematophagous insects. The adult female black fly bite causes large range of problems for humans and other vertebrates (Choochote et al., 2005). Black fly larvae play a vital role as principal processors of plant materials in streams due to its filter feeding organization (Malmqvist et al., 2004; Srisuka et al., 2015).

The world black flies (Simuliidae) are represented by 2232 living species and 15 fossil species (Adler and Crosskey, 2017). In the Oriental region, black flies is represented by only one genus *Simulium* Latreille s. l. with ten subgenera (Currie and Adler 2008; Takaoka 2012). Of these, many species are recorded under vector groups. According to the world black fly inventory, the description of new species is increasing year by year. This may due two main reasons that taxonomic awareness/auxiliary concentration of this group and abundance of this species. Many reports suggesting the environmental factors play a major role for determining the distribution of black fly species (McCreadie et al., 2006a,b; Landeiro et al., 2009; Pachon and Walton, 2011; McCreadie and Adler, 2012; Rabha et al., 2013; Srisuka et al., 2015) and few reports reflecting that anthropogenic impacts influence the distributional pattern (Dinakaran and Anbalagan, 2007; Anbalagan et al., 2011, 2015). Still perplexing pattern found that assemblage of larval black fly species is related to whether environmental variables or anthropogenic impact.

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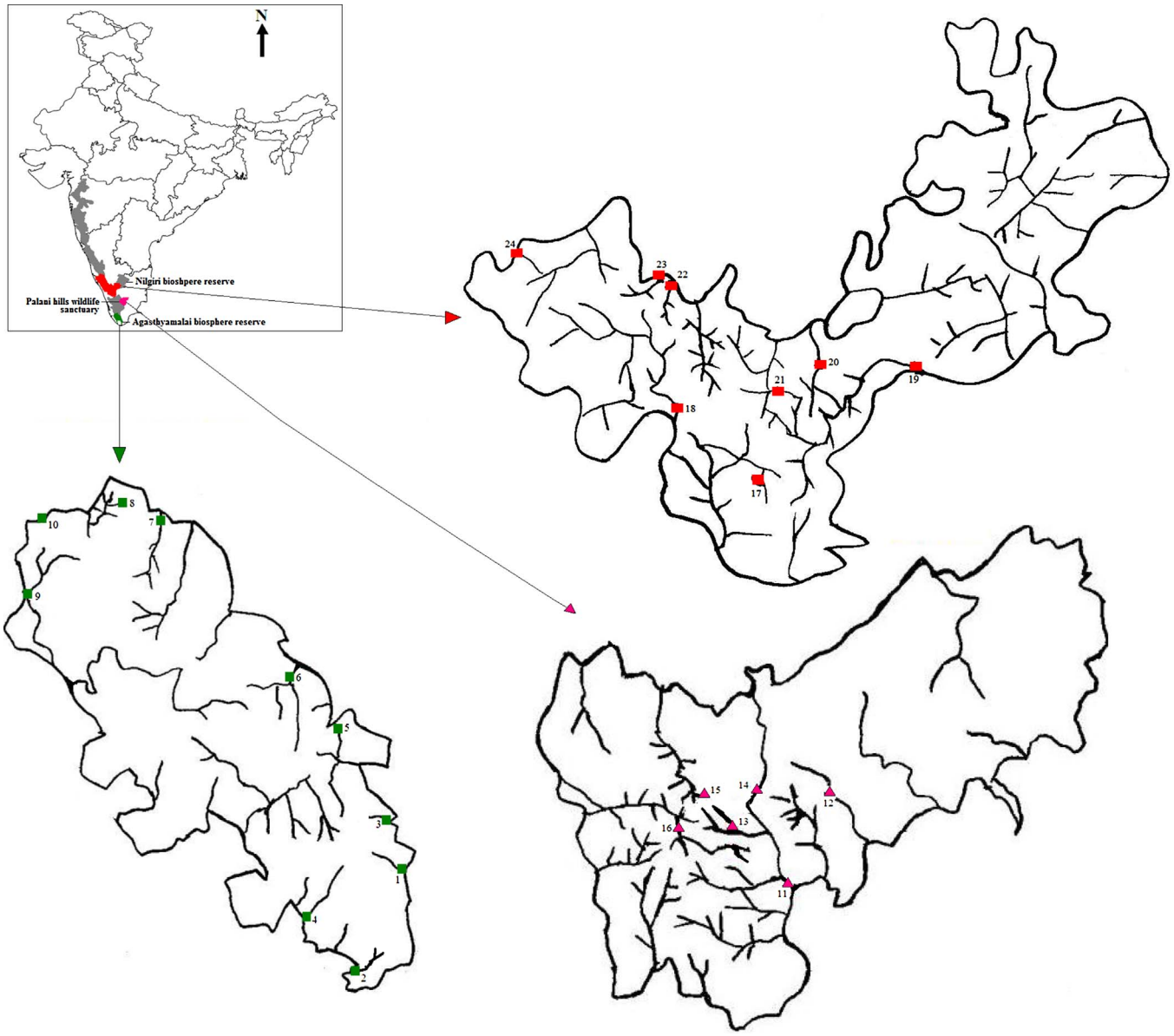

Fig. 1. Map of Western Ghats in South India with sampling sites (sampling site's name is given in Table 1).

South India contains the world's eight 'hottest hotspots' of Western Ghats and covers 1600 km from Kanyakumari to the north of Mumbai. It is characterized by a diverse plant and animal communities and holds many mountainous streams, which are presumed to support the diversity of aquatic insects. Today, a large part of the forest areas of Western Ghats has been rehabilitated to agriculture and urbanization. With these impacts, forests have led to habitat destruction, increased fragmentation and human-wildlife conflict. At this situation, there is necessary to study on the distribution and community structure of aquatic insects. The larval black flies are an important component in stream ecosystem, which heavily influenced by the alteration of environmental factors and anthropogenic impacts in streams of South India (Anbalagan et al., 2011). In this paper, we examined the two main aspects: the spatial and temporal distributional pattern of black flies and identify the precise environmental factor relating to the distribution of black flies in streams.