Distribution of larval and pupal stages of *Simulium* (Diptera: Simuliidae) flies in the Nilgiris hills of Tamil Nadu

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Abstract Endemicity of onchocerciasis (river blindness) in humans is linked to the location of *Simulium* spp. (black fly). The distribution of immature stages of *Simulium* in Sholur, Pykara, Gudalur, Coonoor and Kotagiri streams of the Nilgiris hills of Tamil Nadu was investigated during the months of May and July 2012. Out of these five streams, only Sholur was infested with larval and pupal stages of *Simulium* spp. Out of six plants collected from various water bodies, larval and pupal stages were found on the leaves and stems of an aquatic plant *Nasturtium officinale* and on the roots and leaves of *Pennisetum glandulosum*. The stages of *Simulium* were observed only during the summer month of May.

Keywords *Simulium* · Larval and pupal stages · Distribution and habitats · The Nilgiris hills · Tamil Nadu

Introduction

Black flies of the species *Simulium damnosum* complex, *Simulium exiguum* species complex and *Simulium ochraceum* species complex transmit the filarial nematode *Onchocerca volvulus* responsible for river blindness in

Africa and Central and South America (Cilek and Schaediger 2004). In addition, intense feeding by *Simulium* spp. can cause black fly fever due to injection of their saliva at the feeding site (Harwood and James 1979). *Simulium damnosum* is a species complex of 55 named cytoforms distributed throughout sub-Saharan Africa and the Arabian Peninsula and this complex includes *S. damnosum* sensu stricto, *S. exiguum*, *S. ochraceum*, *S. sanctipauli*, *S. sirbanum*, *S. squamosum*, *S. thyolense*, *S. vittatum* and *S. yahense*. Out of various *Simulium* species complexes, the *S. damnosum* species complex transmits *O. volvulus* and is considered to be of high economic importance as it affects millions of people in the world (Wada 1982; Kirkwood et al. 1983). In Nigeria, 28.70% of the *Simulium* species complex is infected with microfilariae of *O. volvulus* (Bich and Inuwa 2010). *Simulium* flies also bite cattle, horse and poultry and transmit *O. gutturosa*, equine encephalitis and *Leucocytozoon*, respectively (Urquhart et al. 1987). The present study was undertaken to understand the distribution and habitats of larval and pupal stages of *Simulium* flies in the Nilgiris hills of Tamil Nadu.

Materials and methods

The distribution of larval and pupal stages of *Simulium* in five streams (Sholur, Pykara, Gudalur, Coonoor and Kotagiri) of the Nilgiris hills of Tamil Nadu was investigated during May and July 2012. The immature stages (larval and pupal) were collected from submerged plants (Fig. 1) and counted after preservation in 70% ethanol and identification (Soulsby 1982; Mullen and Durden 2009). The plants in the streams were collected and identified (Hiscock 2005).

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Fig. 1 Collection of *Simulium* sp. larvae from a fast running water

Fig. 3 Pupal stages of *Simulium* sp. on *Pennisetum glandulosum*

Fig. 2 Larval stages of *Simulium* sp. on *Nasturtium officinale*

Fig. 4 Pupal stages of *Simulium* sp. on *Nasturtium officinale*

Result and discussion

The Nilgiris hills are an important tourist spot in Southern India. Sholur stream has swift streams with rock. The Pykara region has falls with fast running water and rock; the water comes from a hydroelectric power station (water flow speed increases several times than the normal flow after transient storage and sudden release of water from the power stations). Coonoor and Kotagiri regions have tea plantations and slow movement of water. Four seasons were observed in the Nilgiris hills of Tamil Nadu, namely winter (December to February), summer (March to May), southwest monsoon (June to August) and northeast monsoon (September to November).

Out of the five streams studied, Sholur was heavily infested with larval ($n = 2885$) and pupal stages ($n = 3257$) of *Simulium* (Figs. 2, 3, 4); in contrast, the other streams were free from immature stages of *Simulium*. The collected larvae were identified by the presence of an Indian club-shaped body, mouth parts with a pair of brush-like organs at the anterior end and presence of prolegs at

Fig. 5 Larval stage of *Simulium* sp.

the ventral surface of the anterior extremity (Fig. 5). Pupal stages were identified on the basis of the triangular cocoon with one branched dorsal and one ventral respiratory tube. The gill has 16 filaments arranged in a $[(2 + 3 + 3 + 2) + (2 + 4)]$ (Figs. 6, 7).

The stages of *Simulium* were observed only during the summer month (May) and were not found in the monsoon month (July). This is similar to observations by Cilek and

Fig. 6 Pupal stage of *Simulium* sp.

Schaediger (2004) who reported that the peak incidence of *S. slossonae* occurred more in the summer than the winter season of Florida. In contrast, the highest percentage of *Simulium* species flies was observed during winter followed by summer and monsoon in Palani hills, Tamil Nadu (Anbalagan et al. 2011).

Out of six plants (*Nasturtium officinale*, *Pennisetum glandulosum*, *Polygonum leshnaultucum*, *Cyprus weightii*, *Rotala rotundifolia* and *Eichhornia*), larval and pupal stages of *Simulium* sp. were found only on *N. officinale* and *P. glandulosum*. Larval stages were found on leaves (Fig. 2) and pupal stages were found only on the stem of *N. officinale* (Fig. 4). Similarly, larval stages were found on the leaves and pupal stages were found on the root of *P. glandulosum* (Fig. 3).

Sholur stream had boulders, sand, silt and a variety of plants, viz. *N. officinale* and *P. glandulosum*. Pykara stream had boulders and plants (mostly *P. leshnaultucum*). Coonoor and Kotagiri streams have pebbles and plants. Anbalagan et al. (2011) reported abundance of black flies in Silver cascade stream (90.52%) relative to the other streams. The abundance of larval and pupal stages of *Simulium* species in Sholur stream may be due to favourable stream substrates (boulders, sand, stones and aquatic plants) and flowing water

Fig. 7 Pupal stage of *Simulium* sp. (anterior end)

(Mullen and Durden 2009). In contrast, Anbalagan et al. (2011) opined that the release of a variety of solid and liquid waste at the site during summer by tourists, which was then distributed throughout the stream by water flow during monsoon months, was responsible for the abundance of larval black flies in the substrate during winter as they were able to utilize food from the waste.

In this study, the abundance of larval and pupal stages of *Simulium* species was observed only in the Sholur stream. Since *Simulium* spp. act as a vector for river blindness in Africa, further study is needed to understand the distribution of adult flies and detection of onchocercosis (if any) in human beings in the Nilgiris hills of Tamil Nadu.

Conclusion

Only the stream in the Sholur was heavily infested with larval and pupal stages of *Simulium* and these were found only on the leaves and stems of *N. officinale* and on the roots and leaves of *P. glandulosum*. Public awareness about the control of black flies can be improved in the Nilgiris districts of Tamil Nadu by removing these two plants in the water bodies where the fly population is largest and the immature stages are found on these two plants.

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