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Distribution of mosquito larvae in rice field habitats: a spatial scale analysis in semi-field condition

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ABSTRACT

The distribution of the mosquito larvae in the breeding habitats varies at the spatial scale depending on the availability of the resources and the predators. This proposition was assessed through the observation of the spatial distribution of *Culex* larvae (*Culex tritaeniorhynchus*) in artificially constructed rice field habitats. Using a binomial generalized linear model with logit link, the disparity in the abundance of the larvae was evaluated to justify the effects of light (light vs shade), vertical (surface vs bottom), and horizontal (wall vs center) distribution as explanatory variables. Under light availability, the spatial occupancy of the mosquito larvae was higher in the center than in the walls of the mesocosms. However, the larval orientation was higher on the surface than at the bottom of the mesocosms in all instances. In comparison to open spaces, the larval aggregation was higher in the presence of the floating vegetations like *Azolla* and *Lemna*, indicating that the habitat heterogeneity of the mesocosms influenced the distribution of the mosquito larvae in the available spaces. A reduction in the larval aggregation pattern in the spaces was observed in the presence of the predator (*Anisops* sp.) reflecting the possible evasion tactics of the mosquito larvae. The observations suggest that the mosquito larvae may utilize the vegetation in the rice field habitats quite effectively and occupy empty spaces of predators. The results may be considered as a prototype of the prospective localization of the mosquito larvae in the rice fields and help to frame the strategies of spraying the biopesticides to achieve optimal efficacy in mosquito regulation.

KEYWORDS

mosquito larva, *Culex* sp., rice fields, spatial distribution, vegetation, *Anisops* sp.

INTRODUCTION

Rice fields are exploited as breeding sites by a variety of mosquito species linked with the transmission of diseases affecting human and domestic animals (Pramanik et al., 2006; Sunish et al., 2006; Dale and Knight, 2008). Empirical studies around the world indicate that various species of *Anopheles* and *Culex* dominate the rice field habitats with the pupal productivity varying with the paddy rice cultivation pattern (Sunish and Reuben, 2002; Muturi et al., 2008; Mwangangi et al., 2008; Ohba et al., 2013; Lytra and Emmanouel, 2014). Application of the natural enemies alone, or in combination with the biopesticides, is considered as a feasible way of mosquito management. Successful mosquito control is however related to the understanding of larval dispersion patterns in the rice fields. Although the relative abundance of the mosquito larvae in rice fields varies with the time period of the rice cultivation, the dispersion of the mosquito immature is a crucial factor in successful regulation (Ohba et al., 2013, 2014; Watanabe et al., 2013). The efficacy of the predators and biopesticides depends on the contact with the mosquito larvae, and thus the dispersion of the mosquito larvae in the rice fields is a critical factor. Different studies have substantiated the asymmetric distribution of the larvae in the periphery and the center part of the rice field habitats (Mogi and Miyagi, 1990; Mogi et al., 1995; Sunish and Reuben, 2002; Das et al., 2006; Watanabe et al., 2013). The presence of the mosquito larvae in the central and the peripheral parts of the rice fields may relate to the oviposition habitat selection of the mosquitoes, perhaps in relation with the presence of the natural predators, like *Anisops* sp., dytiscid beetle, odonate larvae, etc, that may induce mortality to the larvae.

The habitat in the rice fields is complex owing to the presence of the paddy plants and physical structures including the sediment and the detritus. Often the mosquito larvae and co-occurring organisms utilize the physical structures as a refuge thereby altering the possible interactions within and between organisms (Saha et al., 2008, 2009). In order to evade