Local distribution of blackfly (Diptera, Simuliidae) larvae in two adjacent streams: the role of water current velocity in the diversity of blackfly larvae

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ABSTRACT. Local distribution of blackfly (Diptera, Simuliidae) larvae on two adjacent streams: The role of water current velocity in the diversity of blackfly larvae. This study aimed to evaluate the influence of water velocity speed on the local distribution and taxocenosis structure of blackfly larvae. The larvae were collected from two adjacent streams located in the municipality of Angra dos Reis (RJ): Caputera River and one of its tributaries. Riffle litter patches were sampled randomly using a 30 x 30 cm quadrat. Four blackfly species were found: Simulium incrustatum s. l. Lutz, 1910; Simulium (Inaequalium) sp.; Simulium pertinax s. l. Kollar, 1832 and Simulium subpallidum s. l. Lutz, 1909. Among these species, Simulium pertinax s. l. was clearly associated with higher water current speeds, while Simulium subpallidum s. l. showed association with lower water velocities, and Simulium (Inaequalium) sp. had a relatively constant distribution along the water current gradient.

KEYWORDS. Co-occurrence; diversity; Neotropical.


PALAVRAS-CHAVE. Co-ocorrência; diversidade; Neotropical.

Even though blackflies present a worldwide distribution, they can be locally restricted to areas where proper conditions allow the development of their immature forms (Lake & Burger 1983). One of the most remarkable characteristics of blackfly biology is their potential as colonizers (Kiel 1983). One of the most remarkable characteristics of blackfly biology is their potential as colonizers (Kiel 1983). One of the most remarkable characteristics of blackfly biology is their potential as colonizers (Kiel 1983).

Some studies relating the occupation of high water velocities as a strategy of predator avoidance for blackfly larvae can be found in literature (Ciborowski & Craig 1991; Hart & Merz 1998; Malmqvist & Sackman 1996; Merz 1991), however, only two studies on the relation between blackfly larvae abundance and water velocity can be found in the literature regarding the neotropical region (Moreira et al. 1994; Santos Jr. et al. 2007). From these mentioned studies, all focus on the effect of water velocity on a single blackfly species, thus, none approaches...
the role of this factor in the structure and composition of blackfly immature taxocenoses, which is evaluated in the current study.

**MATERIAL AND METHODS**

During March 2005, field sampling was taken in two adjacent streams located in the Angra dos Reis Municipality, Rio de Janeiro State, Brazil. Even though they are neighboring streams, they differ significantly in their physiognomic features. The first, which will be referred to as stream A, is a larger stream with about 15 meter mean width, and as such is more exposed to insolation. On the other hand, the second stream, which will be referred to as stream B, is a tributary of the first river, has mean width of about 5 meters, and a denser canopy cover, which results in more shadowing.

The samples were taken from 30 x 30 cm quadrats randomly distributed throughout both streams (one 10 meter section in each stream). As each random quadrat had its riffle litter content sampled, its mean water speed was measured using the head rod method (Wilm & Storey 1944). Blackfly larvae were separated in morphotypes, and identified in according to their cephalic spots patterns in comparison with mature larvae and pupae previously collected in these localities and species lists regarding that region found in literature (Araújo-Coutinho et al. 1988) and then quantified.

Each stream data was analyzed separately. They had their Shannon diversity index values calculated. As the sampling effort varied randomly for each velocity, mean abundance values were used. Correspondence analyses were performed in order to describe distributional patterns of blackfly larvae, to compare current velocity ranges and to establish their relationships with each other. For the correspondence analyses, data was sorted in four water speed classes.

**RESULTS AND DISCUSSION**

Four blackfly species were obtained in the samples from both streams: *Simulium pertinax* sl. Kollar,1832. *Simulium subpallidum* sl. Lutz, 1909. *Simulium incrustatum* sl. Lutz, 1910 and *Simulium* (*Inaequalium*) sp.

Blackfly community structure differed remarkably between streams: *S. pertinax* was the dominant species in both, but the second most abundant species in stream A was *S. subpallidum*, whereas in stream B *S. (Inaequalium) sp.* was the second most abundant species (Fig. 1). Comparison between the streams using Shannon index showed stream A (*H*=0.814715) as slightly more diverse than stream B (*H*=0.775942).

In both streams, there were well defined patterns for the most abundant species (Fig 1a,b), whereas the patterns for the remaining species were unclear. *S. pertinax* tended to be more abundant in higher water current speeds, whereas *S. subpallidum* seemed to have an opposite pattern, with a trend towards smaller abundances in faster sites. *S. (Inaequalium) sp.* showed no particular relationship with water current, as well as *S. incrustatum*.

The correspondence analysis for stream A (Fig. 2) showed *S. pertinax* almost equidistant in the multidimensional space to the third and fourth speed classes (0.95 m/s to 1.21 m/s and 1.21 m/s to 1.44 m/s), which means its optimal conditions are found somewhere in between these speed classes. On the other hand, *S. subpallidum* was located closer to the second speed class (0.70 m/s to 0.95 m/s), indicating that this is its optimal water speed regime. The remaining two species behaved as outliers, probably because of the small number of specimens sampled from them.

In stream B (Fig. 3), however, the correspondence analysis plotted *Simulium pertinax* closer to the third speed class (0.76 m/s to 0.92 m/s), and plotted *Simulium (Inaequalium) sp.* closer to the second water speed class (0.60 m/s to 0.76 m/s). The remaining species showed unclear associations to the water current speed classes, probably because of their rarity, which didn’t allow more detailed analyses.

The dominance of *Simulium pertinax* in stream A was clear, however, in Stream B there was a light difference to the second most abundant species, *S. (Inaequalium) sp.* The second most abundant species differed from stream A to B. As the correspondence analyses showed, both species seem to have a similar water current speed range (or at least, there is some level of overlap between their speed range associations) as their optimal habitat. This suggests that they are potential competitors for habitat. Thus, it seems that some other factor associated with the river physiognomic features must interfere in the outcome of this competition between these two species.
The role of water velocity variation as a form of habitat heterogeneity, and thus, a diversity generator, seem to be clear in our data: comparing both streams in relation to the length of their water current ranges and their respective diversities, it seems to be a positive relation between these two characteristics. Therefore, we suggest that the wider a water current velocity range is in a stream, the more diverse its blackfly taxocenosis tend to be.

This study shows for the first time comparative patterns of distribution of neotropical blackfly larvae species in relation to water velocity preference. However, due to the scarcity of detailed studies on morphology and foraging behavior of larvae, as well as the role of predators in blackfly population regulation and taxocenoses, further studies should be conducted, in order to identify and describe other important factors influencing local blackfly distribution in conjunction to water velocity, such as predation.

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