Acta Scientiae et Technicae, Vol 12, 2024. ISSN 2317-8957

Short Communication

Phenotypic plasticity and spatial distribution of *Simulium pertinax* larvae from the Tijuca National Park

Plasticidade fenotípica e distribuição espacial de larvas de *Simulium pertinax* do Parque Nacional da Tijuca

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ABSTRACT

Black fly larvae are filter feeding organisms that inhabit lotic systems and are considered key-organisms for their role as trophic link converting Fine Particles Organic Matter (FPOM) into Compact Particles Organic Matter (CPOM) making it available to a broader range of microorganisms. Literature suggests that black fly larvae may present phenotypic plasticity due to a wide range of physical factors such as water velocity, as well as food availability. The present study investigates the variation of morphological characteristics of *Simulium pertinax* larvae among different microhabitats in the Tijuca National Park, finding significant correlations among proleg length, anal disk and cephalic capsule sizes and the water velocity.

Keywords: Black flies. Bioindicator, Biomonitoring.

RESUMO

As larvas de simulídeos são organismos filtradores que habitam sistemas lóticos e são considerados organismos-chave por seu papel como elo trófico, convertendo matéria orgânica de partículas finas (FPOM) em matéria orgânica de partículas compactas (CPOM), tornando-a disponível para uma gama mais ampla de microrganismos. A literatura sugere que larvas de simulídeos podem apresentar plasticidade fenotípica devido a uma ampla gama de fatores físicos, como velocidade da água, bem como disponibilidade de alimento. O presente estudo investiga a variação das características morfológicas de larvas de *Simulium pertinax* entre diferentes microhabitats no Parque Nacional da Tijuca, encontrando correlações significativas entre o comprimento da perna, o tamanho do disco anal, da cápsula cefálica e a velocidade da água.

Palavras-chave: Borrachudos, Bioindicador, Biomonitoramento.

Members of the Simuliidae family, commonly known as black flies or "piums" in Brazil, are dipterans with a worldwide distribution, found everywhere except for the Antarctic region, deserts, and islands devoid of streams (CROSSKEY, 1990). The larvae are aquatic and filter-feeding, consuming fine organic particles dissolved and suspended in water (ALENCAR et al. 2001). They are commonly found in rivers with high dissolved oxygen content and varying levels of organic matter (STRIEDER et al. 2002). Currently, there are 2,407 valid species of Simuliidae, with 97 species recorded in Brazil (ADLER, 2024). Among the Simuliidae species found in Brazil, *Simulium pertinax* Kollar is considered the main anthropophilic species in the southeastern region (ARAÚJO-COUTINHO et al. 1988), where it is found in large densities and becomes an annoyance to humans and domestic animals, affecting tourism and agriculture activities (ARAÚJO-COUTINHO & LACEY, 1990). Since the larvae of Simuliidae are rheophilic, meaning they depend on currents (ALENCAR et al. 2001), larvae of different species can be found together, depending on different current speed ranges, and water variability can influence the heterogeneity of Simuliidae habitats, directly correlating with species diversity (FIGUEIRÓ et al. 2008; 2012).

Environmental factors, such as water speed, combined with ontogenetic factors, can influence the growth rate of an organism (BRIERS et al. 2004), impacting the phenotypic plasticity, which is the ability of organisms to alter their physiology or morphology in response to environmental conditions (NYLIN; GOTTHARD, 1998). The aim of this study is to investigate the phenotypic plasticity in *Simulium pertinax*, seeking to identify correlations between its morphology and the microhabitat it occupies.

The study area was the Tijuca National Park, located in the city of Rio de Janeiro, in the mountains of the Tijuca Massif, between the parallels 22°55'S and 23°00'S and the meridians 43°11'W and 43°19'W, a conservation unit that protects fragments of the Atlantic Forest with high biological diversity and good conservation status (ICMBIO, 2008). Collections were made in five sections of streams within the protected areas of Tijuca National Park, and substrates containing Simuliidae larvae were collected from a total of fifteen 30x30 cm quadrats randomly distributed between the stream margins and the center of each site. The average velocity, the dominant substrate type (current leaf litter), and the depth were recorded for each quadrat. Water velocity measurements were taken using the "Head Rod" method (WILM & STOREY, 1944). The larvae were stored in 70% ethanol, and later subjected to morphotyping and species identification using the key by Gil-Azevedo et al. (2005). Final instar specimens, with mature histoblasts, were dissected and mounted between a slide and coverslip following the method of Calvão & Maia-Herzog (2003). Fourteen *S. pertinax* larvae were selected, and their images were captured using a Motic SMZ140 stereoscopic microscope coupled with a Moticam 5.0 MP image capture device. The obtained images were then measured using the CMEIAS Image Tool software. The morphological measurements were each subjected to linear regression, with water velocity as the independent variable.After performing the linear regression analysis (Figure 1 to 3), a negative correlation was found between the head capsule (p=0.0385), proleg (p=0.0154), and anal disc (p=0.0145) with water velocity, indicating that these structures tended to be smaller at higher water velocities. Larvae with smaller head capsules, proleg, and anal discs were more frequent in faster currents.

Figure 1: Linear regression of current velocity versus anal disc.

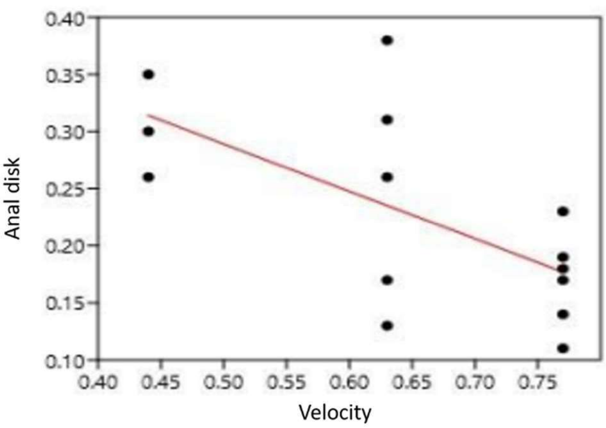


Figure 2: Linear regression of current velocity versus head capsule.

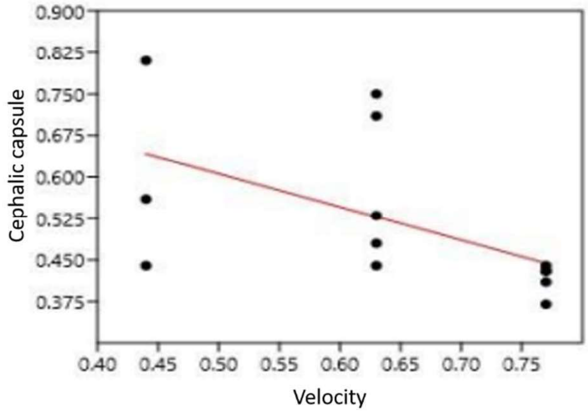
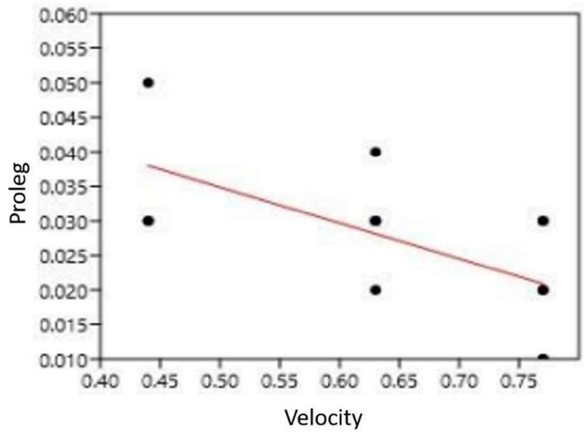


Figure 3: Linear regression of current velocity versus proleg.



These results contrast with those of Figueiró et al. (2015) for the species *Simulium subpallidum* Lutz 1909, where the authors observed a tendency for the structures of the proleg and anal disc to increase at higher current velocities. Such divergence in patterns may be due to species-specific characteristics or even differences between the rivers of the Cerrado biome and those of the Atlantic Forest biome.

Another point is that competition between species may be a factor that explains distribution depending on water speed because larger larvae may competitively exclude smaller larvae from the best locations; thus, smaller larvae are often forced to disperse in search of sufficiently fast flow (HEMPHIL, 1988; 1991). It can be assumed, therefore, that larvae with smaller morphological structures of head capsule, anal disc, and proleg are better adapted to higher current velocities. Studies in the literature suggest that smaller larval structures can reduce the energy cost of resisting the current (ZHANG & MALMQVIST, 1996, 1997; ZHANG, 2000; PALMER & CRAIG, 2000). It can be concluded that phenotypic plasticity was observed in *Simulium pertinax* larvae, with variations in the structures of the head capsule, anal disc, and proleg. The patterns found in this study differ from similar studies in other Brazilian biomes with other species, which may be related to the specificities of each species or different selective pressures.

AKNOWLEDGEMENTS

The authors would like to thank Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ) for the financial support.

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