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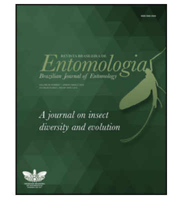

Biology, Ecology and Diversity

The invasive white ginger lily (*Hedichium coronarium*) simplifies the trait composition of an insect assemblage in the littoral zone of a Savanna reservoir

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A B S T R A C T

The invasive white ginger lily (*Hedichium coronarium* – J. Köenig, 1783) simplifies the trait composition of an insect assemblage in the littoral zone of a Savanna reservoir. Invasive plants are believed to shift the trait composition of aquatic insects dwelling in banks of lentic ecosystems. In this study, we analyzed the relationship between the presence of the invasive white ginger lily (*H. coronarium*) and the functional trait indices of the aquatic insect assemblage in the littoral zone of a tropical reservoir. We sampled aquatic insects on the invaded and non-invaded banks of the reservoir and then analyzed the insect trait indices by estimating the Functional Dispersion (FDis), Functional Evenness (FEve) and the Functional Divergence (FDiv), as well as the Community level Weight-Mean traits (CWM). Finally, we compared these indices between invaded and non-invaded banks as well as their relationship with the abiotic variables, such as dissolved oxygen, pH, depth and water temperature. The result confirmed that the invaded banks had lower values of functional indices as well as dissolved oxygen. However, this abiotic variable was found to have no effect on the functional indices. In addition, the white ginger lily bank presented higher contribution of collector-gathering to predator-piercer groups. We suggest that the invasion of white ginger lily promotes low heterogeneity habitat resulting in simplification on functional traits of aquatic insect assemblage.

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Introduction

The littoral zone of lentic system contains highly diversed community (Heino, 2000, 2008); this biodiversity of this ecosystem have been seriously disturbed and threatened by human activities and is on the verge of losing its characteristic features (e.g. nutrient storage, water supply, recreation) (Brauns et al., 2007; McGoff et al., 2013). The invasive species plants are among the main stressors agents that shift the diversity and structure of many assemblages in freshwater systems (Kelly and Hawes, 2005), especially of the aquatic insects (Kovalenko et al., 2010). With respect to this, it research has shown that alteration of structure of aquatic insect assemblage by invasive plants has important implications to their diversity maintenance. This is justified by the ecological relationships observed between these representative communities, especially those involving the changes caused by decomposition and habitat structure (Vannote et al., 1980; Graça, 2001).

For instance, the growth of macrophytes in the littoral zones provides habitat (Cheruvelil et al., 2000; Becerra-Muñoz and Schramm, 2007) and food resource that promote high diversity of aquatic insects (Cronin et al., 1998; Clapcott and Bunn, 2003; Stenberg and Stenberg, 2012). Nevertheless, the consumption of invasive macrophyte plants such as Eurasian watermill foil (*Myriophilum spicatum*), which contains high concentrations of secondary compounds (e.g., polyphenols), can interfere with the growth rate of some aquatic insect species (Choi et al., 2002). This could results to changes of the structural assemblage due to the removal of some functional feeding group especially shredders (Boyero et al., 2012) this change would have a negative impact in the bioconversion of Coarse Particulate Organic Matter CPOM to Fine Particulate Organic Matter (FPOM) which is the major food resource to collector-gather and filtering-feeders groups. Another important aspect is related to changes in habitat structure, the change in the habitat structure is to verify the absence of which invasive macrophyte species have caused the changes in the freshwater systems. In respect to this,

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invasive submerged macrophyte species such as *Hydrilla* (*Hydrilla verticillata*) and Eurasian watermilfoil (*M. spicatum*) with high morphological complexity host great abundance of aquatic insects, especially those that present high vulnerability to fish predators (e.g. Odonata) (Theel et al., 2008; Kovalenko and Dibble, 2011). This occurs because macrophytes with higher morphological complexity impair to predators identify their preys, which present adaptive ability to blend with their intrinsic spaces. The dominance of these invasive macrophytes have been reported as the major factor that disrupts food webs through decoupling of predator-prey interactions due to the homogenization of habitat (Kovalenko and Dibble, 2011).

Considering the role of ecological processes previously mentioned and the biological invasions causing the decrease biodiversity (Dundgeon, 2010), our aim in this study was to investigate the influence of the invasive plant, white ginger lily (*Hedychium coronarium* – J. Köenig, 1783) in the aquatic insect assemblage's traits composition in the littoral zone of a tropical reservoir. In Brazil, this invasive plant is widely distributed with high predominance in marshy areas, mainly in coastal regions, as well as in transition regions between the Atlantic Forest and the Cerrado (Zenni and Ziller, 2011). These invasive emergent plants species (e.g. *Urocloa* sp.), the white ginger lily presents strong competitive strategies such as fast growth and rapid dispersal that enable them to become dominant in wetlands, riparian zones, lake banks, where it forms dense populations (De Castro et al., 2016). Additional information regarding the influence of these invasive plants species in aquatic insects assemblages have been attempted to explain the change in the functional feeding group's (FFG) and the claim about whether invasive macrophyte species can alter other aquatic insect's functional structures such as body length and habit, which are directly related to habitat modification. Here, we explored the Functional Diversity (FD) using a multimetric dissimilarity index approach, which we explored as aquatic insect's combination traits (FFG, body length, strategy feed and habitat) to analyze the influence of invasive plant in the aquatic insect trait assemblage composition. To do this, we utilized three FD indices, which explore different ecological traits aspect of niche assemblages: (i) Functional dispersion (FDis) – which measure how composition traits differ among species within assemblages; (ii) Functional evenness (FEve) – which measure how niche space is occupy by traits composition assemblages, and (iii) Functional divergence (FDiv) – which measure the level of niche differentiation by functional traits within the assemblages.

It was expected that the dominance of the invasive white ginger lily would modify some of the environmental conditions such as abiotic variables and the habitat structure of this invaded bank and consequently would lead to a simplification of the trait composition of the aquatic insect assemblage resulting to a decrease of the FD indices. This resultant would be a niche constrain of aquatic insect assemblages, once specified the aquatic species traits selection would mirror the habitat and the resource food modification caused by the invasive dominance of macrophyte.

Material and methods

Study area

This study was performed in a tropical reservoir located in a preserved area of Brazilian Savanna vegetation (Cerrado Biome) in the central region of São Paulo State (Brazil) (Fig. 1). The Fazzari reservoir presents chemical characteristics such as high levels of dissolved oxygen, slightly acidic pH, low ammonium and nitrite concentrations (Table 1), and diverse vegetation on its banks. Its total area is 11,370 m^2, 220 meters long, an average width of 51.5 m

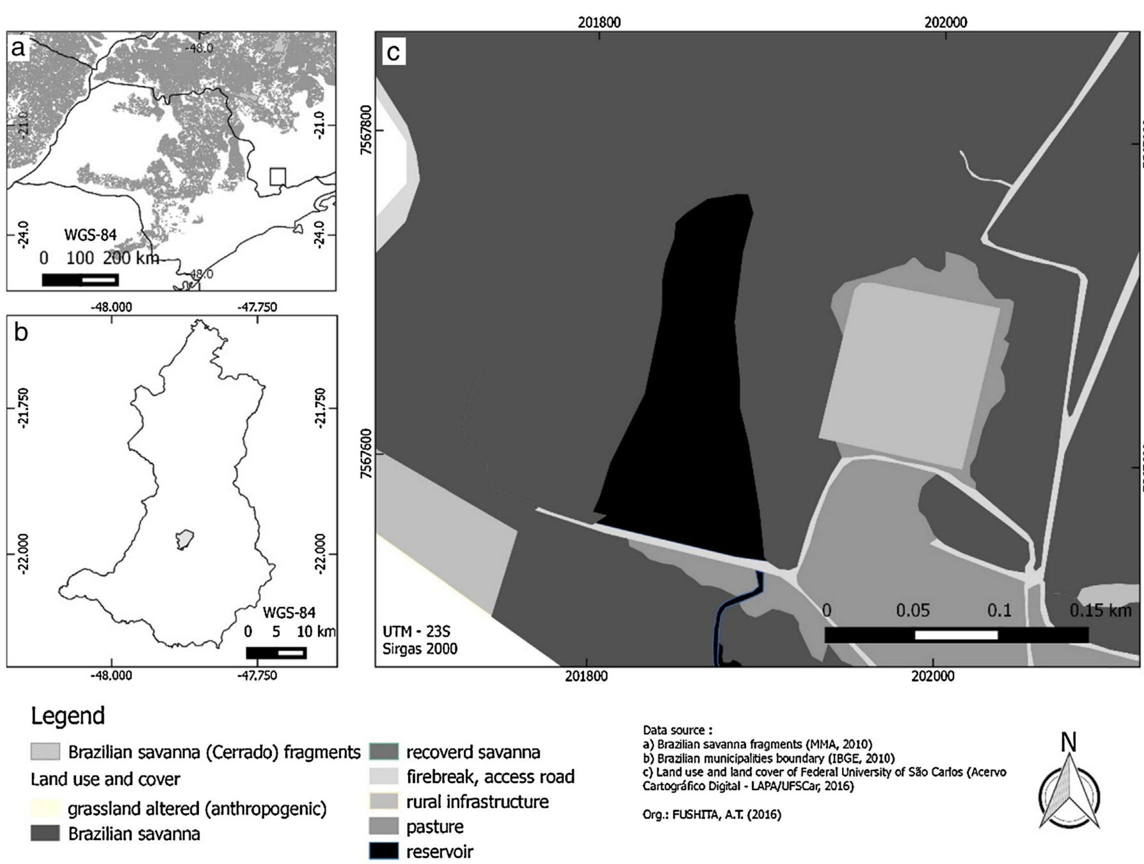

Fig. 1. Location and characterization of plant composition banks of Fazzari reservoir in the Brazilian Savanna (Cerrado Biome, Brazil).

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