



Can insect assemblages tell us something about the urban environment health?

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Abstract: If we consider Drosophilidae, the answer to the question above is yes. Many research groups in Brazil and abroad have been showing that assemblages of flies of this family can reflect environmental alteration levels caused by urbanization, and/or by other human disturbances. I will present here a summary of our findings in Drosophilidae assemblages reflecting different degrees of environmental perturbation. These studies were done by graduate students of two post graduate programs of UFRGS, under my supervision, along several decades. I will also present the results stemming from the effort of other Brazilian Drosophilid study groups while identifying the members of those assemblages in different Biomes. As a result of those field studies, several biological invasions were detected and many new important biological problems arose prone to be investigated by genetic, molecular biology and other related approaches.

Key words: Bioindication, Brazilian Biomes, Drosophilidae, urbanization.

INTRODUCTION

The southern states of Brazil present different morphoclimatic characteristics than the other states of the country. They are influenced by a subtropical climate, with four well-defined seasons. The state of Rio Grande do Sul encompasses two biomes: Pampa and Atlantic Forest. Pampa is a biome exclusive to the state of Rio Grande do Sul, characterized by shrub and grassland ecosystems. According to the Brazilian Environment Ministry (Ministério do Meio Ambiente), “it has great biodiversity not discovered”. Despite this, it is the Brazilian biome with the lowest percentage of areas protected by conservation units. The Atlantic Forest biome, characterized by native forest

formations and associated ecosystems, such as high altitude grasslands, mangroves, and open fields (“restingas”), and is one of the most biodiverse areas in the world. These biomes are interspaced with crop fields, pastures, livestock farming, and urbanized areas.

Our group analyzed whether different levels of urban disturbance could cause changes in genetic and cytogenetic characteristics of Neotropical *Drosophila* populations in the urban and suburban areas of Porto Alegre, Rio Grande do Sul State (Valente et al. 1989, 1993, Santos and Valente 1990, review in Valente 1999).

Bonorino et al. (1993), Rohde and Valente (1996) and Valiati and Valente (1996) characterized the urban fauna of flies and compared assemblages of Drosophilidae in nature and in transitional

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environments. We detected different breeding sites being explored by distinct species, revealing the fine sensibility of those flies to changeable environments (Saavedra et al. 1995).

Later, we characterized the assemblages of Drosophilidae in the urban area of Florianópolis, in the Santa Catarina State (Gottschalk et al. 2007, 2008) and we also re-surveyed the urban area of Porto Alegre, to check if changes occurred over ten years. (Garcia et al. 2008) and (Garcia et al. 2012).

Ruszczyk (1986) compared butterfly assemblages in areas with different levels of urbanization and with woodlands in the suburbs. Lucchese et al. (2003) tested *Drosophila willistoni* as a bioindicator of air quality, measuring its absorption of urban pollutants, as Cd, S, and Pb. The results showed that to be true. However, not only one species should be considered a bioindicator, but the composition and stability of the assemblages.

After these studies, we perceived the presence and dominance of different species and/or composition of species in assemblages. Later, more localities were surveyed, and we detected an unexpected richness composition of the Drosophilidae assemblages in neglected biomes, such as ecosystems of Atlantic Forest, like mangroves (Schmitz et al. 2007) and “restingas” (Bizzo et al. 2010, Mendes et al. 2017).

Extending our review to studies performed in other regions and habitats, we verified the sensitivity of fly assemblages to environments, revealing the peculiarities of each of them. This corroborates other research, starting with Sene et al. 1980, which have been observing the fly associations to morphoclimatic domains in Brazil such as Cerrado (Mata et al. 2008, Ferreira and Tidon 2005, Döge et al. 2015), Amazonia (Martins 2001), xerophytic vegetations and island forest fragments and araucaria fields (Mateus et al. 2006, 2018, Cavasini et al. 2014), and other environments (Medeiros and Klaczko 2004, Torres and Madi-Ravazzi 2006).

Also, several researchers registered the occurrence and rapid expansion of invader species along the continent, such as the pest fly *Zaprionus indianus*, which have been registered in the state of São Paulo (Vilela 1999), in Southern Brazil (Castro and Valente 2001, Silva et al. 2005), Cerrado (Tidon et al. 2003, Leão and Tidon 2004), Amazonia (Furtado and Martins 2009, Amador et al. 2011), in the state of Rio de Janeiro (Loh and Bitner-Mathé 2005) and also in Uruguay (Goñi et al. 2001).

Recently, our group found another pest invader - *Drosophila suzukii* (Deprá et al. 2014) in the Rio Grande do Sul and Santa Catarina states. This species, like *Z. indianus*, quickly colonized a great part of the South American continent (Vilela and Mori 2014, Paula et al. 2014, Bitner- Mathé et al. 2014, Fraimount et al. 2017, Santos et al. 2017), causing significant losses to agriculture, since the females oviposit in healthy fruits (Schlesener et al. 2015).

Besides all those findings while monitoring urban fly assemblages, we detected other singular phenomena, such as hypermutability in urban populations of the cosmopolite *Drosophila simulans* (Loreto et al. 1998; review in Loreto et al. 2018), which paved the way to discover the effect of transposable elements and to investigate the influence of this part of the genomes. Transposable elements (review in Wicker et al. 2007) can move into the host genomes and disturb its stability in response to several types of stress, including environmental changes.

So, insects and particularly Drosophilidae could be considered as a good, cheap and informative way of monitoring the “health state” of the urban environments. They also could be “sentinels” of the invasion by other alien species, like *Drosophila malerkotliana* (Martins 2001), Garcia et al. 2005), besides *Zaprionus indianus* and *Drosophila suzukii*, that endanger the richness of both the native fauna and the host plants, including those of economic value. Still, the Drosophilidae

family can be used to prove the importance of conservation units, as proposed by Mata et al. (2010) and verified by Oliveira et al. (2016b). In the latest study, the authors analyzed three conservation units and surrounding areas of three Northeastern Brazilian states in the Caatinga biome.

The vast Amazonian region and its progressive urban occupation should be an adequate “testing area” for such studies, as have been shown by Dr. Marlúcia Martins and her group at Emilio Goeldi Museum (review in Santa-Brígida et al. 2017).

Finally, the maturity of the Brazilian and South American Drosophilidae researchers, including zoologists, ecologists, and geneticists, allows the creation of a robust collaboration network. These researchers are capable not only of identifying the status of conservation of our natural resources but also several biological sophisticated issues, besides promoting the qualification of skilled specialists for those purposes.

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