Occurrence of invasive species *Drosophila nasuta* in Atlantic Rainforest, Brazil.

Batista, M.R.D.[a], M.T. Brianti[a], C.A.C. Andrade[b], and L.B. Klaczko[a]. [a]Laboratório de Biodiversidade Genética e Evolução de *Drosophila*, Departamento de Genética, Evolução e Bioagentes, Instituto de Biologia, Universidade Estadual de Campinas – UNICAMP, Cx. Postal 6109, Campinas, 13083-970 SP, Brazil; [b]Marine Biology Department, Biology Institute, Federal Fluminense University, P.O. Box. 100644, 24001-970 Niterói, RJ, Brazil; E-mail: LBK@unicamp.br

In March 2015, Vilela and Goñi (2015) reported the occurrence of invasive species *Drosophila nasuta* in the city of São Paulo, Brazil. We have been monitoring shifts in chromosomal inversion frequencies of *D. mediopunctata* from the Parque Nacional do Itatiaia, RJ, Brazil (22°26'S, 44°37'W) in the last 30 years (Ananina *et al*. 2004; Batista *et al*., 2012; Batista and Klaczko, 2013). We had never collected a single specimen of *D. nasuta* in this well preserved National Forest that belongs to the Atlantic Rainforest in Brazil. When sorting collected flies in March 2015, we observed orange colored flies with one row of cuneiform setae on anteroventral side of profemur. We confirmed their identification as *D. nasuta* by examining external morphology and the genitalia of males collected and compared them to the description made by Vilela and Goñi (2015). Thus, for the first time, this species was collected at the Parque Nacional do Itatiaia, RJ, Brazil (N = 60). In our following collection (September 2015), we did not observe *D. nasuta* among the collected flies. However, the species was collected again in our two following field trips: November 2015 (N = 14) and March 2016 (N = 19).

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High abundance of exotic drosophilids in a gallery forest of the Brazilian savanna.

Deus, P.H.M., and F. Roque. Instituto Federal de Brasília, Planaltina, DF – BRAZIL; Corresponding author: francisco.roque@ifb.edu.br.

Introduction

Among the terrestrial environments, forests shelter the highest biodiversity because of their environmental heterogeneity. The Brazilian savanna holds a complex of very rich vegetal formations, located mainly in central Brazil. Forests occupy only 5% of this biome, but contain the highest biodiversity of this region, because they harbor most of the unique and rare species, as well as common species of its different environments (Mittermeier *et al*., 2005; Tidon, 2006). Nevertheless, countless gallery forests of the Brazilian savanna have not yet been studied and so are extremely threatened by anthropogenic pressures (fragmentation,

deforestation, and fire). These areas deserve, therefore, local studies toward obtaining critical subsidies necessary for their preservation and conservation.

Taxonomic surveys focusing on drosophilid of the Brazilian savanna revealed the existence of 129 species (Roque *et al*., 2015). Most of this biodiversity is native to the Neotropical region and is found mainly in the rainy season in preserved forests (Tidon, 2006; Mata *et al*., 2008a; Roque *et al*., 2013). This distribution pattern has been associated with greater availability of resources (fruits, fungi, flowers, etc.) in forest environments during the rainy season (Leão and Tidon, 2004; Roque *et al*., 2009; Valadão *et al*., 2010).

This research is part of a broader project aimed at describing the fauna and flora of the *Campus Planaltina* of the *Instituto Federal de Brasília* to support the creation of an integral protection area for its biodiversity. Thus, to improve the knowledge about the richness and the distribution of drosophilids in the Brazilian savanna, we made collections of adult drosophilids in a gallery forest of Planaltina-DF to (1) identify the local drosophilid fauna, and (2) evaluate the existence of temporal patterns of this fauna.

Materials and Methods

We performed eight collections of adult drosophilids from September 2015 to April 2016 in a gallery forest situated in the vicinity of the *Campus Planaltina* of the *Instituto Federal de Brasília* (15°38'44.2"S; 47°41'44.9"W). In each collection, we sampled the forest by exposing five retention traps (Roque *et al*., 2011) separated by at least 30 m. The traps were baited with fermented bananas and left inside the forest for three consecutive days.

We preserved captured flies in ethanol 70% and identified all of them using external morphology (Freire and Pavan, 1949; Magalhães, 1962; Poppe *et al*., 2015). In cases of cryptic species, we conducted analysis of male terminalia according to Bächli *et al*. (2004). Individual-based rarefaction curves for all drosophilids were compiled to assess the completeness of the samples (Sest; EstimateS 9.1; Cowell, 2013). To evaluate temporal fluctuation of this fauna, we quantified the total amount of native (NEO) and exotic (EXO) species. After removing November 2015 (N = 0) from our data, statistically significant differences in the proportional values of NEO and EXO among months were assessed using the chi-squared statistical test (Contingency Table) in Past 2.16 (Hammer *et al*., 2001). We deposited vouchers at the Collection of the *Laboratório de Biologia Animal* of the *Instituto Federal de Brasília* (*Campus Planaltina*) for comparisons.

Results and Discussion

Overall, we captured 1,876 drosophilids representing 22 species of the genera *Drosophila*, *Scaptodrosophila*, and *Zaprionus*. *Drosophila* was the most specious genus (20 species) and *D. simulans* the most abundant species (N = 466) (Table 1). The rarefaction curves showed a tendency to reach an asymptote (Figure 1), but additional collections will be required for a full description of this assemblage. Although the biodiversity of drosophilids recognized for the Brazilian savanna (Roque *et al*., 2015) is an underestimate, studies carried out in this biome have shown that gallery forests are the biodiversity centers for this taxon (Tidon, 2006; Mata *et al*., 2008a; Roque and Tidon, 2013). Unfortunately, our data do not follow such a pattern, because we captured only about 17% of the total Drosophilidae fauna of the Cerrado. A possible reason for this difference is that the studies cited above were performed within protected areas of the Cerrado with high sampling efforts. Therefore, a complete description of the local species richness may be achieved through additional taxonomic surveys across a larger temporal scale and using different strategies to collect drosophilids.

Fifteen drosophilids were considered NEO, but seven EXO accounted for 77.6% of the total abundance (Table 1). Except in October 2015, the proportions of EXO were higher than NEO across the temporal scale (Chi-squared = 396.53; df = 6; $p = 0.0001$) (Figure 2). Studies have shown that the frequency of exotic drosophilids is related to the degree of disturbance in the environment, that is, altered areas (deforested, fragmented, burned, etc.) tend to harbor more individuals of such species (Ferreira and Tidon, 2005; Mata *et al*., 2008b). As agropastoral areas are found in the surroundings of the researched forest, and the presence of grasses, clearings, and a river bed in advanced silting process were verified in its interior, we conclude that this forest is extremely modified. Thus, our data support the idea that exotic species are more

common in disturbed environments. Such a combination of introduced species and an altered environment compromises the stability of the ecosystem which, in turn, tends to decrease its native biodiversity.

Table 1. Drosophilids collected in a gallery forest in the vicinity of *Campus Planaltina* of the *Instituto Federal de Brasilia*. Data collected from September 2015 to April 2016.

Drosophilids	Collections								Total
	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	
*Drosophila simulans**	36	1	0	414	2	4	5	4	466
*D. malerkotliana**	0	0	0	14	54	185	122	80	455
*Zaprionus indianus**	8	1	0	209	3	74	2	0	297
*D. nasuta**	0	0	0	8	73	66	33	18	198
D. sturtevanti	0	0	0	1	6	107	50	2	166
D. willistoni	0	0	0	3	3	12	86	7	111
D. nebulosa	1	2	0	10	0	3	4	49	69
D. cardini	8	3	0	6	0	2	15	2	36
*Scaptodrosophila latifasciaeformis**	0	0	0	0	0	20	2	0	22
D. saltans	0	1	0	1	1	1	12	1	17
*D. immigrans**	2	0	0	2	9	2	0	0	15
D. mediostriata	0	0	0	0	0	0	0	5	5
D. fumipennis	0	0	0	0	0	0	0	4	4
D. mercatorum	1	0	0	1	0	2	0	0	4
D. cuaso	0	0	0	1	0	0	0	2	3
*D. melanogaster**	2	0	0	0	0	0	0	0	2
D. arauna	0	1	0	0	0	0	0	0	1
D. paraguayensis	0	0	0	0	0	0	0	1	1
D. sp1	0	0	0	1	0	0	0	0	1
D. sp2	1	0	0	0	0	0	0	0	1
D. sp3	0	0	0	0	0	0	0	1	1
D. sp4	0	0	0	0	0	0	0	1	1
Total	59	9	0	671	151	478	331	177	1,876

**Exotic species*

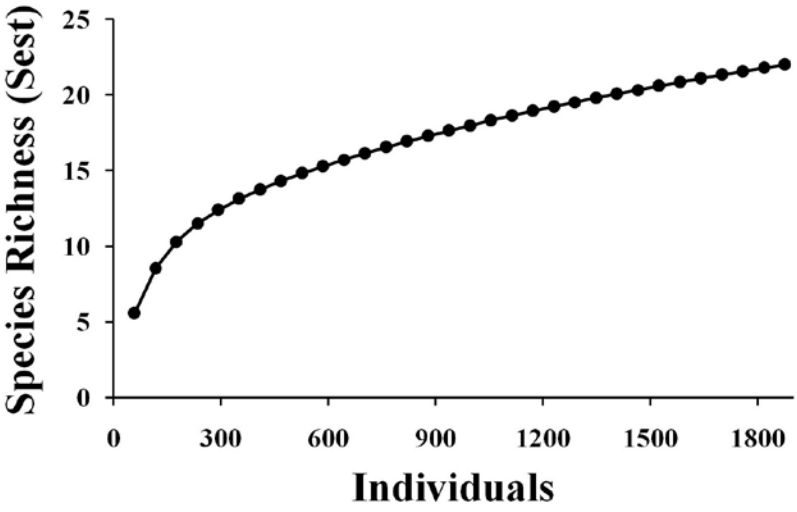

Figure 1. Individual-based species rarefaction curves (Sest) of the drosophilid assemblages associated with a gallery forest near to *Campus Planaltina* of the *Instituto Federal de Brasília*. Data collected from September 2015 to April 2016.

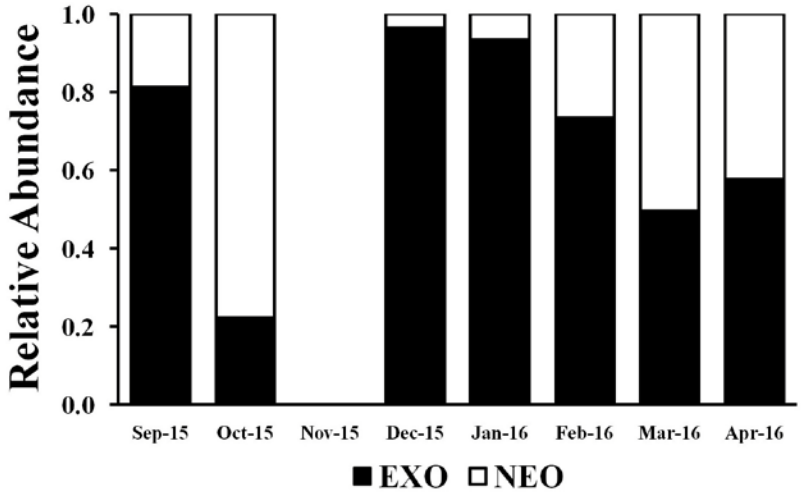

Figure 2. Relative abundance of exotic (**EXO**) and neotropical (**NEO**) drosophilids collected in a gallery forest in the vicinity of *Campus Planaltina* of the *Instituto Federal de Brasília*. Data collected from September 2015 to April 2016.

In summary, this study conducted in an unprotected gallery forest of the Brazilian savanna revealed a smaller number of drosophilid species compared to those studies performed in protected areas of this biome, and a significant reduction in abundance of native species. Controlling anthropogenic actions that degrade nature and facilitate biological invasions is the greatest challenge of humanity, and such actions are essential not only for the maintenance of wildlife but also for the survival of humans. Thus, we recommend the immediate legal protection of biological resources in still unprotected forest environments, the loss or alteration of which may contribute to an additional reduction of the heterogeneity and biodiversity of the neotropics.

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