Landscape and Urban Planning 180 (2018) 207–216

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Research Paper

A plaza too far: High contrast in butterfly biodiversity patterns between plazas and an urban reserve in Brazil

Isabela Freitas Oliveira[a,*], Marília Bruzzi Lion[a], Márcio Zikán Cardoso[a]

[a] Departamento de Ecologia, Universidade Federal do Rio Grande do Norte (UFRN), Natal, Rio Grande do Norte 59072-970, Brazil

ARTICLE INFO

Keywords:
Lepidoptera
Urbanization
Homogenization
Environmental filter
Biodiversity loss
Wildlife refuge

ABSTRACT

The extent of biodiversity in the urban setting is related to the degree of land transformation and the relative quantity of green spaces in the city. Large tracts of green spaces may harbor species and serve as sources of colonists to other urban spaces, but the degree to which this occurs is not well known, particularly in cities in the tropics. Here we evaluate if a large urban green space (Dunas State Park) affects the diversity of fruit-feeding butterflies in city plazas. We sampled 18 plazas, varying in size (1000 to > 3000 m^2) and distance to the Park's edge (up to 3000 m). In each plaza, we measured number of trees, plant cover in it and in surrounding buffers of up to 200 m. Butterflies were captured using standardized traps. We found that butterfly communities were significantly different between Park and plazas, and that individuals plazas represented a poor sample of the total butterfly diversity. Distance to the park did not influence butterfly communities in the plazas, nor did any of the local plaza characteristics. Plazas harbored mostly generalist species and experienced more fluctuations in butterfly abundance than the Park. The Park is the only significant repository of fruit-feeding butterfly biodiversity in our system. We conclude that the urban setting is a strong filter for species settlement, a worrisome conclusion for tropical cities. We offer advice on how city planners may improve this trend.

1. Introduction

Increasing human population has led to the expansion of urban habitats and modification of large tracts of natural landscapes. This process has become an important component of land use transformation around the globe (Grimm, Grove, Pickett, & Redman, 2000) and, with the expansion of cities, natural habitats have become smaller and rarer (Forman, 2008). The spread of these highly-modified ecosystems makes it necessary to evaluate how these changes affect biological communities and what kinds of measures should be pursued to reduce the impacts on native biota (Alberti, 2015; Aronson et al., 2014).

The urban ecosystem has a set of unique factors (Grimm et al., 2008). Conditions such as high temperatures and heat islands, presence of exotic species, isolation of green areas, and various forms of pollution (e.g., air and soil) are some characteristics of urban environments (McDonnell & Hahs, 2015). Many studies have observed that biodiversity in the city tends to be homogenized, being composed mostly of generalist species together with a reduction in specialized species (McKinney & Lockwood, 1999). Consequently, changes in structure and composition of urban communities may reveal which traits and ecological strategies are determinant for species persistence in these ecosystems (Jain, Lim, & Webb, 2017; Williams et al., 2009).

Despite the documented negative impacts of urbanization on biodiversity (Faeth, Bang, & Saari, 2011), some studies have shown encouraging results. Urban mosaics that enhance habitat heterogeneity and contain green areas can support diverse animal and plant communities (Hardy & Dennis, 1999; Hobbs, 1988; Matteson & Langellotto, 2010). Moreover, larger, extensive urban parks with a significant green area may have an important role not only in sustaining complex communities, but also in influencing neighboring green areas, such as public squares. These parks may provide propagules (dispersers or spillovers) that can maintain green areas populated beyond its borders, in a situation analogous to the rescue effect in metapopulation ecology (Hanski & Thomas, 1994; Hanski, 1982).

Many studies in urban environments are carried in parks and reserves that are relatively large and less disturbed than public squares (Goddard, Dougill, & Benton, 2009; Koh & Sodhi, 2004; Matteson & Langellotto, 2010). Even so, public squares (or plazas) can be seen as small public urban green spaces (Peschardt, Schipperijn, & Stigsdotter, 2012), which may provide suitable habitat for some native species. Contrary to larger and moderately preserved urban parks, urban plazas do not contain dense vegetation and may have many exotic species used in gardening, thus suggesting lower habitat quality to some animals (e.g. butterflies and birds; Chong et al., 2014). Even so, plazas may well

* Corresponding author.
E-mail addresses: isabela.biologia@gmail.com (I.F. Oliveira), mzc@cb.ufrn.br (M.Z. Cardoso).

https://doi.org/10.1016/j.landurbplan.2018.09.002
Received 20 March 2018; Received in revised form 30 May 2018; Accepted 2 September 2018
0169-2046/

contain resources and conditions that will allow some species to colonize and even settle in these habitats (Dennis & Hardy, 2007).

To better understand species persistence in the urban landscape, we studied community dynamics of fruit-feeding butterflies living in urban plazas. Our goal was to determine which factors influence the structure (species richness, relative abundance, and composition) of these communities in urban public squares and how those differ from a large urban park nearby. Because of the somewhat central location of the urban park, we explicitly investigated if and how it influenced fruit-feeding butterfly communities in the urban squares. Based on the expectation that community structure was related to distance to the park, we tested whether more distant squares had fewer species. We also expect that butterfly communities in squares farther from the park will be mostly composed of "urban adapters" species, characterized as those adapted to open areas and generalists, in opposition to squares near the park which will show more "urban avoiders" species (Koh & Sodhi, 2004).

Nevertheless, community structure may also respond to factors more related to the plaza itself and its immediate surroundings, such as plaza quality and amount of green cover in nearby houses or edifices (Faeth et al., 2011). Accordingly, we also tested if intrinsic quality of individuals plazas and quality of its surroundings influenced butterfly community structure. In addition, communities would also vary according to seasonal abiotic changes. To evaluate this climatic influence, we followed plazas and park community dynamics in a yearlong period.

Hence, the structure of plaza communities can be an interplay of local, regional and climatic factors and an evaluation of the relative roles of these factors can provide clues as to how species survive in urban landscapes. Moreover, this approach provides us with evidence that can be used to convince social actors to better manage cityscapes for benefit of hosting wild species in human dominated spaces (Miller, 2005).

2. Materials and methods

2.1. Study area

The study was conduct in 18 public squares and in one urban park (Parque das Dunas) in the coastal city of Natal, Brazil (5°48′S; 35°11′W; Fig. 1). Natal is a state capital in northeastern Brazil, with 167 km^2 and a population of around 800,000 inhabitants (IBGE, 2014). The climate is rainy tropical, with well-established dry and wet seasons. The local landscape is dominated by dunes with typical Atlantic Forest vegetation growing as sandbank forests on sandy soils.

2.2. Sampling design

We chose the 18 public squares according to their size and distance from the park. Based on the size distribution of the public plazas in the database of the Office of Urban Planning of the city of Natal, we used the following size categories: small (1000–3000 m^2), medium (3001–5001 m^2) and large (> 5001 m^2) (Fig. 2A–C). Plazas smaller than 1000 m^2 were usually devoid of vegetation and severely impacted, and therefore were excluded from our analysis. We also considered three classes of distance to the park: 1 (0–1000 m), 2 (1001–2000 m) and 3 (2001–3000 m; Fig. 1). We used the function Distance Matrix in QGIS software (QGIS Development Team, 2017) to establish the shortest distance of each plaza border to the park's borders. Within each distance class, we chose two plazas from each size category, small, medium, and large. Because the park has a significant north-south orientation (Fig. 1) our sampling universe was circumscribed to an area roughly parallel to this axis and not farther than 3000 m west of the park border. Appendix A (Supplementary Information) summarizes the data on each of the sampled plazas according to the criteria outline above.

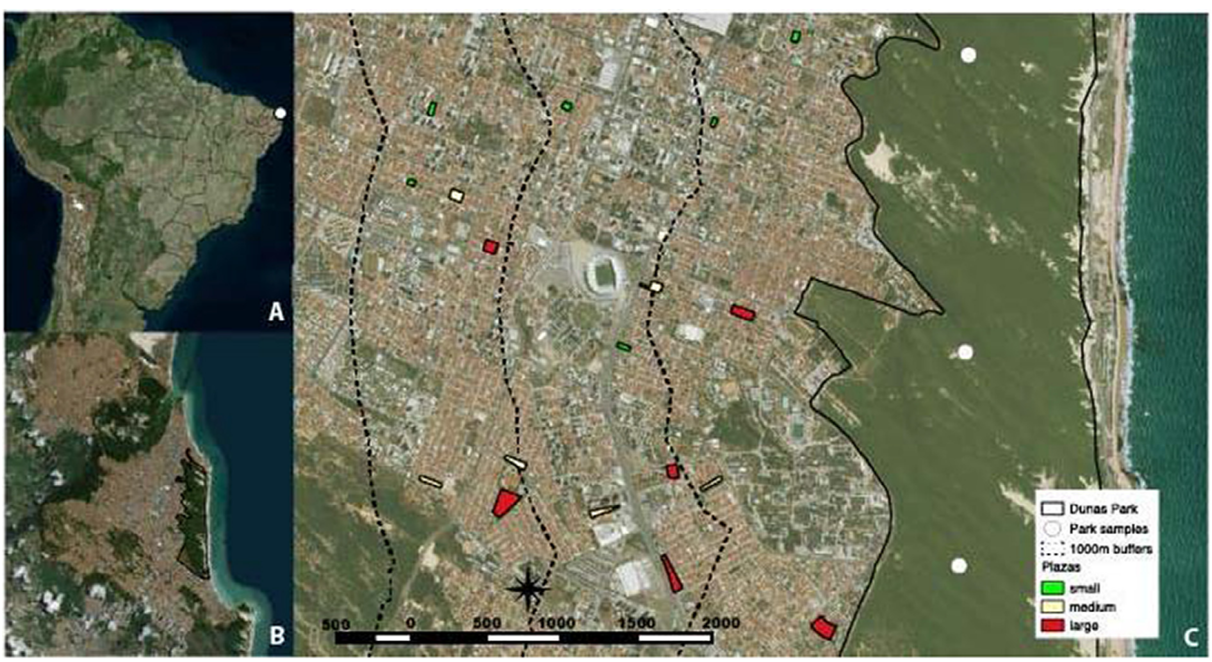

Fig. 1. Location of the study site and sampling points in the urban landscape. (A) Map of Brazil with the approximation location of the city of Natal noted as a dot (northeastern Brazil). (B) View of the city of Natal. The large green extension on the coast (east) is the Park das Dunas. (C) Spatial position of plazas used in the study (colored polygons) and the location of samples taken in the Parque das Dunas (white dots). Lines show the approximate location of the distance from the Park layers used in the study (close, intermediate, distant). Colors indicate plaza size (green = small, yellow = medium, red = large). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)