Landscape and Urban Planning 120 (2013) 158–169

Contents lists available at ScienceDirect

Landscape and Urban Planning

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

Research paper

Biotic homogenization and differentiation of the flora in artificial and near-natural habitats across urban green spaces

Chongfeng Gong[a,1], Jiquan Chen[b,c], Shixiao Yu[a,*]

[a] Department of Ecology, School of Life Sciences/State Key Laboratory of Biocontrol/Guangzhou Key Laboratory of Urban Landscape Dynamics, Sun Yat-sen University, Guangzhou 510275, China
[b] International Center for Ecology, Meteorology and Environment (IceMe), Nanjing University of Information Science and Technology, Nanjing 210044, China
[c] Landscape Ecology and Ecosystem Science, Department of Environmental Sciences, University of Toledo, Toledo, OH 43606, USA

HIGHLIGHTS

- Aliens established across green spaces with greater proportions in artificial ones.
- Native and alien species richness always had positive relationships.
- Urbanization had distinct effects on flora of artificial and near-natural habitats.
- Establishment of aliens caused biotic homogenization in artificial habitats.
- Biotic differentiation in near-natural habitats was preserved by protecting natives.

ARTICLE INFO

Article history:
Received 26 November 2011
Received in revised form
23 December 2012
Accepted 13 August 2013

Keywords:
Urbanization
Urban land use
Plant biodiversity
Species Composition
Native plants
Alien species

ABSTRACT

Shenzhen, a new city existed for less than three decades, experienced dramatic biological invasions of alien plants resulting from the construction of urban green spaces. In an investigation of plant species from 390 plots in 186 sites across five main types of green space (public parks, forests, vegetation corridors, residential and industrial area), a total of 474 plant species, including 221 alien species (46.6%), were recorded. Our study witnessed the spread and establishment of alien species across all urban green spaces and revealed significantly greater proportions of alien species in artificial green spaces than in natural ones. Furthermore, we found the positive relationship between native and alien species richness existed across all the green spaces and was particularly prevalent in the artificial ones. Additionally, successful establishment of alien species instigated by anthropogenic disturbances and most frequent species assemblages caused biotic homogenization in the artificial habitats. In contrast, biotic differentiation in the near-natural habitats was still preserved due to a greater level of protection for native species, which showed some resistance against the establishment of alien species. Therefore, urbanization was proven distinct effects on the flora of artificial and near-natural habitats, coexisting in the new city.

1. Introduction

Plant biodiversity is an important component in urban ecosystems, and contributes to the value of public life (e.g., enhancing aesthetics in recreational parks). However, urbanization usually has a tremendously deleterious influence on local species diversity. Urbanization generates enormous environmental changes (Zhao et al., 2006), separates humans from nature (Miller, 2005), brings about losses of natural habitats, and consistently reduces the accessible areas for many wild species. These factors combine to produce overall reduction of biodiversity in an urban setting (Rosenzweig, 2003). Urbanization can influence the regional floras by changing the availability or spatial arrangement of habitats, the species pool and the pressures of evolutionary selection on plant populations in the urban environment (Williams et al., 2009). The introduction of alien species by human activities in urbanized areas is another well known consequence of urbanization (Bigirimana, Bogaert, Cannière, Lejoly, & Parmentier, 2011; McKinney, 2004b; Richardson et al., 2000) and poses a serious risk to biodiversity (Liu, Daily, Ehrlich, & Luck, 2003; McKinney, 2004a; Thompson & Jones, 1999). Alarmingly, the effects by exotic introductions are expected to accelerate as a result of growing urbanization (McKinney, 2002a). Introduction of alien or exotic species often leads to the extirpation

* Corresponding author. Tel.: +86 20 3933 2980; fax: +86 20 3933 2980.
E-mail addresses: chongfeng.gong@gmail.com, chongfeng.gong@usm.edu (C. Gong), jiquan.chen@utoledo.edu (J. Chen), lssysx@mail.sysu.edu.cn (S. Yu).
[1] Current address: Gulf Coast Research Laboratory, University of Southern Mississippi, Ocean Springs, MS 39564, USA.

0169-2046/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.landurbplan.2013.08.006

of some native plant species (Duncan et al., 2011), and the decline of native biodiversity (Williamson, 1999). However, overall urban species richness is often higher than in surrounding regions (Araujo, 2003; Dobson, Rodriguez, & Roberts, 2001; Pysek, 1998), making the urban setting a potential refuge for local, rare, or threatened species (Schwartz, Thorne, & Viers, 2006). For example, previous study has observed that high richness of alien plant species in a man-dominated habitat corresponded with low richness of native species (Hoffmann, 1998). Yet, another study has confirmed that high richness of both native and alien plants occured simultaneously with moderate artificial disturbances (Planty-Tabacchi, Tabacchi, Naiman, Deferrari, & Decamps, 1996). This pattern could also be repeated in ecosystems with intensive artifical disturbance, such as frequently managed agro-ecosystems, which have low species richness for both native and alien plants (Stadler, Trefflich, Klotz, & Brandl, 2000). Therefore, the question of whether there are positive relationships between native and alien species richness across urban habitats (e.g., different types of urban green spaces) remains a challenging one for the scientific community to address (Sax, 2002).

Accelerating introduction of alien species and tremendous environmental modifications due to urbanization may lead to biotic homogenization (Abadie, Machon, Muratet, & Porcher, 2011; Clavel, Julliard, & Devictor, 2011; Olden & Poff, 2003, 2004). Biotic homogenization is defined as the increase of common (native and alien) species concurrent with the decrease of rare species in abundance and extent, especially their translocation (Arevalo et al., 2010; McKinney, 2006). Within urban regions, this phenomenon has been observed as an expansion of alien species and a reduction of natives (Kühn & Klotz, 2006), not only in developed countries (Schwartz et al., 2006), but also increasingly in less developed countries (Bigirimana, Bogaert, Cannière, Bigendako, & Parmentier, 2012; McKinney, 2002b; Savard, Clergau, & Mennechez, 2000). For example, in Argentina, urbanization and agricultural intensification are proceeding with a faster speed than in developed countries; consequently, the habitat loss or degradation seems to be causing the loss of native biodiversity (Carrete, Tella, Blanco, & Bertellotti, 2009). A previous study in Beijing, China explored the effect of urbanization on plant diversity and found the urban core region had the maximum alien species no matter in the absolute number or the proportion (Wang et al., 2007). The study in the Atlantic forest of northeast Brazil also confirmed that tropical forest biotas were susceptible to biotic homogenization with intensive artificial disturbance (Lobo, Leao, Melo, Santos, & Tabarelli, 2011). Using plant extinction rate data from 22 cities around the world, a recent study found the quantity of native vegetation had a significant effect on the extinction rates, particularly in cities older than 200 years (Hahs et al., 2009). A conceptual framework has been developed to compare floras within cities or among cities to better understand the effects of urban environments on floras (Williams et al., 2009). However, until now, there was not a study on this phenomenon in a relatively young city, especially its effects on the different habitats of the young urbanized area.

Shenzhen, a new city founded in 1979, is now one of the biggest cities in China. In the present study, we focused on the influence of introduction of alien species due to urbanization in Shenzhen on species richness and composition across main types of urban green spaces (public parks, vegetation corridors, residential areas, industrial land and forests, representing the artificial and near-natural urban habitats). Three specific objectives were examined: (1) differences between plant species composition among these green spaces; (2) the relationships between species richness of native and alien plants across urban green spaces; and (3) the effects of biotic homogenization on different urban habitats.

2. Materials and methods

2.1. Study area

Shenzhen Special Economic Zone (SEZ) is located in Guangdong Province, southern coastal China between 113°51′ E–114°21′ E and 22°27′ N–22°39′ N (Fig. 1a and b). The city covers 395.8 km^2 and is adjacent to Hong Kong. It has a subtropical climate with an annual mean temperature of 22.4 °C and annual average rainfall of 1933.3 mm. Its topography is characterized by open plains, rolling hills, and mountains, which provide the topographic heterogeneity. Its soil types include the lateritic red soil, red soil, mountain yellow soil and coastal sandy soil. The lateritic red soil is the dominating type, which spreads in areas below 300 m. The red soil and mountain yellow soil distribute in the hills or mountains with the elevations of 300–600 m or 600 m and above, respectively. The coastal sandy soil mainly covers the coastal area. The subtropical evergreen monsoon forest is the representative vegetation type of this region. In Shenzhen city, the common vegetation types include the evergreen broad-leaved forests, coniferous forest, bamboo forest, shrubs and grassland. Since the long term disturbances by human activities (e.g., agricultural ones for more than 1600 years and recently urbanization since 1979), the original vegetation has disappeared. At present, there are secondary vegetation and planted vegetation, with the characteristics of island habitats (Fig. 1d).

Shenzhen SEZ was a small town adjoining Hong Kong-Mainland China until it was declared a special economic zone in 1979. As the flagship of reform and opening-up policy, Shenzhen SEZ served as the hub of mainland China connecting to Hong Kong. Since then, Shenzhen SEZ witnessed a dramatic economic development and rapid population growth. For example, the gross domestic product

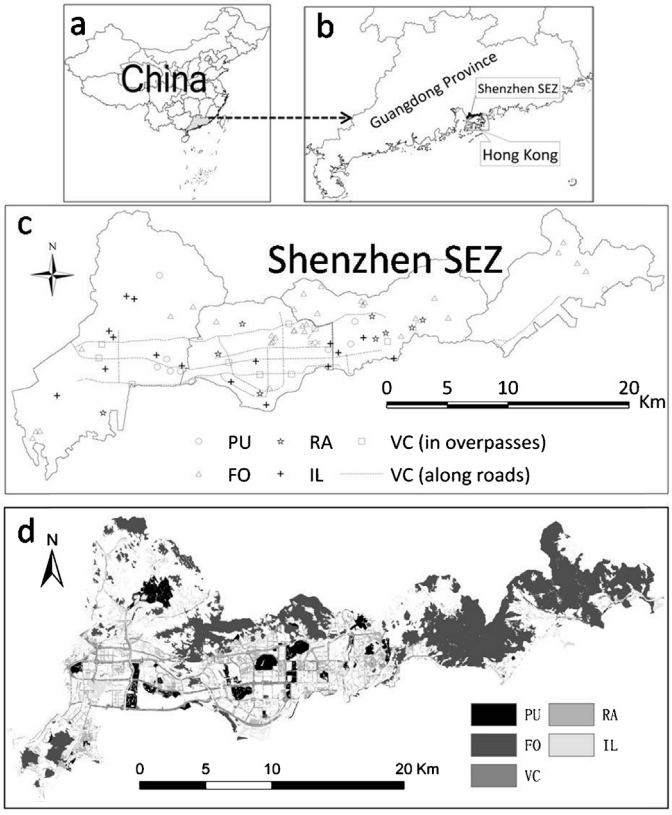

Fig. 1. The location of study area (a and b), sampling sites (c) and vegetation distribution (d) within five types of urban green spaces (public parks, PU; forests, FO; vegetation corridors, VC; residential area, RA and industrial land, IL).