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# Low plant diversity and floristic homogenization in fast-urbanizing towns in Shandong Peninsular, China: Effects of urban greening at regional scale for ecological engineering



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## ABSTRACT

Urban forest construction is believed as an effective method to preserve urban biodiversity and restore urban green ecosystem. However, in some fast-urbanizing towns, the most urban flora in the built-up area was almost totally manmade, where is new expanded areas mainly transformed from cultivated lands. How such urban flora contribute to local and regional diversity is seldom quantitatively tested. In this study, we conducted a comprehensive investigation of man-made urban flora in 15 fast-urbanizing towns in Shandong Peninsular, China, to explore the effect of urban greening on the local and regional plant diversity. The results that showed huge investment to urban greening contribute to high urban green coverage but do not foster high plant diversity. Exotic species has lower overall dissimilarity between town pairs than native in either cultivated or wild flora. Urban greening does not result in high proportion of exotic species, however, either wild flora or cultivated flora show homogenizing tendency due to the expansion of exotic species. Nevertheless, the main driving forces are different: the wild flora are homogenized by diminished species richness difference while the cultivated flora due to the decreased species replacement. We therefore suggest biodiversity conservation should be more considered and strengthened in further urban greening. Our study could also provide useful reference data in biotic homogenization research in China.

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## 1. Introduction

Urban expansion has been one of the leading types of land use change today (Güneralp and Seto, 2013). Due to the long lasting impact upon habitat loss and fragmentation, urbanization often induce great local extinction of natives and has been identified as a major threat to biodiversity (Czech et al., 2000; McKinney, 2002). Furthermore, for urbanization promotes the expansion of exotic and synanthropic species, and induces extinction of some rare natives, it has been a major cause of biotic homogenization, i.e.

the process that disparate locales becoming more similar in species composition over time (McKinney, 2006; Schwartz et al., 2006; Olden, 2006). For biotic homogenization could impair biodiversity form ecological and evolutionary process and even impact economy from human dimension (Olden et al., 2005; Olden, 2006), it has become an important dimension of the biodiversity crisis (Rooney et al., 2007). Simultaneously, urban areas often appear to be the hotspot of vascular plants and even harbor many rare or endangered species owing to the high habitat heterogeneity, vast number of introduced species and the presence of abundant dispersal vectors (McKinney, 2002; Kühn et al., 2004; Kowarik, 2011). With increasing urbanization, the importance of urban areas for biodiversity conservation constantly grows (Miller and Hobbs, 2002; Kowarik, 2011). To preserve urban biodiversity and restore urban green ecosystem, as well as to cope with the exacerbating problem of biotic homogenization, many countermeasures have been proposed (Miyawaki, 1998; Alvey, 2006; Yu et al., 2012), among which constructing urban forest and improving urban green space are

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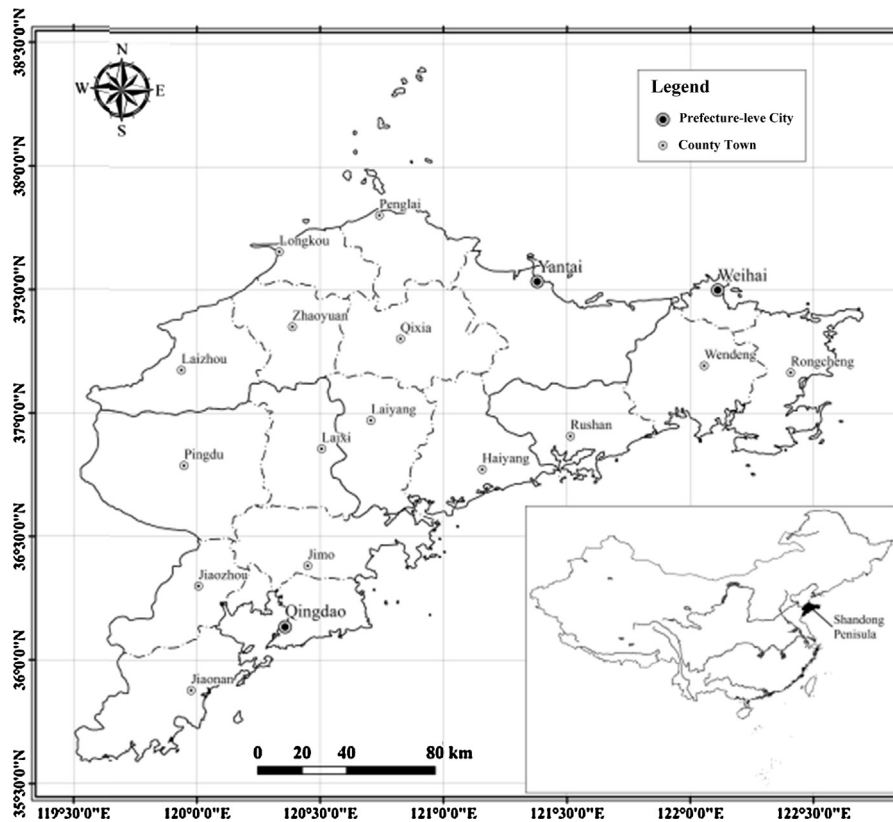


Fig. 1. Location of the investigated 15 towns in Shandong Peninsula, China.

most important and fundamental. This point is adopted by many governments and put into practice.

China has experienced a rapid urbanization in the last two decades, with urban expansion much faster in larger cities at national scale (Wang et al., 2012). In recent years, however, many small cities or towns have sprawled with an accelerating rate higher than big cities (Sun et al., 2012). For environment protection and beautification, local governments invest much in urban greening and urban flora construction. However, for majority of new expanded urban areas was transformed from cultivated lands (Sun et al., 2012), most urban flora in the built-up area was almost totally man-made. How such kind of urban floras contribute to local and regional diversity is seldom quantitatively tested. So far, most studies relevant to urban biodiversity in China were conducted in single big cities (e.g. Wang et al., 2006; Zhao et al., 2006; Wang et al., 2007; Zhao et al., 2010); seldom researches were performed in small cities, or compared the urban flora composition among a series of cities. Considering the limited land resources nearby large cities, future urban expansion in China may more happen at small cities or county towns (Wang et al., 2012; Sun et al., 2012). It is therefore essential to concern the biodiversity and conservation efforts in these regions.

In this study, we selected 15 fast urbanizing county towns to explore the effects of urban forest construction on local and regional biodiversity. These county towns belong to Shandong Peninsula Urban Agglomeration, the fourth biggest Urban Agglomeration in China, and have expanded their built-up area of 2.50-folds in average in ten years' time span from 2000 to 2010. Simultaneously, the local governments invest much in urban greening. As a consequence, the urban green area of the 15 county towns enlarged 3.03-folds in mean, which increased faster than built-up area. The mean urban green area of the 15 county towns has increased to 41.6%, with the per capita public green area of

15 m<sup>2</sup>. Due to the improvement in urban greening, majority of these county towns has been listed as National Garden City, National Environmental Protection Model City, National Excellent Tourism City or National Ecological County. It seemed that the construction of the urban forest in this region is rather sound and the biodiversity conservation in these county towns are well done. However, it was just an assumed conclusion without quantitative tests. What are the compositional characteristics of these man-made urban floras? Does fast-growing urbanization leading to high proportion of exotic species in urban green space? Has the huge investment in urban greening resulted in high local or regional diversity? Does the planting and management practice, especially the introduction of exotic species, lead to biotic homogenization at this narrow scale? These questions are important for further urban greening and biodiversity conservation nevertheless seldom tested quantitatively yet. We, therefore, conducted a comprehensive investigation of the urban flora of these 15 fast urbanizing county towns to evaluate the effectiveness of urban greening on biodiversity preservation and restoration, which is the first report in this aspect along Shandong coastal zone, China. For the purpose of this study, we just investigated the man-made urban flora with the natural or semi-natural habitats not considered.

## 2. Materials and methods

### 2.1. Study area

The 15 county towns we sampled are located in the eastern part of Shandong Peninsula (Fig. 1), in the north temperate monsoon climatic zone while having some characters of marine climate. The mean annual precipitation is 670 mm and the mean air temperature 12.7 °C. The county towns are distributed densely in the Shandong Peninsula, with the maximum geographical distance being 262 km

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