

Leaf litter decomposition in urban forests: test of the home-field advantage hypothesis

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Abstract

• **Key message** The home-field advantage (HFA) hypothesis states that leaf litter decomposes faster in the habitat from which it was derived (i.e., home) than beneath a different plant species (i.e., away from home). We conducted reciprocal translocation experiments to explore the HFA effect of urban leaf litter decomposition. HFA of litter decomposition varied with species and season, and interacted with nutrient and environmental dynamics.

• **Context** Although forest litterfall and subsequent decay are acknowledged as a critical factor regulating nutrient cycling, soil fertility, and ecosystem carbon budgets in natural ecosystems, they remain less understood in urban ecosystems and the evidence for HFA has not been universal.

• **Aims** We select Beijing Olympic Forest Park (BOFP), the largest urban forest park of Asia, as a case study to explore HFA of leaf litter decomposition in urban forest ecosystems. We investigated the litterfall production, mass loss, and nutrient dynamics of two species (*Robinia pseudoacacia* and *Pinus armandii*) commonly planted in Beijing urban forest ecosystems.

• **Methods** Variations in litterfall production were measured in *R. pseudoacacia* stand and *P. armandii* stands over 12 months. HFA of litter decomposition was explored by reciprocal leaf

litter translocation experiments, and leaves were analyzed for C, N, and P during decomposition of 297 days.

• **Results** Two major peaks of total litterfall in *R. pseudoacacia* were observed, while litterfall in *P. armandii* followed a unimodal distribution pattern, which were similar to seasonal patterns of broadleaf and coniferous litter production in natural forest ecosystems. The loss of initial ash-free mass of *R. pseudoacacia* (19 %) was about twofold of *P. armandii* (11 %). The litter quality (e.g., initial C, N, and P) might have contributed to the differences between broadleaf and coniferous species. Leaf litter decomposition of *R. pseudoacacia* showed seasonal switch of HFA. In contrast, *P. armandii* showed a constant HFA during the whole study period.

• **Conclusion** HFA of litter decomposition in urban forests varied by species and season. We found the seasonal switch of the HFA effect for *R. pseudoacacia*, which has not been observed in nonurban ecosystems. More observations or experiments with multiple species or mixed species across various cities are needed to understand the processes and mechanisms of litter decomposition and nutrient dynamics in the urban ecosystems.

Keywords Decay rate coefficient · Home-field advantage (HFA) · Litter production · Mass loss · Nitrogen and phosphorus gain or loss · Urban environment

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Contribution of the co-authors S.Z. designed research; Y.S. and S.Z. performed research, analyzed data, and wrote the paper.

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1 Introduction

More than half of the world's people now live in cities, and this figure is projected to increase to 60 % by 2030 (UN 2014). Urban land area around the world in the meantime is expanding on average at twice the speed of its population growth in recent years (Angel et al. 2011), and the global urban land area by 2030 is forecasted to nearly triple that of

circa 2000 (Seto et al. 2012). Urban areas present both challenges and opportunities for the transition toward sustainability in an increasingly urbanized planet (Grimm et al. 2008). Urban ecosystem is characterized by the presence of exotic flora and fauna; pollution in air, soil, and water; an increase in the temperature of cities known as the urban heat island (UHI); and enhanced atmospheric CO₂ concentrations and nitrogen (N) deposition (Pickett et al. 2008; Pataki et al. 2011; Zhou et al. 2014; Nielsen et al. 2014; Rao et al. 2014). As a result, the biogeochemical cycles in urban areas are controlled by complex interactions between society and the environment that is most likely different from nonurban ecosystems (Kaye et al. 2006; Grimm et al. 2008; Pataki et al. 2011; Rao et al. 2013; Lin et al. 2014). For example, in Phoenix, AZ, spatial variation in plant species diversity is significantly correlated with family income and housing age, in addition to those recognized influences by traditional ecological theory (Hope et al. 2003). In cities that experience altered atmospheric chemistry, the tree sapling growth can be greatly enhanced or inhibited by high N deposition, CO₂, and zone exposure (Gregg et al. 2003). UHI can affect net primary production through the extension of the growing season in cold regions and the inhibition of photosynthetic capacity in warm regions (Imhoff et al. 2004).

Forest litterfall and subsequent decay are the major pathways linking the biogeochemical processes of aboveground and belowground, acting as a critical factor in the regulation of nutrient cycling, soil fertility, and ecosystem carbon budgets (Hunt et al. 1988; Berg and McLaugherty 2008; Staelens et al. 2011). Litter decomposition is mainly controlled by chemical quality of the litter (e.g., initial N and lignin), soil biota (e.g., soil mesofauna), and the physicochemical environment (e.g., temperature) (Swift et al. 1979; Lu and Liu 2012; Wang et al. 2013). Plant litter may decompose faster in the habitat from which it derives (i.e., home) than beneath a different plant species (i.e., away from home), which is referred as the “home-field advantage” (HFA) by Gholz et al. (2000). Although this phenomenon is not always observed (Chapman and Koch 2007; Gießelmann et al. 2011; John et al. 2011), previous studies indicate that HFA is widespread in nonurban forest ecosystems (Gonzalez et al. 2003; Rothstein et al. 2004; Barlow et al. 2007; de Toledo Castanho and de Oliveira 2008; Negrete-Yankelevich et al. 2008; Wang et al. 2013). Ayres et al. (2009a) provided the first quantification of HFA related to leaf litter decomposition and found that on average litter mass loss was 8 % faster at home than away. A possible reason for HFA is that soil biotic community may specialize in decomposing litter derived from the plant above them (Ayres et al. 2009b).

The leaf litter decomposition processes in urban ecosystems can be different, given its distinct physical, chemical, and biological environment (Carreiro et al. 1999; Pouyat and Carreiro 2003). For example, the litter decomposition

experiment along the urban-rural land use gradient of New York City suggested that N release rates of urban litterbags were found to be comparatively high, which could result from the N inputs from atmospheric deposition in cities (Pouyat et al. 1997). In particular, HFA in urban environment was not as acknowledged as in nonurban ecosystems. Relatively limited previous studies yield contradictory results. For example, a study (Vauramo and Setälä 2011) in Lahti, southern Finland, demonstrated that under the same experiment treatment, *Lotus corniculatus* showed HFA while the other labile plant type (*Holcus lanatus*) did not. This indicates that litter decomposition rate might depend on litter type rather than the decomposition place and thus refutes the HFA hypothesis. Reciprocal litter transplantations of European aspen (*Populus tremula* L.) between urban and rural sites in Helsinki Metropolitan Area, southern Finland, implied that N deposition in the urban environment might promote decomposition as the remaining mass of rural aspen litter decomposing at the urban site was approximately 3.7 % less than at the rural site. Guo et al. (2012) showed that the decomposition rate coefficient (k) of *Pinus tabulaeformis* was 0.34 and 0.28 in urban ecosystem in the Northeast China for the home stand leaf litter and transplanted leaf litter, respectively, showing the HFA of leaf litter decomposition. In addition, previous studies have demonstrated that urbanization-related environment changes such as increased temperature for urban island, air pollution from transportation, and frequent disturbance of urban soil all have impacts on the decomposition dynamics (Nikula et al. 2010; Vauramo and Setälä 2011). On the other hand, the nutrient dynamics of urban litter can affect microbial decomposer which in turn could affect the decomposition process (Purahong et al. 2014). Although the retention or loss of N and phosphorus (P) of decomposing litter are important to the soil nutrient availability, there has been less research on the N and P dynamics of urban litter decomposition compared to the attention on C (Moore et al. 2011; Enloe et al. 2015). Therefore, exploring the leaf litter decomposition and nutrient dynamics is necessary not only to a comprehensive understanding of the biogeochemical cycle of urban ecosystems (Hutmacher et al. 2014) but also test the applicability of the litter decomposition hypothesis (i.e., HFA) in urban environment.

Beijing is the capital of China and is recognized as one of the ten largest megacities in the world with a population of more than ten million. It has experienced a rapid urbanization within last several decades, resulting in significant modifications of the environment (He et al. 2002; Tan et al. 2005; Zhang et al. 2009; Wang et al. 2014; Wu et al. 2015). On the other hand, the projects of increasing vegetation coverage in Beijing have been conducted for decades by the government to improve its environmental quality and aesthetics (Zhang et al. 2013). Beijing Olympic Forest Park (BOFP) was built for the 29th Olympic Games held in Beijing in 2008, which is

the largest urban forest park in Asia (Chen et al. 2013). It provides an excellent “natural laboratory” to study the dynamics of urban forest ecosystems. In BOFP, we selected *Robinia pseudoacacia* forest and *Pinus armandii* forest (two commonly planted species of Beijing) to study the dynamics of litterfall and leaf litter decomposition.

The objectives of this study are to measure litterfall production, litter decomposition, and nutrient dynamics in Beijing urban forest ecosystems, test the HFA hypothesis in urban forest ecosystems, and compare them to those demonstrated in nonurban forest ecosystems and other urban ecosystems in previous studies. We hypothesized that in urban forest ecosystems, decomposition would occur faster in the home stand (the habitat from which the plant is derived) than in the other site because of different microclimate conditions and nutrient dynamics of decomposing leaf litter. In other words, HFA phenomenon exists in urban forest ecosystems. We further separated the influence of environmental factors and litter quality on decomposition rates by comparing decomposition processes of litters from two different sites decaying in the same stands using leaf litter decomposition reciprocal translocation experiments.

2 Materials and methods

2.1 Site description

This study was carried out in BOFP (40° 01' N, 116° 23' E), located in the north central part of Beijing City, China. BOFP covers an area of 680 ha with 95 % green vegetation coverage and is called the “green lungs” of the urban agglomeration. It is divided by the 5th Ring Road into two parts (Fig. 1a, b), the northern part of which is a natural landscape. Sites for experiment were on the southern part of BOFP with an entirely constructed landscape of 380 ha. The region has a predominantly warm temperate and semihumid and semiarid continental climate with a mean annual temperature of 10 °C and an annual frost-free period of around 186 days. Mean annual precipitation is 600 mm, mainly occurring from June to August (Xie et al. 2015).

In September 2012, two 20 m × 20 m plots were established in the midslope position of a *R. pseudoacacia* forest (Fig. 1c) and a *P. armandii* forest (Fig. 1d). Selected forest characteristics and some properties of the soil for the two plots are described in Table 1. The average of stand age for the *R. pseudoacacia* forest and *P. armandii* forest is 7 and 11 years, respectively. Both plots have high purity nearly without other tree species and low density of shrubs. Herbaceous plants below the *R. pseudoacacia* are mainly composed of *Chenopodium serotinum* Linn., *Humulus scandens* (Lour.) Merr., *Metaplexis japonica* (Thunb.) Makino, *Convolvulus arvensis* L., and *Viola verecunda* A. Gray. Herbaceous plants below the *P. armandii* are mainly composed

of *Ixerissonchifolia* Hance, *Humulus scandens* (Lour.) Merr., *Taraxacum mongolicum* Hand.-Mazz., *Duchesnea indica* (Andr.) Focke, and *Viola verecunda* A. Gray.

2.2 Litterfall and litter collection

The litter was collected monthly from November 2012 to October 2013 in two plots using traps. These traps were 1.0 m × 1.0 m nylon mesh (2 mm mesh size) net and were set 1 m above the forest floor. Five litter traps were set randomly at each site. The collected litter at each time was oven-dried at 65 °C to constant weight and weighed. The oven-dried litter samples were sorted into leaves, twigs (small branches with diameter < 2.0 cm), and productive materials (e.g., flowers, fruits, and seeds).

2.3 Leaf litter decomposition

The decomposition of leaf litter of dominant tree species was quantified using the litterbag technique (Harmon et al. 1999). In October 2012, freshly fallen/senescent leaves from tree species in two forests (*R. pseudoacacia* and *P. armandii*) were collected for decomposition experiment. Five grams of air-dried leaf litter, by species, was put into a 10 cm × 15 cm, 1.0 mm (bottom) and 0.3 mm (top) mesh size nylon bag. In each forest, six plots were set randomly and litterbags were placed on the forest floor at the end of December 2012 in the home stand (in situ) and the other stand (ex situ), respectively. Six litterbags for each species were collected from the six plots at each forest and transported to the laboratory monthly from January 2013 to October 2014. The adhering soil, plant detritus and the “ingrowth” roots were excluded, and the bags were then dried at 65 °C to constant weight for the determination of remaining weight. Subsamples by species and date were reserved for the analysis of C, N, and P concentrations.

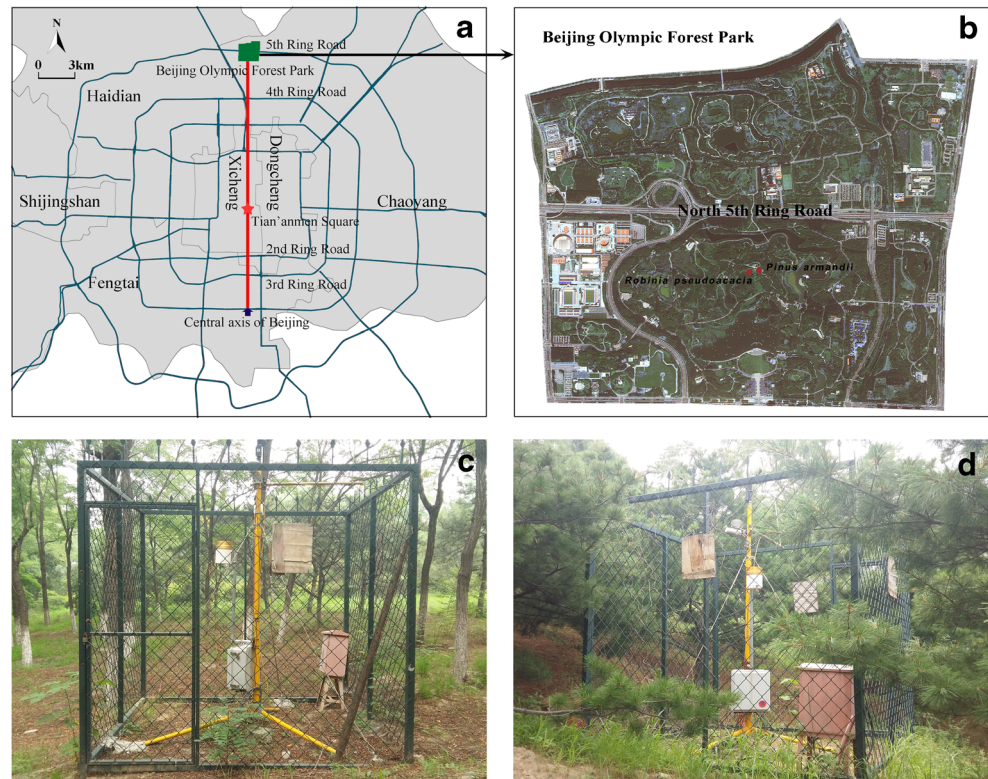
2.4 Chemical analyses

Samples of leaf litter for analysis were ground, homogenized, and passed through a 0.2-mm sieve. Total C and N concentrations, reported on a percentage basis, were measured using a CN elemental analyzer (Vario Macro cube, Germany). For P concentration, the samples were digested in the solution of H₂SO₄-HClO₄ and then analyzed colorimetrically with blue phosphor-molybdate (Yang et al. 2004).

2.5 Data analysis

Mean values were calculated by species, sampling date, and site. The significance of the difference between means among species and sites was tested using a one-way ANOVA. Nutrient content was calculated by mean concentration (%) of each element multiplied by the mean mass of each litter

Fig. 1 Location sketch of Beijing Olympic Forest Park which is divided by the 5th Ring Road of Beijing (a, b) and the photos for *Robinia pseudoacacia* forest plot (c) *Pinus armandii* forest plot (d)



component. The relations between the different litter components and the temperature or precipitation were analyzed using Pearson's correlations. A value of $\alpha = 0.05$ was used for all significance tests throughout the paper.

3 Results

3.1 The components and patterns of litterfall

Mean annual litterfall during the period from November 2012 to October 2013 was $4.08 \pm 1.34 \text{ Mg ha}^{-1} \text{ year}^{-1}$ for *R. pseudoacacia* and $0.37 \pm 0.16 \text{ Mg ha}^{-1} \text{ year}^{-1}$ for *P. armandii* (Table 2). The different components of litterfall production at the two forests are shown in Table 2. The leaf litter was significantly higher than any other components, accounting for 74 and 73 % of the total litterfall for *R. pseudoacacia* and *P. armandii*, respectively. The second largest part was productive materials, and the smallest portion was twigs for both species. The monthly variation of total

litterfall of two species was shown in Fig. 2. Two major peaks of total litterfall in the *R. pseudoacacia* were observed in November or October and May. At the first peak, the composition of litter is mainly leaves (69.7 % in November and 90.0 % in October, respectively) and the major part of litter is flowers (74.1 %) in the second. The *P. armandii* followed a unimodal distribution pattern with the distinct peak in November (Fig. 2).

3.2 Leaf litter decomposition

Litter had lost 19, 11, 11, and 6 % of its initial ash-free dry mass of *R. pseudoacacia* in situ, *R. pseudoacacia* ex situ, *P. armandii* in situ, and *P. armandii* ex situ after the 297-days of decomposition (Fig. 3). The decomposition was slow before June mainly because of the low temperature in winter and early spring. The percentage of leaf litter mass remaining all dropped rapidly from July to September which is the main part of growth season. Overall, leaves of *P. armandii* in both forests decomposed apparently slower than leaves of *R. pseudoacacia*. The decomposing rate

Table 1 Characteristics of *Robinia pseudoacacia* and *Pinus armandii* stand and soil properties

	Density (no. ha^{-1})	Mean DBH (cm)	Mean height (m)	Soil bulk density (g cm^{-3})	SOC density (kg m^{-2})
Robinia	950	11.6	10.6	1.45	1.90
Pinus	700	19.1	5.1	1.47	1.84

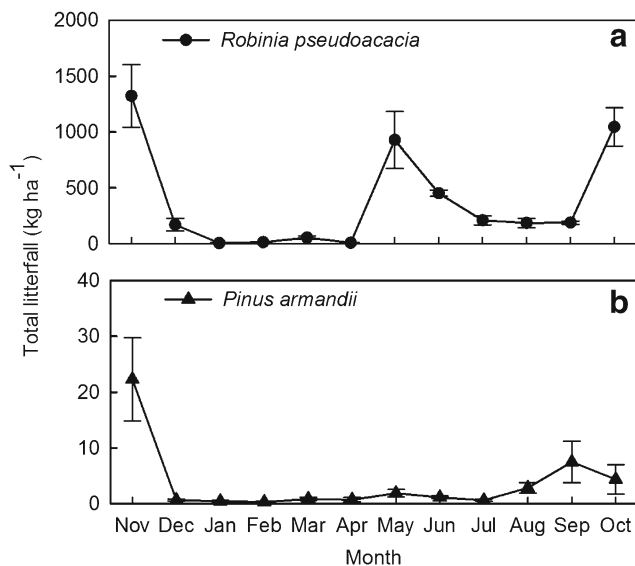
Table 2 Quantity ($\text{Mg ha}^{-1} \text{ year}^{-1}$) and proportion (%) in the total of litterfall in two forests during November 2012 to October 2013 (mean \pm standard error)

Fraction/site	<i>Robinia pseudoacacia</i>		<i>Pinus armandii</i>	
	$\text{Mg ha}^{-1} \text{ year}^{-1}$	%	$\text{Mg ha}^{-1} \text{ year}^{-1}$	%
Leaves	3.00 ± 0.36	74	0.27 ± 0.076	73
Twigs	0.379 ± 0.051	9	0.04 ± 0.009	11
Productive materials	0.697 ± 0.209	17	0.06 ± 0.024	16
Total	4.08 ± 0.60		0.37 ± 0.072	

of the leaf litter of *P. armandii* was significantly faster in situ than ex situ counterpart during the entire study period ($P < 0.05$). In contrast, leaf litter of *R. pseudoacacia* in situ decayed faster than the ex situ before May, and the acceleration of decay started 2 months earlier (May) for ex situ than for the in situ (July). Although the decomposition pathways were different for the in situ and ex situ decays, the total mass loss was similar after the 297-days observation.

3.3 Nutrient dynamics of decomposing leaf litter

The decomposing dynamics of N and P in the 297-days period of study were analyzed. The total N percentage in the leaf litter in *R. pseudoacacia* was significantly higher than that in *P. armandii* (Fig. 4a). The total N percentage in the leaf litter of *R. pseudoacacia* decaying in situ and ex situ showed a fluctuation trend. In contrast, the total N percentage in the litter of *P. armandii* both in situ and ex situ demonstrated a significant increasing trend since June and increased by 102

**Fig. 2** Monthly variations in total litterfall of *Robinia pseudoacacia* forest and *Pinus armandii* forest from November 2012 to October 2013. Bars indicate SE, $n = 12$

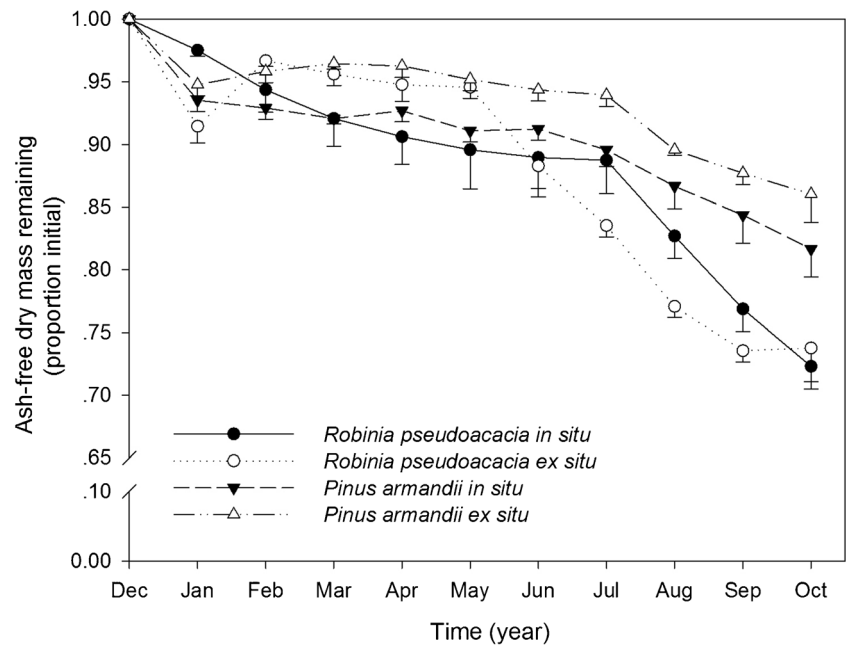
and 97 %, respectively, over the study period. The P concentration of leaf litter for *R. pseudoacacia* was higher than that for *P. armandii*, and there was a discrepancy for the two species in terms of in situ and ex situ situation. The P concentration in leaf litter of *R. pseudoacacia* in situ was mostly higher than ex situ (except an outlier in February) while the opposite was observed for *P. armandii* (Fig. 4b). Although the concentration of P was relatively stable for both species in the early stage of decomposition, it increased rapidly since the growing season. The increasing rate of P concentration was generally faster for the litter decomposing in the home stand for both species. It is noticeable that the initial C/N ratio for the leaf litter of *R. pseudoacacia* (approximately 30) was smaller than *P. armandii* (approximately 130) (Fig. 4c). This ratio for *R. pseudoacacia* declined rapidly from 29 to 22 in February and then declined slowly until the start of the growing season. The C/N ratio of *P. armandii* in situ decreased slowly before the growing season, while in the meantime, the C/N ratio of *P. armandii* ex situ declined greatly in the early months and then fluctuated. The C/N ratio showed a rapid decrease after May for *P. armandii* in situ and June for *P. armandii* ex situ (Fig. 4c). However, at the end of study period, the total decreases of the C/N ratios for *P. armandii* in situ and ex situ were similar (65 and 61 %, respectively).

4 Discussion

4.1 Impacts of litter quality and urban environment

The differences of initial litter quality (e.g., initial N, P, and lignin concentrations) between broadleaf and needle litter is significant, which contributes to the different litter decomposition rates in two kinds of forest investigated in many studies (Prescott et al. 2000; Yang et al. 2004; Zhang et al. 2008; Milcu and Manning 2011). In this study, the initial total N percentage of *R. pseudoacacia* is approximately four times of that of *P. armandii* and the loss of initial ash-free mass of *P. armandii* (11 %) was about half of that of *R. pseudoacacia* (19 %). Higher N content or lower C/N ratio of *R. pseudoacacia* might have contributed to the greater loss of leaf litter mass during the study period (Negrete-Yankelevich et al. 2008; Aponte et al. 2012; Waring 2012; Wang et al. 2013). However, the relatively lower concentration of P compared to *R. pseudoacacia* and other factors related to litter chemical properties such as the presence of aromatics in the *P. armandii* might have contributed as well (Kuiters and Sarink 1986; Ganjgunte et al. 2004). Given the significant role of soil biota in litter decomposition, the soil biota that we did not measure in the current study might also be responsible for the difference in the mass loss between broadleaf and coniferous forests. The abundance and richness of soil microbes in broadleaf forests were generally higher than those of coniferous forests (Wang and Wang 2007; Liu et al. 2012). The decomposing rates for four sets of litter were

Fig. 3 Proportion ash-free mass remaining in the leaf-litter of *Robinia pseudoacacia* and *Pinus armandii* decomposing in home-field and the stand away from home. The error bars are one standard error (the positive and negative error bars for mass remaining of reciprocal translocation experiment were often overlapped and difficult to read. To make the graph more readable, we just showed the negative error bars of them)



much faster in rainy season, which is consistent with the finding from a previous study on decomposition of tree leaf litter on

pavement (Hobbie et al. 2014). The varied decomposition rates can be partially attributed to the microclimate conditions such as

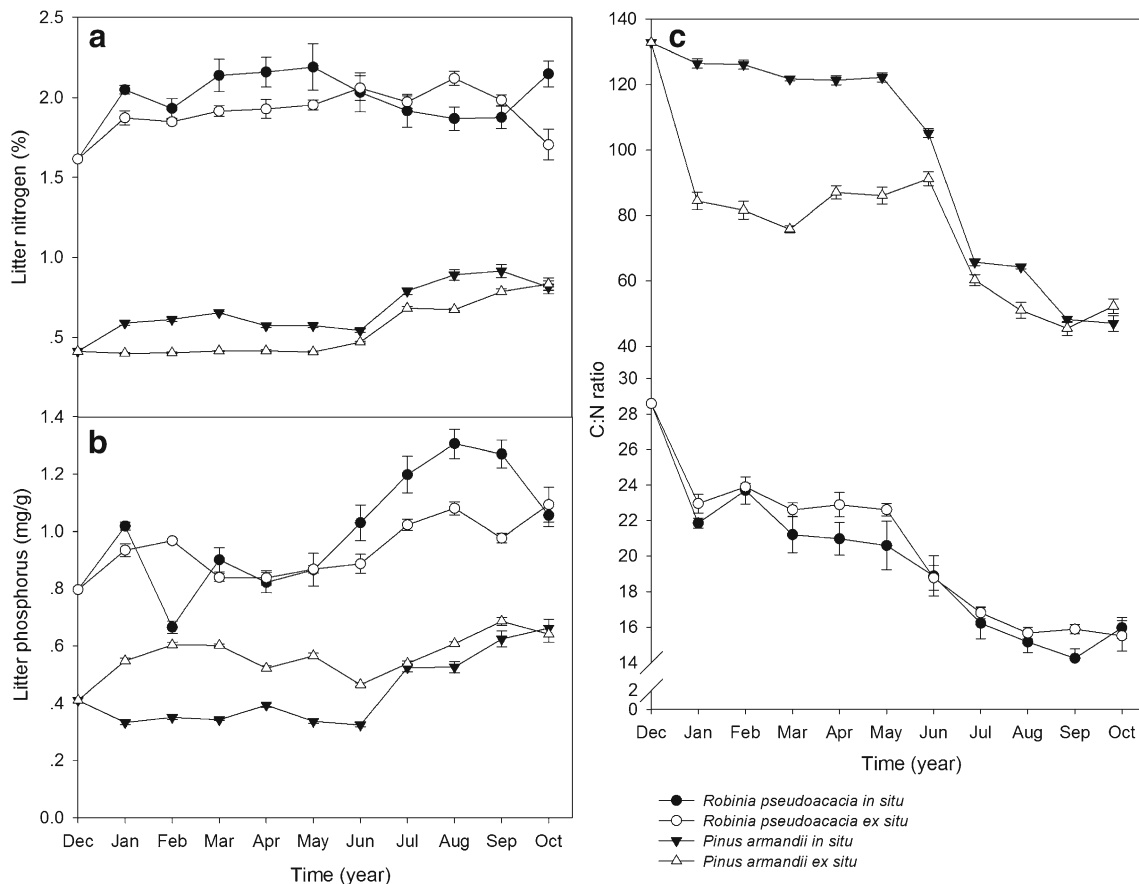
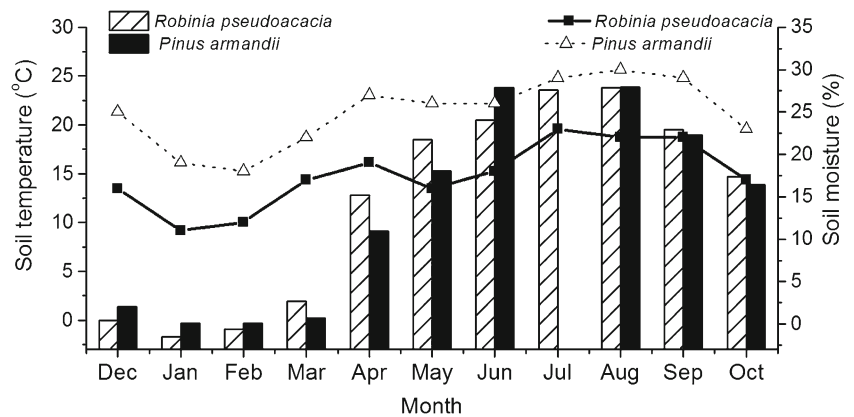


Fig. 4 Total nitrogen in percentage (a), phosphorus mass of the leaf litter (b), and C/N ratio (c) of *Robinia pseudoacacia* and *Pinus armandii* decomposing in home-field and the stand away from home

Fig. 5 Variability of monthly soil temperature (°C) and moisture (%) amount at *Robinia pseudoacacia* and *Pinus armandii* forests from December 2012 to October 2013 (the soil temperature data of *Pinus armandii* in July 2013 is missing because the probe was broken)



temperature and relative humidity (Fig. 5). Decomposition rates were very low in winter because litter was mostly frozen, and the relative humidity was low in spring, which might have resulted in the continual relatively low rates of decomposition.

4.2 Home-field advantage

The test of HFA hypothesis of litter decomposition in urban environment was relatively limited. Leaf litter decomposition of *P. armandii* showed a constant HFA during the whole study period, supporting the HFA hypothesis. It has been generally acknowledged that the litter with high quality is easy to be decomposed by most microbes, and thus, there will not appear the specialization of soil biota in decomposing the litter of the plant species above them (Ayres et al. 2009b). In this study, we found the seasonal switch of the HFA effect for *R. pseudoacacia*. That is, HFA existed during most of the winter or early spring whereas it disappeared at the start of the growing season with a sudden acceleration of the decomposition for the ex situ samples, which was 2 months earlier than the in situ samples. The early startup of the accelerated decomposition for the ex situ broadleaf litter led to larger accumulated decay during most of the growing season. The litter ex situ slowed again in the winter, giving time for the litter in situ decomposition to catch up. At the end, the total annual decomposition was comparable for the litter in situ and ex situ.

To our knowledge, the seasonal switch of HFA has not been found in previous studies and we do not know the reasons behind clearly yet. However, we do see the interactions between decomposition and nutrient and physical environmental dynamics. Higher N content or lower C/N ratio and lower P concentration were generally associated with higher decomposition rate for *R. pseudoacacia* ex situ (Fig. 4). In terms of environmental dynamics, the soil moisture of *P. armandii* forest (ex situ for *R. pseudoacacia*) was significantly higher than that of *R. pseudoacacia* (in situ) (Fig. 5) during the whole study period while the soil temperature was similar or even higher than *R. pseudoacacia* in the summer months (generally lower before the growing season when the switch occurred). As the initial

quality of *R. pseudoacacia* for in situ and ex situ was the same, we suspect that matrix environmental driven effects on soil biota rather than substrate might have contributed to the faster decomposition rate of *R. pseudoacacia* ex situ. Thus, environmental factors and soil biota might have combined to result in the switch of HFA for *R. pseudoacacia*. Nevertheless, the mechanism for the different HFAs of litter decomposition between broadleaf and coniferous litter and switch of HFA in urban forest ecosystems might not be the same as nonurban forest ecosystems due to different abiotic-biotic conditions (Nikula et al. 2010). More observations or experiments on multiple individual or mixed species across various cities with soil biota inventory are needed to understand the ubiquity, magnitude, and the mechanism of HFA for litter decomposition in the urban forest ecosystems.

4.3 Implication for urban carbon cycling

The composition and function of urban ecosystems are different from nonurban ecosystems due to the drastic land use changes caused by rapid urbanization process, and the soils, in particular, are often severely altered (Yaalon 2007). However, the litterfall production and nutrient cycling within urban areas are relatively less understood (Michopoulos 2011). This study selected the Beijing Olympic Forest Park which is a typical urban forest system with artificial soils. Urban soils in industrial areas have been typically considered as biological deserts (Pouyat et al. 2002), because of its relative poverty from lack of primary producers and consequently reduced input of plant-derived litter. However, soils in urban parks and gardens can have high biological activity and contribute greatly to the carbon cycling of urban ecosystem. One of the major urban greening managements is the thorough removal of plant litter for esthetic reasons. Those types of greening management have definitely hampered the invaluable ecosystem services such as the ability to retain nutrients and sequester carbon (Sayer and Tanner 2010; Leff et al. 2012; Chen et al. 2013), because it greatly disturb litter decomposition which is the essential ecosystem process to mineralize nutrients into forms accessible to plants (Aerts 1997). Templer et al. (2015) found that approximately half of residential litterfall carbon and nitrogen was

exported from the City of Boston through yard waste removal which may cause nutrient limitation for some vegetation because of decreased recycling of nutrients in urban ecosystem. Litterfall production and subsequent decay of tree leaf in urban forests is a critical pathway maintaining urban soil fertility and an important component of urban carbon cycle. Understanding the processes and mechanisms of litter decomposition and nutrient dynamics in urban environment provides an ideal natural laboratory for elucidating the biogeochemical processes of aboveground and belowground and their interactions in other nonurban ecosystems under changing global environment.

5 Conclusions

This study was carried out in Beijing Olympic Forest Park, the largest urban forest park in Asia. We investigated the production of urban forest litter and used reciprocal translocation experiments to explore HFA of urban litter decomposition. Results show that there were two peaks in the monthly variations of *R. pseudoacacia* litterfall production and *P. armandii* followed a unimodal distribution pattern, which were similar to general seasonal patterns of broadleaf and coniferous litter production in nonurban ecosystem. The loss of initial ash-free mass of *P. armandii* (11 %) was about half of that of *R. pseudoacacia* (19 %). Initial N percentages and C/N ratio might have contributed to the differences of decay rate of leaf litter between broadleaf and coniferous species.

The reciprocal litter translocation experiments showed that the leaf litter decomposing rate of *P. armandii* decomposing in the home stand was significantly faster than that in the other stand, which demonstrated constant HFA. In contrast, the decomposition rate of *R. pseudoacacia* showed seasonal switch of HFA, which has not been observed in nonurban ecosystems. We suspect that matrix environmentally driven effects on soil biota might be responsible for the seasonal switch of HFA. More research is needed to understand the ubiquity, magnitude, and the mechanism of HFA for litter decomposition in the urban environment.

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