More of the same? In situ leaf and root decomposition rates do not vary between 80 native and nonnative deciduous forest species

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Summary
- Invaders often have greater rates of production and produce more labile litter than natives. The increased litter quantity and quality of invaders should increase nutrient cycling through faster litter decomposition. However, the limited number of invasive species that have been included in decomposition studies has hindered the ability to generalize their impacts on decomposition rates. Further, previous decomposition studies have neglected roots.
- We measured litter traits and decomposition rates of leaves for 42 native and 36 nonnative woody species, and those of fine roots for 23 native and 25 nonnative species that occur in temperate deciduous forests throughout the Eastern USA.
- Among the leaf and root traits that differed between native and invasive species, only leaf nitrogen was significantly associated with decomposition rate. However, native and nonnative species did not differ systematically in leaf and root decomposition rates. We found that among the parameters measured, litter decomposer activity was driven by litter chemical quality rather than tissue density and structure.
- Our results indicate that litter decomposition rate per se is not a pathway by which forest woody invasive species affect North American temperate forest soil carbon and nutrient processes.

Introduction
Although nonnative woody species are increasingly recognized as dominant invaders in many temperate ecosystems, such as deciduous forests (Howard et al., 2004; Fridley, 2008), their impact on biogeochemical processes is poorly understood. It is clear that a few well studied species can influence ecosystem carbon (C), nutrient, and soil microbial processes (Ehrenfeld et al., 2001; Kourtev et al., 2002; Ashton et al., 2005). For example, the invasive shrubs *Rhamnus cathartica* and *Lonicera maackii* in North America exhibit greater productivity and faster litter decomposition than co-occurring native species, which has been shown to alter soil nutrient cycling (Harrington et al., 1989; Heneghan et al., 2006; Arthur et al., 2012). However, these are but two of over 100 woody invaders spreading across North America (Fridley, 2008), and it remains unclear if faster litter decomposition, a major component of terrestrial biogeochemistry, is a general phenomenon of plant invasions.

Nutrient cycling in temperate forest ecosystems is mainly driven by decomposition of plant tissue, particularly leaves and roots (Vogt, 1991). Plant tissue quality, a combination of tissue chemistry (e.g. nitrogen (N), C : N ratio, lignin) and structure (e.g. specific leaf area (SLA), specific root length (SRL), tissue density), is a key driver of decomposition rate, because tissue quality regulates activities of soil organic matter decomposers, including microbes and soil fauna (Silver & Miya, 2001; Cornwell et al., 2008; Chapin et al., 2011; Aulen et al., 2012; Garcia-Palacios et al., 2013). Impacts of nonnative, invasive species on litter decomposition rates should therefore be driven by systematic differences in tissue chemistry and structure compared with natives, if such differences exist; although soil microbial community composition can also play an important role in litter decomposition (Strickland et al., 2009).

Nonnative, invasive plants are often more productive than natives (Liao et al., 2008; Grotkopp et al., 2010; van Kleunen et al., 2010; Fridley & Craddock, 2015). Thus invaders likely possess leaf and root traits associated with greater C gain (e.g. high N and SLA) and nutrient uptake (e.g. high SRL) (Leishman et al., 2007; Osunkoya et al., 2010; Brym et al., 2011; Ordonez & Olff, 2013; Jo et al., 2015). For example, woody forest invaders in the Eastern USA differ in C and nutrient acquisition strategies compared with co-occurring native species, which is reflected in differences in leaf and root structure and chemistry, including greater leaf litter N concentration and SRL (Heberling & Fridley, 2013; Jo et al., 2015). We hypothesize that such differences in tissue structure and chemistry lead to systematic differences in litter decomposition rate between native and nonnative species, which has never before been examined across a large taxonomic array of species. Moreover, very little information exists for root decomposition rates of native and invasive
species, precluding examination of how root decomposition may be linked to the different resource-use patterns of the two groups. Given that roots constitute a substantial portion of annual plant productivity and litter input (Jackson et al., 1997; Freschet et al., 2013), invaders could have significant impacts on nutrient cycling due to root inputs alone, independent of their effects on leaf litter processes.

In this study, we tested for differences in litter decomposition rates across a large sample of native and nonnative woody species present in temperate deciduous forests of the Eastern USA. Leaf and root decomposition rates were measured in the field for 78 and 48 species, respectively. Our primary objective was to compare leaf and root decomposition rates of nonnative species with those of native species. Secondarily, we tested whether nonnative species had different litter-associated traits than natives and how different traits of invaders may have influenced decomposition rates of the two groups, controlling for phylogenetic relatedness across species and covarying environmental factors.

Methods

Litter collection and preparation

We included leaves of 42 native and 36 naturalized, nonnative species of the Eastern USA (Fridley, 2008), and fine roots for a subset of 23 native and 25 nonnative species in the decomposition experiment. Two species of root samples were not used in leaf samples, leaving a total representation of 80 species in the study (Supporting Information Table S1). These species represented 26 genera in 17 families, with both native and nonnative species included in most taxonomic units. Senesced leaves were collected immediately after abscission in autumn 2012 from 5–6-year-old plants established in an experimental garden in Syracuse, NY, USA (lat 43°03’N, long 76°09’W). Roots were collected in December 2012 from plants propagated by cuttings from a subset of the garden plants or saplings (Acer) in 2011 and grown in pots at least for one growing season in the experimental garden with soil from the garden. For most species, we used first- to tertiary roots, but first- to second-order roots were used for Elaeagnus angustifolia, E. commutata, Linder bruennoin, L. ovalifolia, and Shepherdia argentea, in order to exclude secondary structural roots (Hishi, 2007; Guo et al., 2008). Roots were washed with distilled water to remove all soil particles. Leaves and roots were dried at 60°C for >2 d.

For each species, 3 g of dried leaves was inserted into each of twelve 20 × 20 cm or 10 × 20 cm bags (fiberglass screening, mesh size 1 mm), depending on leaf size. Similarly, 200 mg of dried roots of each species was placed in each of twelve 5 × 10 cm N-free polyester bags (mesh size 50 µm, Ankom Technology, Macedon, NY, USA). The filled bags were sealed with a heat sealer. Here, 918 and 546 litterbags were used in the leaf and root decomposition experiments, respectively. Each species was represented by 12 litterbags unless limited by total leaf or root material. These included three species of six bags each (Acer platanoides for leaf and root; Dirca palustris and E. angustifolia for root), and seven species of nine bags (L. canadensis, L. villosa, and Hydrangea paniculata for leaf; A. saccharum, Berberis vulgaris, Sambucus racemosa, and S. argentea for root).

Site selection and litterbag incubation

In May 2013, three adjacent 10 × 10 m blocks were laid out in a typical deciduous forest for the area located in Pompey, NY, USA (42°54’N 76°02’W). The overstory was a mature and moderately shaded secondary forest dominated by sugar maple (A. saccharum). In each block, four leaf litterbags for each species were placed on the soil surface, and four root litterbags for each species were buried in a vertical orientation at a depth of 5–15 cm. One leaf and one root litterbag per species per block (n = 3 per species) was collected after 1, 3, 6 or 18 months to determine mass loss. Two samples were collected after 1, 3 or 18 months for those species with six litterbags and three (in month 1) and two (in months 2, 6 and 18) samples were collected for species with nine litterbags. Mean annual temperature and precipitation during the 2 yr of the experiment (2013 and 2014) were 9.3°C and 1119 mm, respectively, at SUNY ESF station located 17 km north from the study site (National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center, USA).

Trait analyses and sample processing

Properties of leaves and roots for each species were analyzed using subsamples of the initial materials. Tissue N and C concentrations (%mass; [N], [C]) were determined with an elemental CN analyzer (NC 2100, Thermo Quest CE Instruments, Milan, Italy). Klason lignin concentration (%mass) was determined using wet chemistry after removing water and ethanol extractives from the tissue (TAPPI, 2002; Sluiter et al., 2005). Because Klason lignin contains both true lignin and other acid-insoluble compounds (Prescott, 2010), we used the term ‘acid-insoluble residue (AIR)’ instead of ‘lignin’. We included the proportion of mass removed from the tissue during the extraction process (%mass; water and ethanol extractive (WEE)) as a predictive trait for decomposition rate (McClaugherty et al., 1985). WEE consists of nonstructural components of the biomass, including sugars, nitrogenous materials, protein, ash, chlorophyll, waxes, and other minor components (Sluiter et al., 2005). We also measured specific leaf area (a ratio of area to DW (cm² g⁻¹); SLA) for leaves, specific root length (a ratio of length to DW (m g⁻¹); SRL), root dry matter content (a ratio of dry to water saturated weight (mg g⁻¹)); root dry matter content (RDMD), and root tissue density (a ratio of DW to volume (g cm⁻³); RTD) to determine how functional and structural traits influence litter decomposition rates. Leaf area, root length, and volume were measured on scanned images using Delta-T SCAN software (Delta-T Devices Ltd, Cambridge, UK).

Litter was collected from harvested litterbags, dried at 60°C for >2 d, and weighed to determine mass loss during decomposition. Root litter mass remaining was corrected for soil contamination using the ash weight of the collected samples inside the litterbags, initial roots, and soils at the site following Harmon
et al. (1999). Decomposition rate ($k$) of leaves and roots for each species was calculated by fitting a single exponential model ($y = e^{-kt}$) to the proportion of litter dry mass remaining ($y$) over the decomposition period ($t$, year) of 12 samples for each species (except for those with six or nine samples) using a nonlinear regression function ($nlm$) in R (Olson, 1963). Mean $r^2$ of the regressions for leaf and root mass remaining were 0.90 and 0.50, respectively.

Phylogenetic tree construction

To account for the taxonomic dependence of our species-level comparison, we created a phylogeny (Fig. S1) for our studied species using Phylomatic (ver. 3; Webb & Donoghue, 2005), with branch lengths estimated via the BLADJ algorithm in Phylcom (ver. 4.2) based on the node ages from the file ‘aged3’ (Gastauer & Meira-Neto, 2013). Generic polytomies were resolved using the most up-to-date literature phylogenies for Lonicera (Rehder, 1903; Theis et al., 2008; Howarth et al., 2011), Viburnum (Clement & Donoghue, 2012), Berberis (Kim et al., 2004), Hydrangea (Samain et al., 2010), Cornus (Xiang et al., 2006), Euonymus (Blakelock, 1951; Simmons et al., 2012), and Acer (Li et al., 2006).

Statistical analyses

We fit a hierarchical predictive model of tissue decomposition by jointly modeling the independent effects of traits on decomposition rate, and, simultaneously, whether those traits differed across native or nonnative species groups, for both leaf and root decomposition (Figs 1a, 2a). In this way, we could distinguish between effects of traits themselves on decomposition rate and whether such traits varied significantly by nativity. To do this, we used a Bayesian approach that accounted for phylogenetic autocorrelation across species, following the model of de Villemereuil et al. (2012) using JAGS in R 3.12 (Plummer, 2003; R Development Core Team, 2014). Decomposition rates were log-transformed to meet normality assumptions. As covariates we included two categorical variables, species’ nativity (nonnative $= 1$, native $= 0$) and whether plants associated with N-fixing bacteria (N-fixer $= 1$, non-N-fixer $= 0$). All other covariates of continuous variables were standardized by subtracting their mean and dividing by 2 standard deviations (SD) to enable effect size comparisons with categorical predictors (Gelman & Hill, 2006). We included six covariates for leaf decomposition (Fig. 1a) and eight for root decomposition (Fig. 2a). The models allowed us to estimate posterior coefficients ($\beta$s) to determine the relative effects of parameters on dependent variables. Noninformative priors for the coefficients ($\beta$s) were sampled from a normal distribution of mean 0 and variance 1000. The de Villemereuil et al. (2012) model includes estimation of phylogenetic signal (Pagel’s $\lambda$) in the initial litter traits and decomposition rates, from 0 (no phylogenetic signal) to 1 (strong phylogenetic signal). We ran three parallel MCMC chains in JAGS for 20 000 iterations after a 5000-iteration burn-in. We assessed model convergence using the Gelman-Rubin convergence diagnostic ($\hat{R}$), where $\hat{R} = 1$ at convergence (Gelman et al., 2014). All parameters in the models had $\hat{R} < 1.1$. The regression models included the hierarchical model are available in Table S2.

Results

Traits driving leaf and root decomposition rates across species

Among leaf litter traits, only chemical traits significantly affected decomposition rates (Fig. 1a,c). $[N]_{leaf}$ and $[WEE]_{leaf}$ increased, and $[C]_{leaf}$ decreased, leaf decomposition rates ($\beta_{7,8;10}$; Fig. 1a,c). $[AIR]_{leaf}$ and SLA had no significant impact on decomposition rate ($\beta_{9,11}$; Fig. 1a,c). The mean effect size of standardized values for $[N]_{leaf}$, $[C]_{leaf}$ and $[WEE]_{leaf}$ were similar to each other, suggesting that those traits had equivalent effects on leaf decomposition rate (Fig. 1a,c). Root decomposition rate was negatively affected by $[C]_{root}$, $[AIR]_{root}$, and SRL ($\beta_{10,12,13}$; Fig. 2a,c), and positively correlated with $[WEE]_{root}$ ($\beta_{12}$; Fig. 2a,c). $[AIR]_{root}$ had the largest effect size among root traits ($\beta_{11}$; Fig. 2a,c). After including phylogenetic autocorrelation, $[WEE]_{root}$ and SRL effects on root decomposition rate increased in magnitude ($\beta_{12,13}$; Fig. 2a,c). We detected relatively strong phylogenetic signals for both leaf and root tissue chemistry (e.g. $[AIR]$ and $[WEE]$) and weak signals for SLA, RTD, and RDMC (Table 1), suggesting that structural traits were less conserved across the phylogeny than tissue chemistry.

Nonnative effects on leaf and root traits

For leaves, $[N]_{leaf}$ was greater and SLA was lower for nonnative compared with native species ($\beta_{2,6}$; Figs 1a,b, S2; Table 1), but nativity was not significantly associated with $[C]_{leaf}$, $[AIR]_{leaf}$ or $[WEE]_{leaf}$ ($\beta_{3,5}$; Figs 1a,b, S2; Table 1). The significant nonnative effect on $[N]_{leaf}$ appeared after applying phylogenetic autocorrelation ($\beta_{5}$; Fig. 1a,b). Nativity had no effect on root chemical traits ($\beta_{2,6}$; Figs 2a,b, S2; Table 1), but nonnatives had lower RTD and RDMC, two structural traits, than natives when including the phylogenetic autocorrelation ($\beta_{7,8}$; Fig. 2a,b; Table 1).

Effects of trait differences between native and nonnative species on decomposition rates

Among the leaf and root traits that differed by nativity, only $[N]_{leaf}$ was significantly associated with decomposition rate (Fig. 1). However, overall, leaf and root decomposition rates were unaffected by nativity (Wilcoxon’s rank-sum test, $k_{leaf}$: $P = 0.92$, $k_{root}$: $P = 0.53$; Fig. 3). Neither leaf nor root decomposition rates exhibited a strong phylogenetic signal (Table 1).

N-fixer effects on leaf and root decomposition

The N-fixer effect (species in the Elaeagnaceae; see Table S1 for the species list) on leaf decomposition rate was not significant.
Wilcoxon’s rank-sum test: $P = 0.73$; Fig. 3). However, N-fixers had significantly lower root decomposition rates than non-N-fixers (Wilcoxon’s rank-sum test: $P < 0.01$; Fig. 3). N-fixers had significantly higher [N] for both leaves and roots ($\beta_1$, Fig. 1a,b; $\beta_1$, Fig. 2a,b). Also, N-fixers had significantly higher [AIR]$_{\text{root}}$ (30 ± 5.7 SD % vs 20 ± 5.3 SD %; Wilcoxon’s rank-sum test:
Table 1  Mean of initial litter traits and decomposition rates by nativity and Pagel’s lambda (λ) with 95% credible interval (CI) as an estimator of phylogenetic signal in the litter traits and decomposition rates

<table>
<thead>
<tr>
<th>Traits</th>
<th>Units</th>
<th>Native</th>
<th>Nonnative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD) n</td>
<td>Mean (SD) n λ (95% CI)</td>
<td></td>
</tr>
<tr>
<td>Leaf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nleaf</td>
<td>% mass</td>
<td>0.902 (0.326) 42</td>
<td>1.10 (0.507) 36</td>
</tr>
<tr>
<td>Cleaf</td>
<td>% mass</td>
<td>47.0 (2.76) 42</td>
<td>46.3 (2.19) 36</td>
</tr>
<tr>
<td>AIRleaf</td>
<td>% mass</td>
<td>15.0 (5.10) 42</td>
<td>15.3 (5.45) 36</td>
</tr>
<tr>
<td>WEEleaf</td>
<td>% mass</td>
<td>49.9 (7.91) 42</td>
<td>50.8 (8.39) 36</td>
</tr>
<tr>
<td>SLA</td>
<td>cm² g⁻¹</td>
<td>138 (30.4) 42</td>
<td>118 (24.5) 36</td>
</tr>
<tr>
<td>kleaf</td>
<td>yr⁻¹</td>
<td>4.47 (2.92) 42</td>
<td>6.67 (9.21) 36</td>
</tr>
<tr>
<td>Root</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nroot</td>
<td>% mass</td>
<td>1.59 (0.604) 23</td>
<td>1.60 (0.803) 25</td>
</tr>
<tr>
<td>Croot</td>
<td>% mass</td>
<td>44.1 (1.42) 23</td>
<td>43.9 (2.08) 25</td>
</tr>
<tr>
<td>AIRroot</td>
<td>% mass</td>
<td>21.6 (6.31) 23</td>
<td>21.2 (6.04) 25</td>
</tr>
<tr>
<td>WEEroot</td>
<td>% mass</td>
<td>45.0 (7.21) 23</td>
<td>43.8 (6.31) 25</td>
</tr>
<tr>
<td>SRL</td>
<td>m g⁻¹</td>
<td>32.8 (15.3) 23</td>
<td>40.5 (14.8) 25</td>
</tr>
<tr>
<td>RTD</td>
<td>g cm⁻³</td>
<td>0.349 (0.101) 23</td>
<td>0.298 (0.081) 25</td>
</tr>
<tr>
<td>RDMC</td>
<td>mg g⁻¹ yr⁻¹</td>
<td>265 (56.0) 23</td>
<td>239 (34.4) 25</td>
</tr>
<tr>
<td>kroot</td>
<td>yr⁻¹</td>
<td>4.91 (2.32) 23</td>
<td>4.53 (1.37) 25</td>
</tr>
</tbody>
</table>

A λ close to zero indicates a low phylogenetic signal in the trait, while a λ close to 1 implies a strong phylogenetic signal. Nleaf, mass-based leaf nitrogen concentration; Cleaf, mass-based leaf carbon concentration; AIRleaf, mass-based leaf acid-insoluble residue concentration; WEEleaf, mass-based leaf WEE (water and ethanol extractive) concentration; SLA, specific leaf area; kleaf, leaf decomposition rate; Nroot, mass-based root nitrogen concentration; Croot, mass-based root carbon concentration; AIRroot, mass-based root acid-insoluble residue concentration; WEEroot, mass-based root WEE (water and ethanol extractive) concentration; SRL, specific root length; RTD, root tissue density; RDMC, root dry matter content; kroot, root decomposition rate.

P<0.001) and a lower [WEE]root (38 ± 9.8% vs 45 ± 5.9%; P=0.057).

Discussion

In situ measurements of leaf and root decomposition rates for 78 and 48 species, respectively, revealed no significant differences between native and nonnative species. However, a few invaders exhibited markedly higher leaf decomposition rates than others. In general, tissue chemistry rather than structural traits controlled leaf and root decomposition rates. However, those traits that influenced decomposition rates were generally not those that varied between native and nonnative species, whether or not phylogenetic autocorrelation was included in the analyses.

Traits that control decomposition rates of leaves and roots

We found that chemical properties of leaves (N, C, and WEE) and roots (C, WEE, and AIR) were correlated with leaf and root decomposition rates. It was surprising that AIR, primarily composed of lignin, had no effect on leaf decomposition rates as it is often associated with slower leaf and root k values (Melillo et al., 1982; Cornwell et al., 2008; Aulen et al., 2012; Freschet et al., 2012), which was also the case for root decomposition in this study. However, leaf decomposition rate may sometimes be more closely aligned with litter C and N concentrations than lignin (Taylor et al., 1989). Furthermore, in our study, the variance of leaf AIR concentration was 27% less than that of root AIR concentration across species (Table 1), suggesting leaf AIR was relatively invariable across this particular species sample. We also note that, to our knowledge, no previous study has compared root decomposition between woody N-fixers and non-N-fixers. A higher root AIR concentration and a lower WEE for N-fixers compared with non-N-fixers may have reduced root decomposition rates for the N-fixers, which is consistent with the overall results that AIR and WEE were negatively and positively, respectively, associated with root decomposition among all species (Fig. 2). Overall, our findings support the prevailing idea that substrate chemistry is a major factor controlling leaf and root decomposition rates (Melillo et al., 1982; Taylor et al., 1989; Silver & Miya, 2001; Cornwell et al., 2008; Aulen et al., 2012; Freschet et al., 2012).

In global-scale analyses that include diverse plant functional groups, SLA is positively linked to leaf decomposition rate (Cornwall et al., 2008; Pietsch et al., 2014). SLA was not associated with leaf decomposition in the present study, suggesting that the relationship may not occur among species within a single group of plants (e.g. herbaceous, woody). For roots, SRL was negatively related to decomposition rate, although the effect size was relatively small compared with other chemical traits. Given that most of our study species are associated with arbuscular mycorrhizae (Brundrett et al., 1990; Wang & Qiu, 2006; Akhmetzhanova et al., 2012) and that thicker roots tend to have a greater association with arbuscular mycorrhizae (Kong et al., 2014; Eisenstat et al., 2015), lower SRL roots may contain more recalcitrant, mycorrhizal associated compounds (e.g. low concentration of soluble carbohydrates, high AIR concentration) (Langley & Hungate, 2003; Sun et al., 2013). The negative association between decomposition rate and SRL in our study suggests that factors other than mycorrhizal abundance drive root decomposition rates.
Leaf and root decomposition rates of native and nonnative species

One of the most striking results of this study was that leaf and root decomposition rates did not differ between native and nonnative species, which contrasts with the facilitating effects of invading species on forest litter decomposition that have been reported in other studies (Liao et al., 2008; Castro-Díez et al., 2014). For example, the litter decomposition rate of invasive species was 134% higher than co-occurring native species in forest ecosystems in a global meta-analysis (Liao et al., 2008). The perception that invaders have high litter decomposition rates may stem from a bias to include invaders in decomposition studies that have noticeable impacts on ecosystems (Hulme et al., 2013). In comparison, our study included most of the widespread woody invaders of Eastern USA forests (Fridley, 2008), but without bias as to their presumed ecosystem effects, and only examined differences on a mass basis, excluding potential differences in litter quantity or environmental differences between sites dominated by native or nonnative species. We also included root tissue in our comparison.

It was counterintuitive that nativity did not influence leaf litter decomposition, when nonnatives had higher leaf N, which was positively linked to decomposition among the study species (Fig. 1). We suggest that the positive leaf N impact of invaders on the leaf decomposition rate was diluted by the combined effect of other litter traits that influenced decomposition rate (Fig. 1). Nevertheless, three nonnative species (L. xylosteum, L. periclymenum and R. cathartica) had markedly higher leaf decomposition rates (Fig. 1). Two of those species, L. xylosteum and R. cathartica, are considered noxious weeds, which spread aggressively and have proven difficult to control in Eastern USA (USDA, 2015). This result suggests that the qualitative effects of decomposing litter of invasive species on nutrient cycling in Eastern USA forests are species specific (Fig. 3).

Litter quality is one of several drivers of nutrient cycling in forests, and nonnative species may influence this process in other ways. For example, nonnative invaders may alter soil nutrient dynamics by changing soil microbial community composition and activity (Kourtev et al., 2002; Hawkes et al., 2005; Holly et al., 2009). Further, considering the greater productivity rates of many invaders (Liao et al., 2008; Castro-Díez et al., 2014;
Fridley & Craddock, 2015), nonnatives are likely to impact ecosystem processes by increasing litter production. All else equal, similar litter quality but greater quantity may shift the balance toward greater rates of nutrient cycling in ecosystems dominated by fast growing invaders (Reich et al., 1997).

Results from examining litter decomposition of 80 woody species contrast the growing perception that nonnative species, in general, increase terrestrial processes by producing rapidly decomposing litter. We found that leaf decomposition rates were exceptionally high for three invasive shrub species. However, overall, there was no evidence that leaf or root litter decomposition rates differed between native and nonnative woody species found in deciduous forests of Eastern North America. Consequently, the impact of woody invasives on litter decomposition in Eastern USA forests is species specific, and not generalizable.

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References


