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Short communication

Diversification of the urban forest—Can we afford to exclude exotic tree species?

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ABSTRACT

Introduced tree species represent a substantial component of urban forests in cities all over the world. Yet there is controversy about the further use of introduced tree species. Many practice orientated publications,research papers and governmental websites in the fields of urban planning, urban forestry, and urban ecology argue for planting native species and avoiding introduced species. Such arguments for native-only species selection are also touted by environmental groups and the media. Consequently the debate has sometimes spiralled away from a sensible and rational platform where invasion risks and biodiversity loss are discussed, to a groundless and unreasonable argument where exotic species are generally considered incapable of providing ecosystem services. From a European perspective, we here aim to curate a set of necessary considerations for current and future discussions on native and non-native plant material in sustainable urban development. Using examples from Northern and Central Europe we illustrate that in some regions the catalogue of native tree species may be too limited to fulfil ecosystem services and resilience in harsh urban environments. A main message from our line of arguments is that we cannot afford to generally exclude non-native tree species from urban greening. If "native-only" approaches become incorporated in regional, national or international policy documents or legislation there is a risk that urban ecosystem resilience will be compromised, particularly in regions with extreme environmental conditions. Since both invasion risks and sizes of native species pools vary conspicuously at regional to continental scales we also argue to adapt urban policies on using non-native trees to regional contexts.

1. Introduction

Introduced tree species represents substantial component of urban forests in cities all over the world (e.g. Cowett and Bassuk, 2014; Sjöman et al., 2012; Yang et al., 2012; Freire Moro et al., 2014). Yet there is controversy about the further use of introduced tree species. Many practice orientated publications, research papers and governmental websites in the fields of urban planning, urban forestry, and urban ecology argue for planting native species and avoiding introduced species (Kendle and Rose, 2000).

Similarly, guidelines and evaluation programs for sustainable urban development recommend the preference of native over non-native tree species. In the UK, for example, an important instrument for setting standards for best practice in sustainable design (BRE Environmental Assessment Method) emphasises and encourages the use of native plants (BREEAM, 2011). In the US, a similar quality programme, LEED (Leadership in Energy & Environmental Design), recommends native plants in order to reach high performance, though it allows non-native species as long they are site adapted and well-performing (USGBC, 2014). In Sweden, the Green Area Factor approach is a comparable programme to secure sustain-

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able urban planning in developed areas (Stockholm Stad, 2014). In this programme, native plant species receive higher quality marks based on the assumption that they support a higher diversity compared to non-native species. Overall, two major arguments are used for preferring more or less exclusively native tree species in urban settings: possible invasion risks and a putative superiority of native over non-native species.

Such arguments for native-only species selection are also touted by environmental groups and the media, whose opposition to exotic species is often based on philosophical-political notions rooted in romanticism, rather than scientific results (Kendle and Rose, 2000; Kaufman and Kaufman, 2007; Hitchmough, 2011). Consequently the debate has sometimes spiralled away from a sensible and rational platform where invasive species and biodiversity loss are discussed, to a groundless and unreasonable argument where exotic species are generally considered as harmful or incapable of providing ecosystem services such as rainfall interception and storm water control (see e.g. Watson and Adams, 2010). Previous work from conservation biology and restoration ecology have promoted nuanced positions towards using non-native plants (e.g. Davis et al., 2011). Today, concerns of invasion scientists mostly focus on impacts of invasive species, i.e. on those introduced species that spread and maintain populations without human assistance, and not on introduced or alien species in general (Simberloff et al., 2013; but see debate between Simberloff, 2011 and Davis et al., 2011). Yet wordings are still used in public debates that promote a generally negative assessment of introduced species (e.g., “pollute”, “meltdown”, “harm”, “disrupt”, “destroy”, “degrade”; Sagoff, 2005).

Here, we aim to curate a set of necessary considerations for current and future discussions on using native and non-native plant material in sustainable urban development. The aim is not, as such, to delineate one preference to another, but rather to provide a sound background to current misconceptions on the role of native vs. exotic species in harsh urban environments. By reflecting major arguments of the debate, we finally argue, from a north European perspective, that we cannot afford to exclude generally introduced tree species in the urban forest. Urban trees in focus are here street trees and other trees growing in paved environments such as public squares, courtyards etc. Moreover, introduced species (synonymously exotic, alien, non-native species) are here addressed as species that have been introduced to northern Europe by human assistance since the last ice age. Invasive species are a subgroup of these species that spread and maintain populations without human assistance (Simberloff et al., 2013).

2. Invasion risks

The Millennium Ecosystem Assessment (MEA, 2005) presents the spread of invasive alien species as a strong driver of biodiversity loss across major types of ecosystems such as forests, grassland or mountains at local to global scales. Indeed, there is broad evidence of negative ecological and economic impacts of invasive tree species (Rejmánek and Richardson, 2013). Yet it is a basic insight from invasion science that not all introduced species are invasive (Blackburn et al., 2014; Williamson, 1999). *Introduced* (alien, exotic, non-native) tree species are thus not to be equated with *invasive* tree species. Moreover, beneficial effects of some introduced species have been acknowledged (Schlaepfer et al., 2011; Dickie et al., 2014). There are thus two important messages from invasion science: (i) the challenge of reducing invasion risks, that can be associated with introduced tree species, but *not* the task to oppose *all* introduced species at large (Simberloff, 2011); (ii) the need to consider trade-offs between positive and negative effects of introduced, and in particular of invasive tree species (Dickie et al., 2014). For the latter, the environmental context is of vital importance.

Given that a species can be invasive in a specific climate or environment does not mean that it is invasive in a whole region or under other environmental conditions. For example, both Sitka spruce (*Picea sitchensis*) and Western hemlock (*Tsuga heterophylla*) are strongly invasive in the maritime climate of western Norway, but not in central and eastern Sweden, where a more continental climate prevents spreading (Sjöman et al., 2015), nor in Central Europe. Both species are thus safe to use under these conditions. Similarly, black locust (*Robinia pseudoacacia*) is highly invasive only in warmer parts of Central Europe, and even here, keeping a distance of some hundred meters between plantings and susceptible habitats will prevent negative invasion effects since this species is strictly dispersal-limited (Cierjacks et al., 2013). In consequence, plantings of black locust, e.g. along streets in urban cores or parks, can be safe.

Since there is broad evidence of adverse invasion impacts of introduced tree species (Rejmánek and Richardson, 2013), it is unwise to neglect associated risks. Yet considering the context dependence of invasion impacts would help develop recommendations for *where* and *how* exotic species can be planted to limit associated invasion risks, while delivering different ecosystem services. Finding the right balance between the beneficial use of exotic trees in urban environments and preventative measures to protect natural ecosystems from invasive species is thus a major challenge for authorities and the research community for years to come. This requires identifying three groups of species in a regional perspective: (a) generally safe species, without any risk of invasion; these can be listed in “green lists” (Dehnen-Schmutz, 2011); (b) species that may be invasive in some environmental contexts, but safe in other environments; and (c), species that usually imply high invasion risks and should be generally excluded from plantings.

3. Superiority of native species?

Two arguments are often addressed to illustrate an assumed superiority of native over introduced species: (i) a better adaptation of native species to regional environmental conditions, and (ii), a better function of native species as food (or habitat) resource for animal species (Sagoff, 2005). The first argument often holds for (semi-)natural conditions but not necessarily for harsh, novel urban conditions that are, for example, typical of many planting sites in urban streetscapes. Here, tree species are usually subject to multiple stressors (heat, draught, human pressures) which clearly diverge from natural environmental settings and are anticipated to increase with climate change (Roloff et al., 2009). Since many introduced tree species perform better than native species in face of adverse urban conditions (Roloff et al., 2009; Chalker-Scott, 2015), the guidelines of the influential German GALK (2012) for selecting trees for urban streets include 30 species non-native to Germany (and 53 cultivars of these species) opposed to 13 native tree species (and 31 cultivars of these).

Some introduced species can provide habitat and food resources for animals (Kennedy and Southwood, 1984; Schlaepfer et al., 2011; Chalker-Scott, 2015) which has been mostly shown for gardens (Hanley et al., 2014). Yet for invasive plant species, a recent meta-analysis could not demonstrate significant positive effects on animal species across a range of ecosystem types (Schirmel et al., 2016). Urban ecosystems, however, are clearly understudied compared to other types of ecosystems. There is evidence that non-native tree species can decrease the food availability for insects that feed on plant tissues (Kennedy and Southwood, 1984; Schoonhoven et al., 2012; Schirmel et al., 2016). Even if assuming that native tree species generally perform better in providing food resources for