

Scientific Note: An Incursion of the Widely-cultivated Katsura (*Cercidiphyllum japonicum*, Cercidiphyllaceae) in Pennsylvania

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ABSTRACT

Cercidiphyllum japonicum (katsura) is a dioecious tree native to China and Japan. Although imperiled in parts of its natural distribution, the species has become quite common as a cultivated tree in temperate North America. The species is noted as occasionally escaping cultivation in the eastern United States, but few records of established incursions (and the conditions under which they might recruit) exist in the literature. We here report an incursion of *C. japonicum* in central Pennsylvania, along with notes on seedling recruitment on the Bucknell University campus.

Key words: *Cercidiphyllum japonicum*, invasive, nonnative, Pennsylvania, recruitment

Cercidiphyllum japonicum Siebold & Zucc. (Cercidiphyllaceae; Figure 1), commonly known as katsura, is a dioecious tree species native across a wide amplitude of climate and vegetation zones in China and Japan (Kubo and Sakio 2020), ranging from subtropical to subalpine conditions (Zhu et al. 2020). Although the genus was previously more widespread and biodiverse, *C. japonicum* is one of two extant *Cercidiphyllum* species which exemplify Tertiary relict trees (Qi et al. 2012). Tertiary relicts are hypothesized to be members of plant communities that were widespread during the Tertiary (65–15 MYA) that have survived since that time in refugial habitats (Milne and Abbott 2002). These species are typically restricted to southwestern and southeastern North America, East Asia, and southwestern Eurasia (Milne and Abbott 2002) and include tree taxa such as *Metasequoia glyptostroboides* (dawn redwood, Cupressaceae; see Ma 2003), *Liquidambar* spp. (sweetgums, Altingiaceae; see Öztürk et al. 2008), and *Davidia involucrata* (dove tree, Nyssaceae; see Tang et al. 2017).

Cercidiphyllum japonicum was introduced to the United States with a set of other cultivated Japanese plants in 1865 when seeds were sent from Japan by Thomas Hoggs Jr. to his family-owned Manhattan, NY nursery (Klingaman 2007; Del Tredici 2017). Since that time, katsura has been used as a street/park and landscaping tree species throughout temperate areas of the United States (zones 4–8 as per Dirr 1990). Much of its popularity has been ascribed to attractive features including the heart-shaped *Cercis*-like leaves, yellow/apricot/reddish fall color, and pyramidal to wide-spreading growth habit (Dirr 1990; Gilman and Watson 2014). Numerous cultivated varieties have been developed and are available at nurseries throughout the United States, including cultivars with weeping growth forms and purple or gold leaf color (Gibbons 2008).

Seed dispersal and seedling survival of *C. japonicum* tends to be somewhat limited in its native range in China and Japan due to 1) high levels of disturbance in the riparian forests it typically inhabits (Zhang et al. 2015), and 2) a reduced rate of germination in the presence of dense leaf litter (Kubo et al. 2004) that often corresponds with the maturation of fruits/seeds during the autumn season (Kubo and Sakio 2020). Ideal seed germination occurs under direct sunlight (Kubo and Sakio

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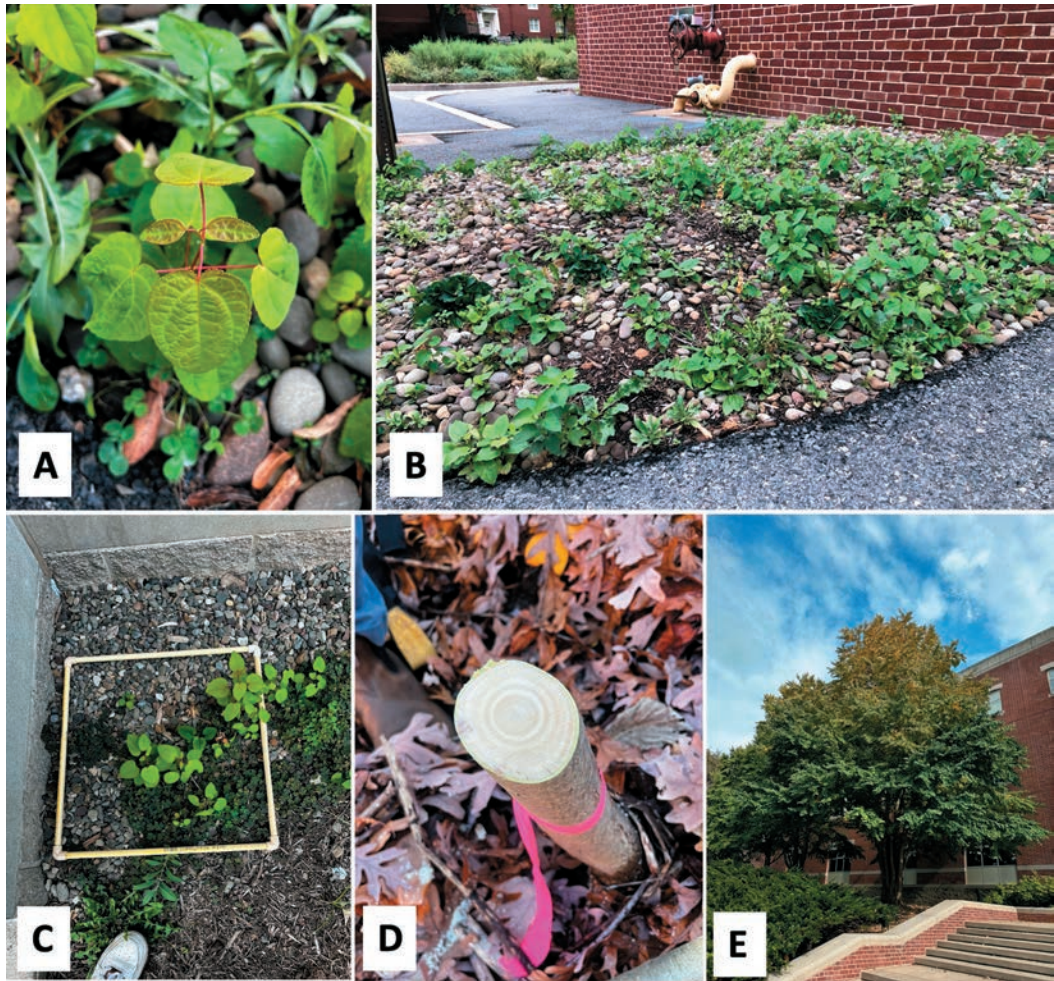


Figure 1. *Cercidiphyllum japonicum* (katsura) on the Bucknell University campus, Lewisburg, PA, USA. **A.** *C. japonicum* seedling (second year); **B.** First-year seedling recruitment in a gravel bed; **C.** Example of quadrat sampling along building edges; **D.** Stem cross-section of young tree from 8-year-old campus woodland incursion; **E.** Mature cultivated tree outside of Rooke Biology Building. Photos by K. Long and C.T. Martine.

2020) and moist conditions (Gilman and Watson 2014), a combination that infrequently occurs (in its native range) at the consistent rate that *C. japonicum* recruitment requires. Coupled with a history of human exploitation (for spice, medicine, and timber), limitations in reproductive capacity have led to the listing of *C. japonicum* as an endangered species in China (Zhang et al. 2015). Outside of its natural distribution, however, *C. japonicum* has been acknowledged as a species capable of escaping cultivation and/or becoming naturalized, including in Pennsylvania (Rhoads and Block 2007), other parts of the mid-Atlantic and southeastern US (Weakley et al. 2022), Ohio (Vincent and Cusick 1998), and southern New England (Gibbons 2008)—although few direct records (see Vincent and Cusick 1998, Gibbons 2008) of this have so far been published.

Recruitment and establishment of adventive populations of *C. japonicum* (Figure 1B) were recently identified in Lewisburg, Pennsylvania (Union County) by C.T. Martine on the campus of Bucknell University where numerous mature specimens (both male and female) of the species have long been cultivated (since at least the early 1990s) around a handful of academic buildings (Figure 1E).

Until 2020, regular landscaping on campus kept plant beds clear of weeds and mulched regularly, minimizing the possibility of establishment for unwanted plant species. The onset of the COVID-19 pandemic reduced general landscape upkeep between 2020–2022. This gap in maintenance created a window for the recruitment of *C. japonicum* in various locations on campus.

The goal of this study was to establish the extent of recruitment of *C. japonicum* on the Bucknell campus. To that end, two surveys were conducted: a plot-based survey in the primary area where recruitment was most visible (unweeded garden beds around building foundations of the university's "science quad," Figure 1A–1C, Figure 2) and a casual assessment of recruitment across campus. In the former case, 38 1×1 m quadrats were run directly along the side of two large buildings in gravel drainage systems as well as around a developed courtyard between the two buildings to assess *C. japonicum* seedling recruitment (Figure 1C). Counts of seedlings ranged from 1–10 per quadrat, with an average of ~2 per m². Recruitment was most prevalent in shallowly mulched beds with good drainage and minimal competition from other species. Well-drained, rocky drainage strips also provided ample opportunities for *C. japonicum* germination, although we cannot be certain about whether this is due to sunlight, substrate characteristics, or moisture. These findings corresponded with our casual assessment of recruitment in other parts of campus where seedling densities were lower, with young trees found growing in gravel/stone beds, gaps between pavers, and cracks in asphalt, similar to what was reported by Vincent and Cusick (1998).

Coincident with the above, we identified an incursion of larger young *C. japonicum* trees on a wooded slope adjacent to a set of campus residence halls (Figure 2). This incursion, consisting of 24 trees in an area of ~3,500 m² and co-occurring with Japanese knotweed (*Reynoutria japonica* Houtt., Polygonaceae) in an open understory beneath mature oaks, was surveyed and mapped. We found these trees were all similar in size, with an average DBH of 5.1 cm and height of ~5 meters; and one tree was cut down to reveal a ring count of eight (Figure 1D). Although the surface below these trees included a thick cover of leaf litter (not ideal for *C. japonicum* recruitment as per above), clearing away that litter revealed recently disturbed soil with much exposed coarse rock material. We confirmed with our campus Facilities office (B. Kuntz, pers. comm.) that the area had been dug up 8–9 years prior as part of a sewer pipe repair. This activity not only created gaps in the woodland canopy and cleared the understory but also brought belowground rocky material to the open soil surface, thus creating an ideal germination and recruitment environment for *C. japonicum* and, likely, for *R. japonica* and the other similarly-aged tree species in this midstory stand such as *Liriodendron tulipifera* L. (Magnoliaceae) and *Acer platanoides* L. (Sapindaceae). It is notable that no other adventive *C. japonicum* individuals outside of this population in the ~8-year age class have been seen anywhere else on campus (aside from the seedlings we report here and the rare individual seedlings we have encountered near some of the female trees identified in Figure 2), which suggests that the ideal conditions presented by the sewer repair work facilitated a recruitment event that likely coincided with the dispersal of *C. japonicum* seeds (and their eventual germination) into the cleared area.

Our observations suggest that when presented with ideal germination conditions, *Cercidiphyllum japonicum* can recruit and become established—and compete with other "pioneer" species, at least in early stages of colonization. None of the individuals in our 8-year age class have reached reproductive maturity so we cannot yet call this population "naturalized," but we will be closely monitoring them from here forward.

Although *C. japonicum* is generally categorized as having little/no invasive potential, a discontinuity in regularly scheduled landscaping amidst the COVID-19 pandemic has allowed for the observation of seedling recruitment where it normally would go unnoticed. A number of characters predicted to increase the likelihood of tree species invasiveness in the northeastern United States (see Herron et al. 2007) are exhibited by *C. japonicum*, including wind-dispersed seeds, rapid growth rate, large native latitudinal range, and some degree of shade tolerance (Dirr 1998) post-recruitment. It is also notable that populations of *C. japonicum*, in the native range, are known to expand and persist via vegetative reproduction or sprouting (Kubo et al. 2005, Kubo et al. 2010)—a proclivity

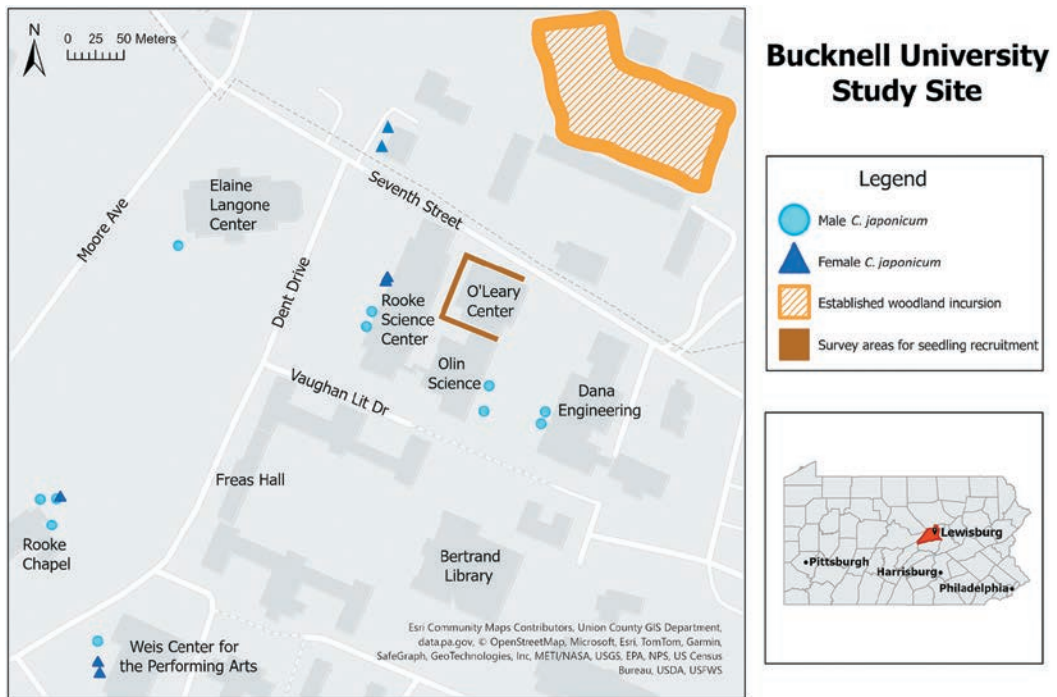


Figure 2. Map of the Bucknell University campus in Lewisburg, PA showing the locations of all cultivated mature *Cercidiphyllum japonicum* trees on campus, survey areas for seedling recruitment, and an established woodland incursion. The nearest cultivated fruit-producing female tree is roughly 130 meters from the incursion area. Map produced by E.H. Williams using ESRI ArcGIS Pro.

that may compensate for reduced rates of seedling survival and regeneration as site conditions change post-colonization (although not a current factor in our study sites given that all of our recruitment is so far via seed). Considering these factors, the increasing prominence of *C. japonicum* in the landscaping setting, and similar reports of recruitment in Ohio (Vincent and Cusick 1998) and southern New England (Gibbons 2008), it is our opinion the species be considered “potentially invasive” in eastern North America.

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