The Exotic Empress Tree, *Paulownia tomentosa*: An Invasive Pest of Forests?

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The empress tree, *Paulownia tomentosa* (Thunb.) Steud., was introduced to cultivation in the United States from its native eastern Asia in 1844 (Hu 1961). Originally grown as a showy-flowered ornamental, *P. tomentosa* is now widely planted in the northeastern and southeastern United States as a source of high-value export lumber (high quality logs may command a price comparable to that of black walnut) and for reclamation of surface-mined lands (Hu 1961, Tang et al. 1980, Preston 1983, Hardie et al. 1989).

Paulownia tomentosa escapes from cultivation and naturalizes in portions of the southeastern and middle Atlantic states where winter temperatures do not drop below 0°C for long periods (Hu 1961, Melhuish et al. 1990). In the Southeast, *P. tomentosa* naturalizes along roadsides, forest edges, and disturbed woodlots, and in streamside forests, growing as scattered individuals or in small stands (Hough 1907, Tang et al. 1980, Gleason and Cronquist 1991, Williams 1993). Braun (1969) stated that *P. tomentosa* was abundant on some mesic slopes and in valley forests in the Appalachian Plateau and Ohio River Valley.

Establishment of commercial *P. tomentosa* plantations has recently begun in the eastern United States (Tang et al. 1980, Preston 1983, Hardie et al. 1989). Does *P. tomentosa* pose a threat to natural communities in this region, particularly since it is being spread geographically by cultivation? Specifically, will *P. tomentosa* become an invasive pest in natural areas as have other Asian woody plants (e.g., *Ailanthus altissima* (Mill.) Swingle and *Lonicera japonica* Thunb.)? I suggest that *P. tomentosa* is unlikely to aggressively invade natural areas in this region.

Life history characteristics can be an important determinant of the success of an exotic species (Ewel 1989). *Paulownia tomentosa* is primarily an early successional species with several characteristics of pioneer species, as discussed by Ewel (1989): massive production of small, wind-dispersed seeds — a mature tree can produce over 20 million seeds a year (Tang et al. 1980); rapid growth rate — height increases of over 2 m a year have been recorded for seedlings (Yinong 1989); strong shade intolerance (Hu 1961, Beckjord et al. 1985); poor competitive ability (Hu 1961, Beckjord et al. 1985); and precocious reproduction — trees may first produce seed at 8 to 10 years of age (Hu 1961). Seed germination is restricted to open substrates, such as exposed mineral soil where light levels are high and leaf litter is absent (Toda and Isikawa 1952, Borthwick et al. 1964, Hu 1961, Tang et al. 1980). While these traits facilitate colonization of disturbed sites, *P. tomentosa* may lack the competitive ability to invade established forests without large-scale disturbance. I surmise that the highly restrictive seedling regeneration niche, particularly the requirement for light-rich, scarified substrates, may be the primary factor that regulates the invasive ability of *P. tomentosa*.

Hu (1961) noted the importance of disturbance in the establishment of *P. tomentosa* in deciduous mesophytic forests of eastern China. In this region, large-scale disturbance such as landslides, flood scour, or other land scarification results in optimal establishment of *P. tomentosa* stands. Likewise, my own research (Williams 1993) implicated large-scale disturbance as a factor in the establishment of *P. tomentosa* in a streamside forest of central Virginia. The age distribution of *P. tomentosa* at my study site was strongly unimodal, suggesting episodic establishment. The age distribution depicted a major recruitment pulse correlated with the passage of Hurricane Camille in 1969, which generated extensive flooding and landslides. Since then, however, large-scale exogenous disturbance has been absent from the study site and recruitment of *P. tomentosa* has been negligible. Thus, invasion of native forests by *P. tomentosa* appears to be primarily facilitated by large-scale disturbance that eliminates competitors and produces the irradiance and seedbed conditions necessary for optimal establishment.

At a regional scale, it is unlikely that *P. tomentosa* will become an aggressive invader of native forests or a recurring management problem in many natural areas in the eastern United States. However, *P. tomentosa* readily colonizes sites that have suitable microsites for establishment (e.g., poorly vegetated rock faces with shallow soil) or that have been extensively modified by a single large-scale disturbance or perhaps by more frequent disturbances of moderate scale (e.g., scouring floods in riparian forests). Thus, occasional removal of this species may be necessary to maintain the integrity of native plant communities. Control of *P. tomentosa* along roadsides and forest edges to remove propagules should be a management priority in early stages of invasion. Natural area managers should be aware that the high value of quality *P. tomentosa* may offset the cost of removal. Profits gained from the sale of *P. tomentosa* logs could be used to fund further stewardship endeavors such as the control of more tenacious exotics.

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