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Noteworthy Collections

An Account of *Triadica sebifera* (L.) Small in Virginia with Comments on Invasiveness and Range Expansion

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Triadica sebifera (L.) Small (EUPHORBIACEAE)—**King and Queen County**: Virginia Seasonally inundated *Nyssa biflora* Walt. swamp in backwater zone of a man-made pond near the York River shoreline, approximately 8 km southeast of the Town of West Point (lat: 37.476529; lon: –76.727332). Eight individual saplings were found growing on hummocks among the following associates: *N. biflora*, *Liquidambar styraciflua* L., *Morella cerifera* (L.) Small, *Eubotrys racemosus* (L.) Nutt., *Ilex opaca* Aiton var. *opaca*, *Juncus effusus* L., *Osmundastrum cinnamomeum* (L.) C. Presl var. *cinnamomeum*, *Acer rubrum* L., *Woodwardia areolata* (L.) T. Moore, *Dulichium arundinaceum* (L.) Britton var. *arundinaceum*, and *Cephalanthus occidentalis* L. All specimens were relatively young saplings (estimated at 3–5 years), and all were found within an area circumscribed by an approximate 50 m radius; no flowering or fruiting was observed on the collection date (15 July 2016) or on a subsequent site visit (17 September 2016). 15 July 2016, *D.A. DeBerry 892*. Voucher specimen deposited at the College of William & Mary Herbarium, Williamsburg, Virginia (WILLI 82064).

Significance. This is the first account of Chinese tallow tree (*Triadica sebifera* (L.) Small) in Virginia and, to the best of our knowledge, the northernmost record of this species in the Atlantic states[1] (University of North Carolina Herbarium [NCU] 2017, USDA, NRCS 2017). Chinese tallow tree was introduced to the USA from China in the late 18th century for the economic potential of the fruits in the soap-making industry (DeWalt et al. 2011). Based on correspondence from the time, it is believed that the original populations of this species were introduced by Ben Franklin via shipments of seeds from London to associates in Georgia in the late 1700s (Bell 1966). Although it was held by some that the "Franklin trees" were the source for the genotype that would eventually become a problematic invader in the Gulf Coast states (see discussion under Invasiveness below), recent work has implicated early-1900s US Department of Agriculture (USDA) introductions in Texas as the invasive genotype (DeWalt et al. 2011). The latter trees were being tested as potential oilseed crops, and the planting program was expanded to other Gulf states in the mid-1900s. The original Franklin trees are relegated to a few thousand square miles in northeast Georgia and adjacent South Carolina. As of summer 2016, the US distribution for all genotypes was understood to include 10 states ranging from North Carolina, south to Florida, and west to central Texas, with disjunct occurrences in northern California (USDA, NRCS 2017).

Seeds of Chinese tallow tree are most frequently dispersed via water (Bruce et al. 1997,

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[1] Of note, Comley (2008) reported an individual tree at a home site in Kentucky but did not ascertain its origin. If the Kentucky tree was of cultivated origin, then the current account is the northernmost record of this species naturalized in the eastern USA.

Figure 1a. Chinese tallow tree (*Triadica sebifera*) found growing in a seasonally inundated swamp within the backwater zone of a pond in King and Queen County, VA. (D.A. DeBerry, 17 September 2016).

Gan et al. 2009). Since the species is also planted as an ornamental tree (DeWalt et al. 2011), we suspected that a possible source for the saplings at the Virginia location was seed dispersed via water from a nearby parent tree perhaps planted somewhere within the small watershed upstream of the pond where they were found. We completed a 2 km radius search of all homesites in this semirural, low-density residential area and found no planted individuals, leading us to believe that the source seeds for these saplings arrived via some other vector. Bird dispersal is the second most prevalent dispersal pathway for Chinese tallow tree (Bruce et al. 1997, Renne et al. 2000), and a likely mode of introduction for these saplings at this site, which is in the center of the Atlantic flyway (Hindman and Stotts 1987) in the backwater of a pond, an attractive wayside for migrating waterfowl. Given that the passage of the seeds through an avian gut enhances germination (Renne et al. 2001), this is a plausible establishment scenario for Chinese tallow tree at this site. The implications of this, along with the survival and growth of a subtropical, nonnative invasive tree quite a bit north of its understood range on the east coast, are discussed below.

Figure 1b. Flooded condition in backwater swamp habitat where Chinese tallow tree was found (D.A. DeBerry, 15 July 2016).

Figure 1c. Drawdown condition (D.A. DeBerry, 17 September 2016).

Invasiveness. Chinese tallow tree is listed as an invasive species by all of the southeastern states within its range (Southeast Exotic Pest Plant Control [SE-EPPC] 2017). In some states, it is classified as a noxious weed and is regulated against movement, trade, or importation by state agriculture departments (USDA-NRCS 2017). Alabama and Mississippi consider it to be among the "ten worst" invaders in those states (SE-EPPC 2017), and South Carolina identifies it as a "severe threat" to invasion (South Carolina Exotic Pest Plant Control [SC-EPPC] 2011).

In its introduced range, Chinese tallow tree develops monotypic forests with ecological effects such as: (a) reductions and/or localized extinctions of native species due to competition (Bruce et al. 1997); (b) habitat modification at local and landscape levels (Bruce et al. 1995, Gan et al. 2009); (c) loss of wildlife habitat due to conversion (Jubinsky and Anderson 1996, Rundel et al. 2014); (d) reduced fitness, reproduction, and survival of certain wildlife species (e.g., anurans) due to substrate toxicity (Leonard

2008, Cotten et al. 2012); and, (e) modification to soil biogeochemistry and substrate hydrology (Cameron and Spencer 1989, Gordon 1998). Woody invaders like Chinese tallow tree are especially problematic in natural habitats due to their potential to modify the structure of the dominant community, which can have strong influences on ecosystem processes as noted above, often creating "edaphic legacies" (i.e., long-term substrate effects) that can persist even after the invaders are removed (Rundel et al. 2014).

Invasiveness in Chinese tallow tree has been attributed to broad ecological tolerance for a wide range of soil types and conditions, rapid growth, precocity, high fecundity, and effective seed dispersal (Bruce et al. 1997, Cameron et al. 2000). The monoecious, dichogamous flowers promote cross-pollination, which is carried out for the most part by generalist insects (Bradley et al. 2009). Individual trees can reach reproductive maturity in 3 yr after seedling establishment, and mature trees have been documented to produce over 300,000 seeds per year (Gan et al. 2009). The species is tetraploid in its native and introduced ranges (DeWalt et al. 2011), consistent with polyploidy characteristics linked to invasiveness in other plant species (te Beest et al. 2011). Examples of rapid ontogentic niche expansion (i.e., increases in niche breadth over an individual's life span) have also been observed, particularly with respect to moisture gradient (Gabler and Siemann 2013). The confluence of invasiveness traits in Chinese tallow tree, and the consistency of these traits with those of many other successful plant invaders (Rejmánek and Richardson 1996, van Kleunen et al. 2010), suggest that the US distributional limit for this species is predicated on factors other than those described above—the most important of which appears to be cold-intolerance (Bruce et al. 1997, Pattison and Mack 2009, Wang et al. 2011).

Range expansion. Chinese tallow tree is primarily a subtropical species, and is therefore cold-limited in its distribution (Bruce et al. 1997). However, recent predictive modeling suggests potential for expansion of its US distribution northward to southeastern Pennsylvania by the middle of the 21st century, due in large part to warming trends in the mid-Atlantic region (Pattison and Mack 2008). If true, our discovery of saplings in Virginia that appear to have arrived via natural dispersal pathways is a preliminary validation of that prediction. This is consistent with similar recent discoveries of nonnative species with classically subtropical distributions that have made their way into novel wetland habitats in Virginia (Perry et al. 1998, DeBerry and Perry 2007).

The extent to which climate change serves to facilitate range extension of problematic nonnative species is unclear, but current research is predicting a northward expansion due to climate effects (Hellmann et al. 2008). Given our knowledge of range-limiting factors for Chinese tallow tree, this is a logical conclusion for this species. For a state like Virginia that is at or just outside of the northern distributional limit for many southern species, we can only view this as a portent of future change.

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LITERATURE CITED

Bell, M. 1966. Some notes and reflections upon a letter from Benjamin Franklin to Noble Wimberly Jones, October 7, 1772. Privately printed at the Ashantilly Press, Darien, Georgia.

Bradley, B.A., M. Oppenheimer, and D.S. Wilcove. 2009. Climate change and plant invasions: restoration opportunities ahead? Global Change Biol. 15:1511–1521.

Bruce, K.A., G.N. Cameron, and P.A. Harcombe. 1995. Initiation of a new woodland type on the Texas coastal prairie by the Chinese tallow tree (*Sapium sebiferum* (L.) Roxb.). Bull. Torrey Bot. Club 122:215–225.

Bruce, K.A., G.N. Cameron, P.A. Harcombe, and G. Jubinsky. 1997. Introduction, impact on native habitats, and management of a woody invader, the Chinese tallow tree, *Sapium sebiferum* (L.) Roxb. Nat. Areas J. 17:255–260.

Cameron, G.N., E.G. Glumac, and B.D. Eshelman. 2000. Germination and dormancy in seeds of *Sapium sebiferum* (Chinese tallow tree). J. Coastal Res. 16:391–595.

Cameron, G.N. and S.R. Spencer. 1989. Rapid leaf decay and nutrient release in a Chinese tallow forest. Oecologia 80:222–228.

Comley, E. 2008. Noteworthy collections: Kentucky. Castanea 73:151.

Cotten, T.B., M.A. Kwiatkowski, D. Saenz, and M. Collyer. 2012. Effects of an invasive plant, Chinese tallow (*Triadica sebifera*), on development and survival of anuran larvae. J. Herpetol. 46:186–193.

DeBerry, D.A. and J.E. Perry. 2007. Noteworthy collections: Virginia. Castanea 72:119–120.

DeWalt, S.J., E. Siemann, and W.E. Rogers. 2011. Geographic distribution of genetic variation among native and introduced populations of Chinese tallow tree, *Triadica sebifera* (Euphorbiaceae). Amer. J. Bot. 98:1128–1138.

Gabler, C.A. and E. Siemann. 2013. Rapid ontogenetic niche expansions in invasive Chinese tallow tree permit establishment in unfavourable but variable environments and can be exploited to streamline restoration. J. Appl. Ecol. 50:748–756.

Gan, J., J.H. Miller, H. Wang, and J.W. Taylor. 2009. Invasion of tallow tree into southern US forests: influencing factors and implications for mitigation. Canad. J. Forest Res. 39:1346–1356.

Gordon, D.R. 1998. Effects of invasive, non-indigenous plant species on ecosystem processes: lessons from Florida. Ecol. Applic. 8: 975–989.

Hellmann, J.J., J.E. Byers, B.G. Bierwagen, and J.S. Dukes. 2008. Five potential consequences of climate change for invasive species. Conservation Biol. 22:534–543.

Hindman, L.J. and V.D. Stotts. 1989. Chesapeake Bay and North Carolina Sounds. p. 27–55. *In:* Smith, L.M., R.L. Pederson, and R.M. Kaminski (eds.). Habitat management for migrating and wintering waterfowl in North America. Texas Tech University Press, Lubbock, Texas.

Jubinsky, G. and L.C. Anderson. 1996. The invasive potential of Chinese tallow-tree (*Sapium sebiferum* Roxb.) in the Southeast. Castanea 61:226–231.

Leonard, N.E. 2008. The effects of the invasive exotic Chinese tallow tree (*Triadica sebifera*) on the amphibians and aquatic invertebrates. Ph.D. dissertation, University of New Orleans, New Orleans, Louisiana.

University of North Carolina Herbarium (NCU). 2017. NCU flora of the Southeastern United States. (http://www.herbarium.unc.edu/seflora/firstviewer.htm, 17 March 2018).

Pattison, R.R. and R.N. Mack. 2008. Potential distribution of the invasive tree *Triadica sebifera* (Euphorbiaceae) in the United States: evaluating CLIMEX predictions with field trials. Global Change Biol. 14:813–826.

Pattison, R.R. and R.N. Mack. 2009. Environmental constraints on the invasion of *Triadica sebifera* in the eastern United States: an experimental field assessment. Oecologia 158:591–602.

Perry, J.E., D. M.E. Ware, and A. McKenney-Mueller. 1998. *Aeschynomene indica* L. (Fabaceae) in Virginia. Castanea 63:191–194.

Renne, I.J., S.A. Gauthreaux Jr, and C.A. Gresham. 2000. Seed dispersal of the Chinese tallow tree (*Sapium sebiferum* (L.) Roxb.) by birds in coastal South Carolina. Amer. Midl. Naturalist 144:202–215.

Renne, I.J., T.P. Spira, and W.C. Bridges. 2001. Effects of habitat, burial, age, and passage through birds on germination and establishment of Chinese tallow tree in coastal South Carolina. J. Torrey Bot. Soc. 128:109–119.

Rejmánek, M. and D.M. Richardson. 1996. What attributes make some plant species more invasive? Ecology 77:1655–1661.

Rundel, P.W., I.A. Dickie, and D.M. Richardson. 2014. Tree invasions into treeless areas: mechanisms and ecosystem processes. Biol. Invas. 16:663–675.

South Carolina Exotic Pest Plant Council (SC-EPPC). 2011. Invasive plant pest species of South Carolina. Forestry Leaflet 28, Clemson Cooperative Extension Service, Clemson, South Carolina.

Southeast Exotic Pest Plant Council (SE-EPPC). 2017. Invasive plants of the southeast. (https://www.se-eppc.org/weeds.cfm, 17 March 2018).

te Beest, M., J.J. Le Roux, D.M. Richardson, A.K. Brysting, J. Suda, M. Kubešová, and P. Pyšek. 2011. The more the better? The role of polyploidy in facilitating plant invasions. Ann. Bot. 109:19–45.

USDA, NRCS. 2017. The PLANTS Database (http://plants.usda.gov, 17 March 2018). National Plant Data Center, Baton Rouge, Louisiana 70874-4490 USA.

van Kleunen, M., E. Weber, and M. Fischer. 2010. A meta-analysis of trait differences between invasive and non-invasive plant species. Ecol. Letters 13:235–245.

Wang, H.H., W.E. Grant, T.M. Swannack, J. Gan, W.E. Rogers, T.E. Koralewski, J.H. Miller, and J.W. Taylor. 2011. Predicted range expansion of Chinese tallow tree (*Triadica sebifera*) in forestlands of the southern United States. Diversity & Distrib. 17:552–565.