Maryland
Department
of Agriculture

October
2017

Version 1

Weed Risk Assessment for *Tetradium daniellii* (Benn.) T.G. Hartley (Rutaceae) – Bee bee tree

Clockwise from lower right: Fruit capsules (Source: Kirsten Johnson); typical leaf size and conformation; trunk showing prominent lenticels; male inflorescence; dense seedling understory (Source: Kerrie L. Kyde).

AGENCY CONTACT

Office of Plant Industries and Pest Management
Maryland Department of Agriculture
50 Harry S. Truman Pkwy.
Annapolis, Maryland, 21401
Telephone: 410-841-5870Telephone: 410-841-5870

Introduction

The Maryland Department of Agriculture regulates terrestrial ornamental invasive plants under the authority of Md. AGRICULTURE Code Ann. § 9.5-101 et seq. Invasive Plant Prevention and Control. An invasive plant is defined as “a terrestrial plant species that a) did not evolve in the State, and b) if introduced within the State, will cause or is likely to cause, as determined by the Secretary: economic harm; ecological harm; environmental harm; or harm to human health.”

Maryland’s Invasive Plant Advisory Committee (IPAC) was established by legislative mandate in October 2011. The IPAC’s primary responsibility is to advise the Secretary of Agriculture on regulating the sale of invasive plants, and on preventing them from entering Maryland or from spreading further in the state. The IPAC evaluates the risk potential of plants already present in Maryland, newly detected in the Maryland or the United States, those proposed for import, and those emerging as weeds elsewhere in the world.

The IPAC evaluates the potential invasiveness of plants using the weed risk assessment (WRA) process developed by the Plant Protection and Quarantine (PPQ) Program of the US Department of Agriculture’s Animal and Plant Health Inspection Service (Koop et al. 2012). PPQ’s risk model uses information about a species’ biological traits and behavior to evaluate its risk potential (Koop et al. 2012).

Because the PPQ WRA model is geographically and climatically neutral, it can be used to evaluate the baseline invasive/weed potential of any plant species for the entire United States, or for any specific region in the United States. In the PPQ process, the geographic potential of the species is evaluated separately so that risk managers can make decisions appropriate for their regions. With respect to Maryland’s evaluation process, we use PPQ’s Geographic Information System overlays of climate to evaluate the potential for a plant to establish and grow in Maryland. The PPQ weed risk assessment also uses a stochastic simulation to evaluate how the uncertainty associated with the assessments affects the model’s predictions. Detailed information on the PPQ WRA process is available in the document, Guidelines for the USDA-APHIS-PPQ Weed Risk Assessment Process (APHIS PPQ 2015), which is available upon request.

The IPAC uses a second tool, the Maryland Filter, to assign plant species that score as highly invasive either Tier 1 or Tier 2 status. Maryland regulations define Tier 1 plants as “invasive plant species that cause or are likely to cause severe harm within the State” and Tier 2 plants as “invasive plant species that cause or are likely to cause substantial negative impact within the State.” The Maryland Filter considers the actual and potential distribution of a species in Maryland, its threat to threatened and endangered ecosystems and species in the state, the difficulty of control of the species, and whether added propagule pressure would be likely to increase its persistence and spread significantly. The IPAC then recommends regulations to reduce the risk of the Tiered invasive plants in Maryland.

1. Plant Information and Background

SPECIES: *Tetradium daniellii* (Benn.) T.G. Hartley. (ARS 2016).

FAMILY: Rutaceae (NRGP 2017).

SYNONYMS: *Euodia daniellii* (Benn.) Hemsl. (ARS 2016); *Euodia daniellii* var. *villicarpa* (Rehder & E. H. Wilson) C. C. Huang (ARS 2016); *Euodia henryi* Dode (ARS 2016); *Euodia henryi* var. *villicarpa* Rehder & E. H. Wilson (ARS 2016); *Euodia* hupehensis Dode (ARS 2016); *Euodia velutina* Rehder & E. H. Wilson (ARS 2016); *Zanthoxylum daniellii* Benn. (ARS 2016).

COMMON NAMES: Bee bee tree (ITIS 2017), bee-bee tree (USDA Plants 2017); Korean evodia (Vincent 2004); bebe tree (Gilman and Watson 1993), bee tree (Vincent 2004).

BOTANICAL DESCRIPTION: *Tetradium daniellii* is a deciduous tree or shrub growing to 50 feet, with a broad, spreading, domed crown (Page and Olds 2001). The leaves are opposite to subopposite, odd-pinnately compound, with 5-11 pointed ovate leaflets, glabrous on the upper surface and pubescent on the lower (Vincent 2004). The white 5-part flowers appear in late summer, in broad terminal corymbs about 6 in. wide (Vincent 2004). They are unisexual, and trees are either male or monoecious with male and female bloom periods separated in time (Zhou et al. 2006). The flowers are attractive to bees, and trees can be located by the buzzing of visiting insects (Aldrich 2015). Fruits are reddish pink follicles containing two shiny black seeds. (Upson 2014, Vincent 2004). For a full botanical description, see Zhang and Hartley (2008).

INITIATION: In November 2015, a Maryland homeowner brought to the attention of the Maryland Invasive Species Council a four-acre infestation of *Tetradium daniellii*, bee bee tree, on her property in Washington County. She had identified the species from bee-keeping websites after a DNR project forester completed a forest stewardship plan for the property. Subsequently, IPAC was made aware that this species was spreading aggressively from historical plantings in arboreta, and on at least one site in PA, was being actively controlled (Block 2016, Davis 2017). Although it is not on DNR's Do Not Plant list at this time, its invasive nature but relatively small naturalized populations in the state suggest that risk assessment is timely. The Do Not Plant list is a policy document available from MD DNR, which lists approximately 90 plant species that may not be planted on DNR land or used in DNR projects (MD DNR 2010).

WRA AREA[1]: Entire United States, including territories.

---

[1] "WRA area" is the area in relation to which the weed risk assessment is conducted [definition modified from that for "PRA area"] (IPPC, 2012).

FOREIGN DISTRIBUTION: *Tetradium daniellii* is native to Tibet and Yunnan Province, China through much of temperate China to North and South Korea (ARS 2016). It is cultivated, and valued by both gardeners and beekeepers, in England, Ireland, Slovenia, and the United States. (Upson 2014, Irish Garden Plant Society 2017, Permies.com 2017). It is not widely reported as escaped from cultivation outside China, except in the United States. One source reported several Evodia species, including *E. daniellii,* as naturalizing in Hungary (Farkas and Zajacz 2007). Specimens reported from Luxembourg, Sweden and Ireland appear to be cultivated trees; one report from Germany of a tree located in a "drain" or "shaft" may be adventive (GBIF 2016).

U.S. DISTRIBUTION AND STATUS: In the US, it has escaped cultivation in several public gardens or arboreta in Pennsylvania (Block 2016, Aiello 2016, Davis 2017), and Virginia (Carr 2016). Non-cultivated escapes are reported from Missouri, Ohio, Pennsylvania, and New York (PA DCNR 2016). In Maryland, a four-acre infestation occurs on private land in Washington County, on land that was taken out of pasture in the 1950s (Aldrich 2015). It has also been reported from land adjacent to the Mt. Pleasant golf course in Baltimore city, and within the wooded areas of Cylburn Arboretum, where it was clearly not deliberately planted (Davis 2017) The species was introduced into cultivation in the US at the Arnold Arboretum in 1905, by seeds collected in Ping-yang Korea, and again by seeds from Shantung China in 1907 (Upson 2014). *Tetradium daniellii* is a target for removal in two public gardens (Aiello 2016, Davis 2017) and on private land in Maryland (Aldrich 2015). Seedlings in the hedgerows at the University of Virginia's Blandy Experimental Farm are removed by regular field maintenance, but are not specific targets for removal (Carr 2016).

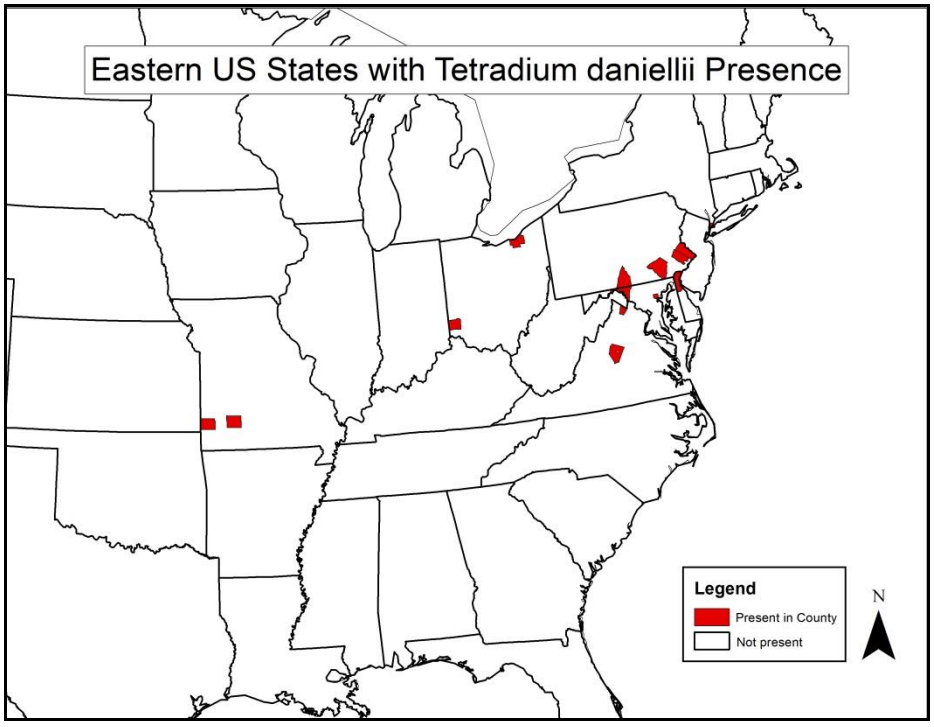

Figure 1. Known naturalized distribution of *Tetradium daniellii* in the United States and Canada. The records shown here were obtained primarily from other species distribution databases (EDDMapS 2017, BONAP and USDA Plants Database) and were not independently verified by IPAC.

3. Analysis

ESTABLISHMENT/SPREAD POTENTIAL

As demonstrated by its status in the United States, *Tetradium daniellii* can spread from cultivated plantings to form a dense understory layer of seedlings, and grow into the canopy (Aldrich 2015, Grow 2017, McAvoy 2017, Author obs). It is shade-tolerant as a seedling or sapling (Aldrich 2015, Author obs.), and can grow at two to more feet per year (Logees.com 2016). Reproductive maturity reported for several Tetradium species, now all considered to be *T. daniellii*, occurs within three to six years (Lengyel cited in Farkas and Zajacz 2007, Farkas and Zajacz 2007). The species is not self-fertile, and is pollinated by generalist pollinators; reproducing individuals can produce several thousand seed/m^2 of canopy (Zhou 2006). Birds eat the seeds (Aiello 2016, MOBOT 2016), which germinate easily without pretreatment (Dirr 2009).) Cut trees stump sprout vigorously after multiple cuttings (Aiello 2016, Black 2017). We had low uncertainty for this risk element.

Risk score = 6.0 Uncertainty index = 0.12

IMPACT POTENTIAL

Most of the risk score for *Tetradium daniellii* is derived from its impacts and potential impacts on natural areas. It appears to change habitat structure and species composition by creating a dense understory under canopy trees, reducing species richness in those woodlands, but reports are observational only. The species invades, and can affect, the mesic mixed Piedmont forest, a globally outstanding ecoregion (Olson and Dinerstein 2002). It is clearly considered a weed, and is being controlled as such outside of cultivation ((Aiello 2016, Aldrich 2015, Beerley 2014, PA DCNR 2016). Although *T. daniellii* is not documented as allelopathic or toxic to animals, the family Rutaceae contains congeners which show both effects (Berenbaum 1987, Nebo et al. 2014). We had low uncertainty for this risk element.

Risk score = 2.1 Uncertainty index = 0.12

GEOGRAPHIC POTENTIAL

Based on three climatic variables, we estimate that about 49 percent of the United States is suitable for the establishment of *Tetradium daniellii* (Fig. 2). This predicted distribution is based on the species' known distribution elsewhere in the world and includes point-referenced localities and areas of occurrence. The map for *Tetradium daniellii* represents the joint distribution of Plant Hardiness Zones 5-10, areas with 0 to more than 100 inches of annual precipitation, and the following Köppen-Geiger climate classes: Humid subtropical, Marine west coast, Humid continental warm summers, and Humid continental cool summers. The wide climatic range of this largely temperate species is expanded by the inclusion of locations of individuals once thought to be congeners, and shown by recent work to be *T. daniellii* (Hartley 1981, Flanagan 1988).

The area of the United States shown to be climatically suitable (Fig. 2) for species establishment considered only three climatic variables. Other variables, for example, soil and habitat type, novel climatic conditions, or plant genotypes, may alter the areas in which this species is likely to establish. *Tetradium daniellii* is adaptable to both soil pH and texture (Upson 2014), and a range of light conditions. It was collected by British staff surgeon William Daniell in 1861 “on a small promontory” north of a village in Liaoning, China. In novel habitats in Maryland infestations, it grows in shaded understory conditions, and reaches canopy heights (Aldrich 2015, Author obs.)

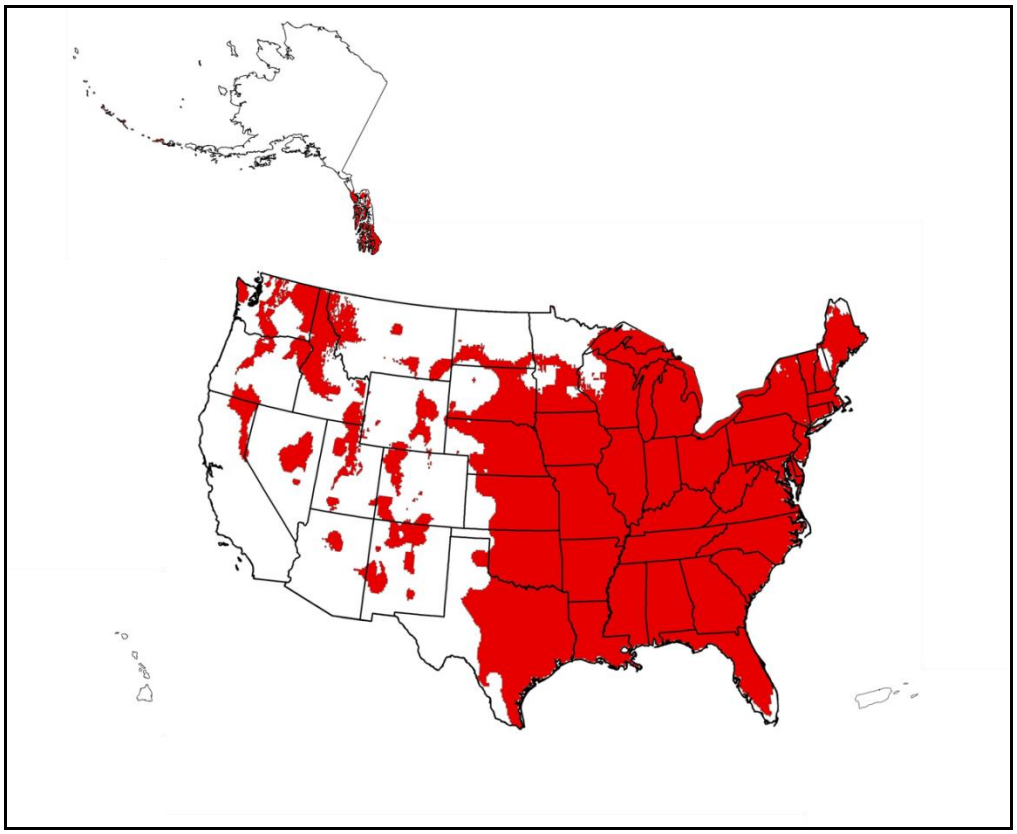

Figure 2. Potential geographic distribution of *Tetradium daniellii* in the United States and Canada. Map insets for Hawaii and Puerto Rico are not to scale.

ENTRY POTENTIAL

We did not assess the entry potential of *Tetradium daniellii* because it is already present in the United States (Aldrich 2015, Block 2016, Carr 2016) (Fig. 1). As this species is available in commercial horticulture (MySeedCo. 2017), and is of particular interest to beekeepers because of its bloom time (Honey Bee Suite 2017), the likely pathway for additional introductions is through plants for planting.

4. Predictive Risk Model Results

Model Probabilities: P(Major Invader) = 18.9%
P(Minor Invader) = 69.6%
P(Non-Invader) = 11.5%

Risk Result = Evaluate Further
Secondary Screening = High Risk

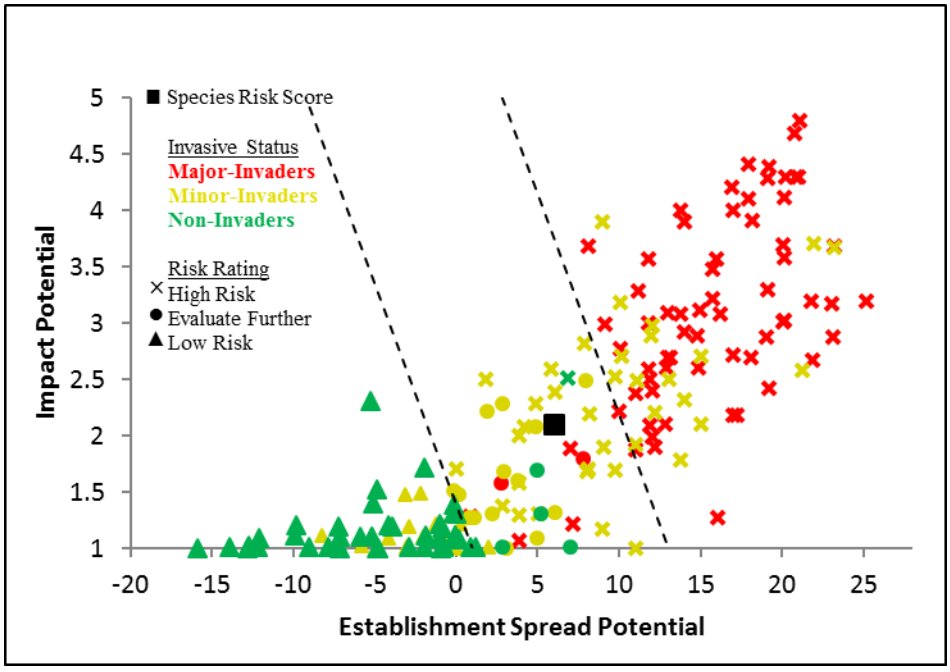

Figure 3. *Tetradium daniellii* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

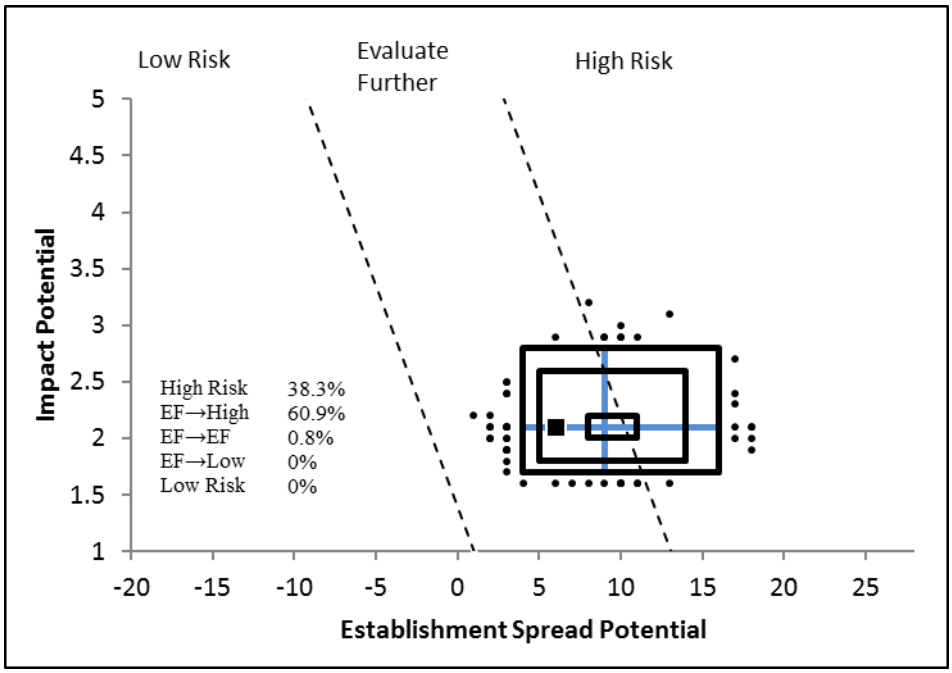

Figure 4. Model simulation results (N=5,000) for uncertainty around the risk score for *Tetradium daniellii*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box

contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

5. Discussion

The result of the weed risk assessment for *Tetradium daniellii* is Evaluate Further, with a Secondary Screening rating of High Risk (Fig. 3). The species has a high probability of being a Minor Invader. We had high levels of uncertainty about specific dispersal mechanisms for this species, although the seeds are consumed by birds. We had high uncertainty about whether it remains present in the landscape after control either through a persistent seedbank or regeneration after cutting. We also had high levels of uncertainty about its ability to change habitat structure, species diversity or to have impacts on rare, threatened or endangered species or habitats. The species' risk derives primarily from its documented ability to spread, its highly invasive congeners, its prolific seed production and formation of dense understory thickets. It clearly is regarded as a weed in natural areas, and land managers have taken steps to control it. Despite the uncertainty associated with the assessment, we are confident in the rating of this plant as High Risk because 99% of the simulation results were High Risk (Fig. 4).

As is often the case for introduced plants, there appears to be a lag time between introduction and demonstration of invasive character for *Tetradium daniellii*. The species is increasing in popularity as an ornamental (Vincent 2004) and is valued by beekeepers as a season-bridging nectar source (Farkas and Zajacz 2007). Given the low number of documented infestations of this species in Maryland, its prolific seed production, and observed effects in woodlands, we anticipate that this species will become an increasingly problematic invader.

6. Acknowledgments

AUTHORS

Sylvan Kaufman, Ecological Consultant, Sylvan Green Consulting
Kerrie L. Kyde, Invasive Plant Ecologist, Maryland Department of Natural Resources

REVIEWERS

Leslie Cario, Chesapeake Horticultural Services
Brent Cassell, Leyland Landscaping
Mike Hemming, Eastern Shore Nurseries
Deborah Landau, The Nature Conservancy
Maile Neel, University of Maryland
Kimberly Rice, Maryland Department of Agriculture
John Sullivan, Maryland Department of the Environment
John Peter Thompson, independent consultant
Kevin Wilsey, Maryland State Highway Administration

SUGGESTED CITATION

Maryland Department of Agriculture. 2017. Weed risk assessment for *Tetradium daniellii* Benn.(Rutaceae) – Bee bee tree. Maryland Department of Agriculture, Annapolis, MD 22 pp.

7. Literature Cited

Aiello, A. 2016. Pers comm. Telephone conversation between K. Kyde and Anthony Aiello,Director of Horticulture and Curator, Morris Arboretum, Philadelphia PA, September 2016.

Aldrich, A. 2015. Pers. comm. Emerging Invasive Species in Maryland. Memo describing bee bee tree infestation on her property by retired BLM botanist. Personal communication by Ann Aldrich to K.Kyde on November 27, 2015.

ARS. 2016. Germplasm Resources Information Network, online database. United States Department of Agriculture, Agricultural Research Service (ARS), National Germplasm Resources Laboratory. Accessed online August 2016. http://www.ars-grin.gov/cgi-bin/npgs/html/paper.pl.

ASPCA. 2016. Toxic and non-toxic plants. Accessed online August 2016. https://www.aspca.org/pet-care/animal-poison-control/toxic-and-non-toxic-plants

Bayly, M.J., G.D. Holmes, P.I. Forster, D.J. Cantrill, and P.Y. Ladiges. 2013. Major clades of Australasian Rutoideae (Rutaceae) based on rbcL and atpB sequences. PLOS 8/13/13 https://doi.org/10.1371/journal.pone.0072493

Beauchamp, V. 2016. Pers comm. Conversations with K. Kyde during and after field visits to Maryland and Virginia infestations in August and November 2016.

Beerley, T. 2014. An adaptive management plant for the natural lands section of Morris Arboretum of the Univeristy of Pennsylvania. Masters of Environmental Studies Capstone Project, University of Pennsylvania. http://repository.upenn.edu/cgi/viewcontent.cgi?article=1060&context=mes_capstones

Berenbaum, M.R. 1987. Charge of the light brigade: phytotoxicity as a defense against insects, chapter in: Heitz and Downum 1987. Light-Activated Pesticides, ACS Symposium Series; American Chemical Society: Washington, DC, 1987, pp 206-216.

Black, S. 2017 Pers. comm. Email to K. Kyde from nurseryman, owner of Raemelton Farms, September 12, 2017.

Block, T. 2016. Pers.comm. Conversations with the Morris Arboretum Director of Botany by K. Kyde, August 30, 2016.

Carr, D.E. 2016. Pers comm. Conversation on site with University of Virginia's Director of the Blandy Experimental Farm and Research Associate Professor and K. Kyde.

Cook, A. 2016. Pers. comm. Email from Maryland Forest Service Washington County Project Forester to K. Kyde. August 19, 2016.

Corlett, R.T. 1998. Frugivory and seed dispersal by birds in Hong Kong shrubland. Forktail 13: 23-27.

Cornell University. 2016. Department of Animal Science - Plants poisonous to livestock. Accessed online August 2016. http://www.ansci.cornell.edu/plants/php/plants.php.

Dave's Garden. 2016. Tetradium daniellii. Accessed online August 2016. http://davesgarden.com/guides/pf/go/73015/#b

Davis, B. 2017. Pers. comm. Emails from head volunteer coordinator at Cylburn Arboretum to K. Kyde.

Dirr, M. 2009. Manual of woody landscape plants: Their identification, ornamental characteristics, culture, propagation, and use, 6th ed.. Stipes Press, Champaign, IL. 1325 pp.

Dugrand-Judek, A., A. Olry, A. Hehn, G. Costantino, P. Ollitrault, Y. Froelicher, and R. Bourgard. 2015. Distribution of coumarins and furanocoumarins in Citrus species closely matches Citrus phylogeny and reflects the organization of biosynthetic pathways. PLoS One 10(11), doi: 10.1371/journal.pone.0142757. Published online November 11, 2105.

Farkas, A. and E. Zajacz. 2007. Nectar production fo the Hungarian honey industry. European Journal of Plant Science and Biotechnology 1(2): 125-151.

Flanagan, M. 1988. Notes on the genus *Tetradium*. Kew Magazine 5: 181–191. DOI: 10.1111/j.1467-8748.1988.tb00277.x

Flora of China. 2016. Flora of China Web. Harvard University Herbaria, Cambridge, USA. http://flora.huh.harvard.edu/china/

GBIF. 2016. GBIF, online database. Global Biodiversity Information Facility. Accessed online August 2016. http://www.gbif.org/.

Gilman E.F. and D.G. Watson. 1993. *Evodia daniellii*. US Forest Service Fact Sheet ST-242. http://hort.ifas.ufl.edu/database/documents/pdf/tree_fact_sheets/evodana.pdf

Glaeser, C.W. and D. Kincaid. 2005. Non-native invasive *Phellodendron amurense* Rupr. in a New York city woodland. Arboricultureal Journal 28:3 151-164.

Grow, D. 2017. Pers. comm. *Tetradium* density. Personal communication to K.Kyde on September 6, 2017 from David Grow, Masters Candidate at Towson University, MD.

Hartley, T.G. 1981. A revision of the genus Tetradium (Rutaceae). Gardens Bulletin, Singapore 34, 91–123.

Honey Bee Suite. 2017. Accessed online September 8, 2017. https://honeybeesuite.com/

IPPC. 2012. International Standards for Phytosanitary Measures No. 5: Glossary of Phytosanitary Terms. Food and Agriculture Organization of the United Nations, Secretariat of the International Plant Protection Convention (IPPC), Rome, Italy. 38 pp.

IPPC. 2015. International Standards for Phytosanitary Measures No. 2: Framework for Pest Risk Analysis. Food and Agriculture Organization of the United Nations, Secretariat of the International Plant Protection Convention (IPPC), Rome, Italy. 18 pp.

Irish Garden Plant Society. 2017. Accessed online September 8, 2017. https://www.facebook.com/IrishGardenPlantSociety/photos/pcb.1050624861659598/1050624098326341/?type=3

ITIS. 2017. Integrated Taxonomic Information System. Accessed online September 6, 2017. http://www.itis.gov.

Koop, A., L. Fowler, L. Newton, and B. Caton. 2012. Development and validation of a weed screening tool for the United States. Biological Invasions 14(2):273-294.

Kyde, K. 2016. Pers. comm. August 18, 2016 email from Maryland DNR Invasive Plant Ecologist K. Kyde to S. Kaufman.

Logees.com. 2016. Bee bee tree. Accessed online August, 2016. http://www.logees.com/bee-bee-tree-tetradium-daniellii-902.html.

McAvoy, W. 2017. Flora of Delaware online. Accessed online September 9, 2017. http://www.wrc.udel.edu/wp-content/heritage/flora-res.php

Martin, P.G., and J.M. Dowd. 1990. A protein sequence study of the dicotyledons and its relevance to the evolution of the legumes and nitrogen fixation. Australian Systematic Botany 3:91-100.

MOBOT. 2016. *Tetradium daniellii*. Missouri Botanical Garden. http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?taxonid=291853&isprofile=0&

Morgan E.C. and J.A. Borysiewicz. 2012. Invasion of *Phellodendron amurense* into the urban and suburban woodlands of the New York city region. Urban Habitats, an electronic journal on the biology of urban areas around the world. March 2012.

Morgan, E.C. 2012. Stand dynamics of a 46-year invasion by *Phellodendron amurense* Rupr. In an eastern North American forest. Castanea 77(1): 21-27.

MySeedsCo. 2017. Accessed online September 8, 2017. http://www.myseeds.co/bee-bee-tree-tetradium-daniellii-evodia-daniellii-tree-seeds-honey-bee-attractant-cold-hardy-zones-5/ .

Nebo, L., R.M Varela, J.M.G. Molinillo, O.M Sampaio, V.G.P Severino, C.M. Cazal, M.F. das Gracas Fernandes, J.B. Fernandes, and F.A. Macias. 2014. Phytotoxicity of alkaloids, coumarins and flavonoids isolated from 11 species belonging to the Rutaceae and Meliaceae families. Phytochemistry Letters 8: 226–232.

Nickrent, D. 2016. Parasitic plant classification. Southern Illinois University Carbondale, Carbondale, IL. Accessed online August 2016. http://parasiticplants.siu.edu/ListParasites.html.

PA DCNR. 2016. Invasive plants in Pennsylvania, Bee Bee Tree. Pennsylvania Department of Conservation and Natural Resources. http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_010298.pdf

Page, S. and M. Olds. 2001. The Plant Book: the world of plants in a single volume. Sing Cheong Printing Co. Ltd., Hong Kong.

Permies. Accessed online September 8, 2017. https://permies.com/t/35596/Tetradium-Daniellii-Bee-Bee-Tree
Posta, D.S. 2015. Research on the use of seed preparation methods for the generative production of seedlings in the species *Evodia danielii* (Benn.) Hemsl. Journal of Horticulture, Forestry and Biotechnology 19(2):54- 56.
Randall R. P. 2012. A Global Compendium of Weeds. Department of Agriculture and Food Western Australia, South Perth, WA.

Razavi, S.M. 2011. Plant coumarins as allelopathic agents. International Journal of Biological Chemistry 5(1):86-90.

Santi, C., D. Bogusz, and C. Franche. 2013. Biological nitrogen fixation in non-legume plants. Annals of Botany 111(5):743-767.

Schuler, J.A. 2015. Forest Restoration: Managing for the Future. Plant Talk: Inside the New York Botanical Garden blogpost. June 4, 2015 by NYBG's Director of the Thain Family Forest.

Simons, D. 2009. Amur corktree. Plant Conservation Alliance's Alien Plant Working Group, Least Wanted. https://www.nps.gov/plants/alien/fact/pham1.htm.

Stevenson, P.C., M.S.J. Simmonds, M.A. Yule, N.C. Veitch, G.C. Kite, D. Irwin, and M. Legg. 2003. Insect antifeedant furanocoumarins in *Tetradium daniellii*. Phytochemistry 63:41-46.

ThePlantList. 2016. *Tetradium daniellii*. Accessed online August 17, 2016. http://www.theplantlist.org/

Tropicos.org. 2016. *Tetradium daniellii*. Missouri Botanical Garden. Accessed online August 2016. http://www.tropicos.org/Name/50116456?tab=specimens

Upson, T. 2014. 780. *Tetradium daniellii*. Curtis's Botanical Magazine, 31(1), 48-57.

USDA PLANTS. 2017. *Tetradium daniellii*. United States Department of Agriculture Natural Resources Conservation Service. Accessed online September 6, 2017. http://plants.usda.gov/

Vincent, M.A. 2004. *Tetradium Daniellii* (Korean Evodia; Rutaceae) as an escape in North America. The Michigan Botanist 43(1):21-24.

Walker, R. 2016. Parasitic plants database. Accessed online August 22, 2016. http://www.omnisterra.com/bot/pp_home.cgi

Wang, J., H. Ren, L. Yang, D. Li, and Q. Guo. 2009. Soil seed banks in four 22-year-old plantations in South China: implications for restoration Forest Ecology and Management 258: 2000–2006.

Wyman, D.1952. Forty-five of the best trees for Massachusetts Gardens. Arnoldia 12(1):1-20. http://arnoldia.arboretum.harvard.edu/pdf/issues/1952-12--Arnoldia.pdf
Zhang, D. and T.G. Hartley. 2008. Flora of China: Tetradium. efloras. Accessed online August, September 2017. http://www.efloras.org/florataxon.aspx?flora_id=2&taxon_id=242351594..

Zhou, Q., R.I. Bertin, and D. Fu. 2006. Gender dimorphism in *Tetradium daniellii* (Rutaceae): Floral biology, gametogenesis, and sexual system evolution. International Journal of Plant Sciences, 167(2): 201-212.

Appendix A. Weed risk assessment for *Tetradium daniellii* Benn. (Rutaceae)

Below is all of the evidence and associated references used to evaluate the risk potential of this taxon. We also include the answer, uncertainty rating, and score for each question. The Excel file, where this assessment was conducted, is available upon request.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 [What is the taxon's establishment and spread status outside its native range? (a) Introduced elsewhere =>75 years ago but not escaped; (b) Introduced <75 years ago but not escaped; (c) Never moved beyond its native range; (d) Escaped/Casual; (e) Naturalized; (f) Invasive; (?) Unknown]	f - low	5	*Tetradium daniellii* is native to southwest, southeast and northeast China and Korea growing in forests, forest margins and open slopes (FOC 2016). Several *Evodia* species, including *daniellii* [synonym] have naturalized in Hungary (Farkas and Zajacz 2007). It was first introduced to the United States in 1905 (Upson 2014; Dirr 2009). The tree has invaded a 4-acre site in Maryland since 1960 (Aldrich 2015). It is spreading rapidly in Pennsylvania (Vincent 2004), and has naturalized in several forested areas in Pennsylvania and Ohio (PA DCNR 2016). Is is reported as "escaping from cultivation to moist deciduous woodlands" in Delaware. (McAvoy 2017). Naturalized in a forest in Missouri near a park in 2004 and established along the edge of a woods in Albermarle, VA near planted trees in 2013 (Tropicos.org 2016). We answered "f" with low uncertainty, with alternative answers "e" and "d."
ES-2 (Is the species highly domesticated)	n - negl	0	We found no cultivars of *Tetradium daniellii* listed and no evidence that the tree is cultivated for reduced fruit set.
ES-3 (Weedy congeners)	y - low	1	The genus *Tetradium* contains nine species and is closely related to *Phellodendron* and *Zanthoxylum* (Vincent 2004). Tetradium hupehensis is grown as an ornamental but is now acknowledged as the same taxon as *T. daniellii* (ITIS 2016; Upson 2014, Dirr 2009). *Tetradium ruticarpum* is listed as cultivated and naturalized by Randall (2012). Several species of *Zanthoxylum* are listed as weedy and invasive by Randall (2012). *Phellodendron amurense* is considered invasive in the eastern and central United States (Simons 2009), and is being actively controlled on the grounds of the New York Botanical Garden (Schuler 2015). Morgan

Question ID	Answer - Uncertainty	Score	Notes (and references)
			(2005) found significant increases in relative density and dominance of *Phellodendron amurense* in a Connecticut forest over a 46-year period and concluded that "the expansion of the species is at the expense of other, mainly native, species." A study of expanding populations of *P. amurense* in five northeastern US sites found it invading "established, mature forest" and concluded the species was a candidate for invasive removal programs and noxious weed listing (Morgan and Borysiewicz 2012).
ES-4 (Shade tolerant at some stage of its life cycle)	y - mod	1	Horticultural literature reports the species as growing at field edges, and having a "preference for good light conditions" (Upson 2014), but within the known Maryland infestation, carpets of seedlings and an understory of saplings exist under full canopy conditions (Beauchamp 2016). Seedlings spreading from an original horticultural planting at UVA's Blandy Experimental Farm occur in both hedgerows and under mostly closed canopy (Author obs.). Tolerates light shade (Missouri Botanical Garden 2016). One landowner with infested ground reported that the species is more shade tolerant than is described in the horticultural literature (Aldrich 2015).
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	n - negl	0	*Tetradium daniellii* is a tree (MOBOT 2016) and therefore is not a vine, scrambling plant, nor does it have basal rosettes.
ES-6 (Forms dense thickets, patches, or populations)	y - low	2	A researcher found the highest density of stems in 10 x 10m plots was 82 trees over 1m tall (Grow 2017). Approximately 10 saplings were found/m2 in a population in Maryland and those formed a solid layer of vegetation more than 1m tall in the understory (Author obs.).
ES-7 (Aquatic)	n - negl	0	*Tetradium daniellii* is a terrestrial tree and is not an aquatic plant (MOBOT 2016).
ES-8 (Grass)	n - negl	0	*Tetradium daniellii* is is the Rutaceae family (ARS 2016) and is therefore not a grass.
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	We found no evidence that it fixes nitrogen. Furthermore, plants in the Rutaceae are not known to fix nitrogen (Martin and Dowd 1990; Santi et al. 2013)
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Seed germination was almost 100% (Dirr 2009). Propagation is by seed with no pretreatment required (Upton 2014). Soaking seeds in warm water for 24 hours prior to sowing both hastened and increased percentage germination significantly (Posta 2015).
ES-11 (Self-compatible or apomictic)	n - low	-1	Although *Tetradium daniellii* is often described as dioecious (PA DCNR 2016), Zhou et al. 2006 found that the tree has male individuals and protandrous monoecious individuals. Monoecious individuals produce male and female

Question ID	Answer - Uncertainty	Score	Notes (and references)
			flowers at different times and at different locations on the inflorescence, preventing self-pollination in 3 out of 5 years of the study (Zhou et al. 2006).
ES-12 (Requires specialist pollinators)	n - negl	0	Flowers are pollinated by honeybees (MOBOT 2016; Dirr 2009). "…bumblebees and flies also use the flowers for foraging" (Peter 1974 as cited in Farkas and Zajacz 2007)
ES-13 [What is the taxon's minimum generation time? (a) less than a year with multiple generations per year; (b) 1 year, usually annuals; (c) 2 or 3 years; (d) more than 3 years; or (?) unknown]	d - low	-1	Lengyel noted that in Hungary "Evodia trees grow fast and flower already at the age of 5-6" (as cited in Farkas and Zajacz 2007). *E. hupehensis* [synonym] "flowers at an early age (3 to 5 years)" (Farkas and Zajacz 2007). "The Bee Bee Tree is relatively fast growing putting on 2 or more feet a year; trees flower at 6-8' in height." (Logees.com 2016). "Took 12 years to flower" (Dave's Garden 2016). We answered "d" with low uncertainty. Alternative answers are "d" and "c."
ES-14 (Prolific seed producer)	y - negl	1	Zhou et al.'s (2006) schematic drawings of the monoecious inflorescence indicate 179 flowers, each with ten seeds, half of which are fertile, or almost 900 fertile seeds per inflorescence. A mature tree with several inflorescenses per square meter would yield several thousand seeds/m2. "Tremendous fruit set" (Vincent 2004).
ES-15 (Propagules likely to be dispersed unintentionally by people)	n - mod	-1	We found no evidence for unintentional dispersal although trees do seed in disturbed areas and seeds could be picked up in the movement of soil on equipment.
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - low	-1	It is unlikely seeds would be dispersed as contaminants.
ES-17 (Number of natural dispersal vectors)	1	-2	Reddish purple seed pods open releasing two seeds per follicle, which are smooth, shiny and black, superposed, the size of buckshot.
ES-17a (Wind dispersal)	n - mod		Seeds have no adaptations that would facilitate dipersal by wind. Online seed sellers advertise 1 oz of seed as containing between 4000 and 7400 seeds (MySeedCo., 2017). One oz of carrot seed, which can be blown about by wind, contains about 7500 seeds. In the Maryland infestation, seedlings cover the ground plane under the mature trees (Author obs.); we found no studies reporting distances between parent trees and new seedlings.
ES-17b (Water dispersal)	n - high		We found no evidence.
ES-17c (Bird dispersal)	y - mod		Seeds are eaten by birds (MOBOT 2016). Mourning doves congregate in fruiting trees in September (Aiello 2016). Fruits of the congener *E. lepta* were reported as among the most consumed in a Hong Kong shrubland (Corlett 1998). Retention and display of seeds in dehisced fruits are adaptations to bird dispersal (Bayly et

Question ID	Answer - Uncertainty	Score	Notes (and references)
			al.2013); *T. danielli* seeds are "attached in dehisced fruit to axile strip of pergamentaceous pericarp tissue" (Zhang and Hartley 2008). We found no information on the effects on seed germination from consumption by birds. In fertile seed, the "seed coat is sclerenchymatous...thick and resistant to breakage" (Zhang and Hartley 2008), but scarification is not necessary for *Tetradium* germination (Upson 2014, Dirr 1990). We answered "yes" with moderate uncertainty.
ES-17d (Animal external dispersal)	n - mod		We found no evidence of dispersal by animals externally. The seeds have no obvious characteristics that would suggest that they cling or attach to fur or feathers.
ES-17e (Animal internal dispersal)	? - max		We found no evidence, although fruit produced by some congeners is consumed by mammals (Bayly et al. 2013).
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	n - high	-1	In one study, 80% of untreated seeds germinated within 2 months of sowing, and this percentage rose to 97% when seeds were soaked in warm water prior to sowing (Posta 2015). Seeds of the congener *Evodia lepta* had among the highest densities of seeds recovered from 22-year old forest plantation soil seed banks (Wang et al. 2009). Evidence of rapid germination in *T. daniellii*, but seed longevity in a congener led us to answer "no" but with high uncertainty.
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	n - high	-1	The plant doesn't sprout from roots " but stump sprouts like crazy." Morris Arboretum has used continuous cutting to control its unwanted trees and "there may be a point at which they don't resprout" but it had not yet occurred (Aiello 2016). One Maryland grower reported that the tree "sprouts robustly from cut roots" but does not spread this way, and they "don't see the tree forming a colony while it's in production" (Black 2017). "I accidentally mowed over my first [small seedling] (yikes!) but watched it recover its growth by the end of the season" (Dave's Garden 2017)
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - high	0	There is some evidence that multiple trees treated by the Maryland landowner were unaffected by commonly available herbicides triclopyr and glyphosate, but application concentrations and methods were not consistent (Aldrich 2015).
ES-21 (Number of cold hardiness zones suitable for its survival)	5	0	
ES-22 (Number of climate types suitable for its survival)	4	2	
ES-23 (Number of precipitation bands suitable for its survival)	11	1	
IMPACT POTENTIAL			
General Impacts			

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-G1 (Allelopathic)	n - high	0	Fruits of *Tetradium daniellii* contain furanocoumarins (Stevenson et al. 2003), and furanocoumarins are considered allelochemicals (Razavi 2011). Members of the Rutaceae contain chemical compounds that show allelopathic activity (Nebo et al. 2014), however we found no research directly assessing allelopathy in this species.
Imp-G2 (Parasitic)	n - negl	0	There is no evidence that *T. daniellii* is parasitic from botanical descriptions (Nickrent 2016; Walker 2016).
Impacts to Natural Systems			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	n - mod	0	We found no evidence that this tree changes ecosystem properties, although it is not a well-studied species.
Imp-N2 (Changes habitat structure)	y - high	0.2	*Tetradium daniellii* grows as a small tree in disturbed areas and forest interiors. In a Maryland infestation on private land, it filled the shrub layer under a *Tetradium* and *Ailanthus* canopy; landowners report that typical understory species declined, and "little grows under it but itself" but no documented evidence is available (Aldrich 2015).
Imp-N3 (Changes species diversity)	y - high	0.2	Species diversity appears to be much lower under dense stands of *Tetradium daniellii* (Cook 2016). The stratum structures of the 4-acre infestation in Maryland (<50 years old) and invaded hedgerows at Blandy Experimental farm suggest that very few species grow under a bee bee tree canopy other than bee bee tree seedlings, but we have no documentation of this (Aldrich 2015, Author obs.)
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	n - low	0	Federal TES known from the limestone areas where *Tetradium* is invading in Maryland are plants of wet areas. No state-listed endangered or threatened species in Maryland occur near Maryland infestation sites.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	y - mod	0.1	Trees are starting to form dense stands in mesic mixed forests of the Piedmont region (PA DCNR 2016), a globally outstanding ecoregion (Olson and Dinerstein 2002). Trees often establish first in disturbed areas, but then move into less disturbed forest interiors (Vincent 2004).
Imp-N6 [What is the taxon's weed status in natural systems? (a) Taxon not a weed; (b) taxon a weed but no evidence of control; (c) taxon a weed and evidence of control efforts]	c - low	0.6	Natural areas managers are concerned about the spread of *Tetradium daniellii* in natural areas and have been controlling the tree (PA DCNR 2016; Beerley 2014; Aiello 2016, Author obs). Answering "c" with low uncertainty and alternative answers "c" and "b."
Impact to Anthropogenic Systems (e.g., cities, suburbs, roadways)			
Imp-A1 (Negatively impacts personal property, human safety, or public infrastructure)	n - high	0	Trees may have weak wood which could pose a threat if planted in anthropogenic areas (Wyman 1952; Vincent 2004; PA DCNR 2016); however,

Question ID	Answer - Uncertainty	Score	Notes (and references)
			Dirr (2009) states that he has seen few structural problems in the tree.
Imp-A2 (Changes or limits recreational use of an area)	n - low	0	We found no evidence that this tree changes recreational use of an area.
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	n - low	0	We found no evidence that this tree affects desirable vegetation.
Imp-A4 [What is the taxon's weed status in anthropogenic systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	a - low	0	We found no evidence that *Tetradium daniellii* is considered a weed in anthropogenic systems or is controlled. Alternative answers are both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	n - low	0	We found no evidence for reducing crop or commodity yield.
Imp-P2 (Lowers commodity value)	n - low	0	We found no evidence for lowering commodity value.
Imp-P3 (Is it likely to impact trade?)	n - low	0	The species is not likely to impact trade.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - low	0	We found no evidence for this species affecting irrigation or strongly competing with other plants for water.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - high	0	We found no evidence that *Tetradium daniellii* is toxic to animals (Cornell University 2016; ASPCA 2016). Seeds and leaves of plants in the Rutaceae frequently contain furanocoumarins toxic to insects (Berenbaum 1987). Members of the family, including *T. daniellii*,contain toxic compounds, with the potential to produce photophytodermatitis reactions in humans (Zobel and Brown 1990). Extracts from *Tetradium daniellii* fruits were shown to be toxic to cotton leafworm and tobacco budworm (Stevenson et al. 2003). Because we found no direct evidence of toxicity to animals, but because the species and congeners contain toxic compounds, we answered "no" with high uncertainty.
Imp-P6 [What is the taxon's weed status in production systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	a - low	0	We found no evidence that this plant is a weed in production systems or that it is controlled in production systems. Alternative answers are both "b."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically-referenced points (pts.) obtained from the Global Biodiversity Information Facility (GBIF), accessed in October 2016. Non-georeferenced locations from GBIF and other sources are noted as occurrences (occ.).
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that the species occurs in this zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence that the species occurs in this zone.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence that the species occurs in this zone.
Geo-Z4 (Zone 4)	n - negl	N/A	We found no evidence that the species occurs in this zone.
Geo-Z5 (Zone 5)	y - low	N/A	China: Xizang (Tibet), Qinghai (occ.)
Geo-Z6 (Zone 6)	y - negl	N/A	China; North Korea; South Korea; US: MO, PA, VA
Geo-Z7 (Zone 7)	y - negl	N/A	China; Germany; Japan; North Korea; South Korea; US: NY, VA
Geo-Z8 (Zone 8)	y - negl	N/A	China; Japan; Luxembourg; North Korea; South Korea
Geo-Z9 (Zone 9)	y - negl	N/A	China; Ireland; Japan; North Korea; South Korea; Vietnam
Geo-Z10 (Zone 10)	y - mod	N/A	Two reports of preserved specimens in Sichuan, China, in the city of Nanchuan, close to the Zone 9 boundary, at under 2000' elevation.
Geo-Z11 (Zone 11)	n - negl	N/A	We found no evidence that the species occurs in this zone.
Geo-Z12 (Zone 12)	n - negl	N/A	We found no evidence that the species occurs in this zone.
Geo-Z13 (Zone 13)	n - low	N/A	One pt. from 1976 is reported, as Euodia (genus only) from Sulawesi, Indonesia. GBIF reports the taxon match as "fuzzy," and we believe that this is most likely one of the tropical Euodia spp. and have not included it in our maps.
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - low	N/A	One pt. from 1976 is reported, as Euodia (genus only) from Sulawesi, Indonesia. GBIF reports the taxon match as "fuzzy," and we believe that this is most likely one of the tropical Euodia spp. and have not included it in our maps.
Geo-C2 (Tropical savanna)	n - negl	N/A	We found no evidence that the species occurs in this climate class.
Geo-C3 (Steppe)	n - negl	N/A	We found no evidence that the species occurs in this climate class.
Geo-C4 (Desert)	n - negl	N/A	We found no evidence that the species occurs in this climate class.
Geo-C5 (Mediterranean)	n - negl	N/A	We found no evidence that the species occurs in this climate class.
Geo-C6 (Humid subtropical)	y - negl	N/A	China; Japan; US: MO, VA.
Geo-C7 (Marine west coast)	y - negl	N/A	China; Germany (occ); Ireland; Luxembourg; Netherlands: Gelderland, Utrecht (occ.)
Geo-C8 (Humid cont. warm sum.)	y - negl	N/A	China; North Korea, South Korea; US: MD, NY, PA
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	China: Sweden
Geo-C10 (Subarctic)	n - negl	N/A	We found no evidence that the species occurs in this climate class.
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence that the species occurs in this climate class.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that the species occurs in this climate class.
10-inch precipitation bands			

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R1 (0-10 inches; 0-25 cm)	y - high	N/A	Five records of the same pt, reported either without date, or from 1908 or 1913 are reported from Heishixiang, Gansu, China at an elevation of 1900m, in a cold steppe area. Although clearly irrigated fields exist in this area, the pt. is not within them. We excluded this pt. from our map analysis.
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	Multiple pts in China in Beijing, Hebei, Sichuan
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	China: Gunsu, Liaoning, Sichuan; Germany
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Widely distributed pts in China; Germany (occ.), Luxembourg (occ.); Netherlands (occ.); North Korea; South Korea (occ); Sweden; US: MO.
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	China; Ireland; North Korea (occ.); South Korea (pt. and occ.); US: MD, MO, NY, PA, VA.
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	China; Japan; North Korea (occ.); South Korea (occ.); US: PA; Vietnam
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	China: Jiangxi, Shaanxi; Japan (occ.); South Korea (occ.)
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	China: pts in Hubei, Jiangxi, Sichuan, occ. in Anhui, Guizhou, Jiangsu, Yunnan; Japan (occ.)
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	Japan (occ.)
Geo-R10 (90-100 inches; 229-254 cm)	y - negl	N/A	China: Hubei; Japan (occ.)
Geo-R11 (100+ inches; 254+ cm)	y - negl	N/A	China: Hubei, Sichuan, Yunnan; Japan (occ.)
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	This species was introduced to the United States in the early 1900s (Upton 2014) and was being sold in Maryland as early as 1952 (Wyman 1952).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	-	N/A	
Ent-4b (Contaminant of plant propagative material (except seeds))	-	N/A	
Ent-4c (Contaminant of seeds for planting)	-	N/A	
Ent-4d (Contaminant of ballast water)	-	N/A	
Ent-4e (Contaminant of aquarium plants or other aquarium products)	-	N/A	
Ent-4f (Contaminant of landscape products)	-	N/A	
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	-	N/A	
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	-	N/A	
Ent-4i (Contaminant of some other	-	N/A	

Question ID	Answer - Uncertainty	Score	Notes (and references)
pathway)			
Ent-5 (Likely to enter through natural dispersal)	-	N/A	

Appendix B. Maryland Filter Ranking for *Tetradium daniellii* Benn. (Rutaceae)

1a Plant occurs outside of cultivation within Maryland and it does, or can potentially…

2a Occupy LESS THAN part of two MD physiographic provinces….go to **3**

3a. Species is documented as occurring in a state listed S1 or S2 community, or is known to occur elsewhere in its native or novel ranges in habitats similar to those state listed as S1 or S2; OR it occurs, or could occur, within a population or habitat of a Threatened or Endangered species or of a CITES-listed species; OR it is documented as harming a Threatened or Endangered species in Maryland. Species is ranked Tier 1.

3b. Species is not documented as above….Species is ranked Tier 2.

2b Occupy part of three or more MD physiographic provinces OR 50% or more of any one province… go to **4**.

4a. Species displays resistance to any herbicide OR has a seedbank of two or more years OR reproduces vegetatively…….go to **5**

5a. Species has been present in Maryland for less than 50 years; is present in fewer than 20 natural area sites; AND the answers to ANY of WRA questions ES14, ES15 or ES16 are Yes OR the answer to WRA question ES17 is equal to or greater than 2….

Species is ranked Tier 1

5b. Species is not as above…… Species is ranked Tier 2

4b. Species has none of these characters.….go to **6**

6a. Species is documented as occurring in a state listed S1 or S2 community, or is known to occur elsewhere in its native or novel ranges in habitats similar to those state listed as S1 or S2; OR it occurs, or could occur, within a population or habitat of a Threatened or Endangered species or

of a CITES-listed species; OR it is documented as harming a Threatened or Endangered species in Maryland. Species is ranked Tier 1.

6b. Species is not documented as above….Species is ranked **Tier 2.**

1b. Plant is NOT reported to occur outside of cultivation within Maryland but it can potentially…

7a. occupy LESS THAN part of two MD physiographic provinces…… go to **8**

8a. Species is known to occur in its native or novel ranges in habitats similar to those state listed as S1 or S2; OR it could occur within a population or habitat of a Threatened or Endangered species or of a CITES-listed species; OR it could harm a Threatened or Endangered species in Maryland….. Species is ranked Tier 1.

8b. Species is not documented as above…..Species is ranked Tier 2.

7b. occupy part of three or more MD physiographic provinces, OR 50% or more of any one province ….. Species is ranked Tier 1

Notes:

1a. *Tetradium daniellii* has been documented as naturalized in Maryland in Washington County and the city of Baltimore. 2b. It is adapted to Plant Hardiness Zones 5-10 and could establish anywhere in the state. 4b. Although the species sprouts repeatedly from cut stumps (Aiello 2016), and the congener *E. lepta* has a documented long-lasting seed bank (Wang 2009), there is no conclusive evidence that *Tetradium daniellii* displays herbicide resistance, has a long-lasting seed bank or reproduces vegetatively. One grower has observed that the "seedlings are robust" and will come "up in the midst of thick tall fescue" but that they do not survive mowing, and that they sprout from cut roots, but do not spread this way – "we don't see the tree forming a colony while it's in production" (Black 2017). 6b. The established populations of bee bee tree in Maryland do not currently threaten rare species or habitats, nor do they occur in S1 or S2 communities. *Tetradium daniellii* earns the rank of **Tier 2.**