DEPARTMENT OF NATURAL RESOURCES

Java Water Dropwort (*Oenanthe javanica*)

Introduction

Java water dropwort (*Oenanthe javanica*) is a perennial herb belonging to the *Apiaceae* (carrot/parsnip) family, previously known as the *Umbelliferae* family (Kumar et al., 2021; Li et al., 2023). This family includes culinary spices such as coriander, caraway, fennel, and cumin. Like these spices, Java water dropwort is an edible herb known for its leave's and stem's distinct aroma and taste, as well as a myriad of medicinal uses. Its native range encompasses southeastern Asia and the Indo-Malaysian region, where it has been cultivated for those properties for thousands of years (Li, et al., 2023; Yatskievych & Raveill, 2001). The plant has spread beyond its native range through cultivation and the aquacultural trade, and it is readily available for purchase online for both purposes. Introduced populations of *Oenanthe javanica* have been documented forming problematic monocultures in moist soils adjacent to lakes and streams in the United States (Curran, 2020; Yatskievych & Raveill, 2001). Currently, there are at least 20 states where introduced populations of java water dropwort have been reported, Minnesota being one (iNaturalist, n.d.). Its potential to become an aggressive aquatic invasive species makes it of concern to management organizations and agencies. This literature review attempts to provide those entities with the latest information on java water dropwort to inform their prevention and management decisions.

Biology

Morphology and Growth

As a member of the *Apiaceae* family, the green, alternately pinnate leaves of java water dropwort resemble that of parsley and celery (Wisconsin Department of Natural Resources, n.d.; Yatskievych & Raveill, 2001). Stems range from 30 to 150 cm long (Yatskievych & Raveill, 2001). These jointed hollow stems grow spreading across the ground, from which fibrous roots can form when the plant contacts the soil or water (Wisconsin Department of Natural Resources, n.d.). Flowers are tiny, white, and possess 5 sepals with small triangular teeth and 5 petals that each come to a slender pointed tip (Yatskievych & Raveill, 2001). Numerous flowers can bloom from late summer/early autumn in umbels at the end of stalks (Wisconsin Department of Natural Resources, n.d.). A cultivar variant of this species features leaves with colorful pink edges (iNaturalist, n.d.).

Images of Java water dropwort's foliage and flowers.
Photo credit: Minnesota Department of Natural Resources

Habitat

This plant has a wide range of growing conditions. Java water dropwort can grow in a variety of saturated soil habitats, ranging from marshes to swampy fields, and along ditches, canals, and streams (Minh, 2019). It fares best in full sun to semi-shade and there is no discernable soil type preference, as it can grow in sediments ranging from sandy to clay (National Parks, n.d.; Plants for a Future, n.d.). Tolerable pH levels range from 5-8, which it can maintain by buffering pH (Pfingsten & Rose, 2024; Xin, et al., 2012). In floating treatment wetlands, this species is thought to be able to buffer pH and maintain a neutral to weakly acidic condition through plant respiration of atmospheric CO_2 and inhibiting CO_2 uptake by photosynthetic microalgae from the surrounding waters (Xin, et al., 2012).

While it prefers growing in soils, it can grow in water with suitable flow velocities ranging from 0.05 to 0.30 meters per second, which is a max flow speed of 0.67 mph, roughly half the average speed of the Mississippi River near its headwaters for comparison (Chen & Lin, 2011; National Park Service, 2024; Plants for a Future, n.d.). It is a fast-growing species capable of thriving in polluted waters (Zhou & Wang, 2010). The species is also capable of tolerating freezing temperatures and has been shown to overwinter in Wisconsin (Curran, 2020; Zhour & Wang, 2010). Limiting factors for its growth include drought sensitivity and salt intolerance above 100-mM NaCl, which is about a sixth the salinity of ocean water (Kumar, et al., 2021).

Reproduction and Life Cycle

Oenanthe javanica is a perennial plant that flowers from June to August (Wisconsin Department of Natural Resources, 2011). The plant is monoecious and self-fertile, but flowers can be pollinated by insects (Plants for a Future, n.d.). Seeds ripen from August to October, with germination occurring in the spring (Wisconsin Department of Natural Resources, 2011). More commonly, reproduction is achieved through vegetative

fragmentation (Pfingsten & Rose, 2024). Stems are relatively fragile, and fragments can spread advantageous roots if a node is present (Wisconsin Department of Natural Resources, n.d., 2011).

Predators

Biological controls for Java water dropwort have not been identified in the literature (Pfingsten & Rose, 2024). In a growth trial at the University of Florida in 1977, researchers reported "almost no pests" were observed on test plantings, but they did not mention what species were found (Stephans, 1994). As for pathogens, nine have been reported including *Bremiella oenanthes*, *Plasmopara oenanthes* (downy mildew), *Puccinia oenanthes-stoloniferae* (rust), *Corticum sasakii* (sheath blight disease), *Sclerotinia sclerotiorum* (sclerotina rot), *Erysiphe heracleid* (powdery mildew), *Oidium sp.* (Oidium leaf disease), *Sclerotinia minor* (stem rot), and *Botrytis cinerea* (grey mould) (Song et al., 2017).

Origin and Spread

Native Range

According to the data provided by the World Checklist of Vascular Plants, *Oenanthe javanica's* home range covers most of eastern Asia (Govaerts, 2024). Its range spans from Japan (at its eastern most extent) to Pakistan (at the western most extent). Its most northern range starts in southern Russia and spans south down to Papua New Guinea (**Figure 1.**).

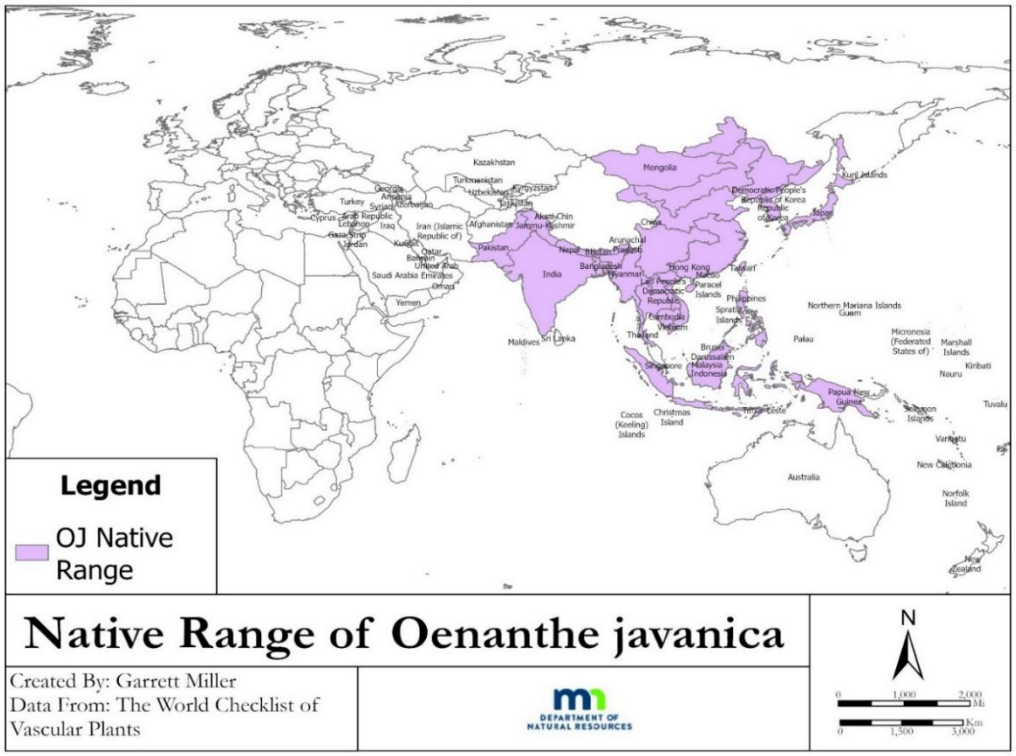

Figure 1. Native Range of Oenanthe javanica

Current Distribution

According to the International Union for Conservation of Red List of Threatened Species (IUCN), Java water dropwort's population is stable and of least concern (Zhuang & Lansdown, 2010). Their assessment was last completed in 2010 and may need updating. Since then, populations in its native range have likely been impacted by urbanization, wetland drainage, poor watershed management, and other anthropogenic environmental changes. However, given its biology and adaptability, this species likely is still present across much of its historic native range, though further investigation is needed. To provide some insight, data can be compared between IUCN and the World Checklist of Vascular Plants (Govaerts, 2024; Zhuang & Lansdown, 2010). The most noticeable native habitat loss can be seen in Mongolia and Pakistan. Beyond these two areas, it appears *Oenanthe javanica* has greatly expanded its range through Russia, China, and Australia (**Figure 2.**).

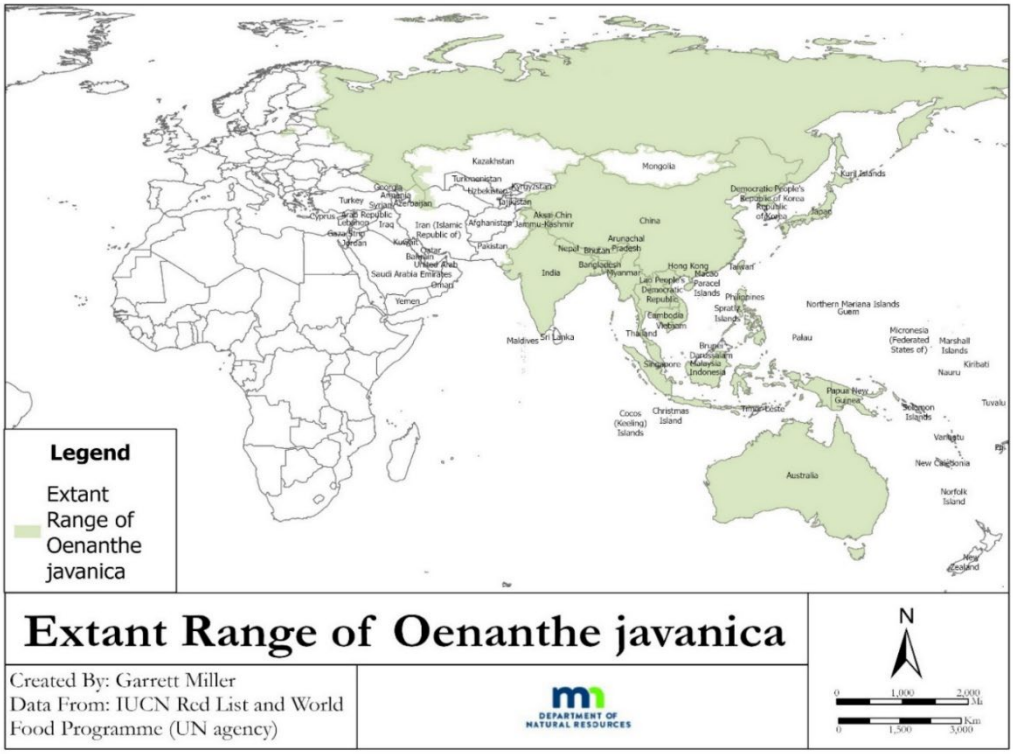

Figure 2. Extant Range of Oenanthe javanica

Spread

Anthropological Pathways

In *Oenanthe javanica's* native range, it is often cultivated as a food source or a medicinal herb (Lu & li, 2019). Its utility for these purposes has led to cultivation for food outside its native range in places such as Italy and Florida (Pfingsten & Rose, 2024; Stephens, 1994). Online searches reveal that Java water dropwort is not commonly sold as produce in the United States, though at some specialty stores, Korean and Asian markets it can still be found (Gyrgus, n.d.; Spurrier, 2012). In California, a Los Angeles Times article reported a community

garden in Elysian Valley growing the herb for consumption (Spurrier, 2012). If this plant's popularity increases as an ingredient in soups, salads, and dishes such as Minari, it could become more commonly found, increasing the risk of introduction into the wild.

Beyond food and medicine, Java water dropwort has also been studied by environmental engineers for its phytoremediation potential in floating wetlands to filter wastewaters (Gao, et al., 2020; Sun et al. 2021). In a study by Sun et al. (2021), java water dropwort was reported to grow rapidly in polluted waters and have a high storage capacity of nitrogen (N) and phosphorus (P) where its storage capacity was similar to that of water hyacinth, another highly invasive aquatic plant. As countries search for cheaper and more energy efficient wastewater treatment methods, the adoption of Java water dropwort for this application could facilitate its spread.

Another anthropogenic mode of transport is through trade and sales as an ornamental species. In particular, the "Flamingo" cultivar variant of java water dropwort can be found for sale online and discussed in gardening forums. This cultivar is enjoyed for its variegated pink serrated leaflets and ease of growth (Spurrier, 2012). Even amongst aquaculture enthusiasts, the plant is known for its fast growth. Many water garden sites that sell and forums that discuss the plant warn readers to be careful of its placement and to expect spread (i.e. Sunland Water Gardens, n.d.).

Biological Pathways

This species can spread both by sexual reproduction and vegetative fragmentation, with the latter being more common (Pfingsten & Rose, 2024). Managing seed heads will not prevent the plant from spreading, as the hollow stems are brittle and can root when broken (Wisconsin Department of Natural Resources, n.d., 2011). As this plant is commonly found growing near lakes and streams, fragments could potentially float on water currents and form new populations (Pfingsten & Rose, 2024; Southeastern Wisconsin Invasive Species Consortium, 2016). However, the risk of seed dispersal and spontaneous growth via seed bank contamination should not be underestimated as suspected *Oenanthe javanica* has been reported at two botanical gardens by staff planting other aquatic species (Yatskievych & Raveill, 2001).

Ecological Threat

Java water dropwort has been described as having invasive tendencies with the ability to grow quickly, alter hydrology in streams, and displace natives (Southeastern Wisconsin Invasive Species Consortium, 2016; Wisconsin Department of Natural Resources, n.d.). The ability to grow in monotypic stands have been documented in a couple of different reports. For example, the report by Yatskievych & Raveill (2001) described a population in Missouri that was left unmanaged and had spread to occupy the entire shoreline of a 1.8-acre artificial lake. In a Wisconsin management report, an introduction of java water dropwort had spread into seven monotypic populations along a river totaling 0.32 acres after two unmanaged years (Curran, 2020). Its ease of spread and growth potential pose a threat to outcompete native taxa.

In Minnesota, the first confirmed occurrence of Java water dropwort in the state was identified by the Minnesota DNR in Le Sueur County in 2016. DNR staff hand pulled two patches of the plant from two small ponds and monitored the site in subsequent years. In 2024, roughly 20 – 30 plants were found growing along the shoreline of one of those ponds and in the water. This indicates Java water dropwort is capable of persisting

through Minnesota's winters and regrowing after mechanical management. These incidences in Minnesota, Wisconsin, and Missouri suggest Java water dropwort has the potential to be a persistent and problematic aquatic invasive species.

Current Invasive Range

International Status

Its range has likely spread through its cultivation as food and medicine, as well as being a popular ornamental cultivar (Yatskievych & Raveill, 2001). For instance, outside of its native range it is commercially grown as a popular vegetable in Italy (Pfingsten & Rose, 2024). Online reports of introduced populations can be found in New Zealand, United Kingdom, Belgium, Ontario Canada and in United States (iNaturalist , n.d.). Within the United States, there have been reports of its cultivation in Hawaii, Florida, and California (Pfingsten & Rose, 2024; Spurrier, 2021; Stephens, 2009). Its first documented population outside of cultivation in the U.S. occurred in Missouri in 1996 (Yatskievych & Raveill, 2001). Since then, it has spread to surrounding states with reported introductions in Arkansas, Colorado, Connecticut, Delaware, England, Illinois, Indiana, Kansas, Kentucky, Maryland, Massachusetts, Minnesota, New Jersey, Ohio, Pennsylvania, Tennessee, Texas, Vermont, West Virginia, and Wisconsin (iNaturalist, n.d.).

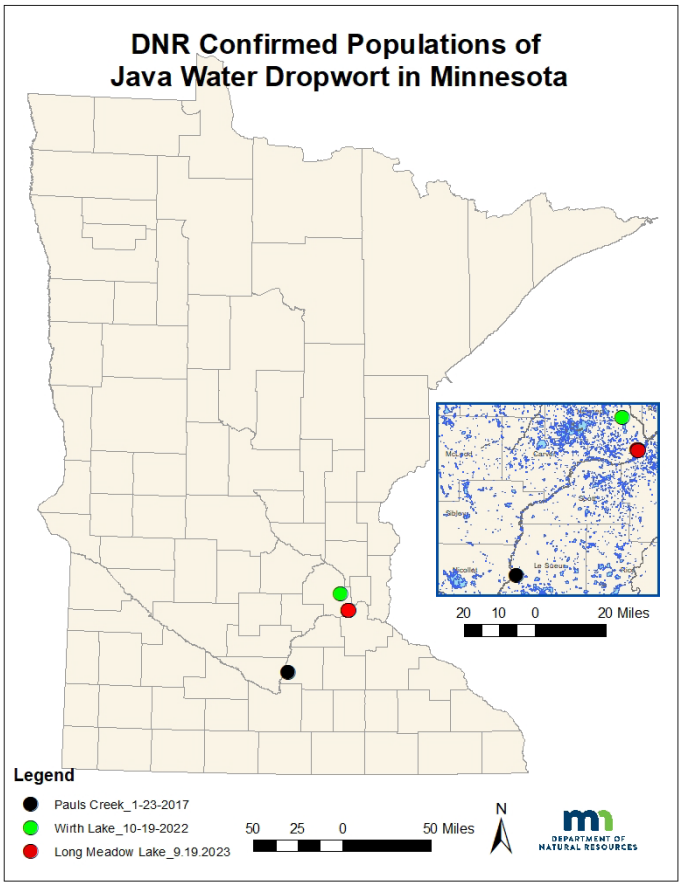

Figure 3 Map of Confirmed Populations of Java Water Dropwort in MN

Minnesota Status

In Minnesota, the first confirmed occurrence of Java water dropwort in the state was identified by the Minnesota DNR in Le Suer County in 2016. Since then, the region 3 MN DNR AIS team has responded and confirmed two other populations, both in Hennepin County. One population was found along Wirth Lake shoreline and the other in an unnamed stream near Long Meadow Lake. There are currently 22 iNaturalist reports of Java water dropwort populations in the state, 12 of which are "research grade" or verified. In addition, there are also eight positive EDDMaps reports. All these reports have occurred at one of the three DNR confirmed populations as recently as the Fall of 2024. This suggests its spread could be limited to these few locations and that the populations are overwintering. Additional populations could likely be identified as DNR staff and the public become more familiar with this species.

Management

Java water dropwort is a relatively new and uncommon invader in the United States, therefore little management information is available. What is available suggests hand pulling could be successful if all roots and stem fragments are collected (Wisconsin Department of Natural Resources, n.d., 2011). Cutting the plant in larger areas is unlikely to prove effective as it could fragment stems, further facilitating its spread. However, mechanical removal on a large scale may be successful through deep plowing and "puddling" (tillage of paddy fields under shallow flooding conditions) (Okuma, et al., 1980). This approach has shown success in paddy fields but may not be feasible at most other sites.

Information on chemical control is also limited, but results of treatments in Wisconsin sheds some insight. A report on O*enanthe javanica* management in Southeast Wisconsin stated a July application using a mixture of 4oz/gallon AquaNeat (glyphosate) concentrate, and 1oz/gallon Habitat (imazapyr) reduced the population by 75% after one treatment (Southeastern Wisconsin Invasive Species Consortium, 2016; Wisconsin Department of Natural Resources, n.d., 2011). A different report using just a 2% solution of the active ingredient Habitat achieved total control after a couple years of management and regrowth has not been observed since (Curran, 2020).

Conclusion

Information on the invasiveness of *Oenanthe javanica* is not well documented in published literature but what is available through papers, management reports, and anecdotal evidence provides some insight. Its home range suggests it can overwinter through freezing temperatures, which has been confirmed in the United States by both the Minnesota and Wisconsin DNR. As of 2024, there are three known populations of Java water dropwort in Minnesota. More populations could establish if this plant is popularized in the state for its culinary and medicinal purposes or its use in aquaculture. Online gardening forums acknowledge the species ability to spread quickly, which has been confirmed by other studies and management reports (Curran, 2020; Yatskievych & Raveill, 2001). Management options are limited as well as information on their efficacy. Though, hand pulling small patches and treating larger areas with herbicide (glyphosate, imazapyr, or a mixture of both) could provide some control (SEWISC, 2016; Wisconsin Department of Natural Resources, 2011). The Minnesota population in Le Sueur County was hand pulled in 2016 when it was discovered and is still being managed in 2024. This species has shown an ability to spread quickly, be fast growing, and be resilient to management, all of which are hallmarks of an invasive species.

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