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Hottonia palustris L. (Primulaceae) – a new vascular plant for Finland found in Turku

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Hottonia palustris L. is a perennial hydrophyte typically found in eutrophic, still or slowly flowing freshwater habitats, often in the presence of groundwater discharge. The species has a Eurasian distribution limited in the north by climatic and hydrological barriers: freshwater habitats in e.g. northern Scandinavia are suggested to be either too cold or too oligotrophic for the species. *H. palustris* has indeed hitherto remained absent in Finland and Norway, with the closest native occurrences situated in Estonia, Denmark and Southern Sweden. In June 2019, *H. palustris* was found growing in a clear-watered, spring-fed and sandy-bottomed pond created by sand and gravel extraction in South-Western Finland, in the municipality of Turku. The extent of this occurrence is roughly 10 m^2. We consider this the first record of *H. palustris* in Finland known to have overwintered and flowered outside private or public gardens. In this paper, we describe the occurrence in greater detail, speculate on its origin and outline certain implications of the species' potential proliferation in Finland. Concluding from the location and characteristics of the pond the species was found in, and the known dispersal syndromes the species relies on, it seems most probable that the introduction of *H. palustris* to Finland was human assisted. The implications of the proliferation of *H. palustris* in South-Western Finland include potential competition with native hydrophytes. However, no waterways suitable for dispersal connect the current occurrence to other waterbodies, and clear-watered, spring-fed freshwater habitats suitable for the species are most likely rare in the surrounding region. The rarity of such habitats, however, may render native hydrophytes inhabiting them more prone to negative consequences that a potential competitive invader, such as *H. palustris*, could cause.

Hottonia palustris L. is a perennial hydrophyte typical to still and slowly flowing freshwater habitats. In addition to ponds and estuaries, the species readily inhabits anthropogenic waterbodies, such as dammed mill and factory reservoirs (Jonsell 2010, Malmgren 1982), ditches (Lindmann 1974), water holes (Malmgren 1982) and harbors (Minchin & Boelens 2005; 2011). Indicative of groundwater discharge (van Moorsel & Barendregt 1993, Klijn & Witte 1999, Jonsell 2010), *H. palustris* prefers eutrophic, neutral to moderately alkaline water (Tyler et al. 2007, Löfgren 2013). It is often found submerged up to depths of roughly 0.5 m but may also occur on exposed substrates (Lindman 1974, Lagerberg 1940, Andersson 1981, Brock et al. 1989, Edqvist & Karlsson 2007).

Hottonia palustris reproduces both sexually by seeds and asexually by detached vegetative parts that develop into new individuals. Both the seeds and vegetative parts, but also floating seedlings and adult individuals, may function as

dispersing agents (Brock et al. 1989, Minchin & Boelens 2011). The literature suggests the dispersal of the species to be hydrochorous, i.e. to rely on passive dispersal via water currents (Kleyer et al. 2008, Minchin & Boelens 2011). However, speculations abound considering the species to disperse with the aid of waterfowl (Brock et al. 1989, Minchin & Boelens 2011), but empirical evidence for this is lacking.

The distribution of *Hottonia palustris* is Eurasian and ranges from the British Isles to western Russia and from southern Central Europe to the Baltic region (GBIF 2019). In the latter, the species is restricted to the southern part of the region, being common in (and native to) Estonia, Denmark and southern Sweden, but absent in Finland and Norway (Lagerberg 1940, Lindman 1974). In Sweden the majority of the species' observations focus into the southern and south-eastern provinces of Småland, Södermanland, Östergötland and Skåne (ArtDatabanken 2020), with the northernmost being found in Hälsingland (Lagerberg 1940). Malmgren (1982) suggests that any dispersal further up north is limited by both cold temperatures and the oligotrophic nature of freshwater habitats.

First record of *Hottonia palustris* in Finland

In June 2019, *Hottonia palustris* was found growing in a pond north-west of the airport of Turku (ETRS-TM35FIN 6719004:238232), close to the communal border between Turku and Rusko (Figs 1–3). The species had already been observed at the site during freshwater habitat surveys conducted by the City of Turku in summer 2018 but remained initially unidentified. In 2019, city employees relocated the species and identified it based on Mossberg & Stenberg (2003).

The occurrence measures roughly 10 m^2 and is situated on the eastern side of a clear-watered, spring-fed and sandy-bottomed pond measuring roughly 0.08 ha (Fig 1). The pond itself is artificial in origin and situated in the north-western part of an esker-formation previously used for sand- and gravel extraction (Joronen 2009). The extraction in the area has led to groundwater exposure and the subsequent development of several small (< 0.5 ha) ponds and springs in the area (Ikonen et al. 1992).

Upon identification, the species was not in flower. However, photographs taken by city employees in 2018 during the same surveys showed the occurrence to sport at least a few flower stalks (Fig 2). Species accompanying *Hottonia palustris* in the pond include *Hippuris vulgaris*, *Hydrocharis morsus-ranae*, *Myriophyllum* sp., *Phragmites australis*, *Potamogeton natans*, *Typha latifolia* and *Comarum palustre*.

While *Hottonia palustris* is mentioned to occur in Finland in certain 19th century botanical publications, the majority of such records are considered misidentifications (Hjelt 1891, Väre & Ulvinen 2005). The only potentially reliable observation of the species in Finland is attributed to Hj. Hjelt in Åland (1877), but no specimens of this exist. Consequently, *H. palustris* is not mentioned in the most recent checklist of vascular plants in Finland (Kurtto et al. 2019), and no records or collections of it have been made into databases observable through the Finnish biodiversity info facility's Laji.fi -portal. We thus consider this the first record of *H. palustris* in Finland known to have overwintered and flowered outside private or public gardens. Two samples have been collected, one by Jussi Lampinen in 1.7.2019 and one by Veli-Pekka Rautiainen in 29.7.2019.

Potential routes of introduction

Several explanations exist for the presence of *Hottonia palustris* in Turku, hundreds of kilometers east from the nearest populations of the species in Sweden. One option is that *H. palustris* is not a newcomer to the flora of Finland, but has occurred in the region all along, as a relic of a more favorable climate, and was only found now for the first time or emerged from a seed bank following some disturbance. Alternatively, the species may have dispersed to the region either passively with water currents or with the help of various vectors, such as waterfowl or humans.

Out of these options, the idea that *Hottonia palustris* would have survived as a relic in the region appears unlikely. The pond inhabited by the species is artificial, at most some few decades old and situated in a site that was previously covered

Fig. 1. ***Hottonia palustris*****, a new vascular plant for Finland was found in 2018–19 in a pond created by sand- and gravel extraction in Turku, SW Finland. The sterile shoots of** ***H. palustris*** **in the occurrence form a loose, entangled net covering approximately 10 m² of the pond's bottom. Photo by J. Lampinen**

Fig. 2. In 2018, *Hottonia palustris* was observed to flower in Turku. Photo by Sonja Risti / City of Turku.

by layers of sand and gravel. This also renders the possibility of the species having emerged from a dormant seed bank appear unlikely, as does the fact that *H. palustris* appears to have a transient seed bank, with the majority of seeds germinating rapidly following their desiccation (Brock et al. 1989).

Passive dispersal of the species to the region or at least the pond in question appears equally unlikely, as neither streams nor creeks connect the pond to other waterbodies. Dispersal assisted by waterfowl could be possible, although difficult to confirm. Also, as mentioned before, the literature describing the dispersal of *Hottonia palustris* suggests hydrochory, rather than zoochory, to be the main dispersal syndrome of the species.

Dispersal assisted by humans is thus the most probable alternative for the introduction of *Hottonia palustris* to Turku. The site surrounding the occurrence is a common, though unofficial spot for recreation and swimming, and it is possible that the species has found its way there with the aid of swimmers. *H. palustris* is also suitable for growing in indoor aquariums, and one must consider the possibility that someone has simply emptied their aquarium into the pond. Other non-native species, namely frogs of the genus *Pelophylax*, were also observed at the pond, possibly hinting at the introduction of these two species together. In addition, the region surrounding Turku has in recent years been the focus of introduction of other non-native plant species, such as *Viscum album* (Issakainen et al. 2019) and *Nymphoides peltata* (Ranta & Piekkala 2018). The origin of these introductions often remains unclear, but human assistance appears to be at least partly to blame. Nonetheless, without further research the origin of *H. palustris* in Turku remains unclear. Studies examining the genetic similarity between individuals in the population in Turku, in the populations geographically closest to Turku, and individuals currently sold at aquarium stores could shed light on the origin of the population in question and thus also its route of introduction.

Potential implications

As with any new species found in a given area, one must consider the implications of the potential proliferation of *Hottonia palustris* in South-Western Finland. The species has been recorded as an invasive at least in Ireland (Minchin & Boelens 2005; 2011), where it is associated with problems that dense, large occurrences of the species may cause to navigation in waterways, and with competition with native hydrophytes (Minchin 2007). However, differing views exist in the literature concerning the species' ability to outcompete other species (Klijn & Witte 1999 vs. Vermeersh & Triest 2006). Traits that could render *H. palustris* competitive advantage over other hydrophytes include the ability to remain evergreen throughout the year (Klijn & Witte 1999, Minchin & Boelens 2011), to tolerate shade (Brock et al. 1989), and the species' remarkable reproductivity: Seeds are

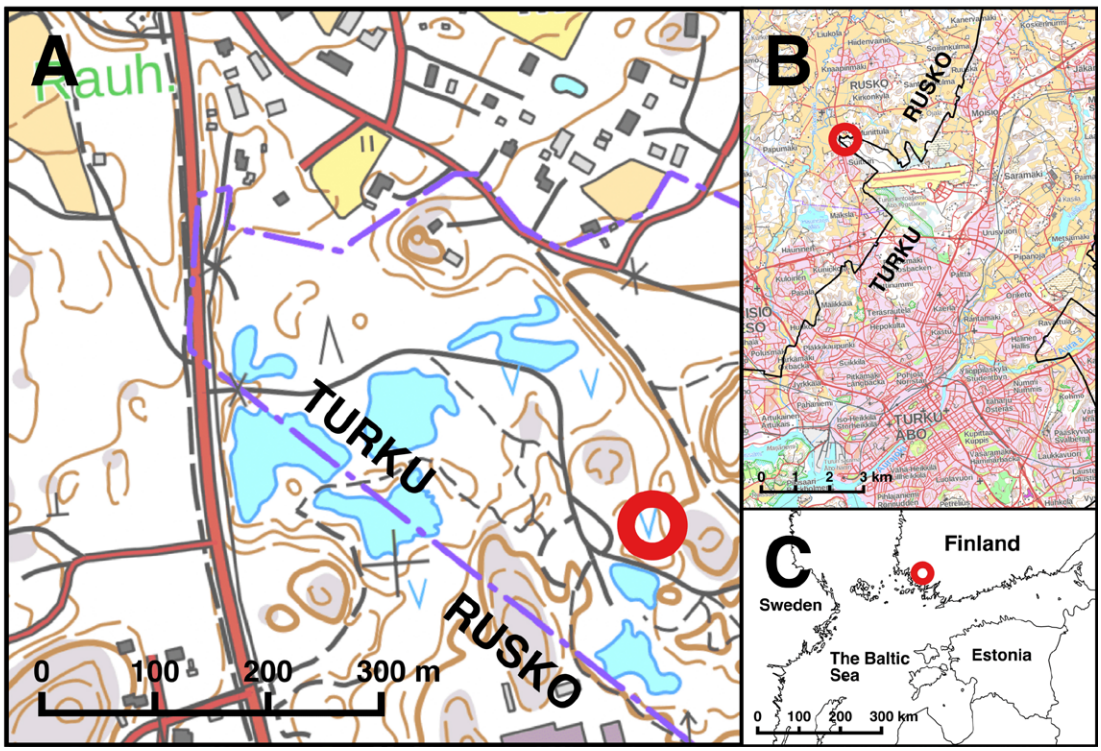

Fig. 3. Location of the occurrence in A–B) Turku and C) SW Finland. Note that the symbol of spring indicates the location of the pond surrounding the occurrence. The maps contain open access data from the National Land Survey of Finland Topographic Database 06/2014, license CCBY-4.0 (A-B), and from Natural Earth, Free vector and raster map data @ naturalearthdata.com (C).

produced in abundance, as much as 60 000 per m^2 (Brock et al. 1989), even in very small populations (Vermeersch & Triest 2006), and detached shoot fragments may also develop into new individuals (Minchin & Boelens 2011).

However, any potential competitive threat that *Hottonia palustris* could pose in South-Western Finland would strongly focus into the types of habitats the species is adapted to, i.e. clear, still or slow-flowing, eutrophic freshwater habitats with potential groundwater discharge. These conditions may coincide in habitat types such as naturally eutrophic lakes and ponds, chalk ponds, spring ponds and spring complexes (Lammi et al. 2018). The distribution of some of these, such as chalk ponds, is centered into northern Finland. Others, such as spring complexes, are distributed evenly across the country, but have declined in abundance in regions dominated by agriculture and forestry, such as South-Western Finland (Lammi et al. 2018). Natural spring ponds, on the other hand, are common to esker and ridge moraine regions in Southern and South-Western Finland and may bear close resemblance to the pond inhabited by *H. palustris* in Turku. Other small freshwater habitats in South-Western Finland are predominantly turbid, and acidic (Kirkkala & Ikonen 2004), partly due to forestry and agriculture, but also to the naturally occurring clay-dominated soils in the region. Thus, with the exception of spring ponds found in esker and moraine regions, the habitats suitable for *H. palustris* are likely rare in South-Western Finland. The rarity and specialized conditions in these habitats, however, may render native species adapted to them prone to negative impacts that a competitive invader could cause: Springs, for example, are often associated with specialist vascular plant and bryophyte species that are not able to inhabit other kinds of habitats.

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