

Asiatic fern *Cyrtomium fortunei* J. Sm. (Dryopteridaceae) – a new naturalized fern in the flora of Slovenia

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Abstract. A naturalized population of Asiatic fern *Cyrtomium fortunei* J. Sm. was found in the surroundings of Nova Gorica. It is the first record of the species in the country, although the locality is an expected prolongation of the secondary distribution range with the species' concentration in southern foothills of the Carnic Prealps (N Italy). The locality is characterized by mild temperate submediterranean climate and slightly degraded forest vegetation of the alliance *Carpinion orientalis*, where the fern occurs in the herb layer. Local occurrence of the fern represents the easternmost point of its secondary distribution range in Northeastern Italy, although this could possibly be connected with the immediate vicinity of the graveyards at the top of the slope.

Key words: biological invasions, invasive alien plant species, naturalization, ferns

Izvleček. Azijska praprotnica *Cyrtomium fortunei* J. Sm. (Dryopteridaceae) – nova naturalizirana vrsta praprotnice v Sloveniji – V okolici Nove Gorice je bila najdena naturalizirana populacija azijske praprotnice *Cyrtomium fortunei* J. Sm. kar je prvi podatek o uspevanju te vrste v Sloveniji. To nahajališče je hkrati pričakovani podaljšek zgoščenosti sekundarnega pojavljanja te vrste na južnem vznožju Karnijskih predalp (S Italija). Za nahajališče te vrste je značilno blago zmerno toplo submediteransko podnebje; gozdna združba, v katere podrasti je rastišče, pripada degradiranemu gozdu iz zveze *Carpinion orientalis*. Pojavljanje te praprotnice na tem mestu dosega skrajni vzhodni del njenega sekundarnega areala v severovzhodni Italiji, morda pa je povezano tudi z neposredno bližino pokopališča na vrhu pobočja.

Ključne besede: biološke invazije, invazivne tujerodne rastlinske vrste, naturalizacija, praprotnice

Introduction

Naturalized alien floras are focus of research and nature conservation concern for the last decades. Thousands of allochthonous flowering plant species have been established and hundreds of them became invasive in Europe, but only about ten alien fern species were successful during colonization of the European continent (Prelli & Boudrie 2021). In Slovenia, *Azolla filiculoides* can be found as a pest in some garden pools, *Cystopteris bulbifera* is escaping from the Alpine botanical garden Juliana, both of American origin, and an ephemeral occurrence of some *Nephrolepis* sp. was detected on a derelict house in Ljubljana about 10 years ago. None of the mentioned three alien ferns occur with completely naturalized populations.

Genus *Cyrtomium* has about 35 species, mostly confined to E and SE Asia. Its centre of diversity is in SW China (Zhang & Barrington 2013). Some of the species are popular ornamental plants and can also escape from cultivation in suitable ecological conditions. In Europe, two *Cyrtomium* species are reported as being locally naturalized, i.e. *C. falcatum* (L. f.) C. Presl and *C. fortunei* (Prelli & Boudrie 2021). Representatives of the genus are easily distinguished from European native ferns, their fronds are imparipinnate with large, more or less asymmetric pinnae and even larger terminal segment slightly lobed basally. Abaxial surface of pinnae is covered with many dispersed sori with almost circular peltate and persistent indusia. Pinnae have anastomosing venation and acuminate apex. The only native fern that can superficially resemble any of the *Cyrtomium* species is *Polystichum lonchitis* (L.) Roth.

Two *Cyrtomium* species which are reported as locally naturalized in Europe are easily distinguished from each other, *C. falcatum* has leathery fronds with 4-10 (-12) pairs of pinnae, distinctly shiny, margins undulate or coarsely dentate, and it can be found in ruderal sites like derelict stone walls or ruins. On the other hand, *C. fortunei* has papery fronds with (8-)10-25 pairs of pinnae, not shiny, margins minutely crenulate-denticulate, and it has also been recorded in natural vegetation on limestone and sandstone (Yatskievych 1993, Zhang & Barrington 2013). Another difference is in the karyology of the two species, *C. falcatum* is reported to be diploid, tetraploid and apomictic triploid, whereas *C. fortunei* is triploid with apogamic apomyxis (Iwatsuki 1995, Ootsuki et al. 2012). Peroni & Peroni (2000) checked the micromorphology of leaf epidermis for distinguishing the two species and they proposed measurements of stomata as reliable trait for identification. As the material of both species belonged to triploids, we have no information about stomata measurements in 2x and 4x populations of *C. falcatum*. Apomictic propagation can partly explain success of *C. fortunei* in other continents (Krippel & Thommes 2021).

C. fortunei has erect rhizome, densely covered with dark brown scales present also in basal part of stipe. Stipe is 12-26 cm long and 2-3 mm wide at base with a longitudinal furrow (U-shaped in transection). Frond lamina oblong-lanceolate, 20-40 cm long and 6-12 cm wide, 1-imparipinnate, rachis and pinnae abaxially glabrous or with sparse linear scales resembling simple trichomes. Lateral pinnae 7-16 (-29) pairs, alternate, with short petioles, lanceolate to falcate; middle pinnae 5-8 × 1.2-2 cm, base oblique, acroscopic part with weakly developed blunt auricle, basiscopic part cuneate, margins entire or sometimes serrulate, apex acuminate; terminal pinna triangularly-ovate-lanceolate, sometimes lower portion with 1 or 2 lobes, 3-6 × 1.5-3 cm; papery, venation anastomosing to form 4 or 5 rows of areoles on each side of

pinna midrib, each areole with 1 or 2 included free veinlets. Sori irregularly scattered on abaxial surface of pinnae; indusia peltate, circular, margins entire (description mostly from Zhang & Barrington 2013).

In its native range (China, NE India (Manipur), Japan, S Korea, Nepal, Thailand, N Vietnam), the species is reported for limestone crevices in open areas or forests in altitudinal range between 100 and 2,400 m a.s.l. Its occurrence in Iran is also reported as spontaneous (Gholipour & Greuter 2010), which would change the native distribution range of the species (and genus). Even if that would be the fact, known European naturalized populations are more than 2,000 km away, with their occurrence distinctly linked to escapes from cultivation.

Neophytic distribution range of *C. fortunei* comprises some parts of N America (mostly SE of US) and parts of Europe (Gholipour & Greuter 2010). In Europe, the genus has been represented mostly by escapes of *C. falcatum*, but in the last decades there have been several records of established populations of *C. fortunei*. There are only a couple of scattered records from the first half of the 20th century (Pignatti et al. 1983, Krippel & Thommes 2021), but in the last four decades the process of naturalization took place in several parts of Europe. It was discovered naturalized in NE Italy (Friuli-Venezia Giulia, Monte De Ragogna; Pignatti et al. 1983, Pignatti 2017) and in the following years several populations were recorded concentrated mostly in the southern foothills of the Carnic Prealps, where the species has become naturalized (Bona et al. 2005). Similar pattern of naturalized occurrence follows in the western direction towards Lombardy (Martini et al. 2012) and Novara (Aeschimann et al. 2004). In addition to that, it has been recorded in many scattered localities in N Italy, where its occurrence is mostly explainable by cultivation in the vicinity. The oldest record of the species for N Italy dates back to 1912 (Bona et al. 2005). In Switzerland, populations are well established in the sub-mediterranean part of Tessin/Ticino (Eggenberg et al. 2018), a direct prolongation of the secondary distribution range in Lombardy, and there are still some further local records in central and western Switzerland (Infoflora 2021). It has not been reported by previous floristic monographs (before 2010). Its habitat is mentioned as wet walls and rocks in the *Cystopteridion* vegetation (Infoflora 2021). In France (Tison & Foucault 2014), it is reported as rare species in the Alpes Maritimes around Nice, where it has been recorded in lowlands (100-200 m a.s.l.), naturalized on shaded tuff walls in humid local conditions, but its local spreading can be interpreted as invasive in some of the narrow valleys (Krippel & Thommes 2021). In the Benelux area, *C. fortunei* is reported as »rare escape from cultivation but increasingly found since 2001« (Verloove 2010), and in addition to ruderal places it has already been recorded in natural locality with terrestrial population in woodland in Moen (Verloove 2010). In Nederland, it has been reported in ruderal places (Denters & Verloove 2007-2008) and similarly in Luxemburg (Krippel & Thommes 2021) and England (Page 2005).

Cultivation of *C. fortunei* as ornamental plant has a long history. As early as 1904, it was mentioned as hardy plant suitable for outdoor planting (Kunert 1902). It has not been so popular as the closely related *C. falcata* (Studnička 2009), but it is mentioned as suitable for herb layer under trees or shrubs with need of winter protection and possibility of propagation by spores, sensitive to winter wet weather (Jäger et al. 2008). Also in Slovenia, *C. fortunei* was mentioned as a house pot plant in some of the translated handbooks (Spangenberg 1976, Vermeulen 2005), but it is not possible to interpret this fact as being connected to naturalized occurrence of the species. In comparison with some other European countries, Slovenian horticultural trade is not very developed and diversity of available plants is comparably low. Among ferns and fern

allies, there are normally less than 10 species available for outdoor gardening in bigger garden centres or from internet providers. And the two mentioned *Cyrtomium* species are often the only really exotic ones.

Material and methods

Plant material was sampled during routine field floristic mapping aimed at *Buddleja davidii* populations. All the previously reported localities of that invasive alien shrub scattered in lowland parts of Slovenia were systematically visited, vegetation relevés done and in the vicinity additional populations of *B. davidii* searched for in suitable sites. Systematic sampling took place in summer 2021 and will go on until 2023. Collected herbarium vouchers are deposited in herbaria LJU (University of Ljubljana, Biotechnical Faculty) and LJS (Jovan Hadži Institute of Biology, Scientific Research Centre of the Slovenian Academy of Sciences and Arts). Identification of plant material was done using many literature sources (Yatskievych 1993, Peroni & Peroni 2000, Verloove 2010, Zhang & Barrington 2013, Tison & Foucault 2014, Prelli & Boudrie 2021).

Results and discussion

Finding of *C. fortunei* in the SW part of Slovenia has not been unexpected, as the fern has been naturalized in several localities of Northern Italy, where it was first recorded more than a century ago. Slovenian locality is almost on the Italian border, with the Soča/Isonzo River crossing the state border just about 1 km SW from the spot.

Slovenian population was discovered as locally naturalized in herb layer of forest on the left bank of the Soča River (0047/2 Slovenia: Nova Gorica, Solkan, Gorišček, forest on NW slopes above the Soča River, ~70 m a.s.l., 45,976912° N 13,649904° E, leg. N. Jogan, 2. 7. 2021). Local population has about 100 plants with ripe fronds (Fig. 1) and covers an area of about 100 m². Nearest known populations on the Italian side of the border are in the vicinities of Cividale del Friuli around 15 km to the NW and Trieste about 35 km to the SE (Bona et al. 2005). Forest above the Soča River bank is slightly degraded due to a walking path and nearby settlement on the top of the slope. As a consequence, there are several invasive alien species in the forest as e.g. *Buddleja davidii*, but the overall impression of the locality is that ground layer of the forest vegetation is quite natural. At the top of the slope, there is a WW1 military graveyard now maintained as a park, as well as a bigger civil cemetery. Graves in Slovenia are often decorated with planted ornamental plants, flower bouquets, mourning wreaths and other flower arrangements, which could possibly be the source of the discussed fern population merely 100 m away.

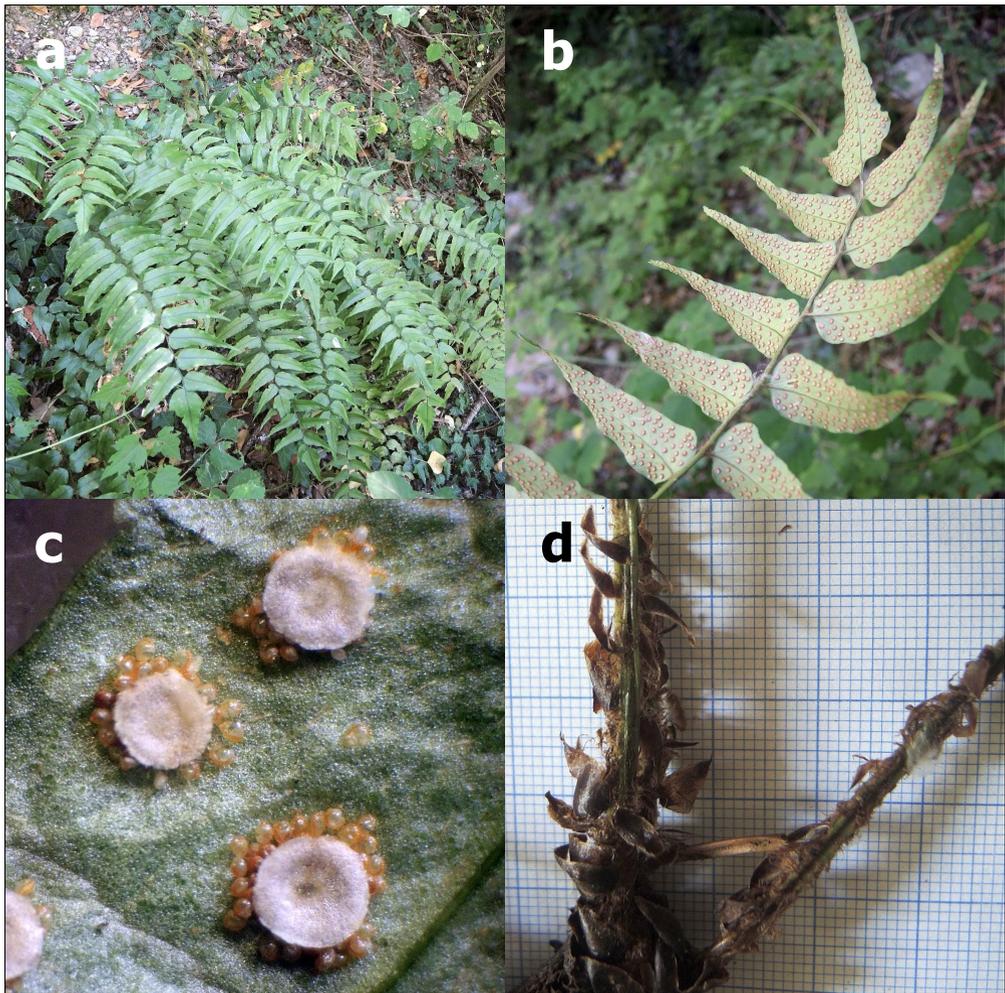


Figure 1. a) Asiatic fern *C. fortunei* in the locality near Nova Gorica; b) abaxial surface of frond with typical sori pattern; c) sori with peculiar persistent circular peltate indusia; d) dark scales at the basal part of stipe (Photo: N. Jogan).

Slika 1. a) Azijska praprotna *C. fortunei* na nahajališču blizu Nove Gorice; b) spodnja stran lista s tipičnim vzorcem trosišč; c) trosišča s prepoznavnimi dežnikasto oblikovanimi obstojnimi zastiralci; d) temne luske pri dnu listnega peclja (Foto: N. Jogan).

Climatic conditions in that particular part of Slovenia are very mild (<https://meteo.arso.gov.si/met/sl/climate/maps/>), with average annual temperature around 13°C, total annual precipitation close to 2,000 mm with most intense autumnal rains and almost without snow cover (less than 5 snowy days per winter).

Vegetation in the discussed locality is slightly degraded forest that could be classified into the alliance *Carpinion orientalis* (*Quercetalia pubescenti-petreae*, *Quercetalia pubescentis*). There is evident influence of riverine forest nearby. Forest community is shaded and moist with ruderal species indicating human impact (as explained above). Substrate is conglomerate, soil is rich in sand (due to the Soča River floods), elevation 88 m above sea level, exposition W, inclination: 30°, average height of the tree layer: 20 m, average height of the shrub layer: 5 m, coordinates (WGS84): 45,976944 N, 13,650000 E, plot area: 100 m², date: 2.7.2021. Tree layer (80% coverage): *Quercus pubescens* 3, *Ostrya carpinifolia* 2, *Populus nigra* 2, *Hedera helix* +, *Robinia pseudoacacia* +; shrub layer (50%): *Sambucus nigra* 3, *Rubus fruticosus* agg. 3, *Euonymus europaeus* 1, *Laurus nobilis* 1, *Ruscus aculeatus* 1, *Acer campestre* +, *Asparagus acutifolius* +, *Clematis vitalba* +, *Cotinus coggygria* +, *Crataegus monogyna* +, *Fraxinus ornus* +; herb layer (60%): *Hedera helix* 3, *Cyrtomium fortunei* 2, *Lamium maculatum* 1, *Lamium orvala* 1, *Acer campestre* +, *Asplenium trichomanes* +, *Brachypodium sylvaticum* +, *Calamagrostis varia* +, *Campanula rapunculoides* +, *Clematis vitalba* +, *Fraxinus ornus* +, *Geranium robertianum* +, *Helleborus odoratus* +, *Hepatica nobilis* +, *Laurus nobilis* +, *Lonicera caprifolium* +, *Mycelis muralis* +, *Rubus fruticosus* agg. +, *Tamus communis* +, moss layer (15%).

Spread of alien plants in natural vegetation could present a threat to local habitat type structure and biodiversity. Bearing in mind more than four decades of sub-spontaneous spread of *C. fortunei* to suitable natural habitats in the wider area of southern Alpine foothills, on one hand we could say that it is not possible to prevent spread of tiny spores to the neighbouring habitats as long as the fern is cultivated as an ornamental and maybe used also as decoration in flower bouquets (and hence appearing in graveyards, garden garbage bins, etc.). On the other hand, after all these decades the populations of the discussed fern are still small and scattered, so at the moment it is not possible to recognize it as a distinct threat to the local biodiversity. But for the future, it can be expected that naturalization process would not go on and in some of the next phases invasiveness of the species could emerge.

As the newly discovered population is clearly naturalized and there are more of them in the neighbouring areas of Italy, it seems highly probable that *C. fortunei* has already been established locally also in some other suitable sites in the Sub-Mediterranean part of Slovenia. It would be even possible that it has been overlooked due to general neglect for ferns as they are often treated as superficially similar. Care should be taken during floristic exploration of shaded stony forests in the river valleys in Goriška Brda and in the Vipava Valley, where comparable micro-ecological conditions could be available.

At the end, as a newly naturalized fern in Slovenian flora, the species would deserve a vernacular name. Availability of names used by Slovenian gardeners is scarce, either they provide it as a »fern« (praprot), simply transliterated name into »cirtomium«, some use only the name of a cultivar (»clivicola«), or pragmatically sell the fern under English vernacular names (holy fern) or simply translate one of the vernacular names in other languages (e.g. »lažni aspidij« as a translation of false aspidium). Obviously a new name has to be coined. If we would like to derive the name from Latin, the author of the name *Cyrtomium* (Presl 1836) used the Greek term *kyrtos* in the meaning of arch, curved as an arch, to refer to the anastomosing leaf nervature. In fact, in the discussed species leaf venation is so obscure that anastomoses are hardly visible. But a distinct trait of the genus is also the shape of pinnulae that are asymmetrically curved in the form of a schyte blade, again resembling an arch shape. Locally, a small traditionally used knife with curved blade is called »fovč«, so using that term as

a linguistic root we propose the name »fovčevka« as a vernacular name for the genus *Cyrtomium*. Naming the species is easier, as it is dedicated to the 18th Century botanist Robert Fortune (Prelli & Boudrie 2021), so the Slovenian name would then be »Fortunova fovčevka«.

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