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SURVEY OF THE *EUPHORBIA* SUBG. *CHAMAESYCE* SECT. *ANYSOPHYLLUM* (EUPHORBIACEAE) IN CROATIA WITH NEW RECORDS OF *EUPHORBIA GLYPTOSPERMA*, *E. SERPENS* AND *E. HYPERICIFOLIA*

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Milović, M.: Survey of the *Euphorbia* subg. *Chamaesyce* sect. *Anysophyllum* (Euphorbiaceae) in Croatia with new records of *Euphorbia glyptosperma*, *E. serpens* and *E. hypericifolia*. Nat. Croat., Vol. 35, No. 1, 43-69, 2026, Zagreb.

The current state of knowledge on *Euphorbia* subgen. *Chamaesyce* sect. *Anisophyllum* in Croatia, based on literature analysis, herbarium specimens, data from the Flora Croatica Database (FCD) and personal field observations, is presented. Before this study, six species from this section have been reported several times for Croatia: two native (E. peplis and E. chamaesyce) and four introduced and naturalized (*E. humifusa, E. maculata, E. nutans*, and *E. prostrata*). Here, I report on the occurrence of two new species, *E. glyptosperma* and *E. serpens*, in the flora of Croatia, and confirm the presence of the recently published record of *E. hypericifolia*. *Euphorbia serpens* and *E. hyperificifolia* were found as weeds in several garden centers in the areas of Šibenik and Zadar, where they were recently introduced through seeds in the soil of pots with ornamental plants imported from Italy. On the other hand, *E. glyptosperma* has been present in Croatia for approximately ten years and can be considered a naturalized species. A brief description of the three newly recorded taxa is provided, along with notes on key characteristics. Data on taxonomy, ecology and current distribution for each species are given, as well as the data on the first occurrence and the dynamics of spread of the introduced taxa in Europe and Croatia. Finally, an updated identification key comprising the nine taxa of *Euphorbia* sect. *Anisophyllum* occurring in Croatia is provided.

Key words: naturalized taxa, neophytes, new findings, prostrate spurges

Milović, M.: Pregled roda *Euphorbia* subgen. *Chamaesyce* sect. *Anisophyllum* (Euphorbiaceae) u Hrvatskoj s novim nalazima vrsta *Euphorbia glyptosperma*, *E. serpens* i *E. hypericifolia*. Nat. Croat., Vol. 35, No. 1, 43-69, 2026, Zagreb.

U radu je prikazano trenutno stanje poznavanja roda *Euphorbia*, podroda *Chamaesyce*, sekcije *Anisophyllum* u Hrvatskoj, na temelju analize literature, herbarskih primjeraka, informacija iz Flora Croatica Database i vlastitih terenskih opažanja. Do sada je sekcija *Anisophyllum* sadržavala šest vrsta: dvije domaće (*E. peplis* i *E. chamaesyce*) i četiri strane udomaćene vrste (*E. humifusa*, *E. maculata*, *E. nutans* i *E. prostrata*). Dodatno, dvije nove vrste (*E. glyptosperma* i *E. serpens*) prvi su put zabilježene u Hrvatskoj, a potvrđen je i nedavno objavljeni nalaz *E. hypericifolia*. *Euphorbia serpens* and *E. hyperificifolia* pronađene su kao korovi u više vrtnih centara na području Zadra, Šibenika i Splita gdje su unesene sjemenom u tlu u loncima s ukrasnim biljkama uvezenim iz Italije. *Euphorbia glyptosperma* je već desetak godina prisutna u Hrvatskoj i već se može smatrati udomaćenom vrstom. Naveden je sažeti opis triju novozabilježenih svojti, s ključnim obilježjima. Za svaku od obrađenih vrsta navedeni su podaci o taksonomiji, ekologiji i trenutnoj rasprostranjenosti te dodatno, za unesene svojte, podaci o prvoj pojavi i dinamici širenja u Europi i Hrvatskoj. Izrađen je ažurirani identifikacijski ključ koji uključuje devet svojti roda *Euphorbia* sekcije *Anisophyllum* koje dolaze u Hrvatskoj.

Ključne riječi: neofiti, novi nalazi, puzajuće mlječike, udomaćene vrste

INTRODUCTION

Euphorbia L. is an exceedingly variable and nearly cosmopolitan genus of about 2000 species (Govaerts *et al*., 2000; Frodin, 2004; Zimmermann *et al*., 2010), particularly well-represented in all tropical or temperate regions of the world (Frajman & Jogan, 2007; Pahlevani & Riina, 2011; Berry *et al*., 2016). The genus *Euphorbia* is economically very important, including numerous ornamental (Carter & Cullen, 1997) and weedy species (Randall, 2017). Recent phylogenetic studies (Steinmann & Porter, 2002; Bruyns *et al*., 2006; Zimmermann *et al*., 2010; Horn *et al*., 2012) have shown the monophyly of *Euphorbia* and contributed to the understanding of its infrageneric relationships, revealing four main evolutionary lineages corresponding to four monophyletic subgenera: subg. *Euphorbia*, subg. *Chamaesyce* Raf., subg. *Esula* Pers. and subg. *Athymalus* Neck. ex Reichb. (Dorsey *et al*., 2013; Yang *et al*., 2012; Riina *et al*., 2013; Peirson *et al*., 2013). Among the four subgenera, *Euphorbia* subg. *Chamaesyce* is the second-most species-rich, encompassing around 600 species worldwide (Yang *et al*., 2012). The subgenus is characterised by the early abortion of the apical meristem of the main stem, followed by sympodial growth, opposite arrangement of often asymetric leaves, and petaloid appendices on cyathium glands (Steinmann & Porter, 2002; Bruyns *et al*., 2006; Pahlevani & Riina, 2011; Horn *et al*., 2012). Yang *et al.* (2012), using a wide taxon sampling, further divided the subgenus *Chamaesyce* into 15 sections with sect. *Anisophyllum* Roep. being the largest, including approximately 365 species. According to Yang & Berry (2011), this section originated in warm and arid areas of North America, from where it diversified globally with frequent long-distance dispersals.

According to the Euro+Med Plantbase (2024), 280 *Euphorbia* species occur in Europe and the Mediterranean region. In Croatia, the genus is represented by 52 taxa (Nikolić, 2024), 45 of which are native and belong to *E.* subg. *Esula* Pers., while the remaining seven are representatives of the subgenus *Chamaesyce* Raf. The subgenus *Chamaesyce* sect. *Alectoroctonum* (Schltdl.) Baill. is represented only by *Euphorbia marginata* Pursch., which is of North American origin, but is cultivated as an ornamental plant and therefore frequently escapes, particularly in the region of Southeast Europe (Smith & Tutin, 1968). The remaining six taxa belong to sect. *Anysophyllum*. Two of them (*Euphorbia peplis* L. and *E. chamaesyce* L.) are native to the Mediterranean region (including Croatia). *Euphorbia humifusa* Willd. is a naturalized neophyte originating from East and Central Asia, while the other three species (*E. maculata* L., *E. nutans* Lag. and *E. prostrata* Aiton) are naturalized neophytes originating in North America. *Euphorbia maculata* and *E. prostrata* can be considered invasive species in Croatia (Boršić *et al*., 2008; Nikolić *et al*., 2014).

This paper aims to increase the knowledge about the species of *Euphorbia* sect. *Anisophyllum* in Croatia. The historical and current distribution of non-native species in Croatia, based on information from literature, herbaria, databases and personal field observations, is presented. In addition, two species are reported for the first time for the flora of Croatia, namely *E. serpens* Kunth and *E. glyptosperma* Engelm. Finally, the first recently published record of *E. hypericifolia* (Ćato *et al*., 2023) is confirmed. An updated identification key comprising the nine taxa of sect. *Anysophyllum* occurring in Croatia is provided. As the data for the Lika region were scarce (Nikolić, 2024), additional field research was conducted there to examine the occurrence and distribution of *Anisophyllum* taxa.

MATERIAL AND METHODS

The study is focused on *Euphorbia*, subg. *Chamaesyce* sect. *Anisophyllum* in Croatia, specifically on six taxa that have been recorded so far (*E. chamaesyce*, *E. peplis*, *E. humifusa*, *E. nutans*, *E. maculata* and *E. prostrata*), as well as on three taxa recently registered in Croatia (*E. glyptosperma*, *E. serpens*, *E. hypericifolia*). Descriptions of these three species presented in this paper are based on Hügin (1998a), Benedi & Orel (1992), Steinmann *et al.* (2016), Ma & Gilbert (2008), Pahlevani & Riina (2011) and Mugnai *et al.* (2021), with notes on key or specific characteristics. Data on taxonomy, ecology and the current distribution (in the world, Europe and Croatia) for each of the species are included, as well as the first report on the occurrence and dynamics of spread in Europe and Croatia for non-native taxa. Information is mostly derived from Hügin (1998a, 1999), Benedi & Orel (1992), Steinmann *et al.* (2016), Mugnai *et al.* (2021) and Nikolić (2024). The analysis of distribution, first appearance and dynamics of spread of the species in Croatia was conducted on data from the literature, field observations, herbarium specimens, photo documentation and other data from the Flora Croatica Database - FCD (Nikolić, 2024).

As a result of recent fieldwork, mostly in the area of Dalmatia (Southern Croatia), and by examining herbarium specimens collected by the author (from 2012 to present), three new species of sect. *Anysophyllum* occurring in Croatia have been identified. The specimens of taxa recorded for the first time in Croatia (*E. glyptosperma*, *E. serpens* and *E. hypericifilia*) were identified using the identification keys of Smith & Tutin (1968), Benedi & Orel (1992), Hügin (1998a), Pahlevani & Riina (2011), Frajman (2011) and Mugnai *et al.* (2021). At each locality where the new taxa were found, the following data were recorded: geocoordinates, estimated population size, a short description of the habitat, and the date of recording. At several sites, the list of species associated with the *Anisophyllum* species was also noted. Repeated field observations were done when possible. Geocoordinates of the localities were determined using a GARMIN GPSMAP 64s handheld device in the WGS84 projection. The data on the habitats and populations of the newly recorded taxa are based on personal observations. Plants and habitats were photographed with a CANON PowerShot G7x camera. The collected specimens were deposited in the Herbarium Croaticum (ZA) in Zagreb.

Additional field research was conducted in the summer of 2024 in the Lika region and the area of Ogulin, botanically less explored regions for which there are no or very few records of adventitious euphorbias from the sect. *Anisophyllum* (Nikolić, 2024). Localities and habitats with the highest probability of occurrence of these species were visited: rest areas along the A1 highway, larger settlements (Ogulin, Otočac, Perušić, Gospić, Gračac) and railway stations. The collected data are associated with the corresponding *Anisophyllum* species in this paper and will be included in the Flora Croatica Database.

The nomenclature of the newly registered *Anisophyllum* species for Croatia follows the WCVP (Greuter 2024), while the nomenclature of other taxa mentioned in the paper follows Nikolić (2024). The terminology of „invasion ecology" follows Pyšek *et al.* (2004).

RESULTS AND DISCUSSION

Overview of the species of *Euphorbia* subg. *Chamaesyce* sect. *Anysophyllum* listed in the Flora Croatica Database (Nikolić, 2024)

Only two species from *Euphorbia* sect. *Anisophyllum*, both native to Croatia (*Euphorbia chamaesyce* and *E. peplis*), are mentioned in floristic works and floras from the 19th century (Visiani, 1852:223; Schlosser & Vukotinović, 1869:1009). The first occurrences of the neophytes *E. humifusa*, *E. maculata* and *E. nutans* were recorded in Rijeka at the beginning of the 20th century (Simnokai, 1907; Hirc, 1912; Ascherson & Graebner, 1917). Since then, all three species have consistently been listed as adventitious species in the keys and lists of Croatian flora (Domac, 1950, 1967, 1994; Hršak, 1997; Nikolić, 2019; Nikolić, 2024). *Euphorbia prostrata* was introduced much later, in the 1980s (Milović & Randić, 2001), bringing the total number of *Euphorbia* sect. *Anisophyllum* taxa recorded in Croatia to six (Nikolić, 2024). A lot of valuable information, collected from the widely scattered literature and herbaria, on the occurrence and distribution of these species in the area of Istria and Kvarner Bay are presented by Frajman (2005, 2022) and Wallnöfer (2008).

The species belonging to *E.* sect. *Anysophyllum* are very similar in general appearance, which increases the possibility of misidentifications (Milović & Randić, 2001; Mugnai, 2021). The most diagnostic features include the stipules, capsule (fruit) and seeds, and to a lesser extent, the shape of the leaves, pilosity of the plant and the shape and colour of the nectary glands and their appendages (Benedi & Orel, 1992; Mifsud, 2018; Hügin & Hügin, 1997; Pahlevani & Akhani, 2011; Mugnai *et al.*, 2021). Apart from *E. nutans* and *E. hypericifolia*, which are ascending to erect, all other species of sect. *Anisophyllum* represented in Croatia are prostrate to decumbent, unless it grows in shaded sites. Below are several key characters of species from sect. *Anysophyllum* growing in Croatia is presented. The data used were mainly from Benedi & Orel (1992), Jauzein (1995), Pahlevani & Riina (2011) and Mugnai *et al.* (2021).

1. *Euphorbia chamaesyce* L.

(syn.: *Euphorbia canescens* L., *Chamaesyce canescens* (L.) Prokh., *C. vulgaris* Prokh.)

Euphorbia chamaesyce is a prostrate annual plant with prostrate stems that can reach up to 30 cm in length. It is native to the Old World, ranging from Macaronesia to Central Asia and Pakistan (Mugnai *et al.*, 2021). According to Euro+Med (2024), it is native throughout the Mediterranean-Macaronesian region and Southern and Eastern Europe, but is regarded as an introduced species in several Central European countries. However, the exact area of origin and its subsequent naturalization remain uncertain and require further investigation (Benedi & Orel, 1992). Some authors recognize two subspecies of *E. chamaesyce*: subsp. *chamaesyce* and subsp. *massiliensis* (DC) Thell., which primarily differ in the shape of their nectary glands (Pignatti, 1982; Radecliffe & Tutin, 1968; Benedi & Orel, 1992; Pignatti *et al.*, 2017), while others argue that the differences are not sufficiently distinct or consistent to justify subspecies classification (Mugnai *et. al.*, 2021; Pahlevani & Riina, 2011). *Euphorbia chamaesyce* is a species reported to colonize rocky hillsides, gravel plains, saline and sandy soils, fields, gar-

dens and roadsides (Pahlevani & Riina, 2011). Benedi & Orel (1992) describe it as a nitrophilic species characteristic of ruderal communities in trampled biotopes.

In Croatia, *E. chamaesyce* is an autochthonous species that appears as a weed on arable land (Horvatić, 1963), and, less often, on ruderal habitats in settlements (see Nikolić, 2024). It is widespread (Fig. 1), especially on the Adriatic coast, including the islands, from Istria in the northwest to the Dubrovnik area in the southeast (Nikolić, 2024). Both subspecies have been recorded, but the number of observations of subsp. *massiliensis* significantly predominates (Nikolić, 2024). It would be important to investigate the future perspective of this autochthonous weedy species, which might become endangered due to the increasing use of herbicides and the competition with invasive neophytes with similar ecology, such as *E. prostrata* and *E. maculata*.

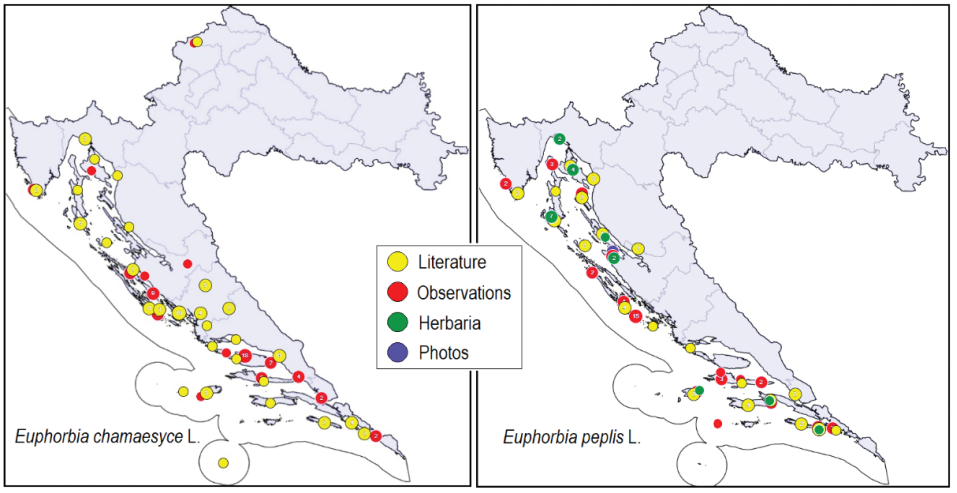


Fig. 1. Distribution of *Euphorbia chamaesyce* and *E. peplis* in Croatia (taken from Nikolić, 2024).

2. *Euphorbia peplis* L.

(syn.: *Chamaesyce peplis* Prokh.)

This plant is a procumbent annual, native to the Mediterranean region (including Croatia) and naturalized on the Pacific coast of North America (Benedi & Orel, 1992). It is a halophytic plant characteristic of subnitrophilous communities in sandy coastal areas. In phytosociological terms, it is characteristic of the alliance *Euphorbion peplidis* Tx. ex Oberd. 1952, ordo *Thero-Atriplicetalia* Pignatti 1953, class *Cakiletea maritimae* Tx. ex Preising ex Br.-Bl. et Tx. 1952 (Benedi & Orel, 1992), but it also occurs in communities of the alliance *Ammophilion* Br.-Bl. 1921, ordo *Ammophiletalia* Br.-Bl, class Ammophyletea Br.-Bl. et Tx. ex Westholff *et al.* 1946 (Šilc *et al.*, 2016).

In Croatia, *E. peplis* is distributed throughout the coastal area (Fig. 1), including the islands (Nikolić, 2024), where it occurs on sandy and shingly seashores and bays, where the waves deposit remains of algae and seagrasses (Horvatić, 1963; Topić *et al.*, 2006). The eastern Adriatic coast consists mainly of solid and steep limestone rocks; sandy and shingly bays are scarce, small and have fragmented vegetation (Horvatić,

1963; Trinajstić, 1989, 1998; Alegro, 2004; Šilc, 2016). Dunes are one of the most extreme ecosystems due to abiotic environmental factors, and among the most endangered, due to various kinds of human impact (Maun, 2009). Anthropogenic impact on many sandy beaches has destroyed or depauperated the vegetation, so that in some locations in Croatia (Nin and Velika Saplunara) only fragments remain (Stešević, 2016). The habitats of *E. peplis,* shingle and dune ecosystems, are listed in the habitats of European interest in Annex I of the Habitats Directive (Heslenfeld *et al*., 2004). There is an urgent need for the protection of these habitats on the eastern Adriatic coast, and some steps have already been taken in Croatia, where Velika and Mala Saplunara and Blace Bay (island of Mljet) have been classified in the category of a *Protected Landscape Area* since 1965 (Alegro *et al*., 2004). Unfortunately, in some countries *E. peplis* is probably already extinct: in England, it was last recorded in 1976 in Alderney (Stace, 1997), in the Maltese islands, from its last two stands it is probably extinct (Mifsud, 2018), while the last records in Slovenia date back to the end of the 19th century (Frajman & Jogan, 2007). It is surprising that *E. peplis* has not yet been assessed for the IUCN Red List of vascular flora (Nikolić & Topić, 2005; Nikolić, 2024) and is not included in the list of strictly protected taxa of Croatia (Anonymous, 2016).

3. *Euphorbia humifusa* Willd.

(syn.: *Chamaesyce humifusa* (Willd.) Prokh.)

Creeping spurge (*E. humifusa*) is a procumbent annual, native to western and central Asia (Smith & Tutin, 1968), from where it has spread to other parts of Asia and the temperate regions of Africa, as well as to South and Central Europe. By the beginning of the 19th century, it was cultivated in the botanical gardens of Europe, from where it probably escaped and has been spreading in Central and South Europe as a weed and ruderal plant (Paulin, 1917; Hegi & Hegen, 1924; Meusel, 1978). It is assumed that only *E. humifusa* var. *glabra* (Thell.) S.Z. Liou occurred in Europe, whereas *E. humifusa* var. *pilosa* (Thell.) S.Z. Liou dominated in its native area in Asia (Acherson & Graebner, 1917; Zimmerman *et al*., 1965). *Euphorbia humifusa* is a plant of ruderal habitats, gravelly soils, paths, roads, railways and cultivated areas, such as gardens, flower beds and fields (Horvatić, 1963; Frajman & Jogan, 2007).

Literature data and herbarium collections indicate that *E. humifusa* has been present as a casual or naturalized plant in Croatia from the turn of the 19th to the 20th century and continues to persist to this day. The first published record comes from Simonkai (1907: 85), who noted that the plant is very common in the gardens of the city of Rijeka ("*ist in den Gärten von Fiume gemein*"). This observation was later reiterated by Degen (1907: 49) and Hirc (1912), though without specifying new sites in Croatia. In the Herbarium in Graz (GZU) there are two specimens of *E. humifusa,* one from Pula ("*Pola, Wege in St. Polycarpo*"; 10/18/1894 leg. K Untchj), and the other from Opatija ("*Abazzia, ad viam Südl. Strandweg*", 08/24/1900 leg. Evers). The accuracy of the determination of both specimens was confirmed by B. Frajman (Starmühler, 2015: 632). *Euphorbia humifusa* has consistently been listed as an adventitious species in various floras, keys and floristic lists concerning the flora of Croatia (Javorka, 1925; Hayek, 1927; Domac, 1950, 1967, 1972, 1994; Hršak, 1997; Nikolić, 2024), despite the absence of new findings during this time. In recent decades, three new sites have been recorded:

in Voloski in the Kvarner Gulf (Čarni & Jogan, 1998), near Plitvički Ljeskovac in Lika (Šegulja, 2000) and in the northern part of Krka National Park (Hršak *et al*., 2022).

Since the 2000s, during numerous botanical trips to different parts of Croatia (mostly in Dalmatia), the author has regularly collected and determined a large number of specimens of adventive euphorbias (*E. maculata*, *E. prostrata*, *E. nutans*), but has not found a single specimen that would correspond to *E. humifusa*. In Croatia, it is a rare species, known so far from only six localities, which are considerably distant from each other (Fig. 2). Three of them were recorded more than 100 years ago (Rijeka, Pula and Opatija) and have not been confirmed in the meantime (Nikolić, 2024). Although it is very rare, *E. humifosa* is usually considered naturalized in Croatia due to its presence in the area for more than a hundred years.

During the field research conducted in the summer of 2024 in the area of Ogulin and the Lika region, the species was not found.

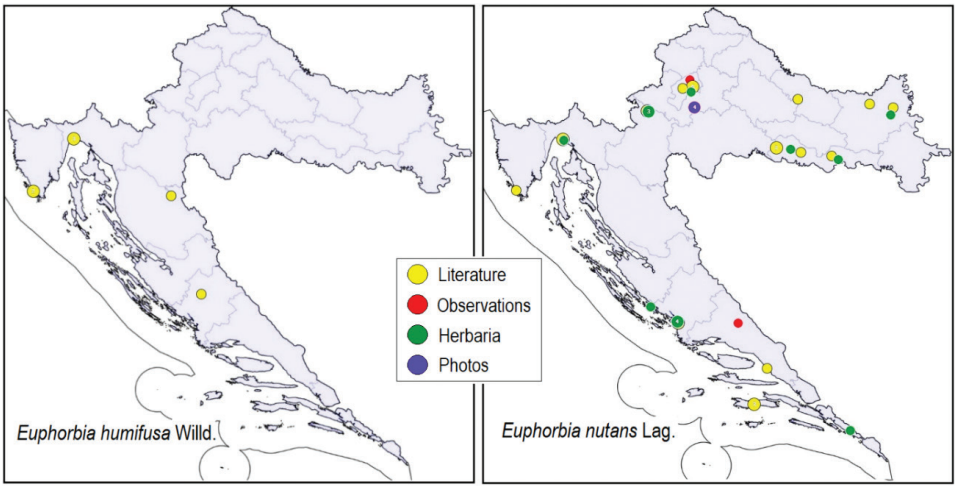


Fig. 2. Distribution of *E. humifusa* and *E. nutans* in Croatia (taken from Nikolić, 2024).

4. *Euphorbia nutans* Lag.

(syn.: *E. preslii* Guss., *Chamaesyce nutans* (Lag.) Small)

Nodding spurge (*E. nutans*) is an annual herb with usually ascending stems reaching up to 60 cm. It is a neophyte native to North and South America, from southeast Canada to Venezuela and Bolivia (Frajman & Jogan, 2007), but naturalized in the Macaronesian, Mediterranean and Iranian-Turanian regions (Benedi & Orel, 1992). It was introduced to Europe (in Italy) probably in the first decades of the 19th century (Mugnai *et al*., 2021). It has been constantly expanding since the beginning of the 20th century along the railway (Degen, 1907; Simonkai, 1907; Thellung, 1907; Paulin, 1917) and it is locally naturalized in South and South-Central Europe, while it occurs as a casual plant elsewhere (Smith & Tutin, 1968; Hüggin, 1999). *Euphorbia nutans* is globally considered a weed of cereals, orchards, plantations, vegetables and pastures. It is also very common along railways and on rocky riverbeds and pond edges (Steinmann *et al*., 2016).

In Croatia, it was first recorded in 1903 at the railway station in Rijeka. *Euphorbia nutans* was probably brought there by train from Trieste, where it had been recorded on the railway tracks much earlier (Simonkai, 1907: 85-86). Several herbarium specimens from that time, recently revised by B. Frajman (Starmühler, 2005), indicate that the species was already widespread in Istria and Rijeka at the beginning of the 20th century: from Rijeka (*"Fiume, Bahnhof"*, October 2, 1903; leg Vončina; GZU), Sušak (*"na grobljah in ob poteh na Sušak" /"at cemeteries and along the paths to Sušak"*; June 6, 1918; leg. R. Justin, LJU 13396) and Pula (July 1905; leg. Stolba; GZU). After that, Keller mentions the plant for the island of Korčula (Keller, 1915: 42, *"Curzola: nahe dem Meeresstrand"*). Later, in the 1950s, Lj. Ilijanić recorded a large number of new finds of *E. nutans* in continental Croatia, mostly along railway lines (Ilijanić, 1957). *Euphorbia nutans* is more common in continental Croatia than in southern Croatia (Dalmatia) (Fig. 2), but it is not found in the areas of Gorski Kotar and Lika (Nikolić, 2024). In continental Croatia, the plant mostly grows along railway lines, but not in Dalmatia (Jasprica *et al*., 2017), where it mostly occurs in ruderal habitats in settlements and as a weed in gardens and flowerbeds. *Euphorbia nutans* is a naturalized species, but it is not on the list of invasive plants in Croatia (Nikolić *et al*., 2014).

During field research conducted in the summer of 2024, the species was not found in the Ogulin area, nor in the Lika region.

5. *Euphorbia maculata* L.

(syn.: *E. supina* Rafin., *Chamaesyce maculata* (L.) Small)

This neophyte is an annual procumbent plant, ramified from the base in several pubescent branches that reach up to 30 cm (Benedi & Orel, 1992). It is native to North America, from northeastern Canada to southern USA (Gleason & Cronquist, 1991), but naturalized in southern and central Europe (Smith & Tutin, 1968; Hügin, 1999) and also found in Central and South America, the Middle East, eastern Asia, New Zealand and Australia (Holm *et al*., 1979; Esler & Astridge, 1987; Benedi & Orel, 1992). Globally, it is considered a weed of cereals, cotton, orchards, plantations, vegetables and pastures, as well as human settlements (Uva *et al*., 1997; Mugnai *et al*., 2021). *Euphorbia maculata* is a common weed of disturbed areas, botanical gardens, sidewalks, cracks, railroads and roadsides (Steinmann *et al*., 2016). This species is found in ruderal communities that colonize intensely trampled soils and sandy and muddy ground, often growing side by side with other species from the sect. *Anysophyllum* (*E. chamaesyce, E. prostrata*). From the phytosociological point of view, it is a characteristic species of the alliance *Euphorbion prostrate* Rivas Martinez 1976 (Benedi & Orel, 1992). It was most likely introduced to Europe in the 17th century. Ascheron & Graebner (1917) mentioned two European botanical gardens where the species was grown, London (before 1660) and Amsterdam (probably in 1689). In the second half of the 18th century, it was recorded in France and Italy (Thellung, 1907), and after that in other regions of Southern and Central Europe, becoming a fully naturalized or invasive species (Smith & Tutin, 1968; Hügin, 1998a, 1999).

It is not correct to consider Visiani's record of *E. maculata* from Šibenik (Visiani, 1826: *"in sterilibus agri Sibenicensis"*) as the first finding of the species in Croatia, as concluded by Ilijanić (1957) and Boršić (2014). Visiani's *E. maculata* is a misapplied name referring

to *E. chamaesyce*, which was later stated by the author himself in his work *Flora Dalmatica* (Visiani 1852: 223; as *E. chamaesyce* L. β *canescens*). That is why the credible first Croatian record of *E. maculata* is from the port of Rijeka, where the plant was found by A. Degen in November 1910. Degen's written communication about that finding ("*im Hafen von Fiume in jüngster Zeit Massenhaft aufgetreten*") was later published by Ascherson & Graebner (2017). Subsequently, the species was recorded for the islands of Cres (Bolzon, 1925: 55; Marchesetti & Béguinot, 1930: 136) and Lošinj (Lusina, 1949) in the Kvarner Bay. In the middle of the 20th century, Ilijanić (1957) confirmed the previous finding for Rijeka and additionally found the species on a large number of new localities: along the railway from Zagreb to Vinkovci, between Spačva and Osijek, as well as in Karlovac and its surroundings. Since then, it has been found in almost all parts of Croatia (Fig. 3), except Gorski Kotar and the Lika region (Nikolić, 2024), becoming not only fully naturalized but also an invasive species (Boršić, 2014). In addition to railway tracks (Ilijanić, 1957; Jasprica *et al.*, 2017) and roadsides, it also occurs in trampled habitats in settlements and as a weed on arable land (Čarni & Jogan, 1998; Nikolić, 2024).

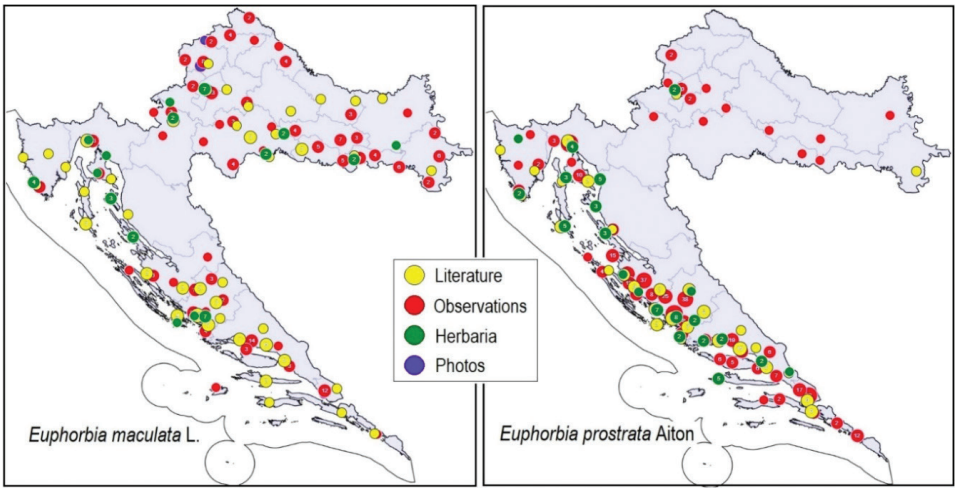


Fig. 3. Distribution of *Euphorbia maculata* and *E. prostrata* in Croatia (taken from Nikolić, 2024).

During the field research conducted in the summer of 2024 in the areas of Ogulin and Lika, the species was found at several new localities:

- Ogulin, railway station (y=5519566, x=5012799; y=5519064, x=5013162), filled and trampled ground near the railway tracks; more than 100 individuals (August 24, 2024)
- Josipdol, railway station (y=5523058, x=5006112), filled and trampled ground near the railway tracks; approximately ten individuals (August 24, 2024)
- Perušić, railway station (y=5531196, x=4944974), filled and trampled ground near the railway tracks; several stunted individuals (August 24, 2024)
- Gračac, in front of the former restaurant "Lički krovovi" (y=5567623, x=4906036), in the cracks of the asphalt; several individuals (August 1, 2024)

- Gračac, railway station (y=5566094, x=4906431), filled and trampled ground near the railway tracks; population of approximately 50 individuals (August 1, 2024)
- railway station Zrmanja (y=5585779, x=4900485), filled gravel along the railway; several individuals (August 24, 2024)

6. *Euphorbia prostrata* Aiton

(syn.: *Chamaesyce prostrata* (Ait.) Small)

It is an annual procumbent plant, ramified from the base into several branches up to 35 cm long (Benedi & Orel, 1992). *Euphorbia prostrata* is characterized by capsules hairy only on the keels and with seeds usually less than 1 mm long, sharply angled, with 5-8 narrow, sharp, slightly irregular transverse ridges (Pahlevani & Akhani, 2011; Pahlevani & Riina, 2011; Steinmann *et al*., 2016). The species is native to North and South America but it is widely distributed as an alien plant in many tropical, subtropical and temperate regions of the world (Randall, 2017; Goaverts *et al*., 2024). The first occurrence of *E. prostrata* in Europe was observed in the early 19th century in France (1806 for Lyon), and later in Italy, Portugal and Spain (Thellung, 1907; Saccardo, 1909; Batori *et al*., 2012). Since then, it has spread throughout Europe and is now considered naturalized in most European countries (Hügin, 1998a; Batori *et al*., 2012; Mugnai *et al*., 2021). *Euphorbia prostrata* is a synanthropic species characteristic of soils subjected to frequent trampling and often grows alongside *E. maculata* and *E. chamaesyce*. In phytosociological terms, it is characteristic of the alliance *Euphorbion prostratae* Rivas-Martinez 1976 (Benedi & Orel, 1992; Čarni, 1997; Čarni & Jogan, 1998).

In Croatia, *E. prostrata* was introduced in the 1980s (Škrljevo and Rijeka), but was correctly identified later in the 2000s (Milović & Randić, 2001). Since then, it has been recorded at numerous localities, mostly along the Adriatic coast, including the islands. *Euphorbia prostrata* occurs much less frequently in the continental parts of Croatia (Fig. 3), and has not been recorded in the areas of Gorski Kotar and Lika (Nikolić, 2024). It occurs in various types of anthropogenic habitats: along the edges of railways, roads and paths, in ruderal trampled habitats in settlements and as a weed on arable land (Čarni & Jogan, 1998; Milović & Randić, 2001; Nikolić, 2024). In Croatia, it is considered a naturalized and invasive species (Boršić, 2014).

During field research conducted in the areas of Ogulin and Lika, the species was found only at the train station in Ogulin (y=5519566, x=5012799). Only three individuals were observed in a trampled habitat near the railway (August 24, 2024).

First reports on *Euphorbia glyptosperma* and *E. serpens* for Croatia and the confirmation of the record of *E. hypericifolia*

Over the past ten years, I have collected extensive plant material of small, often unknown euphorbias from sect. *Anisophyllum*. The subsequent processing of the collected material led to the identification of three alien species new to the flora of Croatia: *Euphorbia glyptosperma*, *E. serpens* and *E. hypericifolia*.

***Euphorbia glyptosperma* Engelm.**

(syn.: *Chamaesyce glyptosperma* (Engelm.) Small)

This plant is native to North America, ranging from Canada and the USA to northeastern Mexico (Goaverts, 2024), where it is one of the most widespread species of *Euphorbia* (Steinmann *et al*., 2016). It occurs along stream and river banks, sand prairies, loess hill prairies, meadows, ballast areas, open disturbed areas, roadsides, etc. (Steinmann *et al*., 2016). As an alien species, it has been recorded in some regions of South America (Peru) and West Asia (Caucasus and Russia), but its main area of introduction is Europe (Goaverts, 2024; Geltman & Medvedeva, 2017). In Europe, it has been known since the beginning of the 20th century. The species was first recorded as a casual alien in Sweden in 1911 (Blom, 1912, 1919) and in the Netherlands in 1916 (Hügin, 1998). Since the 1960s, as a result of fieldworks and revisions of older herbarium specimens, *E. glyptosperma* has been recorded for the first time in several countries in Southern and Central Europe: France (Roux, 1992), Austria (Hügin & Starlinger, 1998), North Macedonia (Hügin & Starlinger, 1998), Italy (Hügin & Hügin, 1999), Hungary (Somlyay, 2009), Romania (Sîrbu & Șușnia, 2018), Belgium (Verloove, 2006), Crimea (Riff & Svirin, 2019), Southeastern European Russia (Geltman & Medvedeva, 2017), and possibly in Switzerland (Hügin & Starlinger, 1998). Its alien status in most European countries remains uncertain, but in neighboring Italy, it is considered a naturalized species (Mugnai *et al*., 2021). So far, *E. glyptosperma* has not been recorded in Croatia (Nikolić, 2024).

Description: It is an annual herbaceous plant with a taproot (Figs. 4 and 5). The plant is ramified with prostrate (somewhat ascending) stems (5 - 40 cm), mat-forming and glabrous. The leaves are opposite, with distinct stipules (0.4 – 2 mm). The stipules are linear to subulate, usually irregularly fimbriate or lobed, and glabrous. The leaf petioles are glabrous and short (0.2-2mm). The leaf blade is narrowly oblong to oblong-obovate (3 – 15 × 2 – 7 mm), with an asymetric base and margins sparsely serrulate, especially near the rounded to obtuse apex. The leaves are glabrous and often slightly curved, palmately veined at the base, but pinnate-veined distally. The abaxial surface of the leaves is usually pale greyish, while the adaxial surface sometimes has a reddish spot. The cyathia are solitary or in small, cymose clusters at the distal nodes of the stem. The involucre is obconic (0.6 – 0.9 × 0.3 – 0.6 mm) and glabrous. The cyathium contains four red or purplish glands, which are narrowly oblong-eliptic (0.1 – 0.2 × 0.1 – 0.5 mm). The appendage of the glands is white to pink, semilunate (0.1 – 0.3 × 0.1 – 0.3 mm) and with a fringing distal margin of the gland. The distal margin of the gland's appendage is crenulate or lobed. The cyathia contain 1 – 5 staminate flowers. The ovary of the pistillate flowers is glabrous, with short styles (0.1 – 0.3 mm) which are split up to 1/2 of their length. The capsules are ovoid (1.3 – 1.9 x 1.6 – 2.0 mm) and glabrous, with a collumella that is 1.3 – 1.5 mm long. The seeds are oblong-ovoid (1.0 – 1.4 × 0.6 – 0.9 mm), with a caducous white coat and a tan-brown testa, sharply angular in the cross-section. The surface of the seeds has 3 – 4(–6) prominent transverse ridges that usually interrupt the abaxial keel (Fig. 5c).



Fig. 4. *Euphorbia glyptosperma*, suberect individual (Šibenik, gas station "Lukoil" in Sv. Petar bay; September 20, 2021).

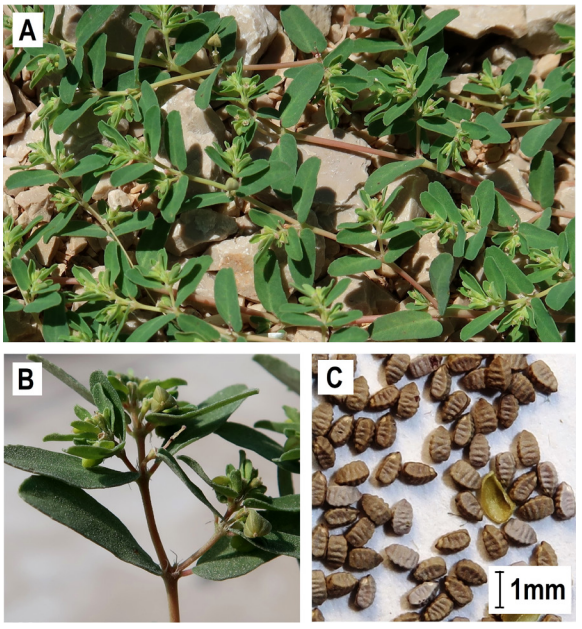


Fig. 5. *Euphorbia glyptosperma*: detail of the stems of a prostrate individual (A); detail of the tips with stipules and capsules (B); seeds (C).

Euphorbia glyptosperma is very similar to *E. humifusa* and to glabrous forms of *E. chamaesyce*, and can often be confused with both species. Among these three species, *E. glyptosperma* can be easily distinguished by its seed ornamentation (Fig. 5c). The surface of the seeds of *E. glyptosperma* has 3 – 4 (–6) prominent transverse furrows and ridges that usually interrupt the abaxial keel, whereas the seeds of *E. humifusa* are smooth with small papillae when ripe (visible only under magnification), and the seeds of *E. chamaesyce* are irregularly tuberculate-rugulose.

During botanical trips to different parts of Dalmatia, I collected specimens of *Chamaesyce* plants that differed from the well-known and common adventive species such as *E. chamaesyce*, *E. maculata* and *E. prostrata*. Only later, I identified the unknown specimens as *E. glyptosperma*. The species was found in several localities: in Šibenik (Crnica and Mandalina), then in the wider surroundings of Šibenik (Zablaće, Miljevci, Oćestovo, Oklaj) and in Trilj (in the hinterland of Split). These localities represent the first finding sites of *E. glyptosperma* in Croatia. Given that it has been constantly present for 5 – 10 years in several localities with stable populations, *E. glyptosperma* can already be considered naturalized, and with the potential for further spread to other areas in Croatia.

Localities of *Euphorbia glyptosperma* in Croatia:

City of Šibenik:

- Crnica district, area of former „The Electrodes and Ferroalloys Factory" - TEF (y=5571531, x=4845210); a mixture of ferro-manganese and silico-manganese slag and garden soil; with *Conyza bonariensis* (L.) Cronquist, *Piptatherum miliaceum* (L.) Coss., *Chondrila juncea* L., *Picris hieracioides* L., *Polygonum arenastrum* Boreau, *Petrorhagia saxifraga* (L.) Link, *Erodium malacoides* (L.) L. Hér., *Plantago lanceolata* L., *Amaranthus retroflexus* L., *Setaria verticillata* (L.) P. Beauv., *Dittrichia viscosa* (L.) Greuter, *E. maculata* L., *Euphorbia prostrata* Aiton (October 18, 2018; last visited on October 23, 2024)
- Crnica district (y=5571531, x= 4845210), ruderal habitat on the building plot; more than 100 individuals (December 26, 2024)
- St. Peter's Bay, „Lukoil" gas station (y=5572128, x=4841927; y=5572144, x=4841918); ruderal habitat along the roadside (September 20, 2021; last visited on September 17, 2024)

Surroundings of the city of Šibenik:

- Zablaće, Velika Solina (y=5571124, x=4841038); embankment along the roadside; more than 20 individuals (November 27, 2020; last visited on September 17, 2024).
- Zablaće, Site (y=5570624, x=4841627), path through the packed ground to the hunting observation post; more than 50 individuals (October 3, 2023; last visited on September 17, 2024).
- Miljevci, Širitovci (y=5585647, x=4859569); gravel piled along the edge of the road; several individuals (August 25, 2020; last visited on October 10, 2023.).

Settlement of Oklaj:

- Oklaj (y=5587290, x=4868502) - trampled ground next to the family house; approximately 20 individuals (October 10, 2024)
- Oklaj (y=5587107, x=4869206) – sidewalk along the road through the settlement; more than 50 individuals (October 13, 2024)

Northern part of the Krka National Park:

- village of Oćestovo, Tanjgina glava (y=5591934, x=4878766); trampled habitat with pioneer ruderal vegetation; several hundred individuals (August 13, 2016), but on the last visit (September 16, 2024), the population had been reduced to approximately 50 individuals due to overgrowth into ruderal grassland.

- village of Matasi (y=5590402, x=4875586); in trampled sites by the side of the road through the village; more than 100 individuals (October 6, 2024).
- village of Zelići (y=5591441, x=4876442); in trampled sites by the side of the road through the village; more than 200 individuals (October 6, 2024).
- village of Marjanovići (y=5592862, x=4877975); in trampled sites by the side of the road through the village; more than 50 individuals (October 6, 2024).
- nearby „The Krka Eco Campus" in Puljane (y=5582864, x=4873667), ruderal site; several individuals (October 10, 2024)
- northwest of Brljane lake (y=5582921, x=4875440), ruderal habitat along the roadside; more than 20 individuals (October 10, 2024)

Settlement of Trilj (hinterland of the city of Split):

- center of the settlement (y=6397873, x=4831109); fissures on the stone pavement along the riverside; several specimens along with *E. prostrata* Aiton, *E. maculata* L., *Poa annua* L., *Petrorhagia saxifraga* (L.) Link, *Chondrila juncea* L. and *Polygonum arenastrum* Boreau (August 9, 2021; last visited on October 10, 2024, but no specimen of the species was found).

Region of Lika:

- south of the village of Otrić (y=5585779, x=4900485), trampled ruderal habitat along the roadside; population of approximately 100 individuals; grows together with *Sedum sexangulare* L., *Lactuca viminea* (L.) J. Presl et C. Presl, *Cynodon dactylon* (L.) Pers., *Sanguisorba minor* Scop., *Cichorium intybus* L., *Daucus carota* L., *Chaenorhinum minus* (L.) Lange ssp. *litorale* (Willd.) Hayek, *Conyza canadensis* (L.) Cronquist, *Polygonum arenastrum* Boreau (August 24, 2024)

Most of the sites are connected to the edges of roads and trampled habitats along recently reconstructed roads, suggesting a possible introduction and spread via trucks that transported material for the road base.

***Euphorbia serpens* Kunth**

(syn.: *Chamaesyce serpens* (Kunth) Small)

The native range of the species extends from southeastern Canada to tropical and subtropical America (Goaverts, 2024). It is one of the most widespread species of the genus *Euphorbia* in the New World (Steinmann *et al*., 2016). The species is weedy and has likely been introduced to many parts of North America, including Canada and the eastern United States. *Euphorbia serpens* was also introduced to temperate, subtropical and tropical regions worldwide: Europe, Africa, Asia and Australia (Steinmann *et al*., 2016; Benedi, 1997). *Euphorbia serpens* is a common weed in ornamental gardens, lawns and roadsides (Pahlevani & Rina, 2011). The species typically occurs in disturbed areas, often in roadside communities subject to trampling, and is commonly found in cohabitation with *E. prostrata* and *E. chamaesyce* (Benedi & Orel, 1997).

In Europe, it was introduced in the 1840s. Tellung (1907) mentions the presence of *E. serpens* (as *Chamaesyce serpens*) in Western Europe from 1842, with data from Montpellier (France). He reports several stations in Germany, the oldest being in 1890, at the Frankfurt Botanical Garden (Thellung, 1907; Hügin, 1998a, 1999). In recent decades, the species has been recorded in most European countries: France (1989), Spain and Portugal (Benedi & Orel, 1992), Belgium (Verloove & Vandenberghe, 1993), Great

Britain (Clement & Foster, 1994), Germany (Hügin & Hugin, 1997), Austria (Diran, 2016; Hügin & Starlinger, 2017), Italy (Hügin, 1998b; Mugnai, 2021), Switzerland (Röthlisberger, 2007), Bulgaria (Hügin, 1999; Petrova, 2018), Greece (Bergmeier, 2007), Hungary (Wolf & Kiraly, 2014), Romania (Sîrbu & Șușnia, 2018), Maltese Islands (Mifsud, 2018) and Cyprus (Frajman, 2011). It has not been recorded in Croatia nor in most neighboring countries (Slovenia, Serbia, Bosnia and Herzegovina and Montenegro).

According to the literature, the long-distance dispersal of *E. serpens* is mainly correlated with human activity related to the trade and transportation of infested crop seeds and/or soils (Hügin, 1999; Wolf & Kiraly, 2014; Petrova, 2018; Sîrbu & Șușnia, 2018). The importation of *E. serpens*, via soil from container plants contaminated with its seeds, from the Mediterranean region to Belgium and Switzerland was reported recently (Hoste *et al*., 2009; Röthlisberger, 2007). *Euphorbia serpens* is a neophyte that seems to be spreading rapidly within Central Europe, though it has certainly been somewhat overlooked or confused with other *Chamaesyce* species in the past. Despite the wide range of its European distribution, *E. serpens* is frequent only in the western Mediterranean, where it is naturalized (Benedi & Orel, 1992) and considered a potential invader (Sanz-Elorza *et al*., 2001). Occurrences in other parts of Europe are mostly isolated, with impermanent populations (Hügin, 1999).



Fig. 6. *Euphorbia serpens* – individual ("Garden Center Dubrava" near Šibenik; August 31, 2023).

Description: The plant is a prostrate, glabrous annual (Figs. 6 and 7). It usually branches from the base and the branches can reach a length of 50 cm. The stem roots at the nodes or has at least primordial root buds (in the absence of suitable soil). The leaves are greyish green without a dark spot (though the entire leaf can later turn purplish), and are shortly petiolate. The leaf blade is orbicular to suborbicular with an entire margin, slightly asymmetrical at the base, rounded or emarginated at the tip, 4 – 7 (10) mm long, with a length/width ratio of 1 – 1.5. The stipules are whitish, connate (deltate), or lacerate to deeply lobed. The cyathia are solitary at the distal nodes of the stem branches. The cyathium glands are oblong, with narrow, white to pinkish appendages, the distal margin of which is entire or crenulate. The capsule is broadly

ovoid or subglobose, glabrous, and 1.5 mm in diameter. The seeds are smooth, greyish-green, somewhat quadriangular, and 0.9 – 1.2 mm long.

Generally, *E. serpens* in habit most closely resembles *E. humifusa*, *E. glyptosperma* and *E. chamaesyce* (glabrous form), and misidentification is common. However, it can be easily identified by its glabrous capsule (the entire plant is glabrous), smooth, unpitted seeds, and rooting at the leaf nodes, especially when in contact with humid soil. Additionally, its gently curved stems, with numerous, opposite and closely packed but evenly spaced leaves (retuse with entire margins), form mats with unique, elegant, symmetrical patterns, by which the trained eye can recognize the species even without examining the finer details of the capsule and seeds (Petrova, 2018; Mifsud, 2018).

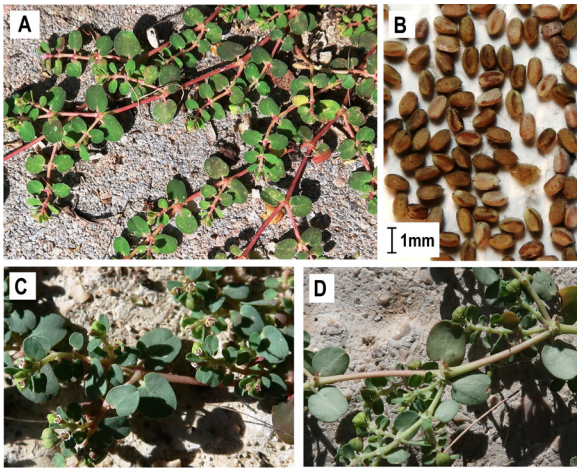


Fig. 7. *Euphorbia serpens*: detail of an individual (A); seeds (B); stem tips in the flower (C), the lower side of the stem with rooting nodes (D).

Among European populations of *E. serpens*, two varietas are recognized: var. *serpens* with entire deltate stipules and var. *fissistipula* Thell. with lacerated or deeply lobed stipules (Thellung, 1907: 755; Hügin, 1998a; Tison & Foucault, 2014). Later, some authors assigned subspecies rank to these varietas: subsp. *serpens* and subsp. *fissistipula* (Thell.) Verloove & Lambinon (Hügin, 1998b; Verloove & Lambinon, 2011; Mugnai *et al.*, 2021; Wolf & Kiraly, 2014; Sirbu & Şuşnia, 2018), though this was not accepted as valid by others (Goaverts, 2024; Pahlevani & Riina, 2011; Steinmann *et al.*, 2016; Mifsud, 2018). Of the two varietas (subspecies) found in Europe, most records refer to var. *serpens* (subsp. *serpens*) (Hügin, 1999; Hoste *et al.*, 2009).

Euphorbia serpens was found for the first time in the garden center of Dubrava (near the town of Šibenik) in July 2022. Three fruiting specimens were found at a trampled site, in the cracks of the concrete base along the edge of one of the paths through the garden center (y=5576615, x=4843952). The plant grew together with *E. maculata*, *E. prostrata* and *Polygonum arenastrum* Boreau. Two additional specimens, approximately 15 meters away from the first location, were found on the trampled, filled ground next to the base of the garden center's outer wall. The same number of

plant specimens was found again in the summers of 2023 and 2024 (last visited in September 2024).

Other localities where I recorded *E. serpens*:

- Murvica, near Zadar, Garden center „Floramye" (y=5525165, x=4888298); gravel path in the open area of the garden center; approximately 60 individuals (September 14, 2024).
- Murvica, near Zadar, Garden center „Geront" (y=5525564, x=4888184), as a weed in pots with woody ornamental plants and in ruderal habitats within the garden center; approximately 50 individuals (September 14, 2024).
- Sveti Filip i Jakov, Garden center „Baković" (y=5533693, x=4869520); as a weed in pots with woody ornamental plants and in ruderal habitats within the garden center; approximately 30 individuals (August 7, 2024).
- Kaštel Štafilić, Garden center „Geront" (y=5606827, x=4823301); as a weed in pots with woody ornamental plants (*Butia*, *Cycas*) and in ruderal habitats within the garden center, both in greenhouses and in the open area of the garden center; approximately 50 individuals (September 7, 2024).
- Split, Garden center „Vaš vrt" (y=5621548, x=4819064); in the open area of the garden center, in the cracks of the concrete base; several specimens (September 7, 2024).

The aforementioned findings of *E. serpens* in several garden centers in the areas of Zadar, Sveti Filip i Jakov, Šibenik and Split suggest that it was introduced along with ornamental plants imported from Italy. There is a high probability that the plant will soon spread from the garden centers to the surrounding settlements. For now, *E. serpens* can be considered a casual neophyte in Croatia.

***Euphorbia hypericifolia* L.**

(syn.: *Chamaesyce hypericifolia* (L.) Millsp.; *E. glomerifera* (Millsp.) L.C. Wheeler; *Ch. glomerifera* Millsp.)

The plant is native to the New World tropics (southernmost parts of the USA, Mexico, the West Indies, Central and South America). It has been introduced to Europe, the Indian subcontinent, China, South Korea, Myanmar, parts of Indonesia, as well as Sub-Saharan Africa (Steinmann *et al.*, 2016; Goaverts, 2024). *Euphorbia hypericifolia* occurs as a weed in open, disturbed areas and nurseries (Steinmann *et al.*, 2016), but also in humus-rich soils, fields, roadsides, scrubs, waste irrigated grounds, and pavements (Pahlevani, 2017).

In the Mediterranean area and Europe, it has been introduced in recent decades. Greuter *et al.* (1986) reported the occurrence of *E. hypericifolia* in Egypt, Israel and Italy. The record for Italy (Lombardy) was erroneous and pertains to *E. nutans* (Banfi & Galasso, 2010). The first findings in Europe are those from Belgium (an exceptional and ephemeral alien) and Spain (with an uncertain degree of naturalization), as reported by Verloove (2002, 2005). In more recent times, it has been found in several other countries: Cyprus (Frajman, 2011), Crete (Gregor & Meierott, 2013), the Canary Islands (Acebes *et al.*, 2009; Santos-Guera *et al.*, 2013), Italy (Banfi & Galuso, 2014, erroneously as *E. hyssopifolia*; Sciandrello *et al.*, 2016), Greece (Sutory & Verloove, 2015), and the Maltese Islands (Mifsud, 2018). The species is treated as an ephem-

erophyte in Europe (Hügin, 1998a), but more recently, it is considered naturalized in some regions: Cyprus, Italy and the Canary Islands (Frajman, 2011; Sciandrello *et al*., 2016; Sutory & Verloove, 2015).

Description: *Euphorbia hypericifolia* is an erect to ascending, upwardly branched, annual plant (Figs. 8 and 9), 15 – 50 cm high. The stems are erect to ascending and glabrous. The leaves are simple, opposite, sometimes purple to reddish, and subsessile, with an oblong to oblong lanceolate blade (10 – 35 × 7 – 15 mm), obliquely truncate at the base, obtuse at the apex, with a slightly toothed margin, especially toward the apex. The stipules are connate, deltate, 1.5 – 2.2 mm long, and sometimes laciniate-fringed at the tip. The cyathia are in dense, axillary and terminal capitate glomerules, with reduced, bract-like leaves subtending the cyathia. The glands are yellow-green to brown, subcircular (0.2 × 0.2 mm); the appendages are white to pink, highly variable in shape, usually round to elliptic (0.3 – 0.4 × 0.5 – 0.7 mm), with an entire margin. The ovary is glabrous, with styles 0.4 mm long and split about 1/2 along their length. The capsules are globoid (1.3 – 1.4 × 1.1 – 1.5 mm), glabrous, with obtuse carinae, and hanging outside the cyathia. The seeds are light brown, with a very thin coat, ovoid-triangular (0.9 – 1.1 × 0.5 mm), slightly 4-angled in cross-section, and with shallow irregular furrows alternating with low, smooth ridges.



Fig. 8. *Euphorbia hypericifolia* as a weed in pots with *Cycas revoluta* Thunb. (Garden center Dubrava near Šibenik; August 31, 2023).

In the past, *E. hypericifolia* was often misidentified as *E. nutans* (Mugnai *et al*., 2021), due to the similarities between the species, particularly in the habit, leaf morphology and the arrangement of the cyathia in dense capitate glomerules. Both species are ascending to erect annuals, up to 60 cm high, with leaves mostly longer than 15 mm, 3 conspicuous veins, a glabrous capsule and seeds irregularly transversely rugulose (Frajman, 2011). However, *E. hypericifolia* differs in having connate, clearly visible, membranaceous stipules, longer than 1 mm and spreading away from the stem (inconspicuous, shorter than 1 mm and erect in *E. nutans*), capsules shorter than 1.4 mm (1.5 – 2 mm long in *E. nutans*), seeds shorter than 1 mm (longer in *E. nutans*), and completely glabrous plants (stems always with some short crinkled hairs in *E. nutans*) (Hügin, 1998a; Pahlevani & Riina, 2011; Frajman, 2011).

Euphorbia hypericifolia is a fairly variable species, and present-day taxonomists mostly tend to accept it in a broad sense (Hügin, 1998a; Steinmann *et al*., 2016; Goaverts, 2024; Mugnai *et al*., 2021). However, if a narrow species concept were to apply, then all plants observed in Europe (with quite glabrous stems and leaves) should be assigned to *E. glomerifera* (Millsp.) L. C. Wheller (Oudejans, 1990; Sutory & Verloove, 2015; Verloove, 2024).

Recently, the first findings of *E. hypericifolia* for Croatia were mentioned by Ćato *et al*. (2023) in the Book of abstracts from the „5th Croatian Symposium on Invasive species" (Zagreb). The authors mentioned three finding sites: the garden center Dubrava near Šibenik (in August 2022), followed by Vodice and Podstrana near Split (in September 2023), but without geocoordinates.

I visited the Dubrava garden center (y=5576615, x=4843952) at the end of June 2023 and confirmed the record of *E. hypericifolia*. On repeated visits from June to October (in 2023 and 2024), a large number of individuals of the species (more than a hundred) were found regularly. The plant grows as a weed in containers with ornamental plants, as well as around them, and also occurs in ruderal habitats along the base of the inner side of the fence wall. For now, the plant grows only inside the garden center and has not been observed in its surroundings. The number of specimens decreased significantly only after the periodic removal of weeds carried out by the garden center staff.

The new localities of *E. hypericifolia* in Croatia are as follows:

- Murvica near Zadar, garden center „Geront" (y=5525517, x=4888131); covered part of the garden center (greenhouse) - weeds in flower pots and the surrounding ruderal habitats; approximately 20 individuals, it can be assumed that the populations are significantly larger, but weeding was carried out a few days before the visit (September 14, 2024).



Fig. 9. *Euphorbia hypericifolia*: habitus (A), cyathia in capitate glomerules (B), stipule (C), seeds (D).

- Sveti Filip i Jakov, garden center „Baković" (y=5533692, x=4869519); as a weed in and around pots with ornamental plants and in ruderal habitats within the garden center; more than 100 individuals (August 7, 2024).
- Bibinje, garden center „Čičvarda Šindija" (y=5523385, x=4881406); in pots with ornamental plants and olive trees; approximately 50 individuals (August 7, 2024).
- Bibinje, parking lot next to the garden center „Čičvarda Šindija" (y=5523374, x=4881415); ruderal habitat along the parking lot's perimeter wall; several individuals grow with plants: *Conyza canadensis* (L.) Cronquist, *C. sumatrensis* (Retz.) E. Walker, *Daucus carota* L., *Picris echioides* L., *Dittrichia viscosa* (L.) Greuter, *Aster squamatus* (Spreng.) Hieron., *Chenopodium strictum* Roth, *Digitaria sanguinalis* (L.) Scop., *L. serriola* L., *L. viminea* (L.) J. Presl et C. Presl, *Lolium rigidum* Gaudin ssp. *rigidum*, *Parietaria judaica* L., *Portulaca oleracea* L., *Plantago major* L. ssp. *intermedia* (Gilib.) Lange and *Setaria verticillata* (L.) P. Beauv. (August 7, 2024).
- Kaštel Štafilić, garden center „Geront" (y=5606811, x=4823366) – in several places in pots with exotic plants and olive trees, as well as in the surrounding ruderal habitats; several hundred individuals (September 7, 2024).

The above records show that *E. hypericifolia*, like *E. serpens*, was introduced to Croatia from Italy through imported plant material. The accidental introduction of *E. hypericifolia* via soil contaminated by seeds in pots with ornamentals has already been reported for several European countries: Bulgaria (Petrova, 2018), Romania (Sirbu & Şuşnia, 2018), the Maltese islands (Mifsud, 2018) and Belgium (Verloove, 2024, as *E. glomerifera* (Millsp.) L.C. Wheeler). For now, *E. hypericifolia* can be considered a casual neophyte in Croatia, but the first findings outside garden centers (Ćato *et al*., 2023) indicate that it will soon become a fully naturalized species.

Updated identification key to *Euphorbia* sect. *Anysophyllum* (Euphorbiaceae) in Croatia

1a. Plant ascending to erect, up to 60 cm high; largest leaves usually longer than 15 mm, with 3 conspicuous palmate veins; capsule glabrous, seeds irregularly transversely rugulose.....**2**

1b. Plant mostly prostrate, rarely ascending; the largest leaves usually up to 12(–15) mm long, with 1 vein, sometimes inconspicuous; capsule glabrous or pubescent; seeds smooth, tuberculate-rugulose or transversely furrowed **3**

2a. Plant glabrous; stipules membranaceous, clearly visible, connate; terminal pseudocorymbiform cymes very dense; capsule up to 1.5 mm long; seeds up to 1.1 mm long, with light brown testa.....***E. hypericifolia* L.**

2b. Plant glabrescent with pubescence limited to the distal stems, at least in the lines on the stem side; stipules inconspicuous, connate or free; terminal pseudocorymbiform cymes lax; capsule 1.5–2.5 mm long; seeds up to 1.3 mm long, with blackish test.....***E. nutans* Lag.**

3a. Mature seeds smooth (fine reticulated or granulated at high magnification!) **4**

3b. Mature seeds tuberculate-rugulose or transversely furrowed **6**

4a. Plant somewhat fleshy; leaves falcate-oblong, conspicuously asymmetrical at the base (half of the limb with a basal auricle); capsule 3–4.5 × 4–5 mm, seeds 2.5–3 mm long, pale grey; plants of sandy coastal areas ..... ***E. peplis* L.**

4b. Plant not fleshy; leaves not conspicuously asymmetrical at the base; capsule 1.2–1.8 mm long and wide; seeds up to 1.3 mm long; weedy and ruderal plants.....**5**

5a. Stems often rooting at nodes (with conspicuous primordia of adventitious roots at nodes); leaves ovate to suborbicular, margin entire, apex retuse to emarginate; stipules united into a triangular, laciniate or fimbriate white scale; seeds tetrahedral, greyish ..... ***E. serpens* Kunth**

5b. Stems never rooting at nodes; leaves oblong to oblanceolate, serrulate at least in the upper part, apex rounded; stipules filiform; seeds ovoid, mottled grey-brown ..... ***E. humifusa* Willd.**

6a. Seeds irregularly tuberculate-rugulose, ± rounded at the base; capsule glabrous to uniform patent pubescens ..... ***E. chamaesyce* L.**

- appendages not more than twice as wide as glands, usually entire ..... ssp. *chamaesyce*
- appendages more than twice as wide as the glands, often 3-lobed ..... ssp. *massiliensis* (DC.) Thell.

6b. Seeds with 3-4 (6) transverse furrows on each face, ± truncated at the base; capsule glabrous or hairy, but never uniform patent pubescent **7**

7a. Capsule crisped villous only along the keels and toward the base (glabrous between the keels); stipules united, triangular-subulate ..... ***E. prostrata* Aiton**

7b. Capsule either entirely glabrous or uniformly apressed hairy; stipules distinct, linear-subulate **8**

8a. Stems and leaves sericeous or villous; capsules uniformly appressed hairy (sericeous); seeds rounded at the apex, with 3-4 shallow, transverse furrows; glands green to yellow-green, turning pink with age, usually ± unequal ..... ***E. maculata* L.**

8b. Stems, leaves and capsules glabrous; seeds apiculate at the apex, with 3-4 (-6) prominent transverse furrows; glands red to purple, usually ± equal..... .....***E. glyptosperma* Engelm.**

CONCLUSION

Although some alien species of Euphorbia sect. *Anisophyllum* has become widespread and abundant in Croatia, it was largely neglected and scarcely collected or studied until the very end of the 20th century (see Nikolić, 2024).

In this work, the first complete survey of the taxa of *Euphorbia* sect. *Anisophyllum* in Croatia is presented. The updated species list contains nine taxa, of which two are native (*E. peplis* and *E. chamaesyce*), while all the other taxa are alien to Croatia. Anthropogenic pressure (tourism, construction, pollution) on coastal habitats with *E. peplis* has increased sharply, so it is necessary to assess the degree of threat to this taxon according to the IUCN criteria. The introduction of alien species of sect. *Anisophyllum* to Croatia began at the turn of the 19th and 20th centuries (*E. humifusa*, *E. nutans* and *E. maculata*), then continued in the 1980s (*E. prostrata*), and the process is still ongoing today. This is evidenced by the most recent findings of *E. glyptosperma* and *E. serpens* (presented in this paper), as well as the findings of *E. hypericifolia* recorded by Ćato *et al.* (2023). The species of *Anisophyllum* that are alien to Croatia are generally strongly associated with anthropized habitats (pavements, parking lots, paths, roadsides, railway lines and stations, cargo ports, cemeteries, garden centres and nurseries, flowerbeds, arable lands, etc.) and human activities (traffic, tourism, transport,

trade, construction, etc.), but have not been observed in natural habitats. Today, four alien species of sect. *Anisophyllum* are considered to be naturalized in Croatia: the most common are *E. prostrata* and *E. maculata*, followed by *E. nutans*, with *E. humifusa* being the rarest. *Euphorbia prostrata* and *E. maculata* are included in the list of invasive species in Croatia (Boršić, 2014). The newly recorded species (*E. glyptosperma*, *E. serpens* and *E. hypericifolia*) are in the initial phase of immigration, so long-term monitoring is necessary to evaluate the success of their naturalization. According to current knowledge, *E. serpens* and *E. hypericifolia* can be characterized as casual taxa, while *E. glyptosperma* is already considered naturalized in Croatia (sensu Pyšek *et al*., 2004).

Numerous studies indicate the important role of garden centers and nurseries as one of the main sources of regional and local spread of alien species (Hügin, 1998; Mifsud, 2018; Petrova, 2018; Sirbu & Şuşnia, 2018; Verloove, 2024). This is further supported by the example of the accidental introduction of *E. serpens* and *E. hypericifolia* into Croatia through seeds mixed with soil in pots with ornamental plants imported from Italy. In the near future, there is a high probability of the accidental introduction of several other species of sect. *Anisophyllum* that have already been recorded in some countries of southern Europe: *E. engelmanii* Boiss., *E. humistrata* Engelm. ex A. Grey, *E. hyssopifolia* L., *E. opthalmica* Pers. and *E. polygonifolia* L. (Smith & Tutin, 1968; Hügin, 1998; Mugnai, 2021).

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