Research Article

Oenothera jamesii (Onagraceae), a neglected alien plant species in Turkey

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Abstract

Oenothera jamesii Torrey & A. Gray (Onagraceae), a native of the southwestern United States and adjacent parts of Mexico, was found along a streamside near Aksu village in Çağlayancerit and along roadsides in Andırın district of Kahramanmaraş Province in the Eastern Mediterranean Region of Turkey. It is the fourth *Oenothera* species noted so far in Turkey. This species is morphologically similar to *Oenothera biennis* Linnaeus and *O. stucchii* Soldano. It is distinguishable from other *Oenothera* species in Turkey by the following combination of characters: stem very long (up to 2 m) and erect, petals yellow and 40–50 mm in length, and very long hypanthia of (6–)8–12(–16) cm in length. A full botanical description, seed surface sculpture in SEM, habitat features, field photographs and a distribution map are provided, as well as an identification key to the genus *Oenothera* in Turkey.

Key words: new occurrence, plant geography, naturalised plant, Western Asia

Introduction

The family Onagraceae comprises approximately 18 genera and 650 species distributed throughout the world, from boreal to tropical regions (Dietrich et al. 1997; Wagner et al. 2007). In the flora of Turkey, the family is represented by a total of 34 taxa belonging to 4 genera (Davis 1965–1985; Davis et al. 1988; Güner et al. 2000, 2012). Several species, especially from genera such as *Epilobium* L., *Ludwigia* L. or *Oenothera* L., are sometimes considered to be noxious invaders (Dietrich et al. 1997).

The genus *Oenothera* is native to Central, North and South America and consists of c. 120–200 species, many of them now naturalized worldwide (Dietrich et al. 1997; Mihulka and Pyšek 2001). The genus is represented by 70 or even up to 120 or more taxa in Eurasia, depending on species delimitation (Rostański 1982; Rostański et al. 2004; Hassler et al. 2020). Eighty *Oenothera* species are naturalized in Europe (Pyšek et al. 2017) and twenty-nine are grown as ornamentals there (Cullen et al. 1997). In the second half of the 20th century, rather numerous new *Oenothera* species were discovered as introduced to Europe from N. America, especially after

World War II. A large number of *Oenothera* taxa were described as new, resulting from crosses between the already present and newly introduced ones (Mihulka et al. 2003; Rostański et al. 2004; Rostański and Latowski 2005; Verloove and Sánchez Gullón 2012; Pliszko and Woźniak-Chodacka 2015; Rostański and Verloove 2015; Woźniak-Chodacka 2015; Pyšek et al. 2017).

Oenothera is exceedingly complex in terms of taxonomy, mostly owing to a peculiar breeding mechanism (permanent translocation heterozygosity). Especially species from subsection *Oenothera* cross freely, producing offspring that differs from either parent and developing populations that consist of many different but in fact continuous genotypes. As such, numerous, closely similar but morphologically well-delimited entities are formed. These are accommodated by some authors (especially those from the so-called "American school") to 13 broadly circumscribed species or recognized by others (the "European school") as independent micro-species (Rostański and Verloove 2015).

Species of this genus mostly survive outside of their natural distribution areas due to their high seed production, high viability of seeds (over 80 years) and easy germination (mostly over 80%) (Chichizola et al. 2019). Therefore, in recent years, many new records were published regarding this genus (Mihulka et al. 2003; Rostański and Latowski 2005; Yüzbaşıoğlu 2014; Pliszko and Woźniak-Chodacka 2015; Alkhesraji et al. 2016). We herewith present a new record of *O. jamesii* in Turkey and compare it with other congeneric species previously recorded from there. Accordingly, our new record brings the species number of the genus *Oenothera* in Turkey, to four.

Materials and methods

During a botanical excursion conducted in Kahramanmaraş Province (Turkey), we encountered an unusual *Oenothera* species with a very long hypanthial tube and large corollas. Using Turkish floras (Davis 1965–1985; Davis et al. 1988; Güner et al. 2000) and floras of neighbouring areas (Townsend and Guest 1966–1985; Rechinger 1965–1977; Post 1883–1896; Komarov 1934–1978) the specimens could not be identified. After closer investigation and using further relevant literature (Torrey and Gray 1838–1843; Tutin et al. 1964–1980, 1993; Dietrich 1977; Raven et al. 1979; Rostański 1982, 1998; Dietrich et al. 1997; Rostański et al. 2004, 2010; Wagner 2005; Wagner et al. 2007; Rostański and Verloove, 2015), we concluded that the plant specimens belong to *Oenothera jamesii* Torrey & A. Gray, a species described from Oklahoma in North America by Torrey and Gray in 1840 (Turland et al. 2018). Our specimens were also compared with many *Oenothera* specimens (cited in the Supplementary material Appendix 1) in LL, TEX, ASU, DUR, P, GRA, PRE, STE, PRE and KASOF (Kahramanmaraş Sütçü İmam University–KSU– Faculty of Forestry) herbaria (Thiers 2021).

Specimens of *Oenothera jamesii* were collected from Çağlayancerit and Andırın districts of Kahramanmaraş province and then pressed and

preserved on herbarium sheets. After identification they were stored in KASOF Herbarium. Plant names used in the text follow The Plant List (2013 onwards). Distributions of the species under consideration was investigated from recent country checklists such as Pyšek et al. (2002, 2012), Protopopova et al. (2006), Sîrbu and Oprea (2011), Medvecká et al. (2012), Petrova et al. (2013), Tokarska-Guzik et al. (2014), Dimopoulos et al. (2016), Galasso et al. (2018), Molnár et al. (2019).

SEM studies: Scanning electron microscopic (SEM) examination was carried out on the outer surfaces of the seeds of *Oenothera jamesii* (Uzun 1945 as in code for KASOF 1316). Seed samples were mounted on metal stubs using double-sided adhesive tape and coated with gold before observation with the EVO LS10 SEM. Scanning of the seeds was performed at different magnifications (100×, 1,000× and 3,000×). Seed surface terminology follows Barthlott (1981), Tobe et al. (1987), Wagner (2005) and Wagner et al. (2007). In addition, the seed dimensions were measured with the photo-stereoscopic microscope with the help of a digital measurement system.

Results

Taxonomic notes

The botanical description below is mainly based on Dietrich et al. (1997) and the field measurements and observations under photo-stereoscopic microscope. The most notable morphological features are in boldface.

***Oenothera jamesii* Torrey & A. Gray (1840: 493) "River Primrose"**

(Figures 1, 2, 3, 4).

Erect biennial rosette herb with a long taproot, stems to 1.8 (–2) m, green with red-flushed branches, secondary branches arising from the middle (or below) of the main stem, densely strigillose or with some additional longer appressed hairs, rarely with a few pustulate hairs. Leaves dull green with paler veins, densely strigillose on both surfaces and along the margins. Rosette leaves 10–30 × 2.5–5 cm, narrowly oblanceolate to oblanceolate, margin bluntly dentate, the teeth widely spaced, apex acute, base gradually narrowed to the petiole. Cauline leaves up to 20 × 5 cm, narrowly lanceolate to lanceolate or narrowly elliptic to elliptic, margin bluntly dentate, apex acute to long-acute, base narrowly cuneate to attenuate, short-petiolate to subsessile. Inflorescence usually unbranched. Bracts 3–10 × 0.9–2.8 cm, narrowly lanceolate, margin bluntly dentate, the teeth widely spaced, apex acute to long-acute, base obtuse to narrowly cuneate, sessile, the apical bracts often recurved. Sepals 3–5.5 cm × 6–10 mm, greenish to yellowish green, pubescence like that of the floral tube; free sepal tips 0.5–3 mm long, straight in bud, strigillose. Petals 4–5 × 4–5.5 cm, yellow, very broadly obovate, retuse. Filaments 2.3–3.0 cm long; anthers 1.2–2.2 cm long; **Hypanthial tube (6–) 8–12 (–16) cm** × 1.8–2.5 mm, yellowish green, densely

Figure 1. Diagnostic features of *Oenothera jamesii* from a naturalized population in Çağlayancerit (Uzun 1945). A: Habit, B: Withered hypanthial tubes, C: Corolla. D: Capsules, E: Calyx, F: Stigma, G: Persistent and withered hypanthial tubes pointing downwards. Photos by Alper Uzun.

or sparsely strigillose, and sparsely to densely glandular-puberulent, **persistent and bent downwards in the withered state on the ovary**. Mature buds 3–5 cm × 7–12 mm, narrowly lanceoloid to lanceoloid, **bluntly quadrangular in cross section**. Ovary 1–1.5 cm × 2.5–3 mm, densely strigillose. Style 9–17(–20) cm long, the exserted part 3–5.2 cm long; **stigma elevated above the anthers at anthesis**, the lobes 5–15 mm long. Capsules 3–5 cm × 6–12 mm at the base, lanceolate, tapering toward the apex, green, the valves with whitish midvein; free tips of the valves conspicuous, 2.5–5 mm long, apex rounded to retuse. Seeds 1–1.2 mm × 0.7–1.3 mm, dark brown to almost black.

Phenology. Flowering principally from August through October.

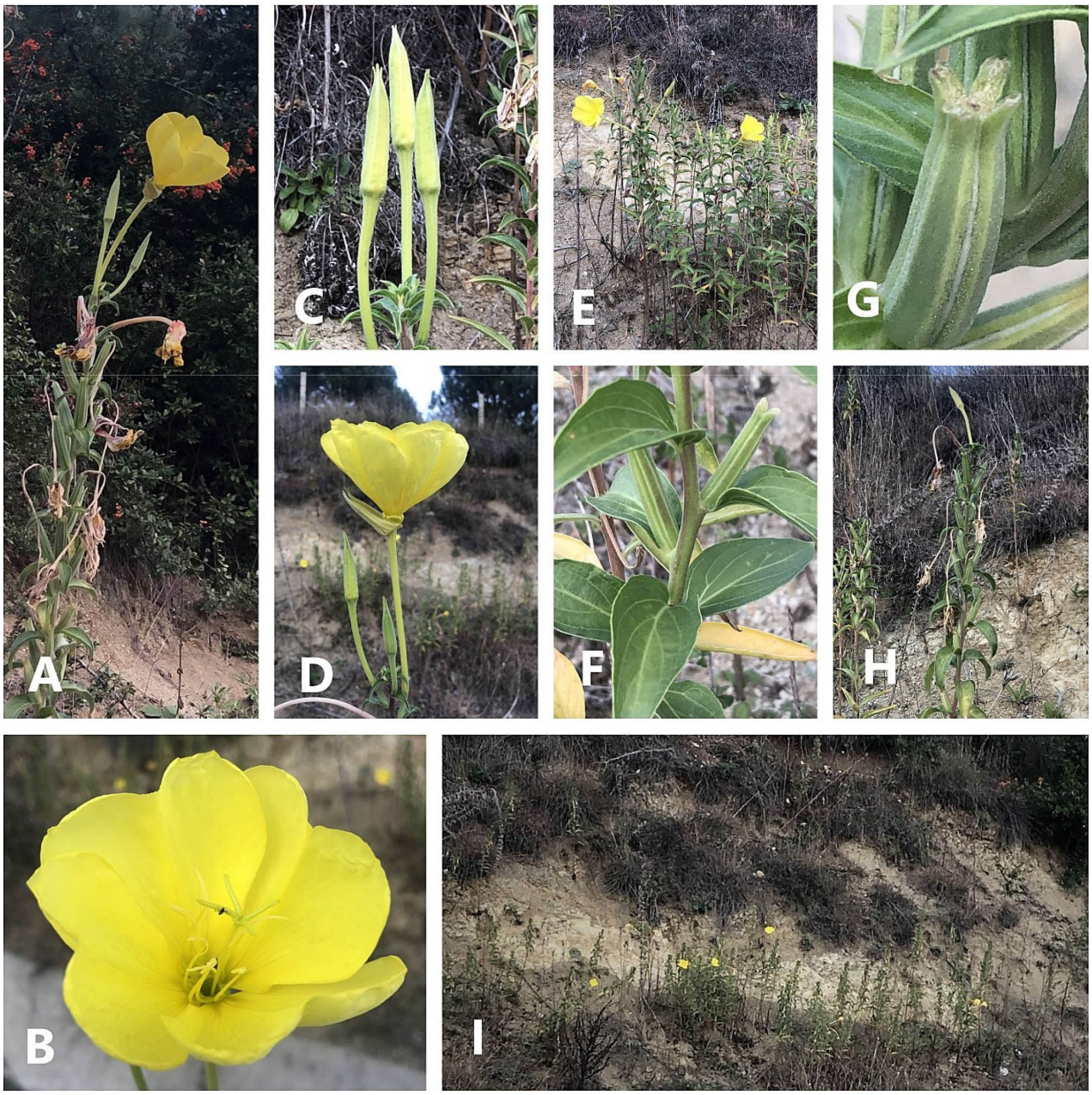

Figure 2. Diagnostic features of *Oenothera jamesii* from a naturalized population in Andırın (Uzun 2061). A: Erect and deflexed hypanthial tubes, B: Corolla with well elevated stigma, C: Buds, D: Flower, E: Habit, F: Stem leaf, G: Capsule, H: Persistent and withered hypanthial tubes pointing downwards, I: Roadside ruderal habitat. Photos by Alper Uzun.

Habitat. In its natural range, it occurs along perennial sandy stream banks and along ditches, and other damp places or occasionally in cultivated areas or disturbed roadsides. It occurs between (30–)300–1750 m elevations.

Oenothera jamesii is a very characteristic species that hardly can be confused with congeneric species. The combination of the long floral tubes (6–)8–12(–16) cm, stigmas well elevated above anthers at anthesis, the absence of red-pustulated hairs on the stems and large petals excludes nearly all other species. Out of the species that were already known from Turkey, two look more or less similar but both have much shorter floral tubes. *O. glazioviana* Micheli shares the stigma position and large petals

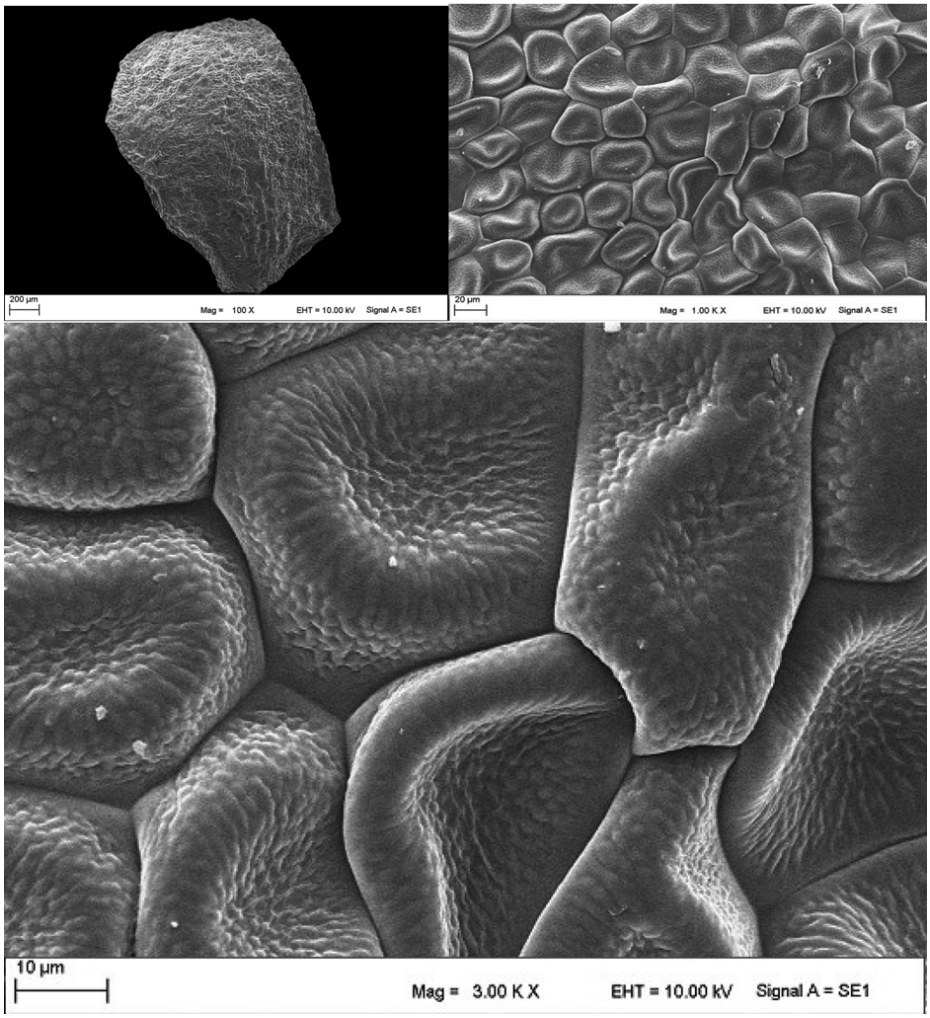

Figure 3. SEM micrographs of *Oenothera jamesii* (Uzun 1945). Panels; lateral view of entire seed (upper left), seed sculptures at magnification 1.00 KX (upper right), seed sculptures at magnification 3.00 KX (below). Photos by Central Laboratory (USKIM).

(4–5 cm in length and width) with *O. jamesii* but it has red-punctate stems. *O. biennis* L. is also somewhat similar, especially in having non-punctate stems, but it has much smaller, medium-sized petals (up to 3 cm) and the stigma is surrounded by the anthers.

Morphologically, probably the closest relative of *O. jamesii* is *O. stucchii* Soldano, a species described from Italy and also known from adjacent parts of southeastern France. It apparently arose in Europe as a spontaneous hybrid of *O. biennis* and *O. jamesii* (Dietrich et al. 1997). Compared with *O. jamesii*, it has a slightly shorter floral tube (up to 7 cm long) and stigmas are surrounded by anthers at anthesis. Most striking, however, is that in *O. jamesii* after anthesis the flowers remain attached to the ovary (Figure 1). It is important to notice that *O. jamesii* (like *O. stucchii*) is considered to be one of the only 13 species that were accepted by Dietrich et al. (1997) as representatives of *Oenothera* subsection *Oenothera*.

Table 1. Seed morphological data of *Oenothera jamesii* (values in mm).

Characters		*O. jamesii*	
Collector ID and Voucher No.		Uzun 1945 (KASOF 1316)	
		Mean ± Std. dev.	min.–max.
Seed Size	Length	1.7 ± 0.2	1.2–2.0
	Width	1.0 ± 0.1	0.8–1.2
Seed	Shape	Prismatic	
Surface ornamentation		Faintly colliculate (covered with small, rounded or hillock-like elevations)	

Revised diagnostic key for Oenothera *in Turkey*

1. Stem, rachis and ovaries with red bulbous-based hairs. Petals 30–50 mm long; cultivated plant sometimes escaping from cultivation ..... ***O. glazioviana***
– Red bulbous-based hairs absent 2
2. Hypanthial tube (60–)80–120(–160) mm long. Stigma elevated above the anthers at anthesis ..... ***O. jamesii***
– Hypanthial tube 11–35 mm long. Stigma surrounded by or below anthers at anthesis 3
3. Petals 20–30 mm long. Hypanthial tube 25–35 mm long. Seeds prismatic (angular) in outline. Stem erect ..... ***O. biennis***
– Petals 6–15 mm long. Hypanthial tube 11–13 mm long. Seeds rotund in outline. Stem often decumbent ..... ***O. parodiana***

Oenothera jamesii *in Turkey and elsewhere in the world*

Tu(A), Asiatic Turkey: Kahramanmaraş province, Çağlayancerit district, scattered on stream banks in wet places along Aksu stream which is a tributary of the Ceyhan River, 37°44′39.07″N; 37°22′27.26″E, 963 m, humid perennial streamside, 2 Oct. 2020, Uzun 1945 (KASOF 1316). Kahramanmaraş province, Andırın district, scattered on roadside, nearby the agricultural field, 37°31′351.028″N; 36°21′243.215″E, 650 m, ruderal sandy soil, 23 Oct. 2021, Uzun 2061 (KASOF 1317) (Figure 4).

While many individuals of this species coexist with *Salix alba* L., *Salix babylonica* L. (cult.), *Mentha longifolia* (L.) L. subsp. *typhoides* (Briq.) Harley, *Trifolium pratense* L. var. *pratense*, *Epilobium hirsutum* L., *Rubus caesius* L., *Solanum nigrum* L. subsp. *nigrum*, *Amaranthus retroflexus* L. and *Polygonum lapathifolium* L. in Çağlayancerit (Figure 1C), they are found together with *Pyracantha coccinea* M. Roem. and some ruderal *Verbascum* and *Echium* species in Andırın (Figure 2I).

Seed properties

In the collected Turkish specimens of *Oenothera jamesii* the seed shape was prismatic and quadrangular in cross-section, dimensions L×W=1.2–2.0 × 0.8–1.2 mm and faintly covered with small, rounded or hillock-like elevations as in Figure 3 and Table 1.

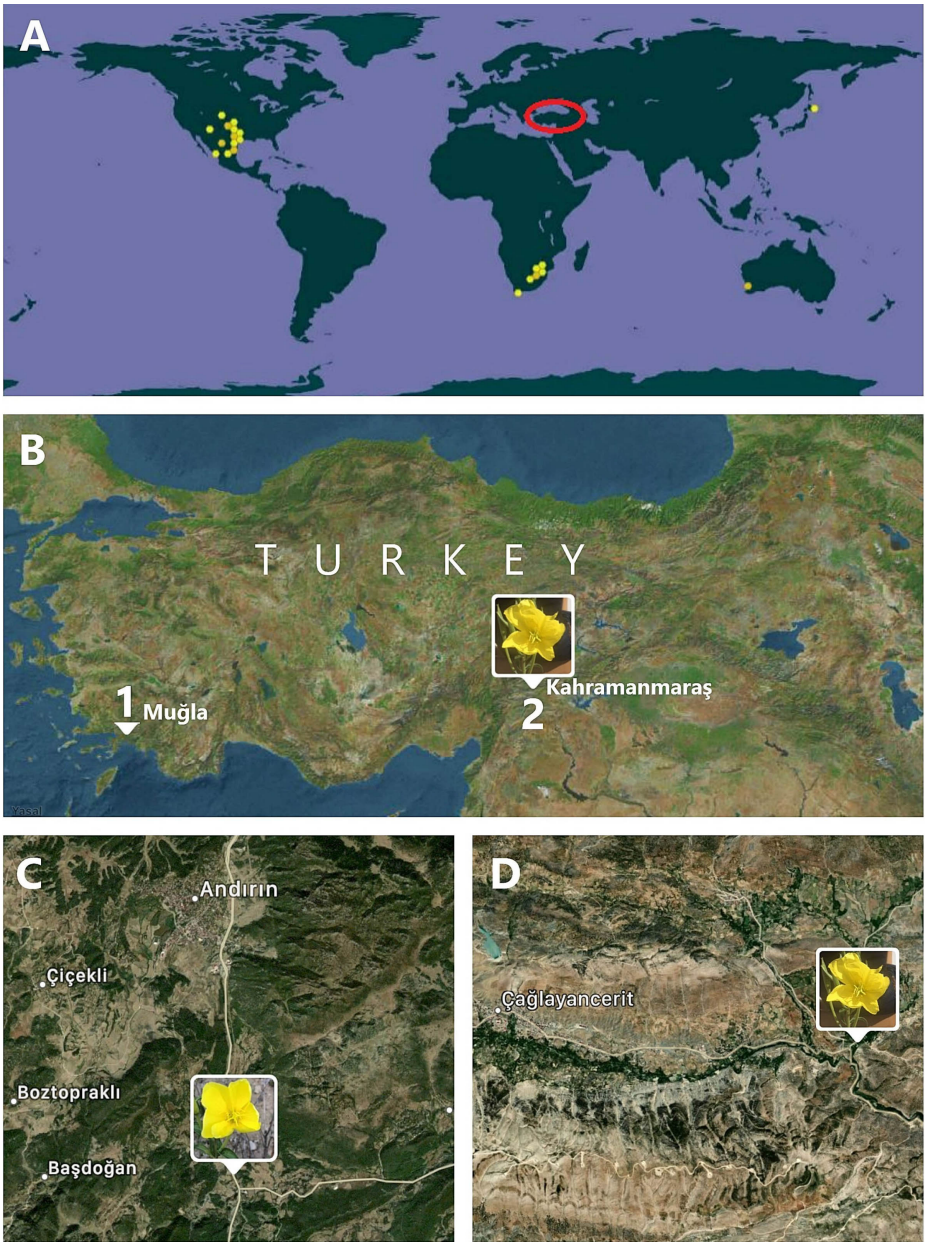

Figure 4. A: World distribution of *Oenothera jamesii*, B: the previous (1) and new establishment sites (2) in Turkey; C and D: new sites in Kahramanmaraş (Andırın district [Uzun 2061] and Çağlayancerit district [Uzun 1945], respectively) (GBIF 2021; Google Earth 2021).

Discussion

Interestingly, *Oenothera jamesii* has been reported before from Turkey (Rostański 1998) but this record, written in Polish in a local botanical journal, apparently completely went unnoticed. Some specimens were observed in 1997 in a roadside in the village of Marmaris, in southwestern Turkey. This previous location reminds that the human factor is at the forefront due to the touristic nature of the region. However, current plant localities in Çağlayancerit and Andırın districts (Kahramanmaraş) are away from intense touristic activities and the former belong to a natural stream ecosystem, while the latter appear in a ruderal place by the roadside.

Oenothera jamesii is a tall biennial herb native to North America (from southern Kansas through central Oklahoma and Texas to Coahuila, west-central Nuevo Leon, and Puebla, Mexico) that is sometimes cultivated and used in landscaping (Dietrich 1999). This species sometimes escapes from gardens by seed dispersal and can compete with hydrophytic shrubs, native herbs on sandy stream banks and ditches, and other moist areas, or can occasionally occur in cultivated areas or along disturbed roadsides (Frean et al. 1997).

The mostly outcrossing bivalent-forming *Oenothera jamesii* is sparingly naturalized in South Africa, the Canary Islands and Japan (Wagner et al. 2007; Acebes Ginovés et al. 2010). In the Euro+Med area, it is only reported from Tenerife in the Canary Islands (Raab-Straube 2018; see also Hansen and Sunding 1993). However, it has most likely disappeared from Tenerife but it was recently discovered in La Palma in scattered localities (Otto and Verloove, 2016). In South Africa, where the species has been known since 1899, it occurs predominantly in the northern provinces extending into the savanna biome. It occurs locally in Lesotho, Free State, KwaZulu-Natal, Eastern Province and Western Province (Frean et al. 1997). There seems to be no recent information on the species' current status in Japan. It is also stated to be alien to Western Australia (Western Australian Herbarium 1998–).

The origin of the Turkish populations has not yet been fully clarified. According to our inquiries in both newly detected sites, it is certain that the species is not recognized by the local people and they have no information about its origin. There is not enough data and information on how this species reached these areas. The species may have been introduced on purpose by humans (e.g. as an ornamental) or inadvertently, for instance as a contaminant in soil. Another hypothesis might be the following: the Kahramanmaraş Province is crossed by two main bird migration routes (one extending from Europe and the other from Russia to North Africa) (Biró et al. 2006), although an introduction by migrating birds appears to be less likely.

In terms of the number of alien plants, Turkey lags far behind in comparison to other regions in the world, especially those with colonial countries (Pyšek et al. 2017). According to the recently published alien plant checklist (Uludağ et al. 2017), Turkey comprises 380 non-native taxa which constitutes 3.4% of the total flora (Güner et al. 2012).

The genus *Oenothera*, which is not native to Turkey, was first represented by only one taxon (*O. biennis*) in the flora of Turkey (Chamberlain 1972). Although *O. biennis* began to naturalize in this country since the beginning of the 18th century (Chamberlain 1972), other new records have continued to be discovered up to date and it is predicted that this process will be prolonged (Yüzbaşıoğlu 2014). This is also because of the very complex taxonomy of the genus, especially with regard to section *Oenothera* subsection *Oenothera*. There are now four representatives of the genus *Oenothera* in the Turkish flora, of which only *O. biennis* is considered

invasive and another three as naturalized (*O. glazioviana*, *O. parodiana* Munz and *O. jamesii*). *Oenothera parodiana* was recorded by Yüzbaşıoğlu (2014) from the Çatalca district of İstanbul Province in European Turkey. The other one is *Oenothera glazioviana*, which was added to the Turkish flora by Güzel (2012) from Erzurum (Eastern Anatolia). In the future, the introduction of additional *Oenothera* species such as *O. speciosa* Nutt., already known from Iraq (Alkhesraji et al. 2016), *O. villosa* Thunb. through Poland (Pliszko and Woźniak-Chodacka 2015), *O. depressa* Greene from Slovakia (Medvecká et al. 2012) or *O. rubricaulis* Klebahn via Ukraine (Protopopova et al. 2006) are very likely. This is because Turkey is a transit crossroad from north to south and from west to east. Actually, 47% of a total of 207 species belonging to the genus *Oenothera* in the world have become naturalized in a region outside their natural ranges, mostly as a result of human-mediated dispersal (Pyšek et al. 2017).

Seeds

The seed shape, colour, size and surface sculpture are taxonomically informative in *Oenothera* and are often of remarkable importance in species delimitation (Tobe et al., 1987). The seeds of species of subsection *Oenothera* are black and the seed coat (testa) is apparent as mostly pentagonal/hexagonal cells which have a sunken surface with minutely pitted sculpture (Dietrich et al. 1997). The seed surface ornamentation of the *Oenothera* taxa actually differs more among subsections as stressed by Wagner (2005).

Oenothera is mostly grown for medicinal purposes because of its seeds containing essential fatty acids (gamma-linoleic acid). Their oilseeds contain many pharmaceutically active secondary metabolites such as Ellagitannins (Greiner and Köhl 2014).

Conclusion

In this study, a new record of *Oenothera jamesii* outside the American, African and Australian continents was presented. New alien species are constantly reported from Turkey due to the increased mobility of alien species and diversified infiltration routes. In particular, distributional patterns and ecological properties of non-native species in Turkey, and their impacts on natural ecosystems, are still imperfectly known and the number of intentional or accidental introductions of new species seems to be still rising. The global climate change will promote a further increase of the number of alien plants in the future.

The results of this study will also provide data for the distribution modelling to be carried out for the genus, and will also enable further studies to find out dispersal strategies of this species in the establishment sites. For this reason, the seed characteristics of this species, which were examined for the first time, were added to the study.

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Authors' contribution

A.U. – Plant and data collection, seed investigation; F.V. – Taxonomical examination; F.V. and A.U. – Research conceptualization, design and draft of manuscript. All authors discussed the results and commented on the manuscript.

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Supplementary material

The following supplementary material is available for this article:

Appendix 1. Representative specimens of *O. jamesii* examined.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2023/Supplements/BIR_2023_Uzun_Verloove_SupplementaryMaterial.pdf