Acta Bot. Croat. 85 (1), 55–59, 2026
DOI 10.37427/botcro-2026-002

Research Article

First records of the invasive weed of Union Concern *Cenchrus setaceus* (Poaceae) in Crete (Greece)

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Abstract – *Cenchrus setaceus* (Forssk.) Morrone has been included in the list of invasive alien species of Union Concern (the EU list) since 2017. This means that the species can no longer be imported, cultivated, transported, commercialized, planted, or intentionally released into the environment in the whole of the European Union. Despite this, the species was recently found in the wild in Crete. The species was observed in 2024 along the route between the cities of Heraklion and Agios Nikolaos, i.e. over a distance of more than 60 kilometers. Research into the presence of the species in Crete revealed that it was also known to occur on the western side of the island (Chania area) from 2020 onwards. Given the relative extent of the species' local distribution area, it appears that the species is either a recent, very rapidly expanding weed, or that it has been overlooked for several years. It is especially alarming that the species is currently still being planted in new green areas, both public and private, and is therefore apparently still available for sale in the local horticultural trade, despite EU regulations. Details of these first records, including a distribution map and new illustrations, are presented.

Keywords: European Union, horticultural trade, new data, *Pennisetum setaceum*, weeds

Introduction

Cenchrus setaceus (Forssk.) Morrone (for a long time called *Pennisetum setaceum* (Forssk.) Chiov. and better known under the latter name) is a grass species with its main natural distribution in North and East Africa, Arabia and West Asia. It grows on dry stony soils and in rock crevices (Phillips 1995). It is cespitose, 40-150 cm tall, with convolute, scabrid, long and narrow leaves (blades are 20-65 cm long and 2-3.5 mm wide). Its inflorescence is a narrow and compact panicle up to 32 cm long, erect or more often arching and pinkish colored (Wipff 2003) (Fig. 1).

The species is a graceful perennial grass that until recently was often used in ornamental horticulture in the warm-temperate regions of the world (usually called "Fountain grass"). The spikelets, which detach very easily at maturity, are covered with numerous hairs and bristles, which promote wind dispersal over long distances. As a result, the species very easily escapes from wherever it is planted, after which it can become established in suitable habitats. In recent decades, the species has succeeded in establishing itself permanently in large parts of North and South America, southern Africa, Australia and southern Europe, to such an extent that it increasingly forms monotypic vegetation, especially in habitats and climates similar to those from which it came (e.g. CABI 2024). It is therefore considered very invasive in most areas in which it has been able to naturalize. This certainly also applies to the European Union, where the species has long been a major problem, especially in the Canary Islands. It is one of the most invasive species there (González-Rodríguez et al. 2010) and its potential area is likely to increase under future climatic scenarios (Da Re et al. 2020) and doubtlessly also under increasing anthropogenic pressure. The species is also known in the EU from Cyprus, France, Italy (incl. Sardinia and Sicily), Malta, Portugal (incl. Madeira; Cabral et al. 2020, Verloove et al. 2024) and Spain, almost without exception as an invasive species (EPPO 2025). Precisely because of its invasive characteristics, the species was included in 2017 in the list of Invasive Alien Species of Union Concern (the Union list). This means that the species must no longer be imported, cultivated, transported, commercialized, planted, or intentionally released into the environment in the whole of the European Union (Regulation 1143/2014 on Invasive Alien Species). In the European Union, Mediterranean coastal areas and islands are of particular concern and need to be prioritized

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Fig. 1. General habit of *Cenchrus setaceus* in Chersonisos, island of Crete, Greece, in May 2024 (A) and detail of inflorescence of *Cenchrus setaceus* in Chersonisos, island of Crete, Greece, in May 2024 (B) (photos: F. Verloove).

for monitoring (Brundu 2017). In Greece, *C. setaceus* was, surprisingly, completely unknown until now, with the exception of a recent find on the island of Milos where the species was considered to be "unlikely to persist outside cultivation" (Biel and Tan 2021). Arianoutsou et al. (2023) mentioned, without further details, that the species was found as a casual escape from cultivation, probably referring to the recent record from Milos.

In that context and with this background, the recent discovery of numerous populations of *C. setaceus* in Crete, whose presence has already been established in a significant area, deserves particular attention. This article lists the locations, including georeferenced coordinates, which will allow local authorities to eradicate the species. A number of other aspects are also discussed, including the future dispersal and establishment opportunities of the species in Crete and the species' local supply routes.

Material and methods

The distribution data presented in this article are the result of fieldwork carried out by the author between 24th May and 7th June 2024. On this occasion, numerous localities were explored in the central northern part of Crete, i.e. in the area between Heraklion and Agios Nikolaos, especially along the coast and in the lowland areas. The main focus was on riparian and anthropogenic, often urban habitats (such as roadsides, parks, etc.), agricultural land, etc.

The species was identified using relevant literature sources, including Clayton and Renvoize (1982), Phillips (1995), Wipff (2003) and Fish et al. (2015).

Voucher specimens were collected in some of the populations and these were deposited in the herbarium of Meise Botanic Garden, Belgium (BR). Specimens deposited in BR will soon be made available online at https://www.botanicalcollections.be/#/en/home. In addition, photos were taken in several of the localities identified. Moreover, all records (including photographs) were registered on the observation.org online platform (https://observation.org/), data which were subsequently also included in GBIF (Global Biodiversity Information Facility; https://www.gbif.org/).

The presence or absence of the species in Crete has been verified in various recent online databases and literature references: Arianoutsou et al. (2010), Dimopoulos et al. (2013, 2016), Arianoutsou et al. (2023), the Flora of Greece Web (2024), and Muer et al. (2024).

The nomenclature in this paper follows Plants of the World Online (POWO 2024).

Results

Below there is a chronological detailed overview of the recently discovered growth sites (see also Fig. 2).

1. Chersonisos, Dimokratias Street (35.3189 N, 25.3891 E), 24th May 2024. A single huge flowering individual at the foot of a fence next to the archaeological site. Herbarium: *F. Verloove* 15043 [BR 0000027060377V];
2. Chersonisos, harbor (35.3226 N, 25.3851 E), 25th May 2024. A single flowering individual in front of the Cine Creta Maris building;
3. Chersonisos, near the entrance of the Convention Center Mikis Theodorakis (35.3231 N, 25.3840 E), 25th May 2024. About ten huge flowering individuals at the foot of a stone wall;
4. Chersonisos, Nikos Kazantzakis Street (35.3192 N, 25.3854 E), 26th May 2024. Two flowering individuals along the road, on the verge of an olive grove;

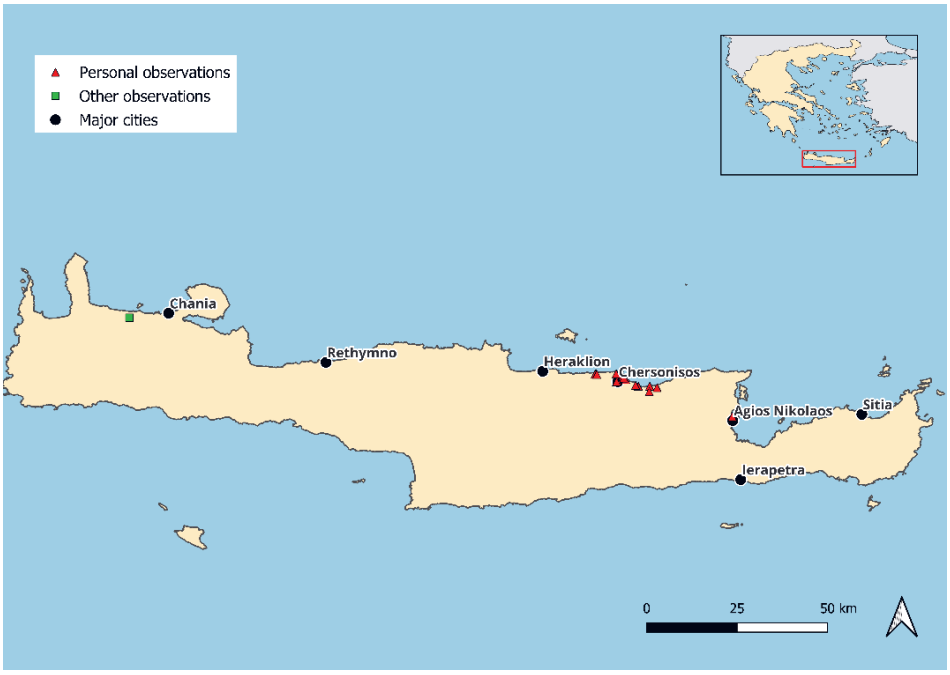

Fig. 2. Distribution of *Cenchrus setaceus* in Crete, Greece: records from 2024 (red triangles) and first record from 2020 (green box).

5. Stalída, Agiou Ioanni Street (35.2961 N, 25.4241 E), 26th May 2024. A flowering individual in a joint of the asphalt, along the sidewalk. The species obviously escaped from a nearby, recent ornamental plantation;
6. Chersonisos, old village, near to the Church of Agios Dimitrios (35.3075 N, 25.3693 E), 26th May 2024. A single flowering individual on the side of the road, under a crash barrier;
7. Stalída, Agiou Ioanni Street near to Resort Beach Hotel (35.2929 N, 25.4323 E), 27th May 2024. A single flowering individual;
8. Agios Nikolaos, Ammoudi, in front of the Lato Hotel (35.2022 N, 25.7150 E), 28th May 2024. A single flowering individual at the foot of a brick wall;
9. Chersonisos, old village, near the entrance of the National Road 90 (35.3066 N, 25.3664 E), 29th May 2024. Several dozen flowering and non-flowering individuals on the side of the road, extending over about a hundred meters;
10. Malia, in front of the Pyrgos Beach Hotel (35.2934 N, 25.4666 E), 29th May 2024. Two flowering individuals on rough ground;
11. Chersonisos, Agkisaras (35.3309 N, 25.3658 E), in front of Caldera Theros Villas, 30th May 2024. Scattered individuals along the road;
12. Malia, National Road 90 (35.2768 N, 25.4652 E), 31st May 2024. About a dozen flowering specimens on the side of the road, under the guardrail;
13. Malia, secondary road near to the National Road 90 (35.2894 N, 25.4887 E), 31st May 2024. Two flowering individuals on the verge of olive groves;
14. Chersonisos, Agia Pelagia, behind Michalis Apartments (35.3136 N, 25.3948 E), 1st June 2024. A single individual on rough land behind the hotel;
15. Chersonisos, near Dimokratias Street (35.3186 N, 25.3888 E), 3rd June 2024. Six flowering individuals;
16. Kato Gouves, Nikos Kazantzakis Street (35.3295 N, 25.3024 E), 4th June 2024. One flowering individual along the side of the road;
17. Kato Gouves, near Villa Maria Apartments (35.3324 N, 25.3046 E), 4th June 2024. One flowering individual along the side of the road, bordering a small stream;
18. Kato Gouves (35.3292 N, 25.3074 E), 6th June 2024. At least a dozen flowering and non-flowering individuals on the side of the road.

In addition to these 18 registered observations, *C. setaceus* was occasionally observed, from a passing car, along the N90 main road between Heraklion and Agios Nikolaos. The species is distributed in small populations along the guardrail between these two cities, which are more than 60 kilometers apart.

While investigating the presence of this species in Crete, it was discovered that *C. setaceus* is also known from the western side of the island (Platanias, Chania, 35°30' N, 23°54' E, comm. Christoforos Chiladakis via Kit Tan). This may be the very first record of the species in Crete.

Discussion

During recent fieldwork, in the spring of 2024, the presence of *C. setaceus* was established for the first time in Crete. As far as is known, the very first find on the island dates from September 2020. There are a number of reasons to believe that the situation is precarious, apart from the fact that

the species has long been known for its highly invasive behavior in the Mediterranean, where islands are particularly vulnerable to species invasion (Brundu 2017).

From the native range (Phillips 1995) it can be deduced that the species naturally occurs in a hot desert climate (Bwh climate type according to the Köppen-Geiger classification; Kottek et al. 2006). Remarkably, *C. setaceus* mainly behaves as an invasive species under a Csa climate type (hot-summer Mediterranean climate), characterized by hot and dry summers and mild winters (Deputy Direction of Nature 2016). This climate type predominates on the largest Mediterranean islands where the species is an increasing problem, for example in Sardinia, Sicily and Malta (Pasta et al. 2010, Mifsud 2022). In the Canary Islands, *C. setaceus* is very invasive in both the Bwh and Csa climate types. With the exception of the higher parts, almost all of Crete falls under a Csa climate type, potentially putting the entire island at risk.

Most of the current populations are relatively isolated and close to the coast (Fig. 2), often close to, and in some cases even directly associated with, human settlements and tourist infrastructure (where the species has clearly escaped from recently developed green areas). However, it is worrying that the species also occurs in several places along or very close to the main road connecting Heraklion with Agios Nikolaos (the National Road 90), an important connecting road with a lot of traffic. The species regularly occurs in small populations over a distance of more than 60 kilometers. Because *C. setaceus* produces large numbers of wind-dispersed seeds, its spread could be rapid, further enhanced by passing cars and trucks. In addition, the NR 90 passes through relatively unspoilt nature, with open rocky habitats, that are very suitable for the species. The almost completed construction of a new motorway connecting the north (exactly near Chersonisos, where the largest concentration of populations are located) and south of the island may soon facilitate the further spread of the species to the south of Crete. It should also be noted that only a relatively limited part of Crete was inventoried in 2024. There is a real (and even high) chance that other, undiscovered, populations occur elsewhere on the island, particularly in the Chania area, from where the species has been known since 2020.

In this context, a possible confusion with *C. orientalis* (Rich.) Morrone, a species native to Greece (floristic regions of Sterea Ellas and Western Aegean Islands, Web 2024), must also be considered. This species is very similar to *C. setaceus* and could be confused with it. Its midculm leaves are much wider and flat (3-11 mm wide *vs* 2-3.5 mm wide and inrolled) and the lower florets of the spikelets are staminate (*vs* usually sterile) (Wipff 2003). Records from Greece of *C. orientalis* may therefore hide observations of *C. setaceus*. It should be noted, however, that the species is apparently poorly documented in Greece, making data difficult to verify. No records of *C. orientalis* from Greece can be found on GBIF (https://www.gbif.org/) or iNaturalist (https://www.inaturalist.org/), and a search of some European herbaria (incl. online herbaria) (e.g. B, BR, G, L, P, WU) yielded no results either.

Finally, it is very disturbing that *C. setaceus* is currently still being planted in public green spaces and private gardens in Crete, despite EU regulations. At several of the above sites, the species had clearly escaped from nearby, recently established plantations (as was the case in Milos, the only other site from which the species is known in Greece; Biel and Tan 2021). This means that *C. setaceus* is still being offered for sale in the local ornamental plant trade and therefore the main source of supply for the species therefore still exists.

Although alarming, the situation may still be manageable: there are already a few dozen growing sites, but these often only contain few plants, which can easily be eradicated. For this purpose, the exact locations of the populations are presented in this paper. More importantly, however, the EU-imposed ban on the sale of the species must be enforced with immediate effect.

Acknowledgements

I thank Christoforos Chiladakis (Heraklion, Crete) and Kit Tan (University of Copenhagen) for providing information on the occurrence of *C. setaceus* in Malia and Chania, Crete. Wesley Tack (Meise Botanic Garden, Belgium) is thanked for preparing the distribution map. Finally, three anonymous reviewers are thanked for their improvements for an earlier version of this paper.

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