

RECONFIRMATION OF RARE PLANTS ON THE NORTHWESTERN BLACK SEA COAST

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Abstract: Rare plant species are particularly vulnerable to anthropogenic influences, which contribute to reducing their populations and restricting their distribution areas. The objective of this study was to reconfirm the information on the distribution of three rare plant species – *Tripidium ravennae*, *Trachomitum venetum*, and *Stachys maritima*, within the Danube Delta Biosphere Reserve, Romania. The research was carried out between 2019 and 2023. The results highlighted that the respective species are rare by showing limited distribution and small populations. Among the main threats to the survival of these species are tourism development, overgrazing, and soil compaction. *Trachomitum venetum* is a rare plant species in specific communities, showcasing its selective habitat preferences. *Tripidium ravennae* is a rare species in specific plant subassociations and plant associations, indicating its limited distribution. *Stachys maritima* is rare within different plant communities, reflecting its adaptability to varied environmental conditions within the Danube Delta Biosphere Reserve.

Keywords: Danube Delta, Romania, *Stachys maritima*, threats, *Trachomitum venetum*, *Tripidium ravennae*.

Introduction

At the global level, biodiversity faces threats [BUTCHART & al. 2010] due to impacts stemming from human activities [REICH & al. 2001; FAGERLI & al. 2011]. Rare species confront an elevated risk of extinction [CHICHORRO & al. 2019]. The reasons behind the persistence of certain plant species as rare, while others thrive abundantly, remain a subject of investigation and debate [TITTENSOR & al. 2010; WAMELINK & al. 2014]. This rarity may result from intrinsic factors, limitations in dispersal capacity, the impact of management practices, or abiotic conditions. Understanding the habitat preferences of rare plants is essential for effective conservation and management strategies. Rare plants often have specific habitat requirements or they are at the limit of their spreading area that can be influenced by factors such as soil pH, moisture levels, light availability, and specific symbiotic relationships. Recognizing these preferences helps identify critical habitats that require protection and can guide restoration efforts in degraded areas [WAMELINK & al. 2014].

The distribution of a species may also be constrained by its dispersal capacity [VERBERK, 2011]. This occurs, for instance, when the conditions of a habitat align with a species' needs, but it fails to reach that suitable habitat due to natural limitations in its spread [NORMAND & al. 2011]. Anthropogenic impact on rare species and their distribution is often

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exacerbated by habitat alterations, such as urbanization, infrastructure development, changes in water management practices, and intensified agriculture [NEWBOLD & al. 2015; CEBALLOS & al. 2017]. These human actions can disrupt ecological balance and drastically limit the natural spaces essential for the survival of rare species.

Understanding threats to rare plant species is important for developing biodiversity conservation and management strategies [McCLINTON & al. 2022]. This understanding relies on three main pillars, namely: 1) individual species assessments [GASTON & FULLER, 2009; IUCN, 2020]; 2) general knowledge about threats [SALA & al. 2000; PIMM & al. 2014], and 3) the role of protected areas [RODRIGUES & al. 2004; FELIX RIBEIRO & al. 2022].

The conservation strategies are essential for addressing these species' specific needs and vulnerabilities. For example, habitat destruction, whether through urbanization or agriculture, removes the unique conditions many rare plants rely on for survival. Similarly, climate change can alter the temperature and precipitation patterns critical to the life cycles of these plants, further endangering their existence [CORLETT, 2016]. Invasive species pose another significant threat: they can outcompete native flora for resources, alter habitat structures, and introduce diseases. The resilience of rare plant species to these threats is often low due to their limited distribution and specialized habitat requirements, making them more susceptible to decline or extinction [EARLY & al. 2016]. Rare plant species often serve as indicators of the overall status of an ecosystem, as they may be susceptible to changes in their environment. Studying these plants can provide valuable insights into the effects of climate change, habitat destruction, and the impact of invasive species. Understanding rare plants' distribution, ecology, and conservation status is essential for effective biodiversity conservation strategies.

The Danube Delta, recognized as a UNESCO World Heritage site, Biosphere Reserve, and Natura 2000 site, stands as proof of the complexity and richness of natural ecosystems, offering a habitat for a myriad of plant species, among which rare and endemic species hold a place of significant interest for conservationists and scientists alike [CLAUDINO-SALES, 2019; IUCN 2017]. The conservation and study of these rare plant species are not merely acts of environmental stewardship but are essential for maintaining the biodiversity and ecological balance that underpin the status and function of the ecosystem.

Material and methods

Fieldwork for this study was conducted in the Danube Delta Biosphere Reserve (Figure 1), spanning from March 2019 to July 2023. Plant species identification followed CIOCĂRLAN (2009), and species nomenclature adhered to the Euro+Med PlantBase standards [EURO+MED, 2024]. COLDEA & al. (2012) guided the categorization of plant communities (as plant associations), and habitat classification was aligned with the EUNIS [CHYTRY & al. 2020]. This research offers an in-depth examination of the species studied, encompassing their distribution, factors affecting their presence, conservation status, and plant communities. Geographic mapping of the findings utilized QGIS software, version 3.28.3 [QGIS Development Team, 2024]. To assess the rarity of species within the plant communities wherein they are situated, we evaluated based on Gaston's measure of rarity method [GASTON, 1994]. Gaston's measure of rarity is a method used to assess the rarity of plant species based on their geographic distribution, habitat specificity, local abundance, and population size and fragmentation as follows: + - very rare or occasional, present but insignificant in coverage; 1 - rare but noticeable, with low density and limited impact on vegetation cover; 2 - more frequent but still sporadic, coverage is less than 25%; 3 - common and widespread, coverage is between

25% and 50%; 4 – dominant, occupying significant space, with coverage between 50% and 75%; 5 – very dominant, overwhelmingly present, with coverage exceeding 75%. This involved recording the aggregate abundance of individual species within one-meter relevés at sites where the respective plant species were identified. Notably, irrespective of a species' high numerical presence within a specific quadrat, it was categorized as rare if its abundance did not demonstrate consistency across multiple relevés within a given area.

Acronymes: DDBR is for Danube Delta Biosphere Reserve; ass. is for plant community/plant association.

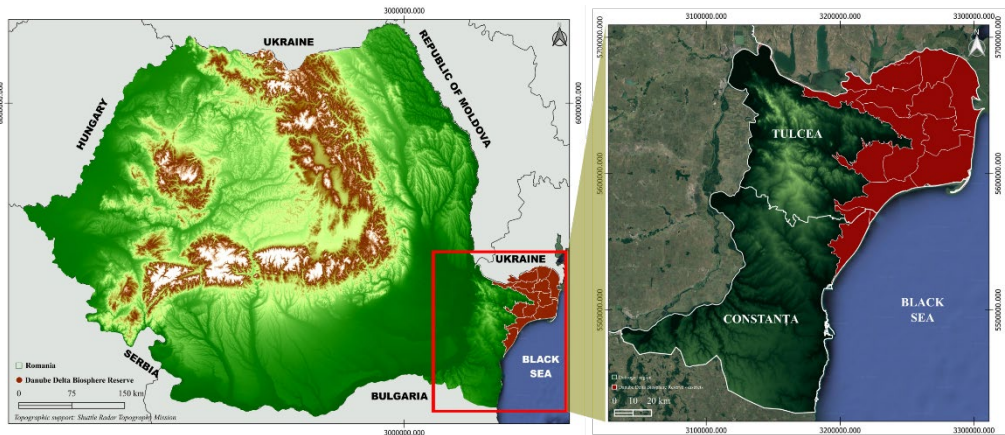


Figure 1. Maps of the study area: a) at the national level; b) at the regional level

Results and discussions

- ***Trachomitum venetum* (L.) Woodson - Fam. Apocynaceae Juss.**

Syn. *Apocynum venetum* L., *Trachomitum venetum* (L.) Woodson subsp. *venetum*

During the study period, the species was identified on the Sand Islet of Perișor (Tulcea County; Figure 2). The species was considered rare in the protected area and was identified in the following plant communities/plant associations: ass. *Artemisio santonici-Juncetum maritimi* Šeljag-Sosonko *et al.* 2000, ass. *Schoeno nigricantis-Plantaginetum maritimae* Horvatić 1934, and ass. *Salsolo ruthenicae-Xanthietum strumarii* Oberd. *et Tx.* 1950. The *Salsolo ruthenicae-Xanthietum strumarii* association has been identified as neighboring *Artemisio santonici-Juncetum maritimi*, with the studied species found in both associations, although evidently more abundant in the latter mentioned association. In the *Salsolo ruthenicae-Xanthietum strumarii* association, the species *Trachomitum venetum* is grazed; the specimens are small, permanently consumed, and exhibit a creeping plant appearance. The main factors limiting the survival of this species include the grazing, as well as the diminution and degradation of natural habitats, such as the dunes area, caused by these activities. Pollution is a significant negative factor as well.

At the site level, *T. venetum* was found in three plant communities, two of them being framed in a single Natura 2000 habitat, as follows: 1410 Mediterranean salt meadows (*Juncetalia maritimi*) within the ass. *Artemisio santonici-Juncetum maritimi* Šeljag-Sosonko *et al.* 2000 - 15 out of 27 relevés (55%), the species is considered frequent and ass. *Schoeno nigricantis-Plantaginetum maritimae* Horvatić 1934 - 5 out of 21 relevés (23%), the species is considered rare. In ass. *Salsolo*

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ruthenicae-Xanthietum strumarii Oberd. et Tx. 1950 the species was found in 4 out of 15 relevés (26%), which is considered rare.

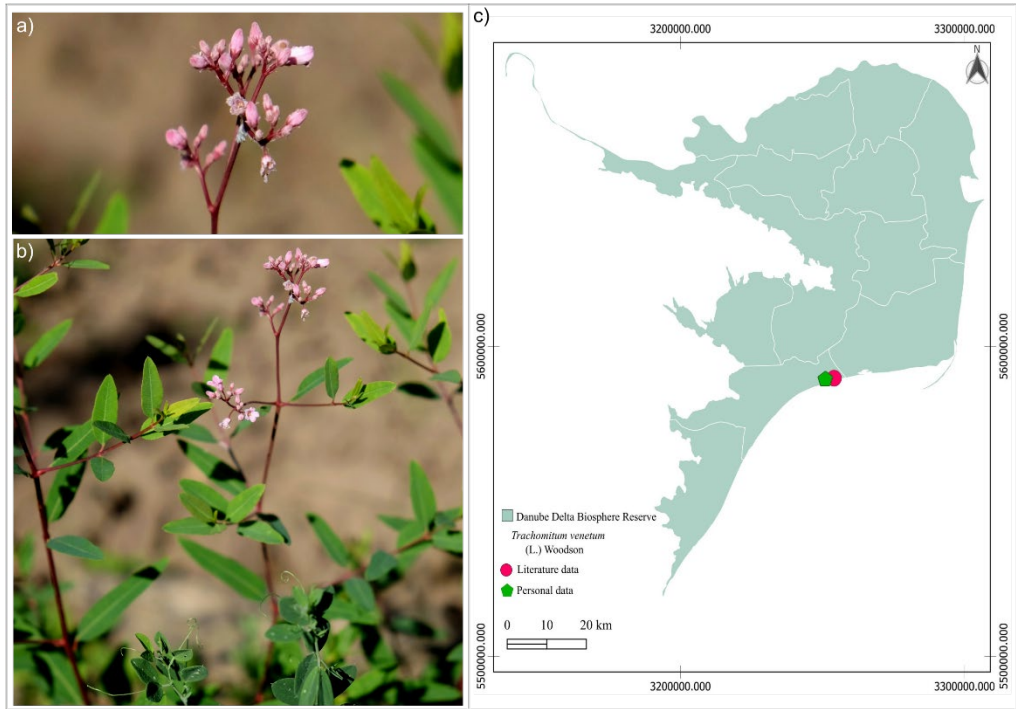


Figure 2. *Trachomitum venetum*: a) stems and leaves, b) habitat, and c) the distribution of the species in DDBR (photos a, b – Adrian Oprea, figure c – Simona Chirilă)

Description. *T. venetum* is a perennial species [NYÁRÁDY, 1961; CIOCÂRLAN, 2009] with a spreading rhizome [NYÁRÁDY, 1961; DIHORU & NEGREAN, 2009]. The stem is erect and richly branched, with a height of 50 (-70) cm [NYÁRÁDY, 1961; FloraVeg, 2024]. The leaves are elongated or elongated-lanceolate, very short petiolate, glabrous, mucronate [NYÁRÁDY, 1961; DIHORU & NEGREAN, 2009], with a length between 20-40 cm and a width between 5-10 cm. The flowers, small in size and with short pedicels, are surrounded by bracts and are pale pink; fruits are pendulous follicles between 5-15 cm long. The plant contains toxic latex [NYÁRÁDY, 1961; DIHORU & NEGREAN, 2009] and reproduces by seeds. Insects carry out pollination (is an entomophilous plant species), and the action of the wind disperses the seeds. The species is considered a relict of Romanian flora [DIHORU & NEGREAN, 2009].

Distribution, conservation status, ecology, and coenology

The species *T. venetum* is widespread in Southern, Eastern, and Central Europe up to Eastern Asia [NYÁRÁDY, 1961; KOZUHAROV & PETROVA, 1982; GBIF, 2024a] (it is cited to grow, also, in China [NYÁRÁDY, 1961], but it is not yet mentioned in Flora of China [FLORA OF CHINA, 2024]). In Romania, the species was reported in Dobrogea, Tulcea County, at grindul Perișor [BRÂNDZĂ, 1898; PRODAN, 1939; CIOCÂRLAN, 1994; SÂRBU & al. 2013]. The species is not evaluated at the Global and European levels [EEA, 2024a]. In

Romania, the species was considered “extinct” [OLTEAN & al. 1994] or “critically endangered” [OPREA, 2005; DIHORU & NEGREAN, 2009]. At the Danube Delta Biosphere Reserve level, the species was considered “endangered” [OȚEL, 2000]. The species *T. venetum* would grow in marshes, sands, sandy places, and on well-drained, moist soil [NYÁRÁDY, 1961; DIHORU & NEGREAN, 2009]. In fact, on Perișor Sand Islet, the only location in Romania, it grows along wet depressions, on salty sands, among the *Juncus maritimus*/*J. littoralis* tufts; marginally, it will be met within *Plantago maritima* and *Salsola kali* subsp. *ruthenica* plant communities.

• ***Tripidium ravennae* (L.) H. Scholz – Fam. Poaceae Barnhart**

Syn. *Andropogon ravennae* L., *Erianthus ravennae* (L.) P. Beauv., *Ripidium ravennae* (L.) Trin., *Saccharum ravennae* (L.) Murray

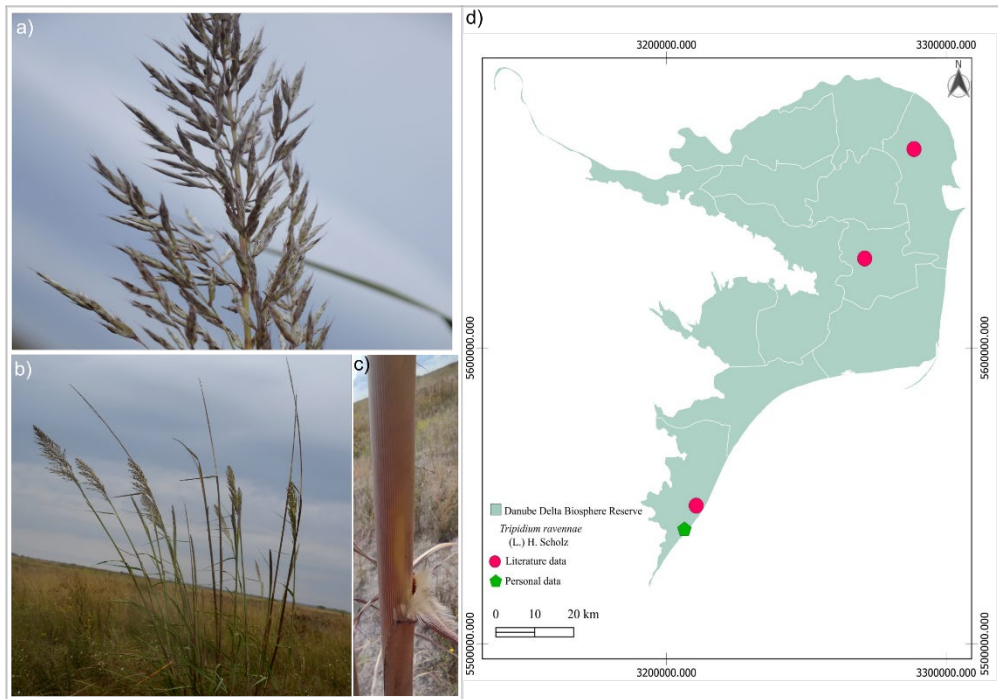


Figure 3. *Tripidium ravennae*: a) inflorescence, b) habitat and plant habitus, c) ligule very short and hairy, and d) the distribution of the species in DDBR (photos a, b and figure d – Simona Chirilă, photo c – Silviu Covaliov)

The species *T. ravennae* was reconfirmed on Chituc Sand Islet (Figure 3) in 2023. During the study period, the species was identified in the following plant communities/plant associations: ass. *Lactuco tataricae-Glaucietum flavae* Dihoru et Negrean 1976 [DIHORU & NEGREAN, 1976; NEGREAN & DIHORU, 1976.], and ass. *Puccinellietum limosae* Magyar ex Soó 1933 subass. *elymetosum elongati* (Șerbănescu 1965) Coldea et al. 2012. Limiting factors include intensive grazing and invasive species such as *Xanthium orientale* subsp. *italicum* (Moretti) Greuter, and dune subsidence. These conditions can lead to the degradation of the species' natural habitat, negatively affecting its survival and dissemination. At the site

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level, *T. ravennae* encountered the above-mentioned two plant communities, each of them being framed in two different Natura 2000 habitat types as follows: a) 1210 Annual vegetation of drift-lines, the ass. *Lactuco tataricae-Glaucietum flavae* Dihoru et Negrean 1976 – 4 out of 11 relevés (36%), the species is considered rare, and b) 1530* Pannonic salt-steppes and salt-marshes, the ass. *Puccinellietum limosae* Magyar ex Soó 1933 subass. *elymetosum elongati* (Șerbănescu 1965) Coldea *et al.* 2012 – 6 out of 17 relevés (35%).

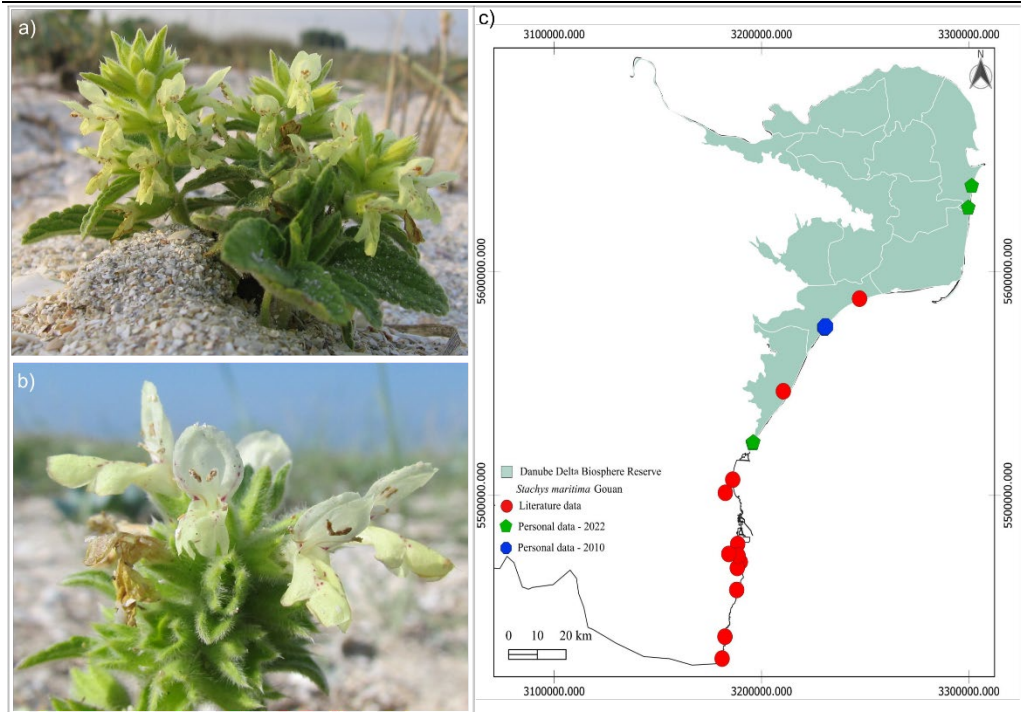
Description. *T. ravennae* (Figure 3) is a perennial plant [GHIȘA, 1972; CIOCĂRLAN, 2009], with a height between 1 and 2 m. The stem is smooth and vigorous. The leaves are linear, with a width between 1 and 1.5 cm. The ligule is short, with long, dense, white hairs. The inflorescence is ovoid, panicle-type, white-hairy, up to 60 cm long. The lower glumes are pale, long, finely pointed, and distinctly 3-nerved. The lema presents an arista two times longer (than the lema) [GHIȘA, 1972].

Distribution, conservation status, ecology, and coenology

The species is distributed across Europe, North America, South America, Asia, and Africa [LANSDOWN, 2013; GBIF, 2024b]. It has been documented in Romania in the Constanța and Tulcea counties [GHIȘA, 1972]. In Dobrogea, the species has been reported in Tulcea County, in Danube Delta [GHIȘA, 1972], on Letea Sand Islet [NEGREAN & DIHORU, 1976], and in Constanța County, on Chituc Sand Islet [CIOCĂRLAN & SÂRBU, 1998; CIOCĂRLAN, 2009; SÂRBU & al. 2013], and between Caraorman (Tulcea County) and Capul Midia (Constanța County) [ZAHARIADI, 1940; GHIȘA, 1972]. At the Global [LANSDOWN, 2013], European [LANSDOWN, 2011], and European Union [EEA, 2024b] levels, the species is considered “Least Concern”. In the DDBR level, the species was included in the “endangered” category. This plant species is in danger of extinction, whose survival is unlikely if the causal factors continue to operate. The number of individuals in the reported populations has been reduced to a critical level [OȚEL, 2000]. The species is usually found in sandy or marshy lands, river banks, and alluvium [GHIȘA, 1972]. The DDBR grows on salty, moist sands, more or less close to the Black Sea beach.

• *Stachys maritima* Gouan – Fam. Lamiaceae Lindl.

In 2010, the species was reconfirmed at Portița (Fig. 4) and was identified in the plant communities/plant associations as ass. *Cakileto euxiniae-Salsoletum ruthenicae* Vicherek 1971 and ass. *Crambetum maritimae* (I. Șerbănescu 1970) Popescu *et al.* 1980 (*Cakiletea maritimae* Tx. et Preising in Tx. ex Br.-Bl. et Tx. 1952). On the total evaluated surface of 200 m², the number of individuals was between 30 and 40; on the total assessed surface of 400 m², the number of individuals was between 10 and 40. The limiting factors identified were marine erosion, grazing, and vehicle traffic. In 2022, the species was identified on Corbu beach sands (Constanța county) and between Sulina and Cășla Vădanei (Tulcea county). At Corbu, the species was identified within the ass. *Artemisietum tschernievianae (arenariae)* Popescu *et* Sanda 1977. On the total evaluated surface of 100 m², the number of individuals is between 10 and 20. The limiting factors identified were uncontrolled tourism that destroyed vegetation and grazing in the beach area. At the beach sector between Sulina and Cășla Vădanei, the species was identified within the ass. *Lactuco tataricae-Glaucietum flavae* Dihoru *et* Negrean 1976, the limiting factors are the accentuated marine erosion. The species is limited in development due



to the reduced specific areas of habitat (coastal region) between the shoreline and marsh vegetation.

At the site level, *S. maritima* was identified within four plant communities, each of them being framed in two different Natura 2000 habitat types as follows: a) 1210 Annual vegetation of drift-lines with ass. *Cakileto euxiniae-Salsoletum ruthenicae* Vicherek 1971 - 8 out of 35 relevés (22%), the species is considered rare and ass. *Lactuco tataricae-Glaucietum flavae* Dihoru et Negrean 1976 - 10 out of 31 relevés (32%), the species is considered rare; b) 2110 Embryonic shifting dunes with *Crambetum maritimae* (I. Șerbănescu 1970) Popescu *et al.* 1980 - 7 out of 11 relevés (63%), the species is considered frequent and ass. *Artemisietum tschernievianae (arenariae)* Popescu *et Sanda* 1977 - 5 out of 36 relevés (14%), the species is considered very rare.

Figure 4. *Stachys maritima*: a) habitat, b) inflorescence, and c) the distribution of the species in DDBR (photos a, b - Mihai Doroftei, figure c - Simona Chirilă)

Description. *S. maritima* is a perennial species [RĂVĂRUȚ, 1961; DIHORU & NEGREAN, 2009], with a height between 15 and 30 cm [RĂVĂRUȚ, 1961]. The rhizome is red, and the leaves are oblong, obtuse, and crenate [RĂVĂRUȚ, 1961; DIHORU & NEGREAN, 2009], with a length between 2 and 3 cm and a width between 7 and 15 mm. The flowers are almost sessile, 4-6 in the whorls, distant in the lower part, and close in the upper part. The calyx is grey-wooly tomentuous, tubular bell-shaped, between 5 and 8 mm long, with ovate-lanceolate and mucronate teeth, and the corolla is yellow, twice as long as the calyx. The stamens are slightly longer than the corolla tube, with hairy filaments in the lower part, and the fruit is a black nut with three edges rounded in the upper part [RĂVĂRUȚ, 1961].

Distribution, conservation status, ecology, and coenology

S. maritima is widespread in Mediterranean Europe and SE Asia Minor [RĂVĂRUȚ, 1961]. In Romania, the species was reported in Constanța County [RĂVĂRUȚ, 1961; DOLTU & al. 1983], in Mamaia [PRODAN, 1939; SÂRBU & al. 2013], Eforie Sud [MORARIU, 1957; NYÁRÁDY, 1959; SÂRBU & al. 2013], Eforie Nord and Eforie Sud [DIHORU & NEGREAN, 2009], Tuzla [PRODAN, 1939; SÂRBU & al. 2013], Palazu Mare and Agigea [SĂLĂGEANU, 1978; SÂRBU & al. 2013], Vama Veche [POP, 1969; SÂRBU & al. 2013], Techirghiol [PRODAN, 1939], Chituc Sand Islet [FĂGĂRAȘ & GOMOIU, 2002; SÂRBU & al. 2013], Costinești and Mangalia [DIHORU & NEGREAN, 2009], and Tulcea county: between Portița and Perișor [DIHORU & NEGREAN, 1976; SÂRBU & al. 2013], Periboina and Periteașca [FĂGĂRAȘ, 2014]. It occurs on littoral sands [RĂVĂRUȚ & al. 1961; DIHORU & NEGREAN, 2009]. In Romania, the species *S. maritima* was considered “critically endangered” [DIHORU & NEGREAN, 2009], “endangered” [OLTEAN & al. 1994; DIHORU & DIHORU, 1994] or rarely [BOȘCAIU & al. 1994]. The species is not evaluated at the Global and European levels [EEA, 2024c]. At the DDBR level, the species was included in the “endangered” category; thus, the species is in danger of extinction, whose survival is unlikely if the causal factors continue operating; the number of individuals in the reported populations has been reduced to a critical level [OȚEL, 2000].

Conclusions

Trachomitum venetum is considered rare in the plant communities *Salsolo ruthenicae-Xanthietum strumarii*, and *Schoeno nigricantis-Plantaginetum maritimae*, and frequent in *Artemisio santonici-Juncetum maritimi*. Regarding the species *Tripidium ravennae*, this is rare in the *Elymetosum elongati* subassociation (*Puccinellietum limosae* association) and the *Lactuco tataricae-Glaucietum flavae* association. In the case of the species *Stachys maritima*, this is considered frequent in the *Crambetum maritimae* association, rare in the *Lactuco tataricae-Glaucietum flavae* association and very rare in the *Artemisietum tschernievianae (arenariae)* association. When a plant’s natural habitat is at risk due to development, climate change, or other anthropogenic pressures, transplanting it to a safer location can help preserve the species. Transplanting species can be one of the measures for rare plant protection, and it is a recognized conservation strategy known as assisted migration or plant translocation. However, it is a complex process that must be approached with careful planning and consideration of ecological, genetic, and practical factors.

Acknowledgments

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