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Ecology and distribution of *Pontechium maculatum* in Romania

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ABSTRACT:
Pontechium maculatum is a western Palearctic forest-steppe element. In this study, the ecological conditions of this species were analysed, along with updating its distribution data in Romania. Distributional data for *P. maculatum* were taken from herbaria, literature records and field surveys. Following the analysis of the species, a map showing its distribution in Romania was provided. In addition, certain considerations regarding the ecology of the species were presented. Our results indicated the presence of 80 populations of *P. maculatum* (38%) out of the 210 previously mentioned in the literature, with some new observations. These populations were distributed in the Banat, Bucovina, Crișana, Dobrogea, Moldova, Muntenia, Oltenia, and Transylvania regions. The highest density was recorded in Transylvania and the lowest in Crișana and Dobrogea. In Romania, the total number of individuals from all the studied sites is approximately 6461. *Pontechium maculatum* was recorded in moderately acidic to weakly alkaline soils, rich in potassium and phosphorus. Precipitation and annual mean temperature in the studied areas are moderate. Comparing these results with data from the literature, we observed a decline in the number of *P. maculatum* populations in Romania. The limiting factors affecting the species include sheep and cattle overgrazing, intensive agricultural practices, fires and the succession of forest vegetation over grasslands caused by the abandonment of traditional silvopastoral systems. The long-term viability of the species can be secured through sustainable management of the grasslands where the species is present, primarily by regulated grazing. The study underlines the urgent need for targeted conservation measures to protect the species.

Keywords: *Pontechium maculatum*, overgrazing, rare species, species distribution maps, meso-xeric grasslands

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INTRODUCTION

Grasslands are one of the most threatened biomes (Scholtz & Twidwell 2022), covering about 40% of the world's surface and 69% of its agricultural land (Wilsey 2018; Bardgett *et al.* 2021). These ecosystems host a high proportion of emblematic and endemic species (Bardgett *et al.* 2021; Scholtz & Twidwell 2022), and fulfil important functions in carbon sequestration and climate change mitigation (Chang *et al.* 2021), food production, water supply and regulation, and pollination (Bardgett *et al.* 2021), among others. In the last decade, grasslands have experienced significant degradation (Zheng *et al.* 2022).

Grassland degradation is a major threat both to humans who depend on these habitats for food (FAO 2006), fuel, fibre and medicinal products (Ceballos *et al.* 2010; Bengtsson *et al.* 2019) and to biodiversity (O 'Mara 2012). The factors driving the degradation of grasslands include anthropogenic

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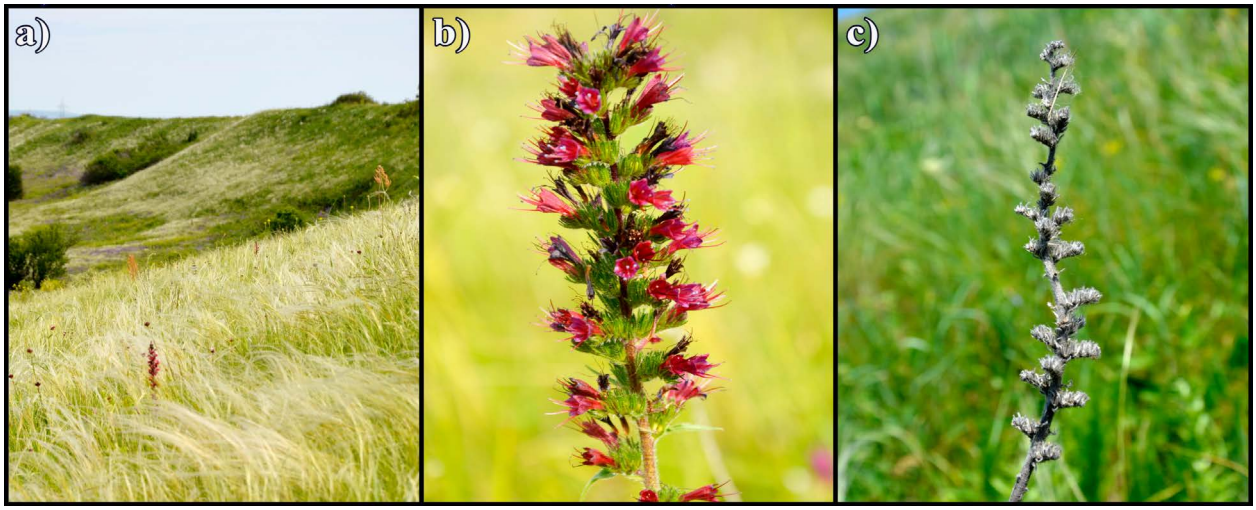

Fig. 1. *Pontechium maculatum* (L.) Böhle & Hilger. a) the habitat of the species, b) the flowering stage, and c) dry plant after the vegetation period (Photographs: Simona Chirilă, a) and b) May 2022, c) August 2023).

factors (overgrazing, eutrophication, land conversion to forestry and crops, land abandonment, and invasive species; Ceballos *et al*. 2010; Gonzalez & Ghermandi 2021), natural factors (climatic variations and modified fire regimes; Wu *et al*. 2021), and socio-economic factors (population expansion, land use economics, changes in land ownership, lack of land use rights, etc.; Bardgett *et al*. 2021). Many species living in these grasslands have suffered a significant reduction in the past decade, with some of them becoming extremely rare or threatened with extinction (Scholtz & Twidwell 2022).

The genus *Pontechium* Böhle & Hilger comprises the species *Pontechium maculatum* (L.) Böhle & Hilger (syn. *Echium russicum* J. F. Gmel.), a plant typical of dry areas. This species is threatened in many Central European countries (Nowak *et al*. 2020) and is mentioned in the national red lists of the Czech Republic, Slovakia and Bulgaria. Thus, the species is critically endangered (CR) in the Czech Republic and Poland, endangered (EN) in Slovakia and vulnerable (VU) in Bulgaria (EEA 2007–2012). The generic name reflects fact that the species is widespread in the forest-steppes north of the Black Sea.

Pontechium maculatum (Fig. 1) is a biennial species, with a height of 20–90(100) cm. It has a pivoting root and the stem is erect. The leaves are linear-lanceolate, acute. The inflorescence consists of an elongated spike with densely arranged red flowers. The fruit is a schizocarp divided into four one-seeded mericarps (Grințescu 1960; Hilger & Böhle 2000; Nowak *et al*. 2020). This species is characteristic of mesoxerophilic grasslands (Chirilă & Vassilev 2024), with a fragmented distribution from Central Europe, Eastern Europe and Southeastern Europe to the North Caucasus and Southwest Asia (Bernhardt *et al*. 2011). In many countries, the species is endangered (Nowak *et al*. 2020). The species is threatened by both natural (climate variations) and anthropogenic factors (overgrazing, afforestation, tourism, etc.). The species is included in revised Annex I to Resolution 6 (1998) of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention 1979), Annexes IIb and IVb of Council Directive 92/43 / CEE (EU Habitats Directive 1992) and is protected by Anonymous (2007). From a biogeographical point of view, the species is considered a western Palearctic forest-steppe element (Meusel *et al*. 1978). In Romania, *P. maculatum* was recorded throughout the country (Oprea 2005). However, the situation has changed drastically since the 21st century, with many of the populations in central and north-eastern Romania disappearing. The highest density of existing populations is reported in the Transylvania region, while the fewest observations

recorded in the Crișana and Dobrogea regions. Field observations suggest this species is more common in dry grasslands – *Festuco-Brometea*, while only a few records from Transylvania and Moldova associated with mesophilic grasslands – *Molinio-Arrhenatheretea* and forest-edge communities – *Trifolio-Geranietea sanguinei* (Chirilă & Vassilev 2024). However, information about the ecology and distribution of this species remains limited. Consequently, we aimed to investigate the ecological conditions and geographical distribution of *P. maculatum* in Romania.

MATERIALS AND METHODS

Study area. The study area comprised 210 locations from the Banat, Bucovina, Crișana, Dobrogea, Moldova, Muntenia, Oltenia, and Transylvania regions. The investigated regions have a temperate continental climate (Velea *et al.* 2023). Among these regions, Transylvania was characterised by the highest annual precipitation (578–731 mm) and elevation (218–725 m a.s.l.) and the lowest temperatures (6.5–10.1°C). In contrast, Dobrogea was characterised by the highest temperatures (from 9.8 to 11.9 °C) and the lowest levels of precipitation (from 395 to 485 mm) and elevation (1–266 m a.s.l.). High elevation values (625–776 m a.s.l.) and annual mean temperature (12°C) were also recorded in Muntenia and Oltenia (Fig. 2; Fick & Hijmans 2017).

The substrate type differs among the investigated historical regions. The Banat, Bucovina, Crișana, Muntenia, Moldova, and Transylvania regions are characterised by sedimentary rocks, such as limestones, marls and sandstones. Transylvania and Oltenia also include crystalline shales. Dobrogea, on the other hand, has a more diverse substrate, which includes both limestone and green shale (Mutihac & Mutihac 2010). The soils are predominantly luvic and haplic chernozems, phaeozems, and occasionally leptosols (Soil Resources of Romania 2017; IUSS Working Group WRB 2022).

Data analysis. To update the data on the distribution of *P. maculatum* in Romania, numerous scientific sources were consulted, including management plans; specialised websites and databases (Vassilev *et al.* 2018 - Romanian Grasslands Database; https://flora.adatbank.ro/); scientific articles; reference

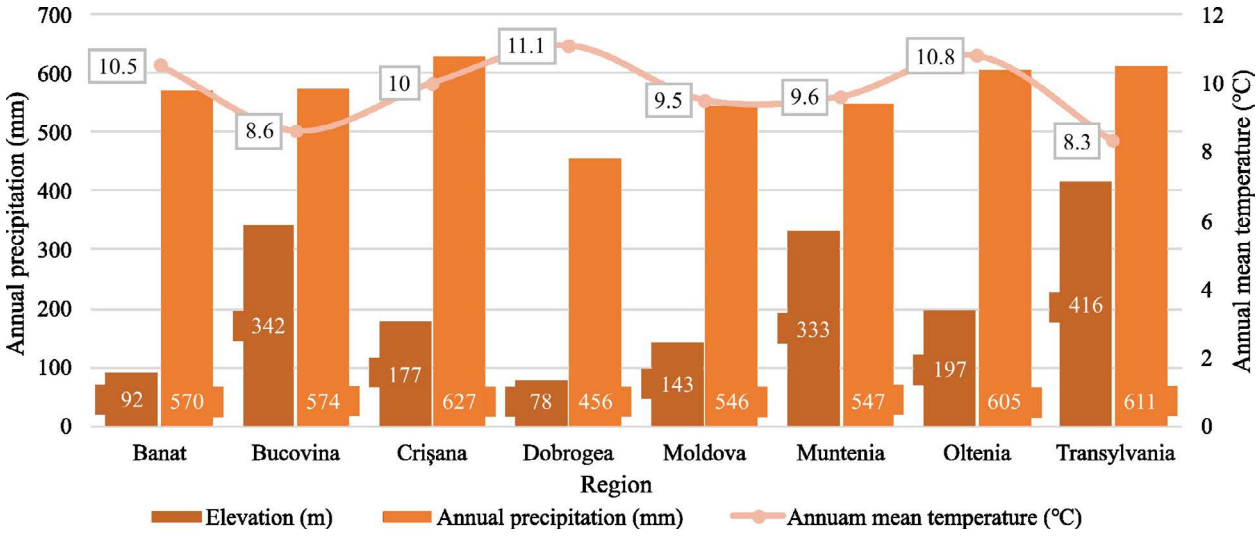

Fig. 2. Topographic and bioclimatic variables for each analysed region

books; herbaria and personal observations. During the period 2017–2024, research was carried out in different locations in Romania to verify the presence of the *P. maculatum* species. The collected data, both from the field and the literature, were presented in the form of a distribution map using QGIS version 3.34.3 (QGIS Development Team 2024) and edited in Inkscape v1.3.2 (https://inkscape.org/). This map shows the populations of *P. maculatum* reported in the literature as well as those verified in the field. The violin plot graphs were generated in Past version 4.03 (Hammer *et al.* 2001), where the middle point represents the median; the thick grey and dark blue bar in the centre represents the interquartile range and the thin grey and blue line represents the overall data distribution.

For each population, the following information was presented: Elevation (m a.s.l.); Annual precipitation – BIO12 (mm), Annual Mean Temperature – BIO1 (°C), Mean temperature – May-August (°C), Mean precipitation – May-August (mm). Soil chemistry variables such as phosphorus – P (mg kg^{-1}), potassium – K (mg kg^{-1}) and soil pH were also presented.

The bioclimatic and topographic variables were extracted from the World–Clim database, at a resolution of 30 arc. sec. (Fick & Hijmans 2017). The nomenclature of the plant associations followed Chifu *et al.* (2014). The Euro+Med (2024) was used for the nomenclature of the plant species.

Phosphorus (P) and potassium (K) concentrations and soil pH (Ballabio *et al.* 2019) were extracted from the European Soil Database & soil properties, at a resolution of 500 m (http://esdac.jrc.ec.europa.eu/).

RESULTS

Distribution of *Pontechium maculatum* in Romania. The analysis of the data from the field regarding the presence of *P. maculatum* in Romania includes 80 populations (Fig. 3). According to the total number of confirmed records in the period 2016–2024, the species was found to be frequent in Transylvania (52 records – 65%), rare in Moldova (14 records – 18%), and very rare in Muntenia (5 records – 6%), Oltenia (2 records – 3%), Bucovina (2 records – 3%), Crișana-Transylvania (2 records – 3%), Dobrogea (2 records – 3%), and Banat (1 record – 1%).

Distribution of the species and analysis of the soil chemistry and climatic data for Banat. In the Banat region (Fig. 4), *P. maculatum* was recorded at a single location (Supplementary Table 1) in Timiș County. The species is found at elevations ranging from 92 to 112 m a.s.l., but the population size is small, with between 10 and 13 individuals / 100 m^2 observed, making the population size approximately 20 individuals. The soils in this area are moderately acidic and rich in potassium and phosphorus. The annual mean precipitation (570 mm) and annual mean temperature (10.5°C) are moderate. The species occurs in the associations *Festucetum rupicolae* Burduja et al. 1956 and *Festucetum valesiacae-rupicolae* Csűrös et Kovács 1962. The main threats are intensive agriculture (transformation of grassland areas into arable land) and overgrazing with sheep and cattle.

Distribution of the species and analysis of the soil chemistry and climatic data for Crișana. In the Crișana region (Fig. 4), the literature records indicate that *P. maculatum* was recorded in three locations, with subsequent studies confirming its presence in two locations (Supplementary Table 1). The species has been found at elevations ranging from 138 to 224 m a.s.l., in weakly acid soils, poor in potassium and phosphorus. The annual mean precipitation (627 mm) and annual mean temperature (9.9°C) in this area are moderate. *Pontechium maculatum* occurs in the associations *Thymo pannonici-Chrysopogon-*

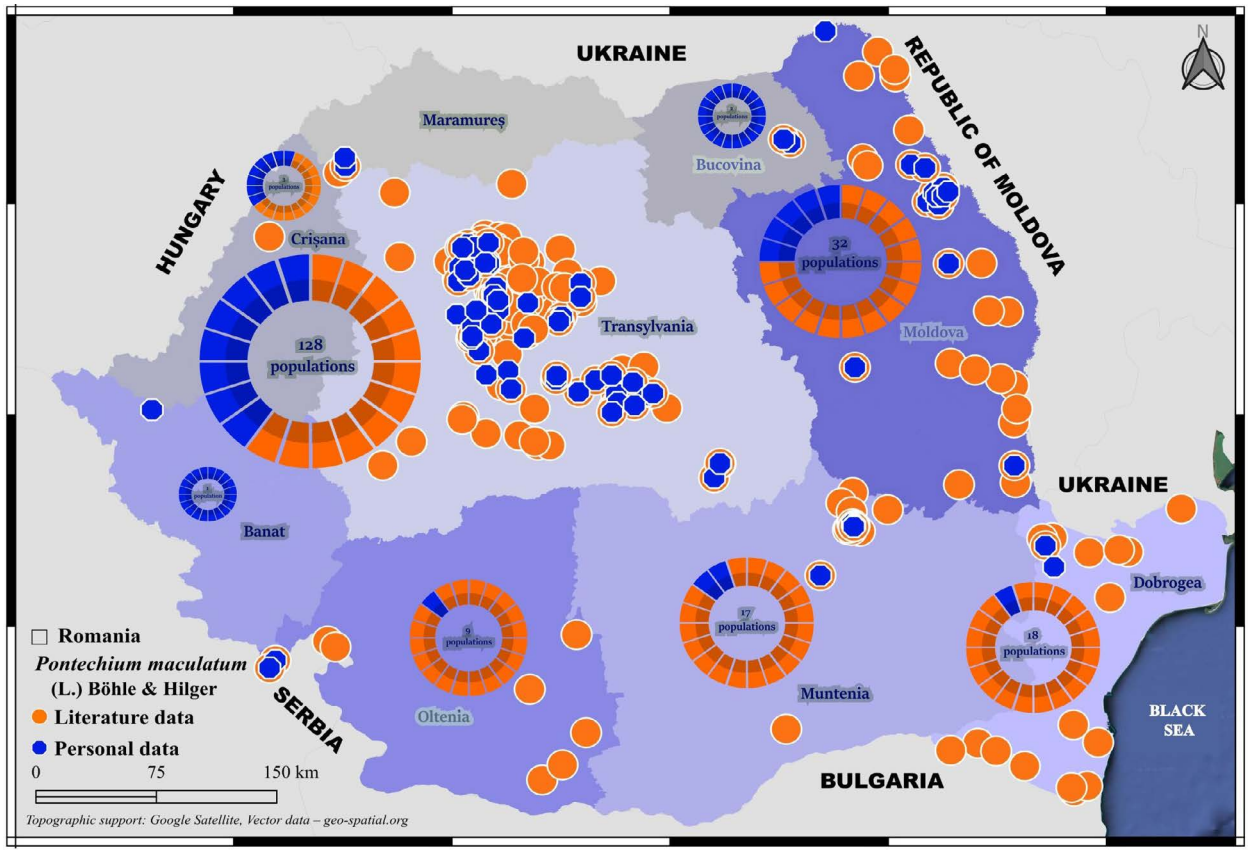

Fig. 3. Distribution of the species *P. maculatum* in Romania (Map: Simona Chirilă)

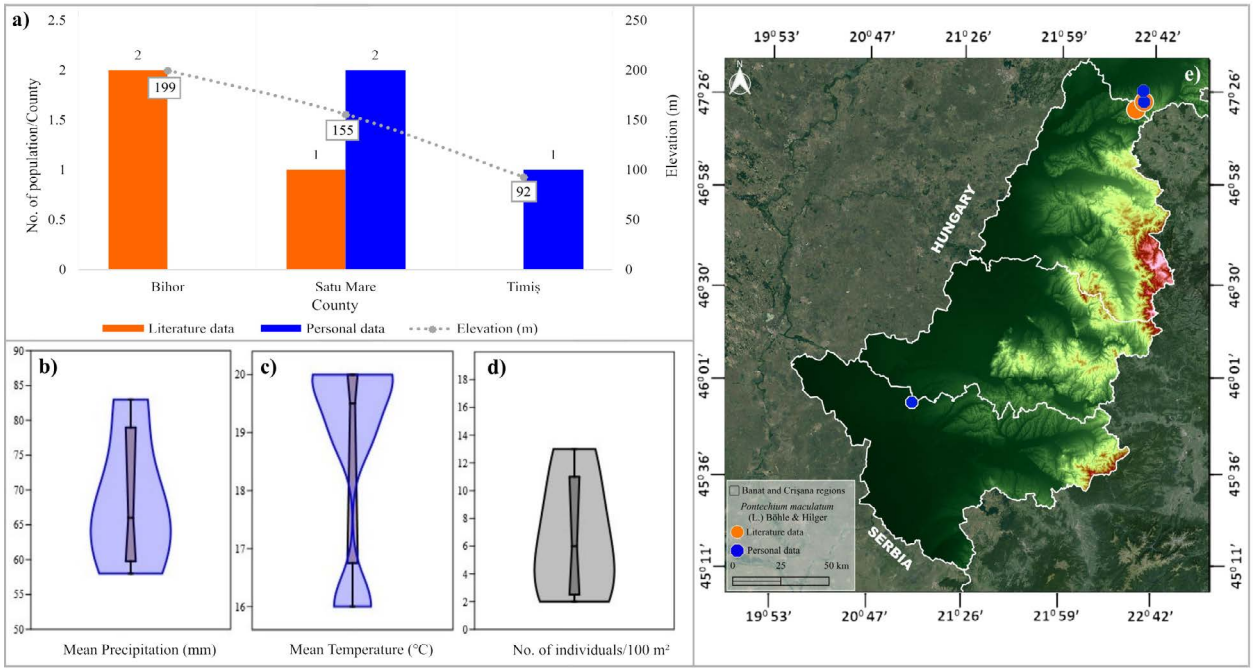

Fig. 4. Ecological profile of *Pontechium maculatum* in Banat and Crișana: number of populations from the literature and confirmed (a), the density of Mean Precipitation values (b), Mean Temperature (c), no. of individuals (d), and distribution analysis (e).

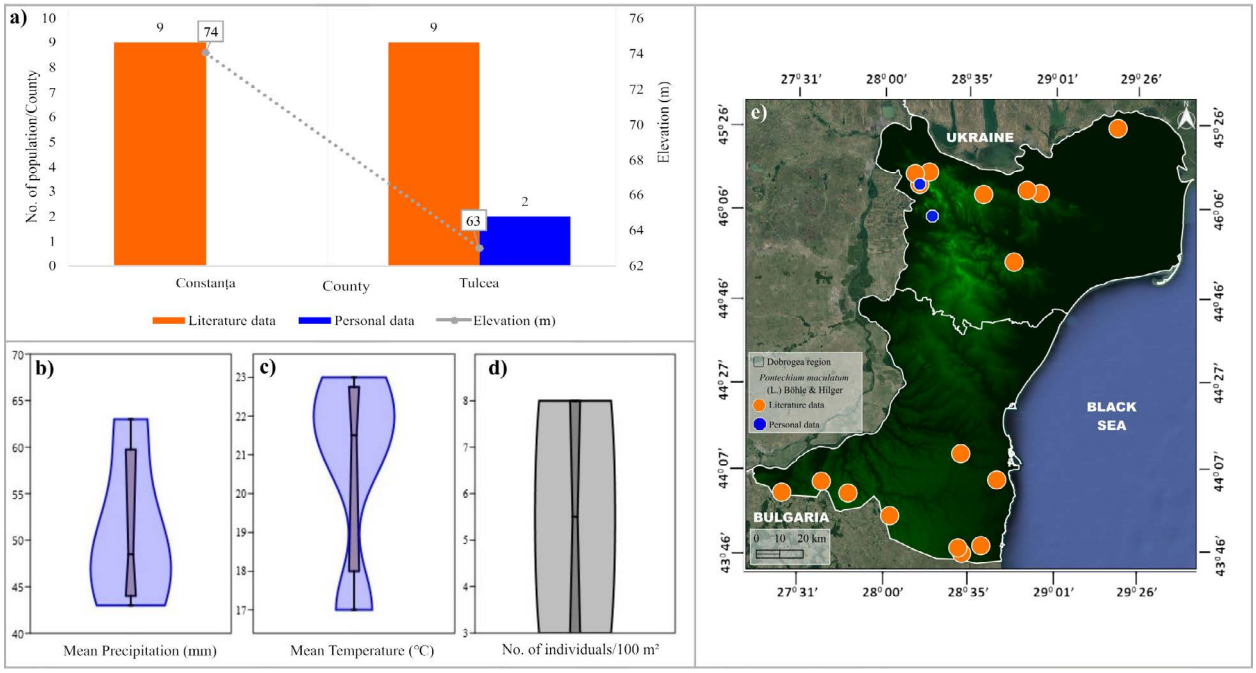

Fig. 5. Ecological profile of *Pontechium maculatum* in Dobrogea: number of populations from the literature and confirmed (a), the density of Mean Precipitation values (b), Mean Temperature (c), no. of individuals (d), and distribution analysis (e).

etum grylli Doniță et al. 1992 and *Danthonio alpinae-Stipetum stenophyllae* Ghișa 1941. As in other regions, *P. maculatum* is very rarely found in Crișana. The lowest density of *P. maculatum* populations was recorded (1–5 individuals / 100 m²) in this region, with the population size being approximately 11 individuals. The species was also recorded, in the rosette stage, in Sânmartin (Bihor County) by Dărăban (2013), but the author is likely to have confused *P. maculatum* with *Echium vulgare*.

Distribution of the species and analysis of the soil chemistry and climatic data for Dobrogea. In the Dobrogea region (Fig. 5), the literature records indicate that *P. maculatum* was recorded in 18 locations from the Tulcea and Constanța counties (Anonymous 2023), but recent surveys confirmed its presence only in two localities (Supplementary Table 1). The species was found at elevations ranging from 57 to 69 m a.s.l., in weakly alkaline soils, with moderate potassium and phosphorus concentrations. The annual mean precipitation (467 mm) is the lowest among the regions, while the annual mean temperature is higher at 10.8°C (Supplementary Table 1). Within an area of 100 m², from 1–5 to 5–10 individuals were recorded, making the total number of individuals from all the studied sites approximately 15. The species occurs in the following associations: *Agropyro pectinati-Kochietum prostratae* Zólyomi 1958 Chifu et al. 2014, *Cynodonto-Poetum angustifoliae* (Rapaics 1957) Soó 1957, and *Stipo ucrainicae-Festucetum valesiacae* Dihoru (1969) Dihoru et Doniță 1970. In Dobrogea, the species is very rare due to overgrazing.

Distribution of the species and analysis of the soil chemistry and climatic data for Bucovina and Moldova. In the Bucovina and Moldova regions (Fig. 6), the literature records indicate that *P. maculatum* has been recorded in 34 locations from the Bacău, Botoșani, Galați, Iași, Suceava and Vaslui counties (Chifu *et al.* 2000; Mânzu *et al.* 2020), while recent surveys confirmed its presence in only 16 of these locations (Supplementary Table 1).

In this region, the species grows at elevations ranging from 78 to 360 m a.s.l., in moderately acidic and weakly alkaline soils, poor in phosphorus and

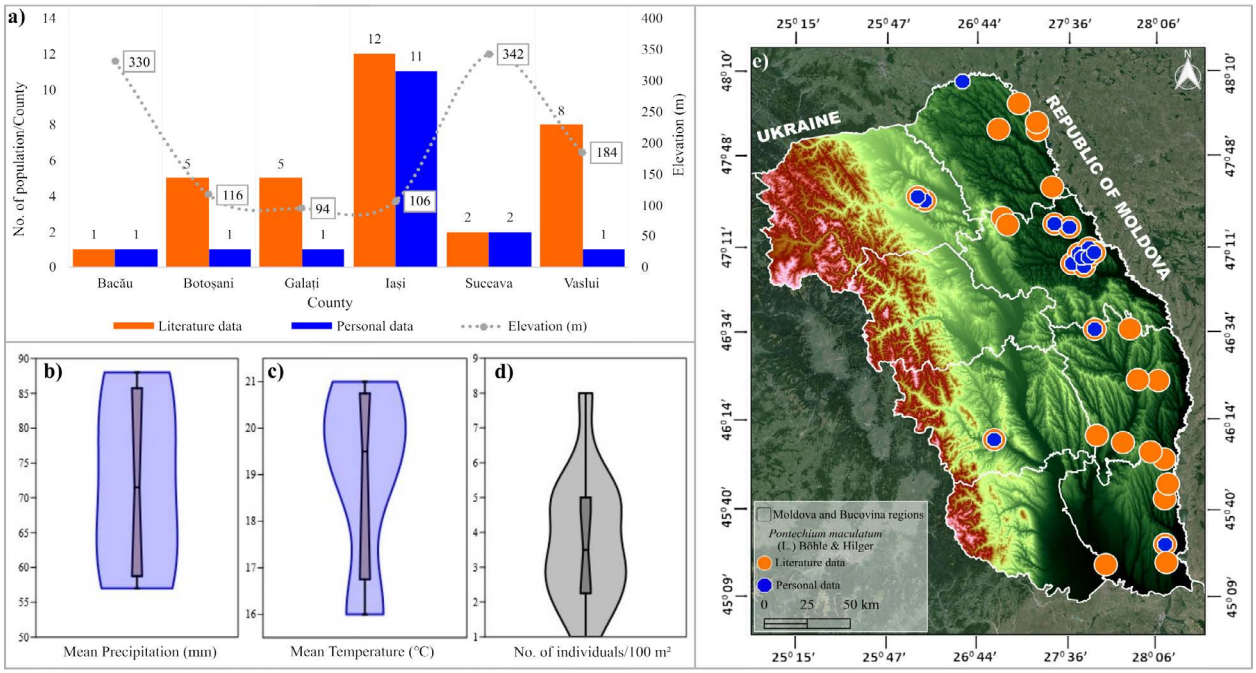

Fig. 6. Ecological profile of *Pontechium maculatum* in Bucovina and Moldova: number of populations from the literature and confirmed (a), the density of Mean Precipitation values (b), Mean Temperature (c), no. of individuals (d), and distribution analysis (e).

rich in potassium. The population size varies from small groups of only two individuals to larger groups of up to 80. The total number of individuals from all the studied sites is about 533, and the number of individuals / 100 m² varies from 1–5 to 10–15. The annual mean precipitation (557 mm) and annual mean temperature (9.4°C) are moderate (Supplementary Table 1). *Pontechium maculatum* occurs in the following associations: *Carici humilis-Stipetum joannis* Pop et Hodișan 1985, *Galio octonarii-Stipetum tirsae* (Ciocârlan 1969) Popescu et Sanda 1992, *Jurineo arachnoidea-Stipetum lessingianae* (Dobrescu 1974) Chifu, Manzu et Zamfirescu 2006, *Medicagini minimae-Festucetum valesiacae* Wagner 1941, and *Taraxaco serotinae-Festucetum valesiacae* (Burduja et al. 1956, Răvăruț et al. 1956) Sârbu, Coldea et Chifu 1999.

Distribution of the species and analysis of the soil chemistry and climatic data for Muntenia. In the Muntenia region (Fig. 7), the literature records indicate that *P. maculatum* has been recorded in 17 locations, but its presence has been confirmed in only five of these (Supplementary Table 1). The species was found at elevations ranging from 280 to 325 m a.s.l., in moderately acidic soils, rich in potassium and phosphorus. The annual mean precipitation (543 mm) and annual mean temperature (9.8°C) are moderate (Supplementary Table 1). The total number of individuals from all the studied sites is approximately 210, and the number of individuals / 100 m² varies from 1–5 to 15–20.

Pontechium maculatum occurs in the following plant associations: *Thymo pannonici-Chrysopogonetum grylli* Doniță et al. 1992, *Taraxaco serotinae-Festucetum valesiacae* (Burduja et al. 1956, Răvăruț et al. 1956) Sârbu, Coldea et Chifu 1999, and *Artemisio austriacae-Poetum bulbosae* I. Pop 1970. Its populations are threatened by factors such as the spread of non-native species (*Elaeagnus angustifolia* L.), the conversion of grasslands into arable land and forests, overgrazing, the construction of houses and other infrastructure, off-road vehicle use and fires.

Distribution of the species and analysis of the soil chemistry and climatic data for Oltenia. In the Oltenia region (Fig. 8), the literature records indicate

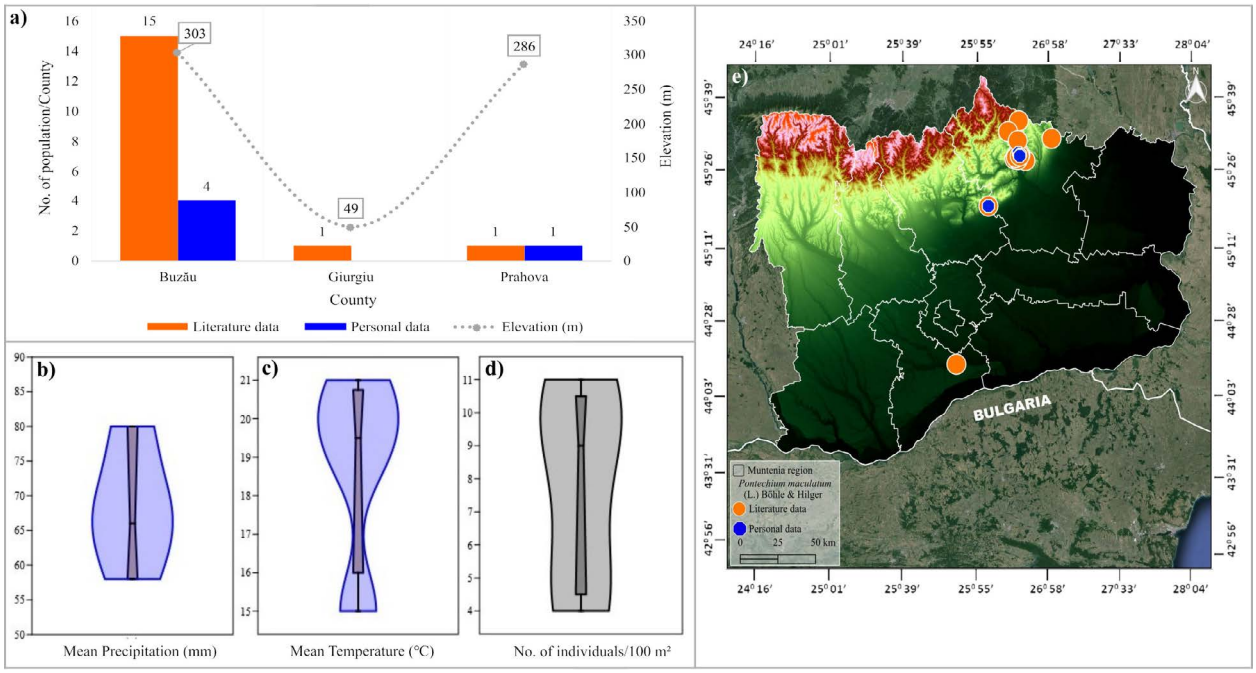

Fig. 7. Ecological profile of *Pontechium maculatum* in Muntenia: number of populations from the literature and confirmed (a), the density of Mean Precipitation values (b), Mean Temperature (c), no. of individuals (d), and distribution analysis (e).

that *P. maculatum* was recorded in nine locations (Supplementary Table 1), whereas recent research has confirmed its presence in only two of them. In the Danube Gorge – the Portile de Fier Natural Park, in Eibenthal (Mehedinți County), the species was recorded at an elevation ranging from 430 to 440 m a.s.l., in the following associations: *Botriochloetum ischaemi* (Kristiansen 1937) I. Pop 1977, *Thymo pannonici-Chrysopogonetum grylli* Doniță et al. 1992, and *Danthonio-Chrysopogonetum grylli* Boșcaiu 1972. The number of individuals / 100 m^2 varied from 24 to 52. On the other hand, in Svinița (Mehedinți County), *P. maculatum* occurs at elevations between 281–450 m a.s.l., in associations *Danthonio-Chrysopogonetum grylli* Boșcaiu 1972 and *Cleistogeno serotinae-Festucetum rupicolae* Zólyomi 1958 corr. Soó 1964. The number of individuals / 100 m^2 was 8.

Historically and geographically, the populations of Eibenthal and Svinița are located in the Almaj Mountains, which belong to the Banat region. From an administrative point of view, the *P. maculatum* populations analysed are located in Mehedinți County, which belongs to the Oltenia region.

In this region, *P. maculatum* occurs in moderately acidic soils, with moderate potassium and phosphorus concentrations. The annual mean precipitation (684 mm) is the highest among the regions, and the annual mean temperature is 9.4°C. The total number of individuals from all the studied sites is approximately 350. The decline in the number of individuals in this region is attributed to factors such as the succession of forest vegetation over the grassland caused by the abandonment of silvopastoral traditions (lack of cleaning, maintenance and mowing of grassland areas) and frequent spring fires. In this context, it is recommended to implement ex situ conservation strategies, including the reintroduction of the species to larger areas to help support population regeneration.

Distribution of the species and analysis of the soil chemistry and climatic data for Transylvania. In the Transylvania region (Fig. 9), the literature records indicate that *P. maculatum* was once widely distributed, with records from 128 locations. The recent field investigations have confirmed the spe-

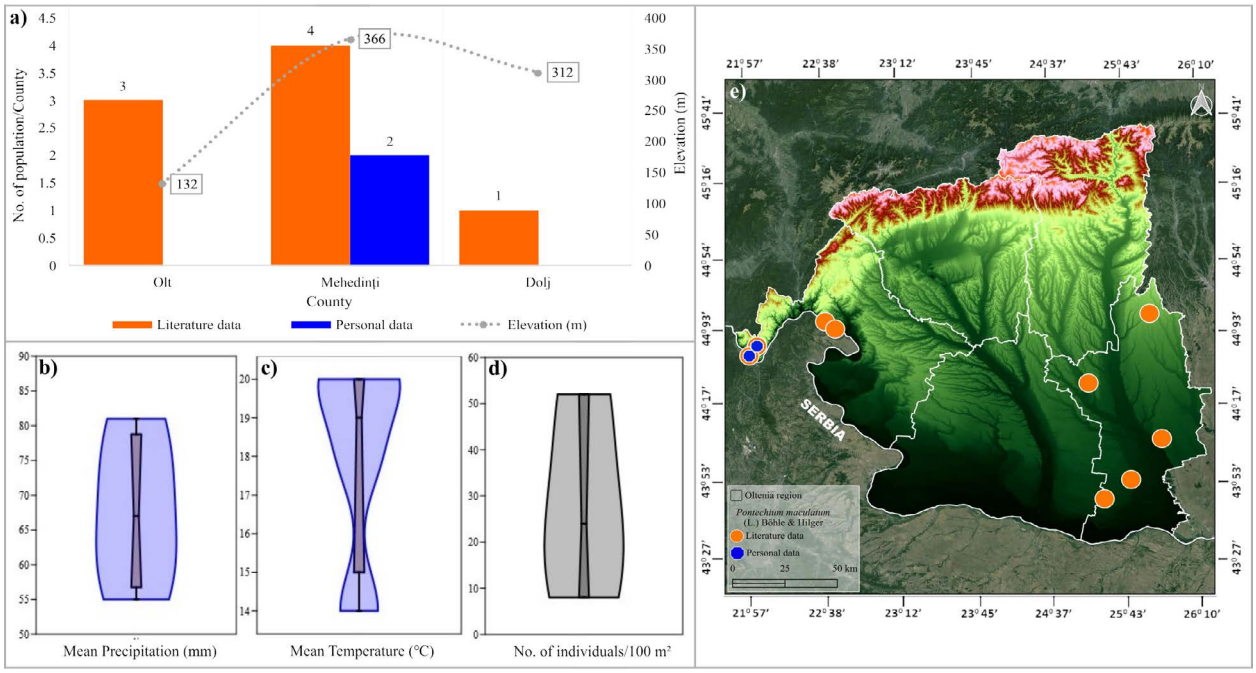

Fig. 8. Ecological profile of *Pontechium maculatum* in Oltenia: number of populations from the literature and confirmed (a), the density of Mean Precipitation values (b), Mean Temperature (c), no. of individuals (d), and distribution analysis (e).

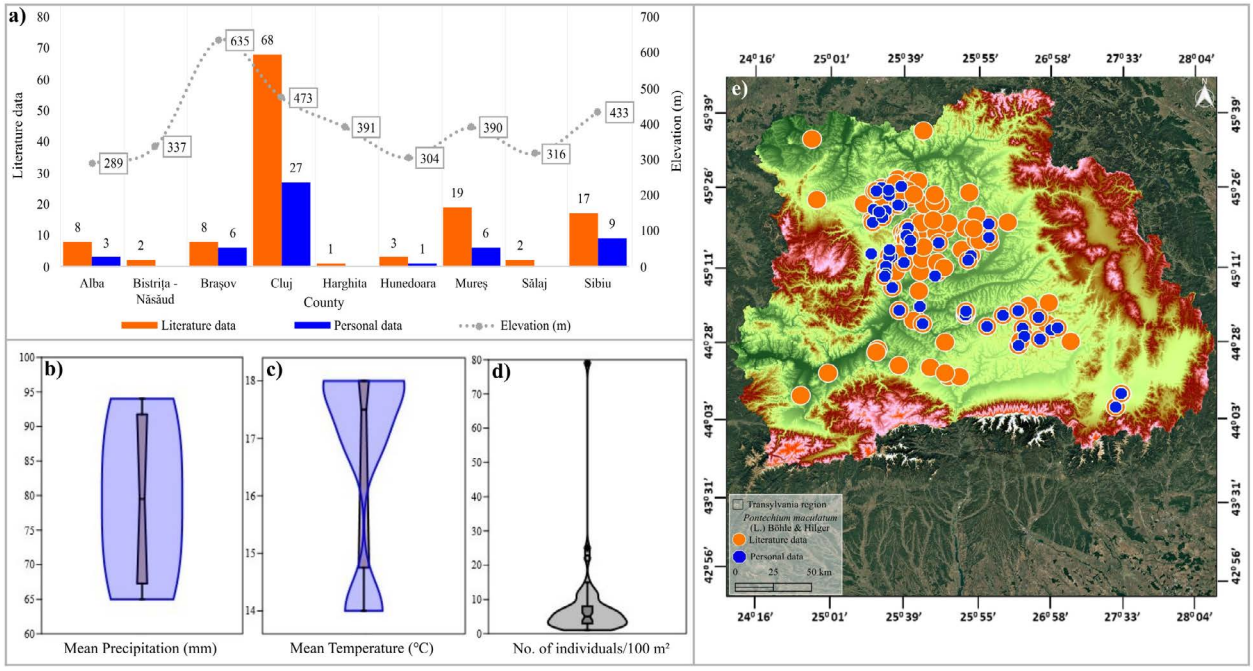

Fig. 9. Ecological profile of *Pontechium maculatum* in Transylvania: number of populations from the literature and confirmed (a), the density of Mean Precipitation values (b), Mean Temperature (c), no. of individuals (d), and distribution analysis (e).

cies in only 52 of these locations (Supplementary Table 1). The elevation range where *P. maculatum* was identified varies from 138 to 725 m a.s.l., with population sizes ranging from just two individuals to several thousand, as observed in the Tureni locality (Cluj County). The total number of individuals from all the studied sites is about 5322, and the number of individuals / 100 m^2 varied from 1–5 to 145–150. In this region, *P. maculatum* grows in soils which vary from moderately acidic to slightly alkaline, with moderate potassium and phosphorus concentrations. The annual precipitation is moderate (606 mm), and the annual mean temperature (8.1°C) is the lowest when compared to the other regions.

Pontechium maculatum was recorded in the following plant associations (Chirilă & Vassilev 2024): *Allio albidi-Stipetum lessingianae* (Soó 1947) Coldea et Sârbu in Coldea 2012, *Artemisietum ponticae* (Soó 1942) Păun 1969, *Cariceto humilis-Brachypodietum pinnati* Soó 1947, *Cleistogeno serotinae-Festucetum rupicolae* Zólyomi 1958 corr. Soó 1964, *Danthonio alpinae-Stipetum stenophyllae* Ghișa 1941, *Festuco rubrae-Danthonietum alpinae* Csűrös et al. 1968, *Festuco rupicolae-Brachypodietum pinnati* Mahn 1965, *Inulo ensifoliae-Peucedanetum cervariae* Kozlowska 1925 em. van Gils et Kovács 1977, *Jurineo transylvanicae-Stipetum pulcherrimae* (Soó 1942) Coldea et Sârbu in Coldea 2012, *Medicagini minimae-Festucetum valesiacae* Wagner 1941, *Arrhenatheretum elatioris* Br.-Bl. Ex Scherrer 1925, *Rorippo austriacae-Agropyretum repentis* (Timar 1947) R. Tx. 1950, *Salvio-Festucetum rupicolae* Zolyomi 1958 corr. Soó 1964, and *Thymo comosi-Festucetum rupicolae* (Csűrös et Gergely 1959) Pop et Hodișan 1985. The species also occurs in communities with *Festuca stricta* subsp. *sulcata-Vicia cracca*, *Bromopsis erecta-Festuca stricta* subsp. *sulcata*, *Festuca stricta* subsp. *sulcata-Stipa tirsa*, and *Carex humilis-Stipa tirsa*. The main causes of habitat degradation for *P. maculatum* include overgrazing, ruderalisation, fires and the impact of tourism.

DISCUSSIONS

Pontechium maculatum is a species characteristic of forest-steppe grasslands (Dresler *et al*. 2017), and is known for its drought-resistance. Similar to the *Crambe tataria* Sebeók species, *P. maculatum* is considered an indicator of the conservation status of grasslands, at the same time being susceptible to overgrazing by sheep (Popescu 2013). Given this context, it is essential to study the impact of climatic variations (temperature and precipitation) on the spread and population density of *P. maculatum* in Romania. The analysis of the *P. maculatum* species in Romania shows a complex interaction between environmental conditions, anthropogenic impacts and its distribution. Fluctuations in its population density underscore the species' sensitivity to such interactions.

The size of *P. maculatum* populations varies significantly at the European level. In Romania, the total number of individuals from all the studied sites is approximately 6461, while the literature (Anonymous 2016) cites values ranging from 1000 to 5000 individuals. According to the Commission of the European Communities (2009), the population size of Slovakia, Hungary and the Czech Republic was estimated at over 31,000 individuals. Populations in the Czech Republic comprise approximately 700 individuals (Bernhardt *et al*. 2011), while populations in Poland number approximately 100 individuals (Kalinka & Nowak 2004). According to Mereďa & Hodálová (2011), populations in Slovakia have declined in recent decades. In contrast, the populations of *P. maculatum* in the Czech Republic are undergoing a slow decline, and the populations in Hungary are stable (Bernhardt *et al*. 2011).

In Romania, the largest population of *P. maculatum* was recorded in Tureni (Cluj County), with thousands of individuals being observed. Unfor-

tunately, in the area where the species is found, a highway is being built which will significantly affect this population. In Slovakia, the largest population was recorded in the Demjatské kopce Nature Reserve, with several hundred individuals (Mereďa & Hodálová 2011; Bernhardt *et al*. 2011). According to Petrova (2015), one of the largest populations of *P. maculatum* in Bulgaria, with 100–250 individuals, is located on Lozenska Mountain. In the last two decades, the number of populations of *P. maculatum* in Romania has undergone significant changes. In our study, 80 populations were recorded compared to over 196 populations cited in the literature (Supplementary Table 1). This indicates a trend of fragmentation and population decline. In other countries, the number of populations includes 14 in the Czech Republic, 16 in Slovakia, and 2 in Poland (Bernhardt *et al*. 2011). In Ukraine, in the Dvorichanskyi National Nature Park, *P. maculatum* has been recorded in 24 locations, comprising 73 individuals (Parkhomenko *et al*. 2021).

In terms of topographical factors, *P. maculatum* shows some differences depending on the region. The results of our study show that *P. maculatum* occurs at elevations ranging from 56 to 725 m a.s.l., while in the past it was observed at elevations from 0 to 776 m a.s.l. (Fick & Hijmans 2017). In Bulgaria, the species was recorded at elevations ranging from 0 to 1200 m a.s.l. (Bernhardt *et al*. 2011). *Pontechium maculatum* occurs on sunny aspects (southwest, south, and west) and gentle slopes (from 3 to 10°; Chirilă & Vassilev 2024). Also, according to the study conducted by Jakovljević *et al*. (2019), *P. maculatum* can grow in areas contaminated with metals.

Regarding the habitat, *P. maculatum* is frequently found in dry grasslands – *Festuco-Brometea* (Dengler *et al*. 2012), occasionally in mesic grasslands (*Molinio-Arrhenatheretea*), and rarely in woodland fringes and clearings, tall forb stands (*Trifolio-Geranietea sanguinei*) and inland salt steppes (*Festuco-Puccinellietea*). The associations in which *P. maculatum* frequently occurs are *Allio albidi-Stipetum lessingianae* (Soó 1947) Coldea et Sârbu in Coldea 2012, *Jurineo arachnoideae-Stipetum lessingianae* (Dobrescu 1974) Chifu, Mânzu et Zamfirescu 2006, *Taraxaco serotinae-Festucetum valesiacae* (Burduja et al. 1956, Răvăruț et al. 1956) Sârbu, Coldea et Chifu 1999, and *Festucetum rupicolae* Burduja et al. 1956 (Chirilă & Vassilev 2024). In the past, the species was more widespread in Bulgaria (Vladimirov *et al*. 2023), where it occurs mainly in plant communities of the *Festuco-Brometea* class, growing in dry grasslands with narrow-leaved (*Festucion valesiacae* alliance) and broad-leaved species (*Bromion erecti* alliance; Bernhardt *et al*. 2011).

Human activities have severely affected the distribution and general abundance of the *P. maculatum* species in Romania. Overgrazing, the expansion of agricultural land, vegetation succession, the loss of hayfields, spring fires, climatic variations and the collection of specimens have led to the decline of this species. Other limiting factors include the spread of non-native species, afforestation of open lands, oil or gas exploitation and extraction, the construction of cabins and other types of buildings, off-road vehicle activity (Oroian *et al*. 2017), the expansion of vineyards (Mereďa & Hodálová 2011), eutrophication and the natural expansion of shrubs and trees (Bernhardt *et al*. 2011; Vladimirov *et al*. 2023). Furthermore, it is important to note that, in the past, pine plantations also represented a threat (Bernhardt *et al*. 2011). These activities not only eliminate potential breeding sites for *P. maculatum*, but also contribute to the isolation of existing populations more than stochastic events would, in turn reducing both habitat and population size, potentially resulting in significant losses in genetic diversity. These problems are compounded by human activity, which in many cases has facilitated the introduction of non-native species which compete with *P. maculatum* for resources.

The main threats to the species are overgrazing and the conversion of grassland into arable land. Overgrazing reduces plant diversity, alters soil chemistry due to animal waste and leads to soil compaction. In addition, intensive agriculture, the introduction of non-native species, recreational activities and climatic variations exacerbate these impacts.

Moreover, the use of pesticides and chemical fertilizers in agriculture can seriously affect natural habitats (Tudi *et al*. 2021), including those of the *P. maculatum* species. Urbanisation and industrial development lead to the fragmentation and loss of natural habitats (Chang *et al*. 2023), thereby reducing the area where local plant species can thrive. Also, habitats are disturbed by various recreational activities, such as hiking and camping (Monz *et al*. 2021), while non-native species compete with native plants for resources (Hanberry 2023). Additionally, climate change and associated variations in temperature conditions and precipitation regimes further impact plant species (Dunlop *et al*. 2012).

Pontechium maculatum is a threatened species, which means that its habitats must be protected and restored to ensure its conservation. This requires the establishment and expansion of nature reserves, and the implementation of habitat restoration projects. Managing non-native species is also indispensable so as to minimize competition for resources. Controlling human activities, particularly in areas of significant ecological value, may help to reduce habitat degradation. Regular monitoring of *P. maculatum* sites and habitats is necessary to assess the effectiveness of conservation efforts for this declining species. Public awareness and involvement also play an equally important role in ensuring the long-term protection of this species.

CONCLUSIONS

Pontechium maculatum has a rare and fragmented distribution in Romania. Most of the populations were recorded in Transylvania, followed by Moldova. In contrast, very small and dispersed populations of the analysed species were recorded in the Muntenia, Oltenia, Crișana, Banat and Dobrogea regions.

The species occurs at variable elevations (from 57 to 725 m a.s.l.) in moderately acidic to weakly alkaline soils, rich in potassium and phosphorus, with moderate precipitation and temperatures. The soil types in which *P. maculatum* occurs include luvic and haplic chernozems, phaeozems, and occasionally leptosols. Population density is low in most regions, with a variable number of individuals / 100 m^2. The analysed species exhibits limited adaptability to variations in topographical and climatic factors, and is predominantly found in dry grasslands (*Festuco-Brometea*).

Pontechium maculatum serves as an indicator of the conservation status of forest-steppe grasslands, which are increasingly threatened by overgrazing, and agricultural land expansion. These limiting factors negatively impact the species' distribution and abundance in Romania. To protect *P. maculatum* populations, it is necessary to create and expand nature reserves.

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COMPREHENSIVE PLANT BIOLOGY

REZIME

Ekologija i distribucija *Pontechium maculatum* u Rumuniji

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Pontechium maculatum je zapadni paleoarktički element šumo-stepe. U ovoj studiji su analizirani ekološki uslovi i ažurirana distribucija vrste *P. maculatum* u Rumuniji. Podaci o distribuciji su dobijeni iz herbarijuma, literature i na osnovu terenskih istraživanja. Nakon analize vrste, napravljene su karte koje su pružile pregled distribucije u Rumuniji. Pored toga, data su neka razmatranja o ekologiji vrste. Naši rezultati ukazuju na prisustvo 80 populacija *P. maculatum* (38%), od 210 navedenih u literaturi, kao i neka nova zapažanja, koje su svojom distribucijom vezane za Banat, Bukovinu, Krišanu, Dobrudžu, Moldaviju, Munteniju, Olteniju i Transilvaniju. Najveća gustina je populacija je zabeležena u Transilvaniji, a najmanja u Crisan ii Dobrudži. Broj individua u Rumuniji je 6461, a vrsta je zabeležena na umereno kiselim i slabo alkalnim zemljištima, bogatim kalijumom i fosforom. Količina padavina i srednja godišnja temperature su umerene. Upoređujući ove rezultate sa podacima iz literature, ustanovili smo da se broj populacija *P. maculatum* u Rumuniji smanjio. Faktori koji utiču na brojnost vrste su prekomerna ispaša ovaca i goveda, intenzivna poljoprivreda, požari i sukcesija travnjačke vegetacije. Dugoročna održivost vrste može se obezbediti primenom održivog upravljanja travnjacima na kojima je vrsta prisutna, i to najpre izvođenjem regulisane ispaše. Hitna potreba za ciljanim merama očuvanja vrste pedstavlja glavni zaključak ove studije.

Ključne reči: *Pontechium maculatum*, prekomerna ispaša, retke vrste, karte distribucije vrsta, mezo-kserični travnjaci