

Acta Scientifica Naturalis

Former Annual of Konstantin Preslavsky University of Shumen: Chemistry, Physics, Biology, Geography

Journal homepage: <https://content.sciendo.com/view/journals/asn/asn-overview.xml>

Supplement to the chorology of rare plant taxa from karst habitats in Eastern Bulgaria

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Abstract: *The present study provides new chorological data on *Anthemis rumelica* (Velen.) Stoj. & Acht. a rare and conservation-significant taxon in the Bulgarian flora. A new locality of the species has been established within the territory of the Provadiysko-Royaksko Plateau Protected area, recorded for the first time within the floristic region of Northeastern Bulgaria, thus extending its currently known distribution range to the northeast. The species was found in open, rocky, and limestone karst habitats, dominated by facultative chasmophytic species, at an altitude of approximately 180 m. The presented data contribute to a more precise mapping of the species' distribution in Bulgaria and highlight the importance of the Provadiysko-Royaksko Plateau Protected area as a floristically valuable area in terms of plant diversity. Brief notes on its ecological preferences and associated vegetation are provided. The results emphasize the need for more detailed field investigations and for the conservation of this Balkan endemic species and its newly established locality.*

Keywords: Provadiysko-Royaksko Plateau, *Anthemis rumelica*, karst habitats, protected area

Introduction

The karst plateaus in Northeastern Bulgaria occupy an important place in the landscape of the region and represent unique natural systems with high ecological, botanical and geological value. With their specific habitats, the so-called refugial zones, they are of particular importance for the conservation of biodiversity owing to their geological, hydrological and microclimatic characteristics. Due to the fragmented nature of karst terrain (e.g., rock ridges), many plant populations remain isolated. This favours the development of local endemism, species found only in one place (for example, on a plateau or rock massif). Habitats with xerophytic vegetation of the type 6110* Rupicolous calcareous or basophilic grasslands of *Alyso-Sedion albi* [1] and 01E1 Pioneer thermophilic herbaceous communities in calcareous, rocky and stony places [2] are characteristic.

Habitats are potentially endangered and are a priority for conservation under the Habitats Directive [1]. It is included in the Bern Convention also [3].

Karst formations also create a variety of microhabitats: shady crevices, sunlit rocks, and damp caves. These conditions allow for the coexistence of thermophilic, mesophilic, and sciophilic species in proximity. The soils in the karst areas are usually shallow, skeletal, poor in humus, and drain quickly. This limits competition from more demanding plant species and creates conditions for the development of specialized vegetation, including very rare and conservation-significant species. The Provadiysko Plateau and the Royaksko Plateau, located in the southern part of the Eastern Danube Plain, belong to the relief forms mentioned above. They are united in the Provadiysko-Royaksko Plateau Protected area (BG0000104) under the Habitats Directive [1], which also overlaps with a protected area under the Birds Directive [4]. They aim to preserve the areas and natural state of natural habitats and the habitats of species and their populations, subject to conservation within the protected area. The area is located in a region with a pronounced climatic influence of the Black Sea, characterized by relatively mild winters, cool springs, cool summers, and warm autumns. For the nearby town of Provadia, the average temperature in July is 22.6°C, and the average January is 1.2°C. Precipitation in the area is relatively low, with an average annual total of 534 mm, with two peaks (June and November) and two troughs (July and February) [25]

In Bulgaria, *Anthemis rumelica* (Velen.) Stoj. & Acht. was first described by the Czech botanist Josef Velenovský as *Anthemis graveolens* var. *rumelica* Velen. in the first flora of Bulgaria [7]. This is one of the varieties previously considered part of the species *Anthemis graveolens* (now most accepted as *Anthemis cretica*). The original taxonomic description of *A. rumelica*, which provides the historical basis for its classification and systematic position within the genus, was provided in 1937 [8]. They determined that its morphological characteristics were sufficiently distinct to warrant classification as a separate species. Since then, its full scientific name has been *Anthemis rumelica* (Velen.) Stoj. & Acht. Until recently, the species was considered a Bulgarian endemic [9]. Following a review of the herbarium at the Bulgarian Academy of Sciences, it has been confirmed that *Anthemis rumelica* was recorded in the European part of Turkey on May 14, 1913, by the Bulgarian botanist Boris Davidov on the sandy hills near Istanbul, near the Buyuk Khan railway station [10]. The species localities are primarily in Southern Bulgaria (Fig. 1): the Black Sea coast (the Ropotamo River, the village of Kondolovo, the village of Fazanovo, Burgas region), the Pre-Balkan region (the village of Krapets, the village of Smolyanovtsi), and the Stara Planina Mountains (Eastern part - the Sinite Kamani Nature Park, Aytos Mountains), Struma Valley (Blagoevgrad), Slavyanka (Stargach Mountain), the Rhodopes (Eastern part - Zlatograd, Kardzhali, Iron Gates, Momchilgrad), the Thracian Lowlands (Haskovo region), Tundzha Hilly Plain (Kazanlak, Sakar Mountains, Topolovo Hills, Svetiliyski Hills, including Omarchevo), Strandzha (Dervent village, Strandzha village); up to 1,000 m above sea level [11].

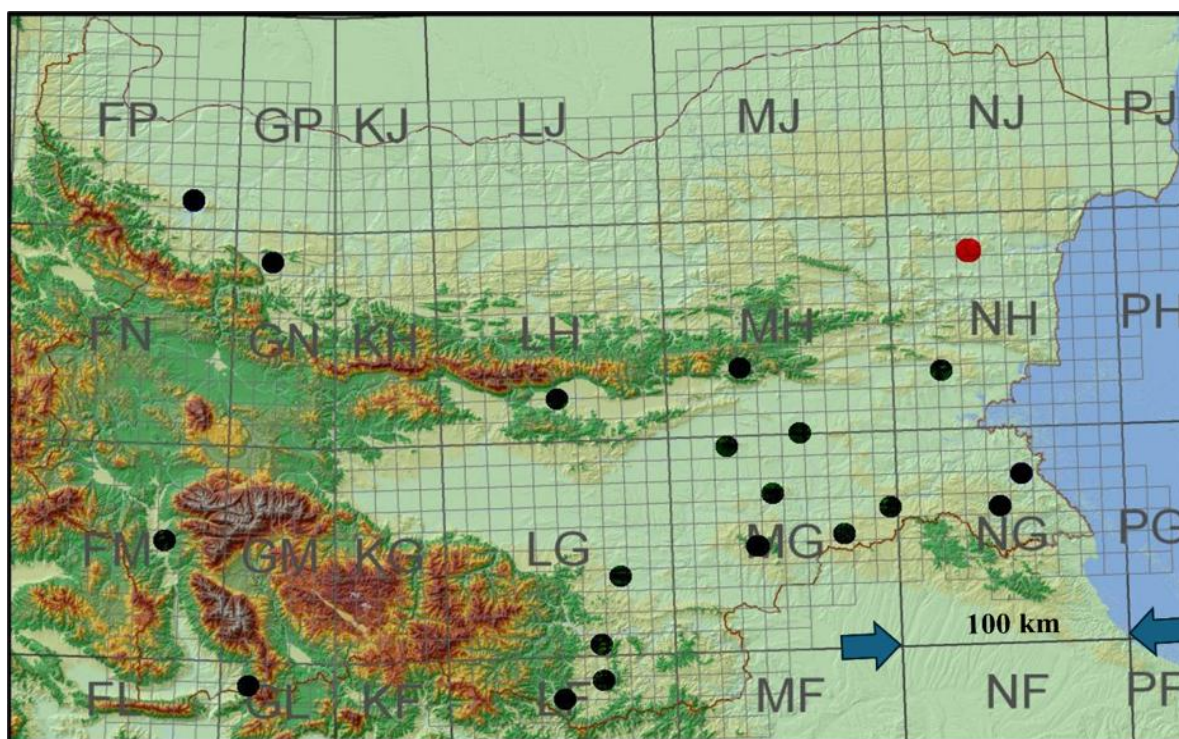


Figure 1. Distribution of *A. rumelica* in Bulgaria (in black – known locations; in red – new location)

Research on *A. rumelica* focusses primarily on three aspects: its unique chemical composition and conservation status as a Balkan endemic, as well as the taxonomy and place of the species within the Bulgarian flora. In 1983, various forms and varieties of the plant (f. *cana*, var. *digitata*, and var. *pallida*) were described [12]. He also provides the only data on its distribution in the Northeastern Bulgaria (the Madara Plateau). Pavlova's studies described in detail the locations of *A. rumelica* in specific geographic regions, primarily in the Southern Bulgaria and the Thracian Lowlands. She analyzed the factors that limit or facilitate the species' distribution. In 2004, Pavlova paid close attention to anthropogenic pressure and conservation measures [13]. In some of her works, the plant's status was emphasized as an endemic species, and the need to protect its populations in urbanized environments [14]. A study conducted in the Eastern Rhodopes notes the presence of *A. rumelica* in calcifilic plant communities [15].

Our study aims to update the chorological data for the conservation-significant species *A. rumelica* by identifying new locations within the Provadiysko-Royaksko Plateau Protected area in the Northeastern Bulgaria. The primary objective was to conduct initial monitoring of the discovered populations, assess their ecological preferences, and analyze the anthropogenic factors threatening their stability.

Material and Methods

Field surveys were conducted between May and September 2025. The floristic composition of the accompanying vegetation in the habitats of *A. rumelica* was determined according to the Identification Guide to the Plants of Bulgaria [16] and Flora of the People's Republic of Bulgaria, volumes 1 through 9 [17, 18] and Flora of the Republic of Bulgaria, volumes 10 [19] and 11 [20]. Taxonomic classification follows the current nomenclature based on the Synopsis of the Higher Flora of Bulgaria [6] and updated data from specialized databases (IPNI, World Flora Online, Euro+Med PlantBase (EMPB)). The life forms of the accompanying species are according to [21] and are placed in parentheses after the authors' names of the plants. Representative herbarium specimens of *A. rumelica* are deposited in the Herbarium of the Agricultural University in Plovdiv (SOA-063605). The authors of the taxa are cited according to the standards of the International Plant Names Index (IPNI). The geographic coordinates and elevation of the site were recorded using a GPS receiver (Samsung Mobile Device) running Orux Maps software.

Results and Discussion

The genus *Anthemis* L. represents one of the most intriguing and taxonomically complex groups within Anthemideae. Its taxonomy has been the subject of long-standing debates and revisions, and contemporary molecular and genetic studies frequently redefine the boundaries of the genus. Among its representatives, *A. rumelica* has a restricted distribution and specific ecological preferences, which make it the subject of intense scientific interest in the context of conservation biology and phytochemistry. The morphology of *A. rumelica* is closely linked to its survival biology in stony, rocky, and dry xerophytic habitats (Fig. 2). The species studied in the mentioned habitats is *A. rumelica* (Velen.) Stoj. & Acht. It is a perennial herbaceous plant characterized by the presence of a vertical, branched rhizome. The stems are numerous, 10 to 20 cm tall, leafy in their lower half, and covered with adnate grey hairs. The leaves are on long petioles, simple to double pinnate, densely covered with greyish hairs (Fig. 2) [5]. It blooms from April to June and bears fruit from July to September. It is pollinated by wind and insects. It reproduces vegetatively by shoots and seeds. At the national level, the species is listed in Appendix 3 of the Biological Diversity Act and the Red Book of the Republic of Bulgaria in the vulnerable category. The species is listed as vulnerable (VU) on the IUCN Red List. In Bulgaria, it is localized in separate, highly fragmented and isolated localities. The species occurs in the Central and Eastern Balkan Mountains, Central and Eastern Rhodopes, Strandzha and the Southern Black Sea Coast, the Thracian Plain, Slavyanka and Southern Pirin floristic regions in the Bulgaria. In terms of altitude, the species' habitats range from 0 to 1000 meters [6]. One of the main difficulties in the taxonomic determination of *A. rumelica* is the large degree of morphological variability observed between different populations. This may be the result of adaptation to different environmental conditions or genetic differences between populations. According to

morphological descriptions [22], as a perennial herbaceous species, the species has developed several adaptations that distinguish it from the more widely distributed annual representatives of the genus. In the 1980s, the Vietnamese botanist Nguyen Tinh, while working on his dissertation, described an intraspecific taxon, *A. rumelica* var. *digitata* [12; 23] in the western part of the Provadiysko Plateau; however, in recent decades, modern records from the area [24]. Due to the lack of evidence regarding its current distribution, its presence in the area cannot be considered confirmed. As a result, the species is not included in the floristic region in contemporary synthetic summaries of the flora [6].



Figure 2. General view of the habitat and morphological details of *A. rumelica* (Photo by Desislav Dimitrov)

In early May 2025, we identified a site in the eastern part of the Provadiysko Plateau, northeast of the town of Provadia, near the Ovech Eco-Trail and the Shashkanite rock monastery. The population is located within the boundaries of the Provadiysko-Royaksko Plateau Protected area from the NATURA 2000. European ecological network. The coordinates at the center of the site are N 43°11'36", E 27°27'11", and the elevation is 182 meters (Fig. 3). The soils are predominantly carbonating humus, known as rendzinas, and the layer that covers the bedrock is extremely thin. In the most leached parts of the ridges, these soils transform into lithosols, where the bedrock lies less than 10 cm below the surface. In these areas, the soil is too poor for most aggressive grasses and shrubs, but *A. rumelica* is specialized to survive in such microhabitats, literally on a thin layer of soil over the bedrock. In this way, the plant avoids competition by occupying areas that are physically unsuitable

for other species. To the northeast of the site lies a belt of open-type shrub formations. The slope varies between 10° and 40°, and the projected grass cover is 25%, which is clearly due to the lack of a sufficient soil layer. The population consists of four reproductive-stage specimens scattered over a small area near the edges of the rocky ridge. Some of the plants were visibly damaged by trampling due to the proximity of a hiking trail.



Figure 3. Location of the *A. rumelica* population in the Provadiysko-Royaksko Plateau Protected area (Northeastern Bulgaria)

The plant communities form a mosaic between the *Festuco-Brometea* class, dominated by the species *Chrysopogon gryllus* L. (H), *Botriochloa ischaemum* L. (H), and the *Asplenietea trichomanis* class (the vegetation within the rock crevices themselves), *Festuca pseudovina* Hack. ex Wiesb. (H), *Onobrychis arenaria* (Kit.) DC. (Th), *Anthyllis vulneraria* L. (H), *Scorzonera austriaca* Willd. (H), *Festuca valesiaca* Schleich. ex Gaudin (H), *Ononis pusilla* L. subsp. *orientalis* (Sir.) Koz. (H), *Galium album* Mill. (H), *Minuartia setacea* (Thuill.) Hayek (H), *Linum flavum* L. (H), *Thesium divaricatum* Jan ex Mert. & Koch. (H). The accompanying shrub species are represented by single specimens of *Cytisus hirsutus* L. (Ph), *Cotinus coggygia* Scop. (Ph), and tree species by single specimens of *Carpinus orientalis* Mill. (Ph). The species list reveals the dominance of hemicryptophytes (H), which is characteristic of the steppe and forest-steppe zones of the Balkans. Each of

these species contributes to the functional integrity of the community. Around the population site, *Chrysopogon gryllus* L. acts as a key stabilizer of the ecosystem. Its robust root system and dense tufts prevent soil erosion on sloping terrain, which is vital for preserving the substrate in which the rhizomes of *A. rumelica* develop. The presence of *Bothriochloa ischaemum* L. is a direct indication of progressive erosion and depletion of the soil layer. The accompanying species, as part of the plant communities of the Provadiysko-Royaksko Plateau Protected area, belong primarily to the widespread Euro-Asian (Eur-As), Euro-Siberian (Eur-Sib), and Euro-Mediterranean (Eur-Med) phytogeographic elements. They are characterized by high ecological plasticity and a wide range of tolerance to soil and climatic conditions, which allows them to occur in both steppe and secondary grassland and forest-steppe communities. Their presence reflects the transitional nature of the flora and the influence of the temperate continental climate, as well as a certain degree of anthropogenic impact.

The Pontic phytogeographic element is one of the most characteristic and diagnostic features of the Provadiysko-Royaksko Plateau Protected area. It encompasses species originating from and mainly found in the Pontic-Caspian steppe region, distributed mainly along the Northern Black Sea coast, Southern Ukraine, Moldova, and Northeastern Bulgaria. It is a structure and indicator element, attesting to the natural character and long-term ecological stability of the landscape (Appendix).

The registered population was surveyed during the following phenological phases: when the leaves reached normal size, the onset of flowering, flowering, fruit set, fruiting, shedding of mature seeds, and the post-leaf fall period. It was found that the phenological rhythm of *A. rumelica* is precisely structured in relation to the seasonal dynamics of the Provadiysko Plateau region. Flowering occurs in April and May, when soil moisture from winter and spring rainfall is still available in sufficient quantities. This allows the plant to complete the inflorescence formation and pollination process before the onset of extreme heat. During our repeated visits, we observed that the species relies primarily on anemochory (wind) and myrmecochory (ants) for seed dispersal. Ants carry seeds to their nests, where they find a protected and nutrient-rich environment. The open spaces and rocky terrain surrounding the population provide a specific ecological niche where interspecific competition is limited, as few plants can survive extreme drought and the lack of a soil layer in the rock crevices. Although the rocky ridges serve as a refuge from competition, 461 species of anthropophytes have been recorded on the Provadiysko Plateau itself [24]. These species occupy the most favorable grassy areas, pushing the endemic species toward the most extreme and eroded rocky habitats. This specialization makes *A. rumelica* highly adapted to specific conditions, which means that even small changes in climate or habitat degradation can have fatal consequences for the population's survival.

The *A. tenuiloba* group, to which the species *A. rumelica* belongs, is defined by a set of characteristics that distinguish it from other sections within the genus *Anthemis* (which consist mainly of annual species) (Fig. 4). The main characteristics include:

- The presence of a perennial rhizome, which is often woody at the base.
 - Stems that are usually simple and terminate in a single flower head.
 - Basal leaves that range from simple to bipinnate.
 - Ray florets that are always white, which is a stable characteristic for the group on a regional scale.
- A conical flower bed exhibiting varying degrees of tapering at the tip.
- Bracts that are developed to varying degrees across the surface of the flower bed; their hairiness and glandularity serve as key diagnostic criteria.

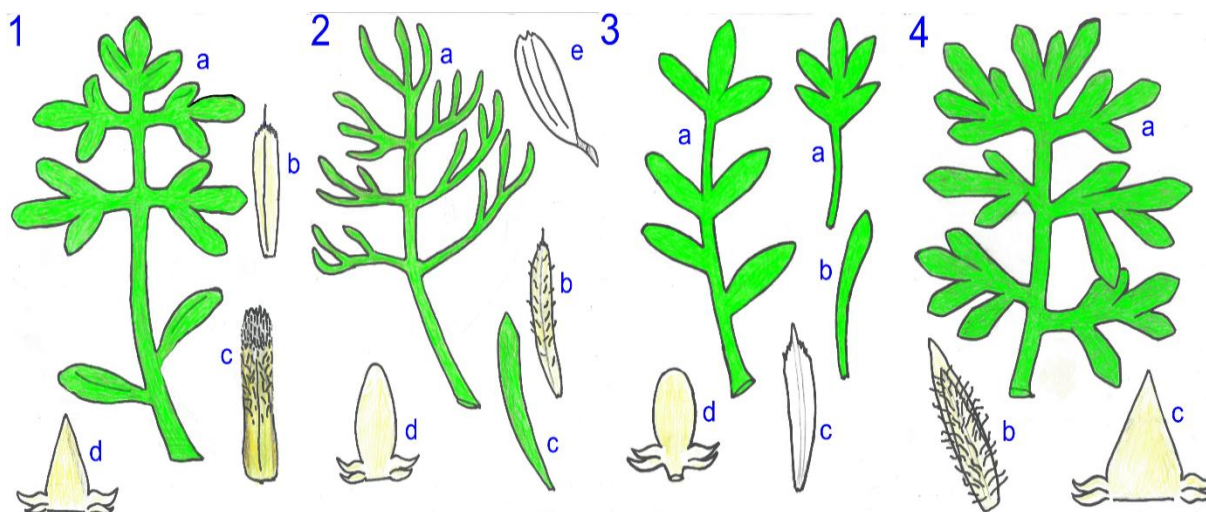


Figure 4. Comparative morphology of certain characters of *A. rumelica* with those of species in the *Anthemis tenuiloba* group (Illustration by Desislav Dimitrov): 1. *A. rumelica*: a - leaf, b - bract, c - outer involucre bract, d - flower bed; 2. *A. jordanovii*: a - basal leaf, b - bract, c - upper leaf, d - flower bed; 3. *A. regis-borisii*: a - leaf, b - upper leaf, c - bract, d - flower bed; 4. *A. tenuiloba*: a - leaf, b - outer bract, c - flower bed

Table for identifying species in the *A. tenuiloba* group

1.	Inner bracts fibrous.....	2
1*	Inner bracts glabrous.....	3
2.	Bract scales punctate-glandular; stems numerous, spreading to appressed, simply gray-fibrous to nearly glabrous.....	<i>A. regis-borisii</i> Stoj. & Acht.
2*	Bract scales at the apex simply fibrous; stems solitary, covered with appressed simple silvery hairs.....	<i>A. jordanovii</i> Stoj. & Acht.
3.	Bracts with only a distinct brown membranous margin.....	<i>A. rumelica</i> (Velen.) Stoj. & Acht.
3*	Bracts with a dark keel and a transparent, indistinct, or pale brown membranous margin.....	<i>A. tenuiloba</i> (DC.) R.R. Fernandes

The key provided to identify species in the *A. tenuiloba* group [20] emphasises several micromorphological characteristics that are critical to distinguish *A. rumelica* from its close relatives. The first and most significant distinction in the key (items 1 and 1*) is based on the presence or absence of pubescence on the inner bracts. The species listed under items 2 and 2* in the key are often found in the same or similar ecological niches in the Bulgaria, creating conditions for misidentification upon superficial observation. It is interesting to note that *A. rumelica* shares the characteristic of numerous stems with *A. regis-borisii*, but differs in the absence of glandular structures and hairs in the bracts.

Conclusions

An analysis of the data collected and the results of the field surveys conducted in the Provadiysko-Royaksko Plateau Protected area indicates that the species' population is in a state of critical vulnerability. The main reason for this is the very limited number of individuals, which makes the population unstable and susceptible to external influences. From the known data could be concluded that most of the existing populations occur primarily in rocky habitats on limestone substrates, characterized by low plant competitiveness and good adaptive mechanisms with respect to extreme temperature conditions, making these species indicators of the quality of local ecosystems. During the study, the following key negative factors were identified that threaten their long-term survival:

1. Anthropogenic pressure: Trampling by tourists due to the site's proximity to the Ovech nature trail. Some plants have been directly damaged by human activity.
2. Biological succession: The overgrowth of rocky ridges with competing species leads to shading and the displacement of heliophytes such as *A. rumelica*.
3. Invasion of anthropophytes: The presence of 461 species of anthropophytes on the plateau creates competitive pressure in the more favorable grassy areas.

In terms of chorology and biology, the discovery of the *A. rumelica* site confirms the current presence of the floristic region of species in the Northeast Bulgaria, which requires an update of the national floristic databases. The range in Bulgaria is highly fragmented, with the karst plateaus in the northeast serving as isolated refugia. The species is strongly related to specific microhabitats, shallow lithosols along the edges of rocky ridges. This ecological specialization is a mechanism for avoiding competition, but at the same time makes the species extremely vulnerable to physical destruction of the substrate. The low population size places the local population in the category of those critically threatened by stochastic events. The probability that the population survives without intervention is low. In the future, it would be advisable to organize additional field expeditions along the rocky ridges within the Provadiysko-Royaksko Plateau Protected area, primarily during the flowering period, as there is a high probability of discovering other small populations in hard-to-reach areas. To ensure

the long-term conservation of *A. rumelica* and its habitat, we propose conducting a comparative genetic analysis between the populations of Northeastern Bulgaria and those of the Southern Bulgaria to determine the degree of isolation and the genetic health of the small groups.

Acknowledgement

This research is supported by Konstantin Preslavsky University of Shumen, Bulgaria, under the Project No. RD-08-125/06.02.2026.

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Appendix

Phytogeographic characteristics and regional significance of the associated species

Species	Geoelement	Significance for the region of the Provadiysko-Royaksko Plateau Protected area
<i>Anthemis rumelica</i> (Velen.) Stoj. & Acht.	Bal	A key conservation species in calcareous communities.
<i>Chrysopogon gryllus</i> L.	Pont-Med	A key contributor to the formation of grassland communities on the plateau and a factor in soil stabilization.
<i>Botriochloa ischaemum</i> L.	subMed-As	An indicator of anthropogenic degradation and erosion processes on slopes.
<i>Festuca pseudovina</i> Hack. ex Wiesb.	subMed	It contributes to the formation of secondary pastures on shallow soils.
<i>Onobrychis arenaria</i> (Kit.) DC.	sPont	A typical example of steppe vegetation on the karst terrain of the plateau.
<i>Anthyllis vulneraria</i> L.	Eur-Med	A pioneer species that colonizes rocky and bare limestone areas.
<i>Scorzonera austriaca</i> Willd.	Eur-Sib	A highly pronounced degree of relictiness underscores the continental character of the plateau.
<i>Festuca valesiaca</i> Schleich. ex Gaudin.	Pont	An important component of xerophilous grassland communities in northeastern Bulgaria.
<i>Ononis pusilla</i> L. subsp. <i>orientalis</i> (Sir.) Koz.	subMed	A southern element rare for the region, penetrating through microclimatic corridors.
<i>Galium album</i> Mill.	Eur-As	A widespread associated species with high ecological plasticity.

<i>Minuartia setacea</i> (Thuill.) Hayek.	Pont	The Obligate Calciphilous is a typical inhabitant of the rocky ridges and ledges across the plateau.
<i>Linum flavum</i> L.	subMed	A decorative element on the fabric that suggests a connection to the Ponto-Sarmatian flora.
<i>Thesium divaricatum</i> Jan. ex Mert. & Koch.	Eur-Med	A specific hemiparasite that indicates the community's floristic richness.
<i>Cytisus hirsutus</i> L.	Eur-Sib	It plays a role in the early stages of shrub invasion in grasslands.
<i>Cotinus coggygria</i> Scop.	Med-As	A dominant shrub that shapes the appearance of the degraded forest-steppe landscape.
<i>Carpinus orientalis</i> Mill.	subMed	It determines the structure of the shrubland, an indicator of the historical presence of forests in the area.