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RESEARCH ARTICLE

First records of a potentially new plant community from the ruderal vegetation in the Black Sea Coast, Bulgaria

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Abstract

The paper presents the first data of an unreported plant community dominated by *Hordeum leporinum* Link and *Bituminaria bituminosa* (L.) Stirt. (class *Stellarietea mediae* R. Tx., Lohmeyer et Preising in R.Tx. 1950). It is currently established in four localities in the region of the Black Sea coast, between the town of Ravda and the town of Nessebar, Bulgaria. Among the characteristic features of the community are: (i) it occupies places with an active human presence near the beach; (ii) preferences for shallow sandy or rocky soils; (iii) *Bituminaria bituminosa* (L.) Stirt. as a dominant, diagnostic and constant species for the community. Other diagnostic species for the association are *Anchusa officinalis* L., *Malva sylvestris* L., *Sonchus arvensis* L. and *Avena fatua* L. (iv) annual and perennial species have an equal participation in the community; (v) increased presence of diagnostic species for the class *Artemisietea vulgaris* Lohmeyer et al. ex von Rochow 1951. Phytogeographically, the species composition of the community has a strong Mediterranean influence. In close proximity to its reléves there are always communities of xerophytic shrubs or low trees (in many cases alien species, such as *Amorpha fruticosa* L., *Ziziphus jujuba* Mill. and *Robinia pseudoacacia* L.) that participate in the association without forming a full second layer (their cover abundance is less than 30%).

Keywords

vegetation, ruderal, weed, syntaxonomic, biodiversity, Arabian pea, mouse barley

Introduction

Bituminaria bituminosa (L.) Stirt. is a species that is relatively rare and is not often mentioned in the phytosociological relevés that have been made on the territory of Bulgaria. In the cases where it is present in these reléves , it is not marked as diagnostic or constant for a specific syntaxonomic category. According to Türe et al. (2005), *Bituminaria bituminosa* is a characteristic species for the class *Cisto cretici-Micromerietea julianae* Oberd. ex Horvatic 1958. Moreover, according to Bolòs (1996) and Mucina (1997), the species is diagnostic for the class *Thero-Brachypodietea ramosi* Br.-Bl. ex A. et O. Bolòs 1950 (synonym *Lygeo sparti-Stipetea tenacissimae* Rivas-Martinez 1978). Both classes are part of the Mediterranean vegetation. In a study of the vegetation of the Canary Islands, Del Arco, Rodríguez (2018) presented this species as diagnostic for the association *Perricalido murrayi-Bituminarietum bituminosae* in class *Artemisietea vulgaris* Lohmeyer et al. ex von Rochow 1951.

Hordeum leporinum Link is indigenous to the Mediterranean region, where it typically occurs in disturbed areas. (Davison, 1971; Dean, 1990). *Hordeum leporinum* is part of the *Hordeum murinum* complex and has often been confused with *H. murinum* and *H. stebbinsii* (synonym *H. glaucum*) (Smith, 1972). *Hordeum leporinum* (Link) was established as a new species in 1834, whereas *H. murinum* was first described by Linnaeus in 1753. *Hordeum leporinum* has been considered as a separate species by some authors because of its ecological distinctiveness (preferring warmer, drier climates) and a subspecies of *Hordeum murinum* by others due to morphological similarity Dean (1990).

Hordeum leporinum is a diagnostic species for the Union *Hordeion leporini* Br.-Bl. in Br.-Bl., Gajewski, Wraber & Walas 1936 corr. O. Bolòs 1962, synonym of the Union *Hordeion murini* Br.-Bl. 1931 (art. 2c, 8) (Brullo, 1982) and the Union *Sisymbrion officinalis* R. 'IX., Lohmeyer et Preising in R. Tx. 1950 (class *Stellarietea mediae* R. Tx., Lohmeyer et Preising in R.Tx. 1950).

The purpose of this publication is to provide information on a new unreported ruderal grass community in which the species *B. bituminosa* and *H. leporinum* have a predominant participation and high species occurrence.

MATERIALS AND METHODS

The subject of the study is a ruderal grass community (Fig. 1) with the following dominant species: mouse barley (*Hordeum leporinum*), Poaceae and the Arabian pea (*Bituminaria bituminosa*), Fabaceae, established at the present stage in four localities in the region of the Black Sea coast, between the town of Ravda and the town of Nessebar (Fig. 2).

Geographically, the object of the study is in the Burgas Lowland, which is part of the Southern Black Sea coast (Georgiev, 1991). The altitude is 80-100 m a.s.l. Nearby

are situated the large coastal lakes Burgas Lake, Mandrensko and Atanasovsko Lakes. Only one higher part stands out by the sea – the hill Vurli briag (209 m a.s.l). The soil cover is diverse due to the differences in the basal rock, relief, climate and vegetation. The podzolic cinnamon brown soils and Vertisols have dominant distribution. In addition, some azonal soil types are also found along the sea coast. The study area is situated in the southern part of the Black Sea climatic area, which is formed by the dominance of two climate factors: atmospheric circulation and the influence of the Black Sea and partly – of the Mediterranean Sea. The average annual temperatures reach up to 13.3°C. The average January temperature is between 1 and 2°C. In

Figure 1. General view of the studied plant community. Photo by: Plamen Glogov

Figure 2. Map of the study area and the localities (1-4) of the studied plant community. (Map data 2020 (C) Google)

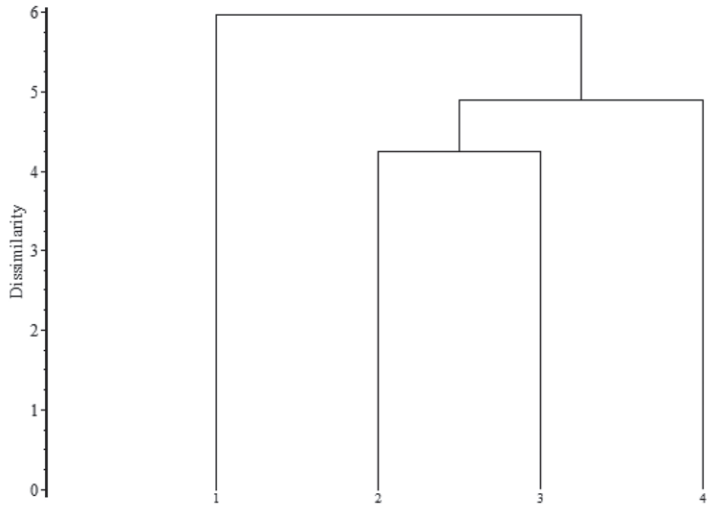

Figure 3. Numeral analysis of the reléves with the SYNTAXA program

the summer, the temperatures are around 22-24°C. Due to the mitigating role of the sea basin, the temperature is between 20-21°C. In general, the winter is warmer, the spring is cooler than the autumn, the summer is cooler compared to other parts of the country with lowland and hilly terrain, the autumn is warmer and softer compared to the spring.

These temperatures provide a longer growing season, about 300 days. Annual precipitation is from 500 to 1000 mm and has a winter maximum. Snow cover is rarely formed in the region, and when it is, it melts quickly over a period of 4-5 days. Unfavourable climatic phenomena in the region are the torrential rains. Winds in the winter are mainly west-northwest or north, while in the warm half of the year, the east-northeast winds dominate. The Black Sea breeze has a significant impact on the local climate.

The relevés were made in the period 24-26 May 2020, but in some of the localities (3 and 4), the community has been observed during the last ten years. The characteristics of the individual localities are as follows:

The first locality of the community (Relevé № 1) has geographical coordinates: 42°38'57"N; 27°42'09"E (DMS). The altitude is 3 m a.s.l. The area occupied by the community is 150 m^2. The slope inclination is 0°. The soil is shallow, sandy and saline, in some places just bare rock. The place is a natural rocky reef breakwater. The community is located at the terrestrial part of the breakwater and a small path passes through it. In the immediate vicinity of the studied community, there is a shrub community with the edificator *Ulmus minor* Mill.

The second locality (Relevé № 2) has coordinates 42°38'54"N; 27°42'25"E (DMS); altitude of 54 m a.s.l., area of 250 m^2 and slope of *10*°. The soil is shallow, sandy. There

is a road next to the community. The community borders with a private plantation of fruit trees, rose hips, mulberries and other species.

The third locality (Relevé № 3) has coordinates 42°38'53"N; 27°42'28"E (DMS); altitude of 50 m a.s.l.; area of 200 m^2 and slope of 5°. The soil is shallow, sandy and stony. The community is located on the road to the local beach and passes through vine shrubs (*Vitis vinifera* L.)

The last fourth locality (Relevé № 4) has coordinates 42°38'52"N; 27°42'33"E (DMS); altitude of 52 m a.s.l.; area of 200 m^2 and slope of 0°. The soil is sandy and very stony. It is located close to the parking of the local hotel. It is bordering a shrub community of *Ziziphus jujuba* Mill.

The taxonomical nomenclature and biological types of the plants followed Delipavlov, Cheshmedzhiev (2003). The Plant List (2010) was used to standardise the scientific names. The determination of the floristic elements was made according the Asyov, Petrova (2012). The study follows the floristic approach of Braun-Blanquet (1964).

The relevés were set up in representative parts of the researched community. The plot area was 16 m^2, which is the recommended area for grasslands by Chytrý at al. (2003). The quantitative participation of the species in the community was calculated based on their cover abundance using the Braun-Blanquet scale (van der Maarel, 1979). Species Constancy (occurrence) was calculated on a five-point scale by Raunkiaer (1934).

The relevés were processed with the SYN-TAX 2000 program (Podani, 2001) for data analysis in ecology and taxonomy. Combined cluster analysis (UPGMA, Horn index) was applied. The syntaxonomic classification of the studied community was performed after reviewing reference sources (Mucina, 1993, 1997; Tzonev at al., 2005, 2008, 2009; Cano-Ortiz, 2009; Lososová, 2009; Rendeková, Mičieta, 2018 and others cited in the text)

Results

At this stage, only four independent localities (4 relevés) of the studied community have been discovered and described, which is an insufficient number for announcing a new syntaxa (association or subassociation) according to the Code of Phytosociological Nomenclature (Weber at al., 2000; Theurillat et al., 2020).

The present research gives preliminary results and possible idea for the character of a new for the science plant association: *Hordeo leporini-Bituminarietum bituminosae* ass nova hoc loco, holotypus relevé No3. Dominant in all relevés were the species *H. leporinum* Link and *B. bituminosa* (L.) Stirt. (Syn *Psoralea bituminosa* var. *plumosa* (Rchb.) Rchb. (Yordanov, 1976).

The floristic composition in the relevés included 49 species of vascular plants. The relevés of the communities, together with the biological type and their phytogeographical affiliation are presented in diagnostic Table 1.

Table 1. Diagnostic table of the researched community

Species	Other syntaxa for which the species is diagnostic	Biological type	Floristic element	No of relevés and species cover abundance				Constancy
				1	2	3	4	
Total cover abundance of the shrub layer				10%		8%	8%	
Total cover abundance of grass layer				65%	65%	60%	60%	
Diagnostic species for ass. *Hordeo leporini-Bituminarietum bituminosae*								
Bituminaria bituminosa (L.) Stirt.	*A.v.*	3	Pont-Med	3	3	3	2c	V
Anchusa officinalis L.	A.v.	3	Pont-Med	1	1	1	1	V
Malva sylvestris L.	A.v.	1	Kos	2a	1	2a	1	V
Sonchus arvensis L.		3	Eur-As	+	1	+	+	V
Avena fatua L.		1	Boreal	1	1	1	1	V
Constant species from other syntaxonomical classes								
Xanthium strumarium L. subsp. *italicum* (Moretti) D. Löve	C.m.	1	Kos	1	+	1	+	V
Erodium cicutarium L' Herit in Ait	K.C.	1	SubBoreal	+		1	+	IV
Linum austriacum L.	F.B.	3	SubMed	+		+	+	IV
Rosa canina L. (2)	R.P.	5	SubMed	1	1		+	IV
Plantago lanceolata L.	M.A.	3	Kos		1	1	1	IV
Diagnostic species for Al. *Hordeion leporini* Br.-Bl. (1931) 1947								
Hordeum leporinum Link		1	Med-Cas	4	3	3	3	V
Lactuca serriola L.		1 и 2	Eur-As		1	+	1	IV
Bromus sterilis L.		1	Boreal	1	1	1	1	IV
Carduus picnocephalus L.		1	Med		+	+	+	II
Diagnostic species for Ord. *Sisymbrietalia* J. Tx. in Lohmeyer et al. 1962								
Cynodon dactylon (L.) Pers.		3	Kos	+	1	1	1	V
Conyza canadensis (L.)Cronq.		1	Nam(Adv)		1	1	1	II
Convolvulus arvensis L.		3	Pont		1	+	+	II
Diagnostic species for Cl. *Stellarietea mediae* R. Tx., Lohmeyer et Preising in R.Tx. 1950								
Anthemis arvensis L.		1	Eur-Med	+		+	+	IV
Crepis pulchra L.		1	Euro-Med		1	+	+	IV
Reseda lutea	A.v.	1	subBoreal		1	1	+	IV
Vicia villosa Roth		1	Eur-CAs		+	+	1	IV
Papaver rhoeas		1	Eur-Sib		1	1	+	IV
Cardaria draba (L.) Desv.	A.v.	3	Eur-Med		1	1	+	IV
Sinapis arvensis L.		1	Med		1	1	+	IV
Capsella bursa-pastoris (L.) Medik.		1и2	Kos		1	1	1	IV
Ajuga chamaepitys (L.) Schreb		1и2	Pont-Med	+	+			III

Tragopogon dubius Scop.	A.v.	1	Eur-Med	+	+		+	III
Daucus carota L. subsp. *maximus* (Desf.) Ball.	A.P.	1и2	Eur-As		1	1	+	III
Trifolium campestre Schreb.	K.C.	*2*	Euro-Med		+		1	II
Diagnostic species for Cl. *Artemisietea vulgaris* Lohmeyer et al. ex von Rochow 1951								
Elymus repens (L.) Gould.		*3*	Boreal		1	1		
Foeinculum vulgaris Moench		*3*	SubMed				+	II
Diagnostic species for Cl. *Festuco-Brometea* Br.-Bl. et Tüxen ex Soó 1947								
Alyssum hirsutum M. Bieb.		1	subMed	1	+			II
Euphorbia seguieriana Neck.		3	Eur-As		+	+		III
Diagnostic species for Cl. *Molinio-Arrhenatheretea* Tüxen 1937								
Rumex crispus L.		*3*	Boreal	+	+	+		II
Sanguisorba minor Scop.		*3*	SubBoreal			1	1	II
Diagnostic species for Cl. *Galio-Urticetea* Passarge ex Kopecký 1969								
Cynanchum acutum L.		3	Med-Cas	+			+	II
Diagnostic species for Cl. *Koelerio-Corynephoretea* Kltka in Kuka et Novak 1941.								
Vulpia myurus (L.) C. C. Gmel.		1	SubBoreal		1		1	III
Diagnostic species for Cl. Querco-Fagetea Br.-Bl. et Vlieger in Vlieger 1937.								
Ulmus minor Mill. (2)		6	Eur-Med	2a				II
Vitis vinifera L. (3)		5	subMed			1		II
Diagnostic species for Cl. Quercetea ilicis Br.-Bl. ex A. Bolòs and O. de Bolòs in Bolos y Vayreda 1950								
Celtis australis L. (2)			Med				1	II
Ziziphus jujuba Mill. (2)			Adv				1	II
Other species								
Medicago minima (L.) Desr.		1	Eur-As	1			1	III
Astragalus onobrychis L.		3	Eur-As	1				II
Coronilla varia L.		3	Euro-Med				+	II
Hypericum tetrapterum Fr..		3	Eur-Sib		+			II
Potentila recta group.		3		+	0		+	II
Silene dichotoma Ehrh.		1и2	Euro-Med				+	II
Amorpha fruticosa L. (2)		5	Adv			2a		II
Ziziphus jujuba Mill. (2)		5	Adv				1	II

Legend to Table 1. Layers (column 1): 2- second (shrub) layer; 3 (third) grass layer; **Biological types**: 1- annual; 2- annual-biennial; 3- perennial; 4- semi-shrubs; 5- shrubs; 6- trees. **Floristic elements**: **Adv**-adventive; **Boreal**-Boreal; **Eur**- European; **Eur-As**- European-Asian; **Eur-Med**- Euro-Mediterranean; **Eur-Sib**- European-Siberian; **Kos**-cosmopolitan; **Med**- Mediterranean; **Med-CAs**- Mediterranean-Central Asian; **Pont** - Pontic; **Pont-Med**- Pontic-Mediterranean; **SubBoreal**- Subboreal; **SubMed**- SubMediterranean; **SubMed-As**- SubMediterranean-Central-Asian. **Syntaxonomic classes**: **A.v.-** *Artemisietea vulgaris* Lohmeyer et al. ex von Rochow 1951; **M.A.** - Molinio-Arrhenatheretea R. TX. 1937; **F.B**.- *Festuco*-Brometea Br.-Bl. et Tüxen ex Soó 1947; **C.m**- *Cakiletea maritimae* R. Tx. et Preising ex BR.-BL. et R. Tx. 1952. **K.C.** - *Koelerio-Corynephoretea* Kltka in Kuka et Novak 1941. **A.P.-** *Agropyretea pungentis* Géhu 1968 *;* **R.P.-** *Rhamno-Prunetea* Rivas Goday et Borja Carbonell 1961.

The distribution of the species by floristic elements was dominated by the Euro-Mediterranean species (16.3%), the Euro-Asian (14.3%) and the SubMediterranean species (10.2%). The distribution of the other elements was as follows: Adventive (8.2%); Boreal (8.2%); SubBoreal (8.2%); European (2.0%); European-Siberian (4.1%); Cosmopolitans (10.2%); Mediterranean (6.1%); Mediterranean-Central Asian (4.1%); Pontic (2.0%); Pontic-Mediterranean (6.1%); SubMediterranean-Asian (2.0%).

The participation of annual and perennial species in the spectrum of biological types was equal (36.7%), followed by annual-biennial type (10.2%), shrubs (10.2%), tree species (4.1%) and biennial species (2.0%). Representatives of the semi-shrubs were not identified.

The species with the largest percentage in the relevés (53.1%) were diagnostic for the class *Stellarietea mediae*, followed by the class *Artemisietea vulgaris* (16.3%). The diagnostic species for each of the other classes were between 2.0% and 4.1%, and among them there were also representatives of pioneer vegetation in sandy and shallow soils (*Koelerio-Corynephoretea* – 4.1% of species); meadows and mesic pastures (*Molinio-Arrhenatheretea* – 4.1%); dry grasslands (*Festuco-Brometea* – 4.1%); mesic and wet deciduous broad-leaved forests (*Querco – Fagetea*- 4.1%); Mediterranean evergreen woodland and macchia (*Quercetea ilicis*- 4.1%); nitrophilous perennial ruderal vegetation of wet to mesic habitats (*Galio-Urticetea* – 2.0%); Mesic and xeric shrub vegetation (*Rhamno prunetea* – 2.0%); strandline-dwelling, short-lived nitrophilous coastal vegetation (*Cakiletea maritimae* – 2.0%). 33.3% of the species in the community which were diagnostic for the class *Stellarietae mediae* were diagnostic for also other syntaxonomic classes, and the most (25.0%) were diagnostic species for the class *Artemisietea vulgaris*.

The cluster dendrogram (Fig. 3) showed higher similarity between the relevés № 2,3 and 4. Their locations were closer to each other, at a higher altitude and farther away from the sea. The community of relevé № 1 had a poorer floristic composition, but it contained a large part of the main diagnostic species for the individual syntaxonomic levels.

Discussion

The characteristics of the studied community are close to two associations that have been previously described, in which its both dominants participate separately. According to Del Arco, Rodríguez (2018), the association *Perricalido murrayi-Bituminarietum bituminosae* is a vivacious herbaceous and nanophanerophytic community that grows in abandoned agricultural fields, preferentially in the dry-subhumid Thermomediterranean and Mesomediterranean belts. Pure community stands are difficult to distinguish because they grow in an intricate mixture with annual herbaceous communities of *Stellarietea* and *Tuberarietea*. At the same time, the association *Hordeo leporini-Sisymbrietum orientalis* Oberdorfer 1977 has similar characteristics. It is an association occurring in urban and suburban stands of coastal

places characterised by the dominance of *Hordeum leporinum* and several species of the alliance and with higher rank. The aridity of the coastal environment is not favourable to the settlement of a coenosis of *Hordeum leporine* (Brullo et al., 1982).

If further investigations confirm the phytosociological independence and sustainability of the community, the proposed classification scheme of the new association could be as follows:

Class *Stellarietea mediae* R. Tx., Lohmeyer et Preising in R.Tx. 1950
Order *Sisymbretalia officinalis* J. Tx. 1962
Alliance *Hordeion leporini* Br.-Bl. (1931) 1947
Association *Hordeo leporini-Bituminarietum bituminosae* ass. nova

Characteristic features of the community are:

- It occupies places with an active human presence near the beach.
- Preferences for sandy-rocky or sandy-stoney terrains.
- Participation of *Bituminea bituminaria* as a dominant, diagnostic and constant species for the community.
- The community has equal participation of annual and perennial species. It could be considered a transitional type of community between the classes *Stellarietea mediae* and *Artemisietea vulgaris*, which is usual order in the secondary succession of the ruderal type of vegetation (Lanikova, 2009). But increased anthropogenic activities, such as the motor vehicles traffic, mowing and insecticide treatment for the sake of tourists etc., slows down the course of succession, returning the community to its initial stage each year and favouring the therophytic elements. The community bears many of the characteristics of the class *Artemisietea vulgaris*, it contains fewer mesophilic species and more alien plants, both archaeophytes and neophytes (Lanikova, 2009).
- Among the diagnostic and constant species in the community, there is a high percentage of perennial species (including shrubs with low participation) and representatives, which are diagnostic for both of the classes *Stellarietea mediae* and *Artemisietea vulgaris.*
- The species composition of the studied community has a strong Mediterranean influence.
- In the immediate vicinity of the relevés, there are always communities of xerophytic shrubs or low trees, in many cases alien species such as *Amorpha fruticosa*, *Ziziphus jujuba* and *Robinia pseudoacacia* participate in the association without forming a full second layer (their cover abundance is less than 30%)

Conclusions

The present study gives perspective to a new for the science plant association of a complex and dynamic class of ruderal vegetation.

In combination with the other species, diagnostic for the studied community, *Bituminaria bituminosa* could be considered a characteristic species for the class *Stellarietea mediae*.

The communities we have studied have characteristics of both the vegetation of the Mediterranean and Temperate zones and can be used as an indicator of the cumulative impact of climate change and the anthropogenic factor on the succession processes.

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