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Synopsis

Syntaxonomical and Ecological Diversity of Class Artemisietea vulgaris Lohmeyer et al. in Tx. ex von Rochow 1951 in Bulgaria

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Abstract. Class *Artemisietea vulgaris* includes thermophilic and (sub)xerophytic ruderal vegetation, which consists mostly of biannual and perennial seminitrophilous to nitrophilous species, widely distributed in the temperate and the submediterranean zones of Europe. The study presents a comprehensive review of its ecology and syntaxonomy on the territory of Bulgaria, based on 160 relevés stored in the Balkan Vegetation Database and selected using the "EuroVegChecklist Expert System". Numerical classification and ordination were performed by hierarchical agglomerative clustering and Detrended Correspondence Analysis. The diagnostic species were determined by calculating the Phi-coefficient. The syntaxonomical diversity of the class *Artemisietea vulgaris* on the territory of Bulgaria is presented by 2 orders (*Agropyretalia intermedio-repentis, Onopordetalia acanthii*), 3 alliances (*Convolvulo arvensis-Elytrigion repentis, Dauco-Melilotion* and *Onopordion acanthii*), 10 associations (*Convolvulo arvensis-Elytrigietum repentis, Falcario vulgaris-Elytrigietum repentis, Convolvulo arvensis-Brometum inermis, Cardarietum drabae, Tanaceto vulgaris-Artemisietum vulgaris, Melilotetum albo-officinalis, Berteroetum incanae, Poo compressae-Tussilaginetum farfarae, Potentillo argenteae-Artemisietum absinthii* and *Carduo acanthoidis-Onopordetum acanthii*) and 1 plant community (*Achillea pannonica-Elytrigia repens*). One order, two alliances and nine associations were discovered for the first time in the country. All of the syntaxa are well separated floristically and ecologically in the ordination space. The associations of the alliance *Dauco-Melilotion* represent initial stages of succession of antropogenic habitats and has higher species diversity, whereas those of the alliances *Convolvulo arvensis-Elytrigion repentis* and *Onopordion acanthii* represent more stable antropogenic vegetation types and have lower species richness.

Key words: ruderal vegetation, Braun-Blanquet approach, *Artemisietea vulgaris*.

Introduction

The *Artemisietea vulgaris* class unites thermophilic and (sub)xerophitic ruderal vegetation consisting mostly of biannual and perennial seminitrophilous to nitrophilous species. Typically, it develops in sunny

anthropogenic places affected by different levels of human impact. The soils are sandy and may contain a lot of gravel. This vegetation thrives within human settlements and their surroundings. In case of full absence of human or animal caused disturbances, such vegetation changes by secondary succession into grassland or shrub vegetation (Mucina, 1993; Jarolímek et al., 1997; Láníková, 2009).

The *Artemisietea* class is widely distributed in places with warm local microclimate in the temperate and the sub-Mediterranean regions of Europe, while in the Mediterranean region it occurs at higher altitudes. The class is presented by 5 orders and 20 alliances in Europe, including the heavily disturbed semi-ruderal and ruderal grasslands of *Agropyretalia intermedio-repentis* and *Elytrigio repentis-Dittrichietalia viscosi* (Mucina et al., 2016).

On the territory of Bulgaria *Artemisietea vulgaris* class has been invesitigated by Kolev (1965), Mucina & Kolbek (1989) and Dimitrov et al. (2005). According to Tzonev et al. (2009) it is presented by 2 orders, 3 alliances, 7 associations and 2 plant communities. Following the most recent scheme about syntaxonomical division of high-rank syntaxa in Europe (Mucina et al., 2016) currently the alliances *Artemisio-Kochion prostratae* Soó 1964 and *Arction lappae* Tx. 1937 are moved to the classes *Festuco-Brometea* and *Epilobietea angustifolii*. Up until now the syntaxonomical diversity of the *Artemisietea vulgaris* class in Bulgaria has been presented by 1 order (*Onopordiethalia acanthii*), 1 alliance (*Onopordion acanthii*), 3 associations (*Carduo acanthoidis-Onopordetum acanthii*, *Onopordetum acanthii*, *Echio-Melilotetum*) and 2 plant communities (*Ballota nigra - Artemisia absinthium* and *Achillea pannonica-Elymus repens*).

The aim of this study is to investigate the distribution, ecology and syntaxonomical diversity of the *Artemisietea vulgaris* class in Bulgaria.

Material and methods

Study area

The *Artemisietea vulgaris* class occurs in a vast array of geographical territories with diverse features (Fig. 1). The Thracian, Sofia and Kostenets-Dolna Banya Valleys are among the lowest lying areas where the investigated class was observed. The hilly and plateau relief include the features of the Dobrudzha Plateau and the Chirpan Highlands, ranging from 300 m to 600 m a.s.l. Low mountainous territories include the areas of the Western and Central Forebalkan, the mountains of Mala Planina, Ponor, Lyubash, Chepun and Sredna Gora that mainly fall within the hypsometric zone between 600 m and 1200-1300 m a.s.l. and reach over 1600 m a.s.l. The highest mountains within the studied area are Belasitsa, the Balkan Range, Pirin and Rila.

The climate is mainly temperate. Nevertheless, significant territories are located in the transitional climate zone and some even have typical submediterranean features. The latter are found around the city of Petrich and along the Black Sea coast. The rivers of Iskar, Maritsa and Yantra, accompanied by some their most prominent tributaries, are watering the zone.

The class is distributed in territories with high soil diversity with a prevalence of the different subtypes of Cambisols, Vertisols, Luvisols, Fluvisols and Leptosols.

Data collection and statistical analysis

Vegetation sampling. During 2017-2020 were sampled 650 vegetation plots (relevés) presenting synantropic vegetation from the territory of Bulgaria, following the Braun-Blanquet approach (Westhoff & van der Maarel, 1973). The sample plots were square-shaped with size in the range 10-100 m^2, as recommended for synantropic vegetation (Chytrý & Otýpková, 2003). Altitude, slope, inclination and location were measured with a Garmin eTrex Vista device for all reléves whereas the slope aspect was determined by a compass. Soil depth was estimated in three degrees as (1) shallow (<10 cm depth), (2) moderately deep (10-20 cm) and (3) deep (>20 cm). For each relevé full species composition was recorded as well as the total vegetation cover, the cover of the shrub, the herb and the cryptogam layers. All of the relevés were stored

in the Balkan Vegetation Database (Vassilev et al., 2020). Then they were exported in the JUICE 7.0 (Tichý, 2002) software. We applied the "EuroVegChecklist Expert System" function of JUICE, which uses diagnostic species lists according to the EuroVegChecklist (Mucina et al., 2016) and were selected 160 relevés, which were classified to the *Artemisietea vulgaris* class (19 relevés from digitized literature sources and 141 new collected relevés).

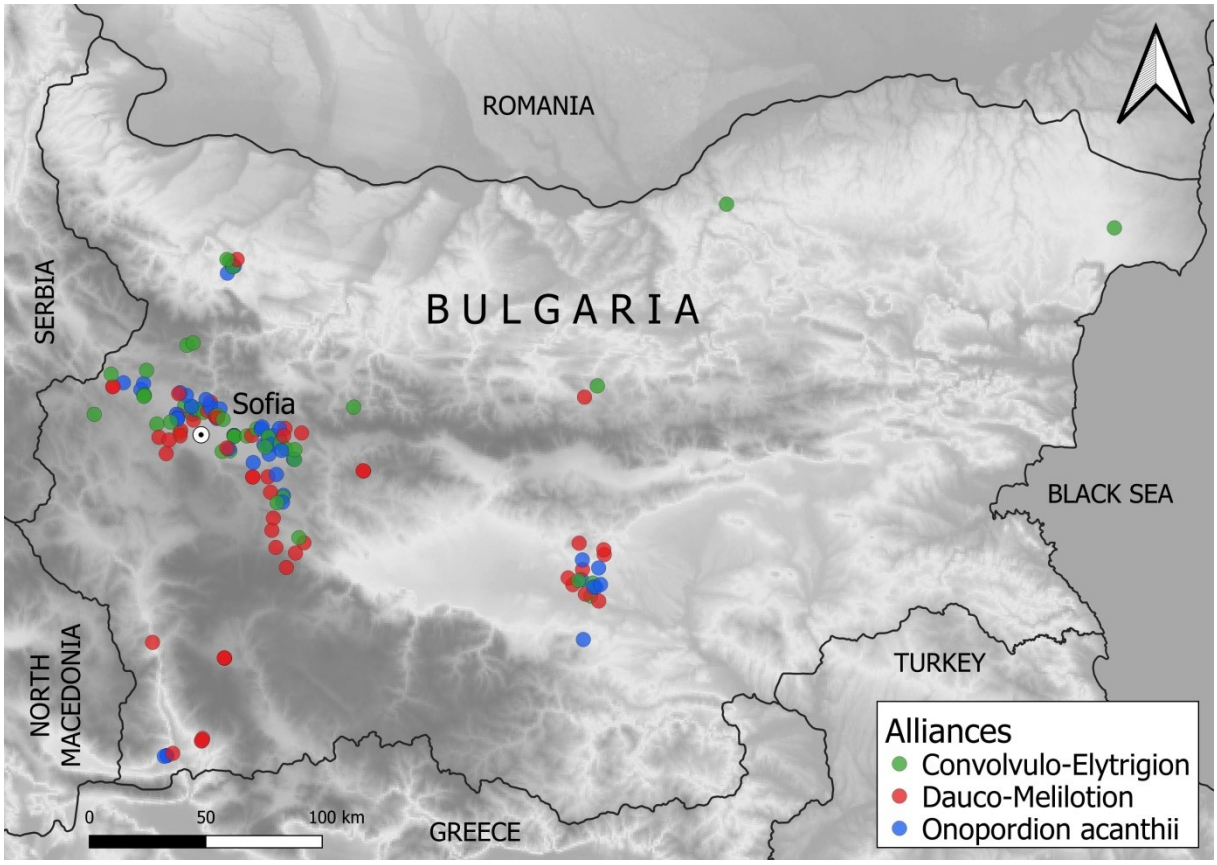

Fig. 1. Map of the studied areas. Here all collected relevés are given classified to alliance levels because on association level they are overlapping.

The selected relevés were analyzed by the PC-ORD (McCune & Mefford, 1999) and the JUICE 7.0 (Tichý, 2002) software packages. Sørensen (Bray-Curtis) was used as a distance measure and similarity was calculated by flexible beta clustering method. The species values were square-root transformed and three cut levels (0, 5, and 25) were used. The clusters were standardized to equal size (Chytrý et al., 2006). The diagnostic species were determined by calculating the Phi-coefficient (Chytrý et al., 2002). Only the statistically significant Phi-coefficient values evaluated by Fisher's exact test (*P<0.05) were considered. In the synoptic table the threshold value for a species to be considered a diagnostic one was set up at a Phi-coefficient ≥ 0.3 (multiplied by 100). They were coloured in light-green in Table 1. The species with a Phi-coefficient ≥ 0.5 were considered highly diagnostic (coloured in darkgreen in Table 1). The species in the synoptic tables were ordered by decreasing of their fidelity value. The diagnostic role of the species was also considered on the basis of available literature sources. Two values were presented for each species in the synoptic table: "Fidelity" - expressed as a Phi-coefficient and "Frequency"expressed in

percentage. Species with coverage above 50% in at least in 20% of the relevés in any cluster were considered as dominants, whereas constant species were those having at least 50% presence in a cluster.

Detrended Correspondence Analysis (DCA) was used as indirect ordination technique using the CANOCO 4.5 software package (ter Braak & Šmilauer, 2002) to reveal the major environmental gradients determining vegetation distribution. Square root transformation and downweighting of the rare species were applied. The habitat's ecological conditions were assessed using the "Ellenberg Indicator Values" (Ellenberg et al., 1992) passively projected onto the ordination space.

The nomenclature of the vascular plants followed Delipavlov & Cheshmedzhiev (2003) and was subsequently standardized according to the Euro+Med PlantBase (2006-2020). The floristic elements were interpreted according to Assyov & Petrova (2012). The species life forms were determined according to the classification of Raunkiær (1934). The nomenclature of the high-rank syntaxa was harmonized with Mucina et al. (2016). The species, identified to the genus level, were deleted. In addition, bryophytes and lichens were removed from species composition because they were still not identified for all relevés. We also merged the following taxa into aggregates: *Ajuga chamaepitys* agg. (*Ajuga chamaepitys*, *A. chamaepitys* subsp. *chia*), *Cerastium fontanum* agg. (*Cerastium fontanum*, *C. fontanum* subsp. *vulgare*), *Consolida regalis* agg. (*Consolida regalis*, *C. regalis* subsp. *regalis*), *Crepis foetida* agg. (*Crepis foetida*, *C. foetida* subsp. *rhoeadifolia*), *Euphorbia seguieriana* agg. (*Euphorbia seguieriana*, *E. seguieriana* subsp. *niciciana*), *Heracleum sphondylium* agg. (*Heracleum sphondylium*, *H. sphondylium* subsp. *sibiricum*), *Lamium purpureum* agg. (*Lamium purpureum*, *L. purpureum* var. *hybridum*), *Ononis spinosa* agg. (*Ononis spinosa*, *O. spinosa* subsp. *hircina*), *Polygonum rurivagum* agg. (*Polygonum rurivagum*, *P. aviculare*), *Tragopogon pratensis* agg. (*Tragopogon pratensis*, *T. pratensis* subsp. *orientalis*), *Trifolium michelianum* agg. (*Trifolium michelianum*, *T. michelianum* var. *balansae*), *Vicia sativa* agg. (*Vicia sativa*, *V. sativa* subsp. *cordata*), *Vicia villosa* agg. (*Vicia villosa*, *V. villosa* subsp. *varia*).

Results

Based on the numerical analysis the syntaxonomical diversity of *Artemisietea vulgaris* class is presented by 2 orders, 3 alliances, 10 associations and 1 community. The syntaxonomical scheme proposed is:

Cl. *Artemisietea vulgaris* Lohmeyer et al. in Tx. ex von Rochow 1951

Ord. *Agropyretalia intermedio-repentis* Müller et Görs 1969*

All.*Convolvulo arvensis-Elytrigion repentis* Görs 1966*

Ass. *Convolvulo arvensis-Elytrigietum repentis* Felföldy 1943*

Ass. *Falcario vulgaris-Elytrigietum repentis* Müller et Görs 1969*

Ass. *Convolvulo arvensis-Brometum inermis* Eliáš 1979*

Ass. *Cardarietum drabae* Tímár 1950*

Ord. *Onopordetalia acanthii* Br.-Bl. et Tx. ex Klika et Hadač 1944

All. *Dauco-Melilotion* Görs ex Rostański et Gutte 1971*

Ass.*Tanaceto vulgaris-Artemisietum vulgaris* Sissingh 1950

Ass. *Melilotetum albo-officinalis* Sissingh 1950*

Ass. *Berteroetum incanae* Sissingh et Tideman ex Sissingh 1950*

Ass. *Poo compressae-Tussilaginetum farfarae* Tüxen 1931*

All. *Onopordion acanthii* Br.-Bl. et al. 1936

Ass. *Potentillo argenteae-Artemisietum absinthii* Faliński 1965*

Ass. *Carduo acanthoidis-Onopordetum acanthii* Soó ex Jarolímek et al. 1997

Achillea pannonica - Elytrigia repens plant community

The new syntaxa for vegetation of Bulgaria are marked with *.

Ass. *Convolvulo arvensis-Elytrigietum repentis* Felföldy 1943 (Table 1, cluster 1)

Constant species: *Elytrigia repens*, *Convolvulus arvensis*

Dominant species: *Elytrigia repens*

Distribution and ecology: This association has a wide distribution on the territory of Bulgaria along roads, park alleys, near buildings, parking lots and other anthropogenic areas. It is presented by 34 relevés (Fig. 1). It was found between 70 and 1250 m a.s.l. predominantly on flat terrains or with inclination up to 5-8°. The vegetation was sampled from the Sofia lowland (Sofia city, Elin Pelin, Gorna Malina, Slivnitsa, Bozhurishte municipalities), the Thracian plain (Chirpan municipality), Sredna Gora Mt (Ihtiman, Kostenets municipality), the Danubian plain (Nisovo municipality), the Znepole region (Breznik municipality), West Balkan Range (Etropole and Godech municipalities) and the northern Black Sea coast (Balchik municipality). The soils are moderately deep and the bedrock is diverse. Habitats are characterized by extensive sunlight.

Vegetation description and syntaxonomy: Its communities have closed horizontal structure with a total cover of 90-100%. The dominant species is *Elytrigia repens*. Species richness is between 4 and 39 species (an average of 18 species). *Elytrigia repens* is a geophyte, which has vegetative propagation with stolones. Its cover determines the different successional stages of development. In stands with cover of *Elytrigia repens* > 60% it has very strong shade effect. Other specific feature is high accumulation of litter as aboveground layer. *Convolvulus arvensis* is a constant species, with a different cover in the different samples of the association. Other ruderal species such as *Cirsium arvense*, *Carduus acanthoides*, *Berteroa incana*, *Cyanus segetum*, etc. are found in the species composition. Some diagnostic species for *Festuco-Brometea* (such as *Galium verum*, *Trifolium striatum*, *Potentilla argentea*, *Eryngium campestre*) and *Molinio-Arrhenatheretea* classes (e.g. *Agrostis capillaris*, *Poa pratensis*, *Alopecurus pratensis*, *Dactylis glomerata*) are also typical for the species composition.

The hemicryptophytes (H – 50.3%) prevailed in the species composition, followed by the therophytes (T – 32.4%), the biannuals (B – 7%) and the therophyte-biannuals (T-B – 6.6%). Euro-Asiatic (Eur-As – 19.5%), Euro-Mediterranean (Eur-Med – 13.7%), Euro-Siberian (Eur-Sib – 9.4%) and sub-Mediterranean (subMed – 8.6%) are dominant floristic elements in the species composition.

The ecology and the species composition of the association in Bulgaria are similar to its communities in other European countries – the Chezh Republic (Opálková & Cimalová, 2011; Láníková, 2013), the Russian Federation (Golovina, 2015), Romania (Sanda et al., 2008). According to Sanda et al. (2008) 4 subassociations are known for Romania - *convolvuletosum arvensis*, *lepidietosum drabae*, *cirsietosum arvense* and *rubetosum arvalis*.

Ass. *Falcario vulgaris-Elytrigietum repentis* Müller et Görs 1969 (Table 1, cluster 2)

Constant species: *Elytrigia repens*

Dominant species: *Falcaria vulgaris*

Distribution and ecology: This vegetation type is presented by 6 relevés (Fig. 1), which are distributed in the Sofia lowland (Sofia city, Slivnitsa municipality), West Forebalkan (Krivodol municipality) and Znepole region (Dragoman municipality). It covers an area up to 100 m^2 around arable fields and along roads. The altitudional range is between 147 and 665 m a.s.l. The terrains are flat or with inclination of up to 5°. The soils are moderately deep and frequently dry. This vegetation sometimes is mown.

Vegetation description and syntaxonomy: The communities have closed horizontal structure with a total cover of 100%. In the species composition dominant species is *Falcaria vulgaris* and subdominant is *Elytrigia repens*. In some stands other species with cover up to 25-30% are *Festuca pseudodalmatica*, *F. dalmatica*, *Rubus caesius*, *Poa angustifolia* and *Salvia amplexicaulis*. The number of species is between 12 and 24

(average 17). Frequently the communities of the *Falcario vulgaris-Elytrigietum repentis* association form mosaic with other antropogenic vegetation types of classes *Artemisietea vulgaris*, *Stellarietea mediae* and dry grassland of class *Festuco-Brometea* (alliance *Festucion valesiacae*). Other ruderal species in the species comoposition are *Rumex crispus*, *Lactuca serriola*, *Cichorium intybus*, *Lepidum draba*, *Artemisia absinthium*, *Carduus acanthoides* and *Lathyrus tuberosus*.

The hemicryptophytes (H – 47.7%) prevailed, followed by the therophytes (T – 26.2%), the biannuals (B – 12.3%) and the therophyte-biannuals (T-B – 7.7%). Chamaephytes are presented by 3.1%.The floristic elements dominant in the species composition are Euro-Asiatic (Eur-As – 18.5%), sub-Mediterranean (subMed – 16.9%), Euro-Mediterranean (Eur-Med – 13.9%), Euro-Siberian (Eur-Sib – 9.2%) and Boreal (7.7%).

The syntaxonomical diversity of *Elytrigia repens* communities in Bulgaria is poorly studied. According to Apostolova & Slavova (1997) 7 associations are described following the Dominance approach in the country. The *Falcario vulgaris-Elytrigietum repentis* association is well-know from other European countries (Mucina, 1993; Jarolímek et al. 1997; Láníková, 2013).

Ass. *Convolvulo arvensis-Brometum inermis* Eliáš 1979 (Table 1, cluster 3)

Constant species: *Convolvulus arvensis*

Dominant species: *Bromopsis inermis*

Distribution and ecology: It is found near arable fields, along roads and in proximity of shrub vegetation in different stages of succession. It forms horizontal narrow stripes. Terrains are flat or slightly inclined (up to 5°). So far it is found in the lowlands and the semi-mountainous regions in Western Bulgaria – Sredna Gora Mts, Western Balkan range and Sofia lowland. The altitudional range is 626 and 730 m a.s.l. (average 677 m). The habitats are shiny and during the summer there are long dry periods. The soils are moderately deep, whereas the bedrock type is predominantly silicate.

Vegetation description and syntaxonomy: This vegetation has closed horizontal structure with a total cover of 100%. There is a well-developed herb layer, but in some stands there are also single shrubs (such as *Prunus spinosa*, *Crataegus monogyna*, *Rubus* spp.). This is a species poor community dominated by grasses. The dominant species is *Bromopsis inermis* with a cover of 50-75%, which leads to a strong shade effect. The litter is accumulated above the ground and its cover is up to 70-80%, which increased the shading effect. The number of the species per plot varies between 3 and 24 species (average 14 species). Some xerophytic species of *Festuco-Brometea* class are found in the species composition, such as *Botriochloa ischaemum*, *Achillea collina*, *Poa angustifolia*, *Medicago falcata*, *Eryngium campestre*, *Euphorbia seguieriana* agg., and *Festuca pseudodalmatica*.

The hemicryptophytes (H – 53.9%) prevailed, followed by the therophytes (T – 20%), the therophyte-biannuals (T-B – 7.7%) and the biannuals (B – 6.2%). The chamaephytes are presented by 4.6%. The floristic elements that are dominant in the species composition are Euro-Asiatic (Eur-As – 29.2%), Euro-Mediterranean (Eur-Med – 20%), sub-Mediterranean (subMed – 10.8%), Euro-Siberian (Eur-Sib – 4.7.

The phytocoenoses of *Bromopsis inermis* have not been investigated in Bulgaria so far. *Convolvulo arvensis-Brometum inermis* is a well-known association of the *Artemisietea vulgaris* class in the European vegetation. The ecological preferences and the species composition of our stands is very similar to those given by Láníková (2009) for Czech Republic. In comparison to the Bulgarian stands, the Czeck ones have a higher number of ruderal species. This association is also known for Austria (Mucina, 1993) and Slovakia (Jarolímek et al., 1997).

Ass. *Cardarietum drabae* Tímár 1950 (Table 1, cluster 6)

Constant species: *Convolvulus arvensis*, *Elytrigia repens, Anisantha sterillis*

Dominant species: *Lepidium draba*

Distribution and ecology: This vegetation type inhabited diverse antropogenic habitats. It was found as stripe communities along roads (incl. such in arable areas), railways, as a mosaic with other ruderal vegetation types in proximity to arable fields. It is widely distributed in the country but in our data set it is presented by 4 relevés and was studied on the territory of the Thracian plain (Chirpan municipality), Western Sredna Gora (Elin Pelin municipality) and the Sofia lowland (Sofia-town municipality). It grows on flat and sunny terrains in the altitudional range 141-921 m a.s.l. (average 667 m). The soils are moderately-deep and the bedrock type is quite diverse.

Vegetation description and syntaxonomy: *Cardarietum drabae* includes monodominant communities of *Lepidium draba* with a cover of 50-75%. Other species with a cover up to 20-25% in some stands are *Anisantha sterillis*, *Convolvulus arvensis*, *Elytrigia repens*. The total vegetation cover is 80-100%. The horizontal structure is semi-open to closed. *Lepidium draba* does not have a strong shade effect and thus some annual termophylous plants such as *Holosteum umbellatum*, *Alyssum alyssoides*, *Trifolium striatum*, *Arenaria serpyllifolia* are also found in the species composition. Some diagnostic species for *Stellarietea mediae* class are also distributed, such as *Veronica polita*, *Lamium amplexicaule*, *Erodium cicutarium*, *Cota austriaca*, *Torilis japonica*.

This vegetation develops as a spring and early summer ruderal vegetation type. After mid-June it is replaced by other ruderal vegetation syntaxa mainly dominated by high herbs (such as *Artemisia vulgaris, Tanacetum vulgare*, etc.) and grasses (such as *Elytrigia repens*, *Dasypyrum villosum*, etc.).

The therophytes (T – 33.3%) prevailed, following by the hemicryptophytes (H – 29.8%), the therophyte-biannuals (T-B – 17.5%) and the biannuals (B – 8.8%). The chamaephytes are presented by 5.2%. The dominant floristic elements in the species composition are Euro-Asiatic (Eur-As – 29.8%), Euro-Mediterranean (Eur-Med – 19.3%), Euro-Siberian (Eur-Sib – 7%), sub-Mediterranean (subMed) and Boreal with 5.3%.

Mucina (1993), Jarolímek et al. (1997) and Coldea (2012) classified the communities of *Lepidium draba* to the association *Lepidio drabae-Agropyretum repentis* Müller er Görs 1969, which is a synonym of *Cardarietum drabae* Tímár 1950 (Láníková, 2009). Generally its communities in other parts of Europe are similar to those in Bulgaria but more data is required for comparison.

Ass. *Tanaceto vulgaris-Artemisietum vulgaris* Sissingh 1950 (Table 1, cluster 4)

Constant species: *Elytrigia repens*, *Artemisia vulgaris*, *Dactylis glomerata*, *Lactuca serriola*, *Cichorium intybus*

Dominant species: *Tanacetum vulgare*, *Artemisia vulgaris*

Distribution and ecology: Occurs in quite diverse habitats – abandoned arable fields and gardens, forestbelts, landfills, along roads and alluvial terrace of rivers, edges of fences and parking slots. From the territory of Bulgaria this community was recorded from the Sofia lowland, West Sredna Gora Mts, Lyulin Mt., the Dolna Banya-Kostenets lowland, the Danubian plain. It is distributed in the altitudional range 151-928 m a.s.l. (average 666 m) and predominantly on flat and sunny terrains. The soils are moderately deep, clay and dry during the summer period.

Vegetation description and syntaxonomy: This is a moderately species-poor community with closed horizontal structure and a total cover of 95-100%. The dominant species are high herbs *Tanacetum vulgare* and *Artemisia vulgaris*. There are 2 well-formed layers - a 1-2 m high herb layer presented by *Tanacetum vulgare*, *Artemisia vulgaris, Elytrigia repens* and a lower herb layer formed by other herbs (such as *Ballota nigra*, *Galium aparine*, *Tragopogon pratensis* agg.,

Vicia villosa agg., etc.) with up to 60-80 cm heigh. A dense litter cover (up to 60-80%) prevents the formation of a cryptogam layer.

The hemicryptophytes (H – 47.2%) prevailed, followed by the therophytes (T – 28.4%), the therophyte-biannuals (T-B – 8.7%) and the biannuals (B – 7.9%). The dominant floristic elements in the species composition are Euro-Asiatic (Eur-As – 22.8%), Cosmopolitan (Kos – 10.3%), Boreal (9.5%) and Euro-Siberian (Eur-Sib – 8.6%).

This association has been reported for the Bulgarian vegetation for the first time by Kolev (1965). Tzonev et al. (2009) classified it to the *Arction lappae* alliance, but we placed it in the *Dauco-Melilotion* alliance following the classification scheme suggested by Mucina et al. (2016). In the species composition we also found 2 variants – with *Artemisia vulgaris* and with *Tanacetum vulgare*, with concides with Láníková (2009) for Czech Republic.

Ass. *Melilotetum albo-officinalis* Sissingh 1950 (Table 1, clusters 5, 11)

Constant species: *Cichorium intybus*, *Plantago lanceolata*, *Elytrigia repens*, *Convolvulus arvensis*, *Carduus acanthoides*, *Anisantha sterillis*

Dominant species: *Melilotus albus*, *Melilotus officinalis*

Distribution and ecology: This vegetation type is presented by 17 relevés and is found on fully sunlit habitats between 115 and 1117 m a.s.l. (average 406 m) and predominantly on flat terrains. Its communities cover areas from 50-60 m^2 up to 200-250 m^2. This vegetation is formed in athropogenic areas – around parkings, arable fields, vineyards, industrial areas, quarries, along roads. It is distubuted in the Thracian plain (Bratya Daskalovi and Chirpan municipalities), the valley of the Struma river (South) (Petrich municipality), the Sofia lowland (Sofia-town and Bozhurishte municipalities), the Znepole region (Dragoman municipality), Sredna Gora Mts (Panagyurishte municipality) and the central Forebalkan (Gabrovo municipality). The soils are shallow to moderately deep but during most of the vegetation season they are dry. In some stands they are are also sandy. The bedrock type is quite diverse.

Vegetation description and syntaxonomy: From an ecological point of view this vegetation was separated in 2 clusters dominated by *Melilotus alba* (cluster 5) and *Melilotus officinalis* (cluster 11). The *Melilotus alba* group is found in xero-mesic habitats, which retain water for a longer period during the raining season. The soils are clay and moderately deep. Plants in the species composition with a cover up to 10-15% are *Dactylis glomerata*, *Dipsacus laciniatus*, *Rumex crispus*, *Lotus corniculatus*. *Melilotus officinalis* prefers warmer habitats with shallow to moderately-deep sandy soils. Most stands are also distributed at a lower altitude (between 115 and 400 m a.s.l.). This thermophilic community is richer of annual species such as *Sorghum halepense*, *Dasypyrum villosum*, *Vulpia ciliata*, *Scolymus hispanicus*, *Setaria viridis*, *Medicago minima*, *Anisantha sterillis*.

This association includes species-rich vegetation (average number of species is 22) and has semi-open to closed horizontal structure with a total cover of 80-100%. Two layers are well-formed in the vertical structure – a high herb layer (1-2 m high) formed by *Melilotus alba* and *M. officinalis* and a lower herb layer (up to 60-80 cm high) with quite diverse species compostion. Some species from neighbouring vegetation types are found in the species composition. In the submontane and mountainous regions species such as *Dactylis glomerata*, *Verbascum longifolium*, *Fagus sylvatica* (low shrub), *Scrophularia canina*, *Plantago major* which come from different mesic vegetation types (*Carpino-Fagetea* and *Molinio-Arrhenatheretea* classes) are also found.

The hemicryptophytes (H – 46.9%) prevailed, followed by the therophytes (T – 28.6%), the therophyte-biannuals (T-B – 10.2%) and the biannuals (B – 8.2%). The dominant floristic elements in the species composition are Euro-Asiatic (Eur-As – 22.5%), Euro-Mediterranean (Eur-Med – 18.4%), European (Eur), subBoreal and Euro-Siberian (Eur-Sib) presented with 7.1%.

Kolev (1965) reported the association *Echio-Melilotetum* Tüxen 1947 for the first time for the territory of Bulgaria. According to Jarolímek et al. (1997) and Láníková (2009) it is a synonym of the ass. *Melilotetum albo-officinalis* Sissingh 1950. For Slovakia the association is presented by 2 subassociations - *brometosum tectori* and *tussilaginetosum farfarae* (Jarolímek et al., 1997), which are not found in our data. In the Czech Republic the association has 3 variants with *Potentilla argentea*, *Carduus acanthoides* and *Agrostis capillaris* (Láníková, 2009).

Ass. *Berteroetum incanae* Sissingh et Tideman ex Sissingh 1950 (Table 1, cluster 9)

Constant species: *Cichorium intybus*, *Plantago lanceolata*, *Convolvulus arvensis*

Dominant species: *Berteroa incana*

Distribution and ecology: This plant community occurs on abandoned fields, near roads, parking slots and railways. It is presented by 9 relevés distributed in the Sofia lowland, the Valley of Struma River (South), Bansko and Kostenets-Dolna Banya lowlands. The habitats are sunny and arid and this vegetation is developed during the spring to early summer period. It is found on flat to moderately inclined terrains (up to 25°). The soils are shallow to moderately-deep.

Vegetation description and syntaxonomy: It has semi-closed to closed horizontal structure with total cover 75-100%. In the vertical structure there is one well-developed herb layer, dominated by *Berteroa incana*, which has cover 50-80%. The number of species in the vegetation plots is between 15 and 46 (an average of 26 species). The species composition includes some diagnostic species for ass. *Melilotetum albo-officinalis* (such as *Melilotus alba*, *Plantago lanceolata* and *Echium vulgare*) and ass. *Carduo acanthoidis-Onopordetum acanthii* (such as *Onopordon acanthium*, *Hordeum murinum* and *Cynoglossum officinale*), which shows floristical similarity between the communities.

The hemicryptophytes (H – 45.4%) prevailed, followed by the therophytes (T – 27.7%), the therophyte-biannuals (T-B – 10.9%) and the biannuals (B – 10.1%). The dominant floristic elements in the species composition were Euro-Asiatic (Eur-As – 18.5%), Euro-Siberian (Eur-Sib – 11.8%), Euro-Mediterranean (Eur-Med – 10.9%), Cosmopolitan (Kos – 10.1) and Boreal (7.6%).

Berteroetum incanae presents termophylic vegetation distributed mainly at a lower altitude and in more open and sunny habitats. In our data set 7 out of all 9 classified relevés are published by Mucina & Kolbek (1989) to association *Centaureo diffusae-Berteroetum* Oberd. 1957 (ord. *Eragrostietalia* Tüxen in Poli 1966). Tzonev et al. (2009) placed it in alliance *Amarantho-Chenopodion* Morariu 1943, which according to Mucina et al. (2016) is a synonym of all. *Eragrostion* Tx. in Oberd. 1954. Based on results from analysis the *Berteroa incana* dominated communities were classified to the class *Artemisietea vulgaris* and the *Berteroetum incanae* association. Its species composition and ecology are very similar to its communities from other parts of Europe (Jarolímek et al., 1997; Láníková, 2009; Coldea, 2012). For the territory of Romania Coldea (2012) also proposes 2 subassociations – *typicum* and *carduetosum thoermeri*.

Ass. *Poo compressae-Tussilaginetum farfarae* Tüxen 1931 (Table 1, cluster 10)

Constant species: -

Dominant species: *Tussilago farfara*

Distribution and ecology: This community is disturbed in ruderal habitats around quarries, embankements, construction sites, road edges and landslides. It is distributed in the mountainous regions of western Bulgaria (West Balkan Range, Lulin Mt., West Sredna Gora Mt. and Viskyar Mt) in the altitudinal range between 517 and 1844 m a.s.l. (average 905 m). It inhabits predominantly moderately-steep and steep terrains (45-80°) with different exposition. The habitats are sunny, eroded, with unstable soil substrate. The soils are shallow to moderately-deep, rich in skeleton materials and rocks.

Vegetation description and syntaxonomy: Moderately species-poor community (average number of species is 12) with open

horizontal structure and total cover 60-85%. Only in 2 stands, where soils substrate is stable and terrains are flat or with inclination up to 5° the total cover is 95-100%. The dominant species is *Tussilago farfara*. The species composition is quite diverse. It is formed by infiltration of species from neigbouring habitats and represents pioneer vegetation, often with a very heterogeneous species composition. Other species with a higher cover (10-15%) in some stands are *Epilobium lanceolatum*, *E. dodonaei*, *Plantago subulata*, *Melilotus officinalis*. Some other ruderal species found in the communitites are *Torilis arvensis*, *Dipsacus laciniatus*, *Cephalaria transsylvanica*, *Lactuca serriola*, *Cichorium intybus*, *Cirsium arvense*, *Polygonum rurivagum* agg., *Bromus arvensis*.

The hemicryptophytes (H – 57.8%) prevailed, followed by the therophytes (T – 17.2%), the therophyte-biannuals (T-B – 10.9%) and the biannuals (B – 6.3%). The dominant floristic elements in the species composition are Euro-Asiatic (Eur-As – 20.3%), Boreal (12.5%), Euro-Mediterranean (Eur-Med) and European (Eur) presented by 9.4%.

The phytocoenoses of *Tussilago farfara* have not been investigated in Bulgaria so far. *Poo compressae-Tussilaginetum farfarae* is a well-know association in different European countries – Romania (Coldea, 2012), the Czech Republic (Láníková, 2009), Slovakia (Jarolímek et al., 1997), Austria (Mucina, 1993).

Ass. *Potentillo argenteae-Artemisietum absinthii* Faliński 1965 (Table 1, cluster 7).

Constant species: *Lactuca serriola*, *Elytrigia repens*, *Cichorium intybus*, *Rumex crispus*, *Convolvulus arvensis*, *Anisantha sterillis.*

Dominant species: *Artemisia absinthium*

Distribution and ecology: This association is distributed in warmer habitats, abondoned intensive pastures, along roads, the edges of arable fields, close to infrastructure buildings and other urban areas. In the analyzed data set it is presented by 7 relevés from the Sofia region (near Negovan and Kazichane villages), Western Sredna Gora Mts (near Golyama Rakovitsa village), the Western Balkan Range (close to Eleshnitsa and Dragovishtitsa villages). It occurs both on flat and slightly inclined terrains (up to 5°) with varying expositions. The soils are shallow to moderately deep and in some stands they are rich in gravel and skeletons.

Vegetation description and syntaxonomy: It is a moderately species-rich community (the average number of species is 23) with semi-closed to closed horizontal structure and a total vegetation cover of 85-100% (average 94%). The dominant species is *Artemisia absinthium* with a cover of 50-80%. Other high ruderal species included in the phytocenoses are *Carduus acanthoides*, *Lactuca serriola*, *Elytrigia repens*, *Rumex crispus*. Some annual ruderal species also occur such as *Anisantha sterilis*, *Papaver rhoeas*, *Torilis arvensis*, *Polygonum rurivagum* agg., *Arenaria serpyllifolia*, *Petrorhagia prolifera*. There are 2 well-developed herb layers – a tall herb and a ground floor layers.

The hemicryptophytes (H – 39.4%) prevailed, followed by the therophytes (T – 33%), the therophyte-biannuals (T-B – 12.8%) and the biannuals (B – 9.6%). The dominant floristic elements in the species composition are Euro-Asiatic (Eur-As – 22.3%), Euro-Mediterranean (Eur-Med – 13.8%), Euro-Siberian (Eur-Sib – 10.6%) and subBoreal (8.5%).

On the territory of Bulgaria the syntaxonomy of *Artemisia absinthium* phytocoenses has been investigated by Mucina & Kolbek (1989), who established the *Ballota nigra-Artemisia absinthium* plant community, which is classified to the order *Onopordietalia*. Tzonev et al. (2009) placed it in the alliance *Onopordion acanthii* but during done analyses those relevés were not classified to the class *Artemisietea vulgaris*. Dimitrov et al. (2005) also determined *Artemisia absitnhium-Elytrigia repens* (*Elymus repens*) from landfill near Dolni Bogrov village. *Potentillo argenteae-Artemisietum absinthii* is a well-known association of the

alliance *Onopordion acanthii* in Europe (Mucina, 1993; Jarolímek et al., 1997; Láníková, 2009; Coldea, 2012).

Ass. *Carduo acanthoidis-Onopordetum acanthi* Soó ex Jarolímek et al. 1997 (Table 1, clusters 8, 13)

Constant species: *Lactuca serriola*, *Daucus carota*, *Galium aparine*, *Elytrigia repens*, *Convolvulus arvensis*, *Anisantha sterillis*,

Dominant species: *Carduus acanthoides*, *Onopordon acanthium*

Distribution and ecology: It is a widely distributed association on the territory of Bulgaria (presented by 40 relevés in the analyzed data set). It is found in the Sofia lowland, the Thracian planin, the Danubian plain, Eastern and Western Sredna Gora Mts, West Balkan Range and Viskyar Mt. This vegetation is found in sunny open habitats such as landfills, around farming houses, etc. It occurs in the altitiudional range 123-851 m a.s.l. (average 468 m) on both flat to slightly inclined with varying expositions terrains (up to 10°). The soils are moderately deep and nutrient rich soils. The bedrock type is rather diverse.

Vegetation description and syntaxonomy: This vegetation is presented by 2 clusters dominated by *Carduus acanthoides* or *Onopordon acanthium*. The species composition is very diverse. In the communities dominated by *Carduus acanthoides* (cluster 8) the average number of species is 23, whereas for the *Onopordon acanthium* (cluster 13) stands the average number of species is 13. The structure of both phytocenoses is predominantly closed with a total cover of 95-100%. The total cover is 70-75% only in 3 stands, which are in different stage of successions. The *Carduus acanthoides* phytocoenoses formed more heterogenous habitats, which included many annual and biennual species. *Onopordon acanthium* with its wider leaves has a stronger shade effect and the accumulation of litter in the stands is substantial, which determines a lower species diversity.

In the vertical structure 2 layers are formed – a high herb layer with ediphicators *Carduus acanthoides* and *Onopordon acanthium* and a low herb layer with quite diverse species composition. Other ruderal species participating in the species composition are *Lactuca serriola*, *Artemisia vulgaris*, *Lamium purpureum* agg., *Papaver rhoeas*, *Elytrigia repens*, *Erigeron canadensis*, *Dipsacus laciniatus*.

The therophytes (T – 42.3%) prevailed, followed by the hemicryptophytes (H – 28.6%), the therophyte-biannuals (T-B – 16.3%) and the biannuals (B – 9.2%). The dominant floristic elements in the species composition were Euro-Asiatic (Eur-As – 26.5%), Euro-Mediterranean (Eur-Med – 15.3%), subMediterranean (13.3%) and subBoreal (6.1%).

Carduo acanthoidis-Onopordetum acanthi was reported for the first time for the Bulgarian vegetation by Mucina & Kolbek (1989). Kolev (1965) classified the *Onopordon acanthium* phytocoenoses to the ass. *Onopordetum acanthii* Braun-Blanq. 1936. According to Mucina (1989) this association is tied to the continental deep valleys of the Alps and the Pyrenees and may secondarily occur in other parts of Western Europe, where it is tied to dry valleys in the rain shadow of the mountains. On the other hand *Carduo acanthoidis-Onopordetum acanthi* association has wider distribution in Europe with 2 geographical races – a more mesophilic western race occurring in the northern and western parts of Central Europe and a more drought-loving Eastern European race.

Achillea pannonica - *Elytrigia repens* plant community (Table 1, cluster 12)

Constant species: *Elytrigia repens*, *Cichorium intybus*, *Anisantha sterillis*, *Melilotus officinalis*, *Matricaria chamomilla*

Dominant species: *Elytrigia repens*

Distribution and ecology: This community has local distribution on the landfill near Dolni Bogrov village, closely to Sofia. All relevés are digitized from literature (Dimitrov et al., 2005).

Vegetation description and syntaxonomy: It has a semi-open to closed horizontal

structure with a total cover of 70-100%. The dominant species is *Elytrigia repens*. It was described by Dimitrov et al. (2005) and it includes 2 subcommunities – a *Hordeum murinum-Poa annua* variant with *Descurainia sophia* and an *Artemisia absinthium-Elytrigia repens* variant with *Dipsacus fullonum*. Some species of other ruderal classes like *Sisymbrietea* are found in the species composition (such as *Crepis tectorum*, *Artemisia annua*, *Erodium cicutarium*, *Descurainia sophia*), *Polygono-Poetea annuae* (such as *Plantago major*, *Ochlopoa annua*), *Epilobietea angustifoliae* (e.g. *Dipsacus fullonum*, *Symphytum officinale*), *Digitario sanguinalis-Eragrostietea minoris* (e.g. *Amaranthus deflexus*, *Cynodon dactylon*). Additionally, some diagnostic species for neighbouring grasslands of classes *Festuco-Brometea* (such as *Inula britannica*, *Potentilla argentea*, *Medicago falcata*, *Eryngium campestre*) and *Molinio-Arrhenatheretea* (such as *Alopecurus pratensis*, *Poa pratensis*, *Mentha arvensis*, *Veronica chamaedrys*, *Lotus corniculatus*) also occur.

The hemicryptophytes (H – 44.6%), prevailed, followed by the therophytes (T – 32.3%), the biannuals (B – 9.2%) and the therophyte-biannuals (T-B – 6.2%). The dominant floristic elements in the species composition were Euro-Asiatic (Eur-As – 29.2%), Euro-Mediterranean (Eur-Med – 18.5%), Boreal and Cosmopolitan (Kos) presented by 7.7% and Pontic-Mediterranean (Pont-Med – 6.2%).

Vegetation – environment relationships

The studied associations are well separated in the ordination and the ecological space (Fig. 2). The first axis was related to the continentality and temperature conditions. Association *Poo compressae–Tussilaginetum farfarae* was found in steep and fully light habitats with high radiation. The soils were eroded and unstable. All the other syntaxa were predominantly distributed on flat or slightly inclined terrains and arid habitats, where the soil radiadion is lower. The variability expressed by the second axis may be associated with the soil conditions – soil depth, moisture and nutrient conditions. The stands of the alliance *Dauco-Melilotion* have semi-closed to closed horizontal structure, where soils are with a high content of gravel and skeleton materials, which are dry and poor of nutirients. This vegetation represents the initial stages of the succession of antropogenic habitats. On the other hand the associations of the alliances *Convolvulo arvensis-Elytrigion repentis* and *Onopordion acanthii* represent more stable antropogenic vegetation types. The soils are rich in nutrients and the soil moisture is higher because of the stronger shade effect and the higher litter accumulation. This determined the lower species richness in comparison to the *Dauco-Melilotion* associations.

Table 1. Synoptic table for class *Artemisietea vulgaris* Lohmeyer et al. in Tx. ex von Rochow 1951 in Bulgaria. In the table Fidelity is given as Phi, whereas Percentage frequency is given as PF. Were used following abbreviations for syntaxa: CE - ass. *Convolvulo arvensis-Elytrigietum repentis*, FE - ass. *Falcario vulgaris-Elytrigietum repentis* , CB - ass. *Convolvulo arvensis-Brometum inermis*, TA - ass. *Tanaceto vulgaris-Artemisietum vulgaris*, MAO - ass. *Melilotetum albo-officinalis*, CD - ass. *Cardarietum drabae*, PA - ass. *Potentillo argenteae-Artemisietum absinthii*, CO - ass. *Carduo acanthoidis-Onopordetum acanthii*, BI - ass. *Berteroetum incanae*, PT - ass. *Poo compressae–Tussilaginetum farfarae*, AE - *Achillea pannonica-Elytrigia repens* plant community. Legend: [1] - Diagnostic species for ass. *Potentillo argenteae-Artemisietum absinthii*, ass.*Tanaceto vulgaris-Artemisietum vulgaris*, cl. *Artemisietea vulgaris*; [2]- Diagnostic species for ass. *Tanaceto vulgaris-Artemisietum vulgaris*, all. *Dauco-Melilotion*, cl. *Artemisietea vulgaris*; [3] - Diagnostic species for ass. *Melilotetum albo-officinalis*, ass. T*anaceto vulgaris-Artemisietum vulgaris*, all. *Dauco-Melilotion*, *Onopordion acanthii &*cl. *Artemisietea vulgaris*; [4] - Diagnostic species for ass. *Berteroetum incanae*, ass. *Melilotetum albo-officinalis*, all. *Dauco-Melilotion*, *Onopordion acanthii &* cl. *Artemisietea vulgaris*; [5]- Diagnostic species for all.

Onopordion acanthii; [6] - Diagnostic species for ass. *Potentillo argenteae-Artemisietum absinthii*, all. *Onopordion acanthii* &cl. *Artemisietea vulgaris*; [7]-Diagnostic species for ass. *Carduo acanthoidis-Onopordetum acanthii*, ass. *Potentillo argenteae-Artemisietum absinthii*, ass. *Berteroetum incanae*, all. *Onopordion acanthii* &cl. *Artemisietea vulgaris*; [8] - Diagnostic species for ass. *Carduo acanthoidis-Onopordetum acanthii*, ass. *Melilotetum albo-officinalis*, all. *Dauco-Melilotion* & *Onopordion acanthii*; [9] - Diagnostic species for ass. *Potentillo argenteae-Artemisietum absinthii*, ass. *Carduo acanthoidis-Onopordetum acanthii* & all. *Onopordion acanthii*; 10 - Diagnostic species for ass. *Berteroetum incanae*, ass. *Falcario vulgaris-Elytrigietum repentis.*

Life forms	Floristic elements	Number of cluster	1	2	3	4	5	6	7	8	9	10	11	12	13
		Syntaxa	CD	FE	CB	TA	MAO	CD	PA	CO	BI	PT	MAO	AE	CO
		Number of releves	34	6	6	15	6	4	7	17	9	8	12	13	23
		Phi/PF	Phi/PF	Phi/PF	Phi/PF	Phi/PF	Phi/PF	Phi/PF	Phi/PF	Phi/PF	Phi/PF	Phi/PF	Phi/PF	Phi/PF	Phi/PF
Diagnostic species for ass. *Convolvulo arvensis-Elytrigietum repentis*															
H	Boreal	*Elytrigia repens*[1]	22.4 100	— 100	— 33	— 73	— 67	— 75	— 86	— 53	— 33	—	— 33	22.4 100	— 57
Diagnostic species for ass. *Falcario vulgaris-Elytrigietum repentis*															
B	Eur-As	*Falcaria vulgaris*	—	91.2 100	—	— 7	—	—	—	— 12	—	—	—	—	—
H	Eur-Sib	*Centaurea scabiosa*	—	39.5 17	—	—	—	—	—	—	—	—	—	—	—
Diagnostic species for ass. *Convolvulo arvensis-Brometum inermis*															
H	Eur-As	*Bromopsis inermis*	—	—	100 100	—	—	—	—	—	—	—	—	—	—
H	Kos	*Poa angustifolia*	9.3 32	— 50	34.2 67	— 20	—	— 25	— 14	— 6	— 11	—	— 25	—	— 4
H	Kos	*Convolvulus arvensis*[10]	17 79	— 17	— 83	— 27	— 50	— 100	— 57	— 53	— 56	—	— 58	—	— 70
Diagnostic species for ass. *Tanaceto vulgaris-Artemisietum vulgaris*															
H	Eur-Sib	*Tanacetum vulgare*[2]	—	—	— 17	53.2 67	— 17	—	—	— 12	— 11	— 13	—	—	—
H	subBoreal	*Artemisia vulgaris*[3]	— 3	—	— 17	29.7 73	— 50	—	— 43	— 24	— 44	—	— 17	32.1 77	— 9
Diagnostic species for ass. *Melilotetum albo-officinalis*															
T	subBoreal	*Melilotus albus*[4]	— 3	—	—	— 7	67.4 83	—	— 14	—	20.9 33	—	—	—	—
T	Eur-As	*Melilotus officinalis*[8]	— 4	—	— 17	— 13	— 50	—	—	— 12	—	— 13	57 100	23.9 54	— 4
H	Kos	*Plantago lanceolata*	— 12	— 17	— 33	— 27	— 67	— 50	— 14	— 24	18.6 67	—	13.6 58	34.1 92	— 4
B	Eur-As	*Echium vulgare*	—	—	—	— 13	30.1 50	— 24	— 14	— 18	25.5 44	—	— 8	— 8	—
Diagnostic species for ass. *Cardarietum drabae*															
T-B	Kos	*Capsella bursa-pastoris*	— 9	—	—	— 7	— 17	— 25	— 29	— 29	— 11	—	— 17	55.4 100	— 25
H	Eur-Med	*Lepidium draba*	— 6	— 33	— 17	—	— 33	50.6 100	— 29	— 12	— 22	—	— 17	14.5 46	— 4
H	Boreal	*Bromus hordeaceus*	— 3	—	—	—	—	—	35.4 29	—	26.2 22	—	—	—	—
Diagnostic species for ass. *Potentillo argenteae-Artemisietum absinthii*															
H	Pont-Med	*Artemisia absinthium*[5]	— 6	— 17	—	— 20	— 17	—	61.7 100	— 6	— 22	—	—	21.2 46	—
H	Eur-Med	*Ballota nigra*[6]	—	—	—	— 21	— 18	—	—	— 7	30.5 56	—	—	53.2 85	— 30
Diagnostic species for ass. *Carduo acanthoidis-Onopordetum acanthii*															
T	Eur-Med	*Onopordum acanthium*[9]	— 6	—	—	— 7	—	—	—	— 24	— 22	—	— 17	— 38	65.1 100
B	Med	*Carduus acanthoides*[7]	— 9	— 33	—	— 20	— 17	— 25	— 29	46.4 100	—	—	19.6 58	— 46	— 26
T	Boreal	*Hordeum murinum*	—	— 17	—	— 8	—	—	— 14	— 6	— 33	—	—	33.6 54	28.6 48
B	SPont	*Cynoglossum officinale*	—	—	—	—	—	—	—	— 7	39.8 22	—	—	—	—
B	Eur	*Verbascum phlomoides*	—	—	—	—	—	—	36.5 14	—	—	—	—	—	—
Diagnostic species for ass. *Berteroetum incanae*															
H	SPont	*Berteroa incana*	— 3	—	—	— 20	— 17	—	—	— 6	81.3 100	—	—	—	—
H	Eur-Sib	*Cichorium intybus*	— 24	— 33	—	— 53	32.8 100	—	— 71	— 24	19.8 78	— 13	18.2 75	23.8 85	— 13
H	Eur-Sib	*Linaria vulgaris*	— 15	— 17	—	— 13	— 33	— 25	— 29	— 12	— 11	— 13	— 8	—	—
Diagnostic species for ass. *Poo compressae-Tussilaginetum farfarae*															
H	Eur-As	*Tussilago farfara*	—	—	—	—	— 17	—	—	—	— 11	84.4 100	— 8	—	—
Diagnostic species for community of *Achillea pannonica - Elytrigia repens*															
H	Pann-Bal	*Achillea pannonica*	—	—	—	—	—	—	—	—	—	—	—	100 100	—
Diagnostic species for alliance *Dauco-Melilotion*															
H	Eur-subMed	*Rumex acetosella*	— 6	—	—	—	— 17	—	—	—	— 11	—	—	34.3 31	—
Diagnostic species for alliance *Onopordion acanthii*															
T	subMed	*Xeranthemum annuum*	— 9	—	— 17	—	—	52.1 50	—	— 6	—	—	—	—	—

Diagnostic species for order *Onopordetalia*, order *Agropyretalia repentis* & class *Artemisietea vulgaris*															
H	Eur-Med	*Centaurea solstitialis*	— ^{12}	—	—	—	— ^{17}	— ^{25}	— ^{14}	— ^{29}	—	—	— ^{33}	59.5 ^{100}	— ^{17}
H	Eur-As	*Marrubium vulgare*	—	—	—	—	—	—	—	—	—	—	—	53.9 ^{31}	—
H	subMed	*Geranium pyrenaicum*	—	—	—	—	—	48.5 ^{25}	—	—	—	—	—	—	—
T	SPont	*Torilis ucranica*	—	—	—	—	39.5 ^{17}	—	—	—	—	—	—	—	—
B	Med	*Scolymus hispanicus*	—	—	—	—	—	—	—	—	—	—	39.5 ^{17}	—	—
H	subMed	*Verbascum densiflorum*	—	—	—	— ^{7}	—	—	—	—	39.2 ^{22}	—	—	—	—
B	Eur-OT	*Dipsacus laciniatus*	— ^{3}	— ^{17}	—	— ^{7}	37.9 ^{50}	—	—	12.7 ^{24}	—	— ^{25}	— ^{8}	—	—
H	subMed	*Salvia verticillata*	—	34.1 ^{33}	— ^{17}	— ^{13}	—	—	—	— ^{12}	—	—	—	—	—
H	Eur-Sib	*Saponaria officinalis*	—	—	—	—	—	—	— ^{14}	—	33.9 ^{22}	—	—	—	—
H	Eur-Sib	*Achillea millefolium*	— ^{18}	— ^{50}	—	30.8 ^{60}	— ^{17}	— ^{50}	—	— ^{35}	— ^{11}	—	—	—	—
Diagnostic species for class *Stellaretea mediae*															
T	Kos	*Chenopodium album*	— ^{3}	— ^{17}	—	— ^{20}	—	—	—	— ^{29}	— ^{25}	—	—	56.6 ^{85}	— ^{17}
T	Eur-As	*Euphorbia helioscopia*	— ^{9}	—	—	—	—	—	— ^{14}	— ^{6}	—	—	—	46.7 ^{46}	— ^{9}
H	Eur-As	*Sonchus arvensis*	— ^{3}	—	—	—	—	—	—	—	—	—	39.5 ^{15}	—	—
T	Eur-Sib	*Silene noctiflora*	—	—	—	—	—	—	36.5 ^{17}	—	—	—	—	—	—
T	Eur-Med	*Cyanus segetum*	33.1 ^{12}	—	—	—	—	—	—	—	—	—	—	—	—
T	Eur-subMed	*Adonis aestivalis*	— ^{6}	—	—	—	—	—	—	30.9 ^{18}	—	—	—	—	— ^{4}
Diagnostic species for class *Sisymbrietea*															
T	Eur-Sib	*Crepis tectorum*	—	—	—	—	—	—	—	—	—	—	—	72 ^{54}	—
T	Eur-Med	*Artemisia annua*	—	—	—	—	—	—	—	—	—	—	—	66.5 ^{46}	—
T	subBoreal	*Erodium cicutarium*	— ^{3}	— ^{17}	—	— ^{7}	— ^{17}	— ^{50}	— ^{14}	— ^{6}	— ^{22}	—	— ^{8}	53.7 ^{92}	— ^{13}
T-B	Eur-As	*Descurainia sophia*	—	—	—	—	—	—	—	—	—	—	—	46.7 ^{31}	— ^{9}
T	Kos	*Chenopodium strictum*	—	—	—	—	—	—	—	—	45.7 ^{22}	—	—	—	—
T-B	Eur-As	*Malva pusilla*	—	—	—	—	—	—	—	—	45.7 ^{23}	—	—	—	—
T-B	subMed	*Bromus squarrosus*	—	—	—	—	—	—	42.8 ^{29}	—	— ^{11}	—	—	—	—
T-B	Eur-As	*Sisymbrium orientale*	—	—	—	—	—	—	—	—	37.6 ^{22}	—	—	—	— ^{9}
Diagnostic species for class *Polygono-Poeteae annuae*															
T	Kos	*Ochlopoa annua*	— ^{6}	—	—	—	—	—	—	— ^{6}	— ^{22}	—	—	83.7 ^{100}	— ^{4}
T-B	Eur-As	*Herniaria glabra*	—	—	—	—	—	—	—	—	45.7 ^{22}	—	—	—	—
B-H	Kos	*Plantago major*	— ^{3}	—	—	— ^{7}	42.3 ^{50}	—	—	— ^{12}	— ^{11}	—	—	22.6 ^{31}	—
Diagnostic species for class *Epilobietea angustifolii*															
B	Eur-OT	*Dipsacus fullonum*	— ^{3}	—	—	—	—	—	—	—	—	—	—	51.2 ^{31}	—
H	Eur-As	*Symphytum officinale*	— ^{4}	—	—	—	—	—	—	—	—	—	—	51.2 ^{32}	—
T-B	Eur-As	*Conium maculatum*	— ^{12}	—	— ^{17}	— ^{13}	— ^{17}	—	— ^{14}	— ^{6}	—	—	— ^{17}	—	40.3 ^{57}
H	Adv	*Fallopia* x *bohemica*	—	—	—	—	39.5 ^{17}	—	—	—	—	—	—	—	—
T	Eur	*Veronica sublobata*	—	—	—	—	39.5 ^{18}	—	—	—	—	—	—	—	—
H	Eur	*Euphorbia polychroma*	—	—	—	—	—	—	36.5 ^{14}	—	—	—	—	—	—
Diagnostic species for class *Papaveretea rhoeadis*															
T	Eur-As	*Alopecurus myosuroides*	— ^{18}	—	—	— ^{7}	— ^{17}	52.9 ^{75}	—	13.9 ^{29}	—	—	— ^{17}	—	— ^{9}
T	Eur-Sib	*Papaver rhoeas*	— ^{3}	— ^{17}	—	— ^{13}	—	—	47.8 ^{71}	— ^{24}	— ^{11}	—	— ^{17}	—	— ^{26}
T	Eur-As	*Lamium amplexicaule*	— ^{3}	—	—	—	—	45.5 ^{25}	—	—	—	—	—	—	—
T	Eur-As	*Veronica polita*	— ^{3}	—	—	—	—	45.5 ^{26}	—	—	—	—	—	—	—
T	Eur-Med	*Vicia tetrasperma*	—	—	39.5 ^{17}	—	—	—	—	—	—	—	—	—	—
T	Eur-Med	*Vicia pannonica*	—	—	—	—	—	—	—	—	—	—	35.7	—	—
T	Eur-Med	*Ranunculus arvensis*	—	—	—	—	—	—	—	33.1 ^{12}	—	—	—	—	—
T	Eur-Med	Cyanus segetum	33.1 ^{12}	—	—	—	—	—	—	—	—	—	—	—	—
Diagnostic species for class *Chenopodietea*															
T	subMed	*Cota altissima*	— ^{6}	—	—	—	—	—	— ^{14}	— ^{6}	— ^{11}	—	— ^{8}	48.9 ^{54}	— ^{4}
T	Eur-Med	*Vicia sativa agg.*	— ^{15}	—	— ^{17}	—	—	44.7 ^{50}	—	— ^{6}	—	—	— ^{17}	—	—
T	subMed	*Dasypyrum villosum*	—	—	—	—	—	—	— ^{29}	—	—	—	43 ^{42}	—	— ^{9}
B	subMed	*Echium italicum*	—	—	39.5 ^{17}	—	—	—	—	—	—	—	—	—	—
T	Med-Cas	*Vulpia ciliata*	—	—	—	—	—	—	—	—	—	—	39.5 ^{17}	—	—
T	Eur-As	*Vicia peregrina*	—	39.5 ^{17}	—	—	—	—	—	—	—	—	—	—	—
T	Eur-Med	*Alyssum simplex*	—	—	—	—	—	—	36.5 ^{14}	—	—	—	—	—	—
H	Eur-As	*Rumex pulcher*	—	—	—	—	—	—	—	—	—	—	—	—	34.9 ^{13}
Diagnostic species for class *Digitario sanguinalis-Eragrostietea minoris*															

T	Adv	*Amaranthus deflexus*	—	—	—	—	—	—	—	—	—	—	—	91.4 85	—
H	subMed-As	*Sorghum halepense*	—	—	—	—	—	—	—	—	—	—	48.5 25	—	—
T	Eur-Sib	*Plantago arenaria*	—	—	—	—	—	—	—	—	45.7 22	—	—	—	—
H	Boreal	*Anisantha tectorum*	—	—	—	—	—	—	—	—	45.7 23	—	—	—	—
T	Boreal	*Dysphania botrys*	—	—	—	—	—	—	—	—	45.7 24	—	—	—	—
H	Kos	*Cynodon dactylon*	—	—	—	— 7	— 17	—	— 29	— 18	35 56	—	— 17	— 15	— 22
T	Boreal	*Setaria viridis*	— 3	—	—	—	— 17	—	—	—	31.1 22	—	—	—	—
Diagnostic species for class *Festuco-Brometea*															
H	Boreal	*Erigeron acer*	—	—	—	—	—	—	—	—	—	—	—	66.5 46	—
H	Pont-Med	*Achillea coarctata*	—	—	—	—	—	—	—	—	65.2 44	—	—	—	—
H	subMed	*Cynoglottis barrelieri*	—	—	—	—	—	—	—	—	65.2 45	—	—	—	—
T	Eur-Med	*Trifolium striatum*	— 9	—	—	—	—	56.8 50	—	— 12	—	—	—	—	—
H	Pann-Bal	*Achillea crithmifolia*	—	—	—	—	—	—	—	—	56.2 33	—	—	—	—
H	Eur-Sib	*Artemisia campestris*	—	—	—	— 7	—	—	—	—	50.6 33	—	—	—	—
H	subMed-As	*Bothriochloa ischaemum*	—	—	49.4 33	—	—	—	—	—	—	—	— 8	—	—
B	Eur-Sib	*Chondrilla juncea*	— 3	—	—	—	—	—	— 14	—	46.6 44	—	— 17	—	—
B	Eur-Med	*Inula britannica*	—	—	—	—	—	—	—	—	—	—	—	46.6 23	—
B	Pont-subMed	*Silene bupleuroides*	—	—	—	—	—	—	—	—	45.7 22	—	—	—	—
B	Eur-Med	*Lactuca viminea*	—	—	—	—	—	—	—	—	45.7 22	—	—	—	—
H	Eur-subMed	*Achillea collina*	— 3	—	44 33	—	—	—	— 14	—	—	—	—	—	—
H	SPont	*Potentilla argentea*	— 12	—	—	— 27	— 17	— 25	— 14	—	—	—	— 8	42.5 62	—
H	Eur-Med	*Inula oculus-christi*	—	—	39.5 17	—	—	—	—	—	—	—	—	—	—
H	subMed	*Anthericum liliago*	—	39.5 17	—	—	—	—	—	—	—	—	—	—	—
H	Eur-As	*Poa bulbosa*	—	—	—	—	—	—	—	—	37.9 22	—	— 8	—	—
H	Pont-Med	*Trifolium leucanthum*	— 3	—	—	—	—	—	—	—	—	—	35.9 17	—	—
B	CSEur	*Erysimum diffusum*	— 6	—	—	—	—	—	—	—	34 22	—	— 8	—	—
H	Eur-As	*Medicago falcata*	— 6	— 17	32.4 33	—	— 17	—	—	—	—	—	—	— 8	—
H	Eur-As	*Euphorbia seguieriana agg.*	—	—	32.8 33	— 7	— 18	—	—	— 12	— 11	—	—	—	—
T	Eur-As	*Medicago minima*	— 3	—	—	—	—	—	31.3 29	—	—	—	37.6 33	—	—
H	Pont-Med	*Eryngium campestre*	— 18	—	31.5 50	—	—	— 50	— 14	— 12	— 11	—	— 8	— 9	—
Diagnostic species for class *Molinio-Arrhenatheretea*															
H	Eur-As	*Mentha arvensis*	— 3	—	—	—	—	—	—	—	—	—	—	75.2 62	—
H	Eur-As	*Alopecurus pratensis*	— 15	—	—	— 5	— 17	—	—	— 6	—	—	—	70.9 85	— 4
H	Kos	*Poa pratensis*	— 18	—	—	— 27	— 17	—	—	— 6	—	—	—	65.6 85	—
B	subMed	*Crepis biennis*	— 3	—	—	—	61.7 50	—	—	—	—	—	— 8	—	—
H	Eur-As	*Veronica chamaedrys*	— 6	—	—	—	—	—	—	—	—	—	—	48.7 31	—
H	Boreal	*Rumex crispus*	— 21	— 50	— 17	— 20	42.8 83	—	24.5 57	— 29	—	—	— 8	—	—
H	Eur-Med	*Lotus corniculatus*	—	—	— 17	— 7	38.2 67	— 25	—	— 18	—	25.3 50	—	16.5 38	—
T	Eur-Med	*Trifolium dubium*	— 3	—	— 17	—	— 17	—	—	—	35.9 33	—	—	—	—
H	Eur-As	*Dactylis glomerata*	— 24	— 33	— 17	19.8 60	34.7 83	—	— 43	— 24	— 33	— 38	— 8	—	— 13
H	Kos	*Prunella vulgaris*	33.1 12	—	—	—	—	—	—	—	—	—	—	—	—
Diagnostic species for class *Trifolio-Geranietea sanguinei*															
H	Eur-Sib	*Astragalus cicer*	—	39.5 17	—	—	—	—	—	—	—	—	—	—	—
H	Med-OT	*Silene coronaria*	—	—	—	35.3 13	—	—	—	—	—	—	—	—	—
Diagnostic species for class *Crataego-Prunetea*															
Ch-P	Eur-As	*Prunus cerasifera*	—	—	— 17	— 7	—	—	—	—	—	—	— 8	42.3 38	—
P	subMed	*Pyrus communis* subsp. *pyraster*	—	—	—	—	—	—	—	—	—	—	39.5 17	—	—
Other species with Phi>30															
B-H	Bal-Anat	*Tripleurospermum tenuifolium*	—	—	—	—	—	—	—	—	—	—	—	100 100	—
T	Eur-As	*Holosteum umbellatum*	—	—	—	—	—	69.3 50	—	—	—	—	—	—	—
T-B	Eur-Med	*Alyssum alyssoides*	—	—	—	—	—	69.3 50	—	—	—	—	—	—	—
B	subMed	*Centaurea stoebe*	— 3	—	—	— 7	—	—	—	— 6	57.8 56	—	—	—	—
T	Kos	*Polygonum arenastrum*	—	—	—	—	—	—	—	—	56.2 33	—	—	—	—

H	Eur-Sib	*Cota tinctoria*	—	—	—	—	—	—	—	—	— [11]	— [13]	—	52.2 [46]	—
H	Pont-Med	*Bituminaria bituminosa*	—	—	—	—	—	—	—	—	—	—	48.5 [25]	—	—
T	Eur-As	*Persicaria hydropiper*	—	—	—	—	—	—	—	—	—	48.5 [25]	—	—	—
Ch	Carp-Bal	*Syringa vulgaris*	—	—	—	—	—	48.5 [25]	—	—	—	—	—	—	—
T	Pont-Med	*Petrorhagia prolifera*	— [3]	—	—	—	—	—	47 [43]	—	— [11]	—	—	— [15]	—
H	Eur-Med	*Scrophularia canina*	—	—	—	—	39.5 [17]	—	—	—	—	—	—	—	—
T	Eur-Med	*Senecio leucanthemifolius subsp. vernalis*	—	—	—	—	39.5 [17]	—	—	—	—	—	—	—	—
T	Eur-Med-CAs	*Draba verna*	—	—	—	—	39.5 [17]	—	—	—	—	—	—	—	—
H	Eur-Med	*Verbascum longifolium*	—	—	—	—	39.5 [17]	—	—	—	—	—	—	—	—
P	Eur	*Fagus sylvatica*	—	—	—	—	39.5 [18]	—	—	—	—	—	—	—	—
P	Adv	*Robinia pseudoacacia*	—	—	—	— [7]	—	—	—	39.2 [22]	—	—	—	—	—
H	Pont	*Festuca valesiaca*	—	—	—	—	—	39 [25]	—	—	—	—	—	—	—
H	subBoreal	*Lythrum salicaria*	—	—	—	—	—	—	36.5 [17]	—	—	—	—	—	—
H	Eur	*Anchusa hybrida*	—	—	—	—	—	—	36.5 [14]	—	—	—	—	—	—
H	Eur-Med	*Rumex sanguineus*	—	—	—	—	—	—	36.5 [14]	—	—	—	—	—	—
H	Eur-Med	*Scleranthus perennis*	—	—	—	—	—	—	36.5 [15]	—	—	—	—	—	—
H	Eur-Sib	*Vincetoxicum hirundinaria*	—	—	—	—	—	—	36.5 [14]	—	—	—	—	—	—
T-B	Med	*Cirsium ligulare*	— [3]	—	—	— [13]	—	—	—	—	—	35.9 [25]	—	—	—
T	Eur-Med	*Vicia hirsuta*	— [12]	—	34.7 [50]	— [7]	—	— [25]	— [29]	— [12]	—	—	—	— [17]	—
T-B	subMed	*Vicia grandiflora*	— [6]	33.7 [50]	— [17]	— [20]	—	— [25]	— [14]	— [12]	—	—	—	—	— [13]

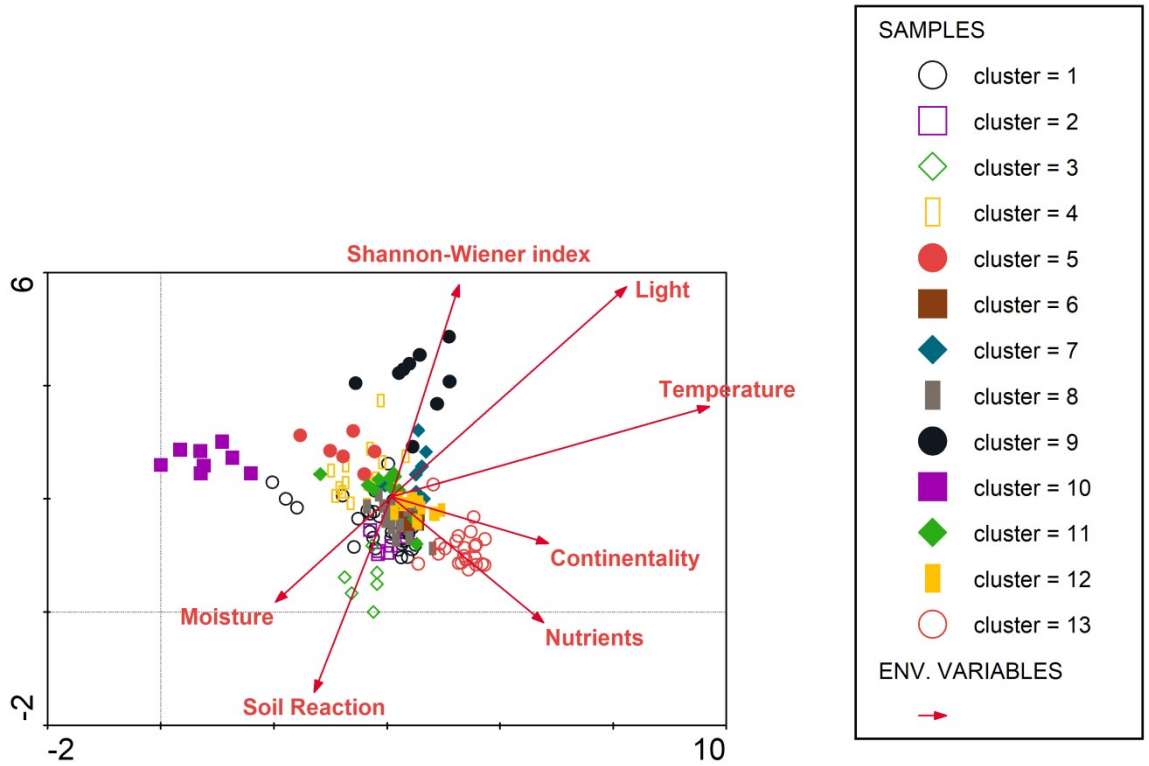

Fig. 2. Ordination diagram of the analyzed data set along the first two axis.

Discussion

Despite the wide distribution of the communities of the *Artemisietea vulgaris* class in the country, studies, focusing on this vegetation are restricted to the western and the central parts of Southern Bulgaria that

fall within the temperate and transitional climate zones. The current study focused on 10 associations that are widely distributed. Their ecology and floristic composition are similar to those of the associations that are distributed in the Southeastern and the Central Europe e.g. Romania (Coldea, 2012), the Czech Republic (Láníková, 2009), Slovakia (Jarolímek et al., 1997), Austria (Mucina, 1993), etc.). The phytocoenoses of the *Artemisietea vulgaris* class are located in termophylic and sunny habitats and different stages of anthropogenic pressure, stabilization of substrates and species' composition diversity may be observed. The low-growing vegetation of *Tussilago farfara* is presented by *Poo compressae–Tussilaginetum farfarae.* The association includes early successional communities, typical of habitats with recently disturbed soils (Láníková, 2009). On the contrary *Onopordion acanthii* represents an ancient ruderal vegetation, which has probably been common since the Neolithic age and consists of many archeophytes. The species' composition of the *Potentillo argenteae-Artemisietum absinthii* and *Carduo acanthoidis-Onopordetum acanthi* in Bulgaria includes more perennial species than the phytocoenoses in the Central Europe (Láníková, 2009). On the other hand the alliance *Convolvulo arvensis-Elytrigion repentis* includes semi-natural and ruderal communities, whose species composition includes many typical species for neighbouring grassland vegetation types of classes *Festuco-Brometea*, *Molinio-Arrhenatheretea* and *Trifolio-Geranietea*.

Studies of the class in Bulgaria need to continue. There are some other associations, belonging to the *Artemisietea vulgaris* class that we expect to be found in the country: *Carduetum hamulosi* F. Diaconescu 1978, *Artemisietum scopariae* Borza et Lupşa 1963, *Dauco-Cephalarietum transsylvanicae* M. Coroi et A.-M. Coroi 1998, *Bromo japonico-Aristolochietum* Ubrizsy 1967, *Dauco-Salvietum verticillatae* Soran 1962, *Centauretum calcitrapae* Mititelu ex Mititelu et Barabas 1975, which are well-known from Romania (Sanda et al., 2008; Coldea, 2012). The communities of *Cephalaria transsylvanica*, *Bromus japonica*, *Aristolochia clematitis*, *Salvia verticillata* and *Daucus carota* should also be studied. They are located within the vegetation stripes in agricultural areas. They also occur as a successional phase (in the second or third year) of the development of the ruderal vegetation in abandoned agricultural lands. These phytocoenoses are widely distributed but poorly studied.

The ruderal vegetation in the sub-Mediterranean zone of Bulgaria forms transitional phytocoenoses of the classes of *Artemisietea vulgaris* and *Stellarietea mediae* s.l. that are also poorly researched. The presence of other phytocoenoses from the order *Carthametalia lanati* S. Brullo in S. Brullo et Marcenò 1985 is also possible. The future regional analyses of this vegetation class should incorporate data of regional and national databases (Balkan Vegetation Database, Romanian Grassland Database, etc.), as well as the information from the European Vegetation Archive (Chytrý et al. 2016). It is expected that this is the right way to uncover the full syntaxonomical diversity of the class on Balkan peninsula and South-East Europe.

Conclusions

The current study evaluated the syntaxonomical diverisity of the *Artemisietea vulgaris* class on the territoriy of Bulgaria. One class (*Artemisietea vulgaris*), two orders (*Agropyretalia intermedio-repentis, Onopordetalia acanthii*), three alliances (*Convolvulo arvensis-Elytrigion repentis, Dauco-Melilotion* and *Onopordion acanthii*), ten associations (*Convolvulo arvensis-Elytrigietum repentis, Falcario vulgaris-Elytrigietum repentis, Convolvulo arvensis-Brometum inermis, Cardarietum drabae, Tanaceto vulgaris-Artemisietum vulgaris, Melilotetum albo-officinalis, Berteroetum incanae, Poo compressae-Tussilaginetum farfarae, Potentillo argenteae-Artemisietum absinthii* and *Carduo acanthoidis-Onopordetum acanthi*) and 1 plant community (*Achillea pannonica-Elytrigia repens*) were

found. One order, 2 alliances and 9 associations are found for the first time in Bulgaria. The studied associations are well floristically and ecologically separated. Only the association *Poo compressae–Tussilaginetum farfarae* is found in steep, eroded and unstable habitats. All the other syntaxa are predominantly distributed on flat or slightly inclined terrains. The stands of the alliance *Dauco-Melilotion* represent the initial stages of the succession of antropogenic habitats and has a higher species diversity. On the other hand the associations of the alliances *Convolvulo arvensis-Elytrigion repentis* and *Onopordion acanthii* represent more stable antropogenic vegetation types. The soils are rich of nutrients and the soils moisture is higher because of the stronger shade effect and the higher litter accumulation, which leads to a lower species richness. The species composition and the ecology of the established syntaxa are similar to same communities from other parts of Europe.

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