

# **SAXIFRAGO FERDINANDI-COBURGI- SESLERIETUM ACTAROVII – A NEW ASSOCIATION FROM THE SUBALPINE BELT OF THE SLAVIANKA (ORVILOS) MTS. (BULGARIA)**

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## **Abstract**

The paper discusses the phytosociological and syntaxonomical position of the dry subalpine grasslands in the Slavianka (Alibutoush, Orvilos) Mts. (South-Western Bulgaria, Northern Greece). A new association *Saxifraga ferdinandi-coburgi-Seslerietum actarovii* ass. nova has been established as a result of the phytosociological study. It is considered as an endemic vegetation unit from the calcareous subalpine terrains in the Central Balkan Peninsula high mountains (SouthWestern Bulgaria, Former Yugoslav Republic of Macedonia, Northern Greece). The new syntaxon belongs to the alliance *Edrajantho-Seslerion* Horvat 1949. A comparison with related syntaxa from other calcareous mountains from Northern Greece and the Former Yugoslav Republic of Macedonia is discussed.

**Keywords:** dry calcareous grasslands, phytosociology, syntaxonomy, Slavianka Mts., vegetation, *Edraiantho-Seslerion* Horvat 1949.

## **Izvešček**

V članku avtorji obravnavajo fitosociološki in sintaksonomski položaj suhih subalpskih travnikov v gorovju Slavjanka (Alibutoush, Orvilos) (jugozahodna Bolgarija, severna Grčija). Kot rezultat fitocenoloških raziskav so opisali novo asociacijo *Saxifraga ferdinandi-coburgi-Seslerietum actarovii* ass. nova. Obravnavajo jo kot endemično vegetacijsko enoto iz subalpskega pasu visokih gora v srednjem delu Balkanskega polotoka (jugozahodna Bolgarija, Makedonija, severna Grčija). Novoopisani sintakson uvrščajo v zvezo *Edrajantho-Seslerion* Horvat 1949. Sintakson so primerjali s sorodnimi sintaksoni iz drugih apneniških gora iz severne Grčije in Makedonije.

**Ključne besede:** suhi travniki na apnencu, fitosociologija, sintaksonomija, gorovje Slavjanka, vegetacija, *Edrajantho-Seslerion* Horvat 1949.

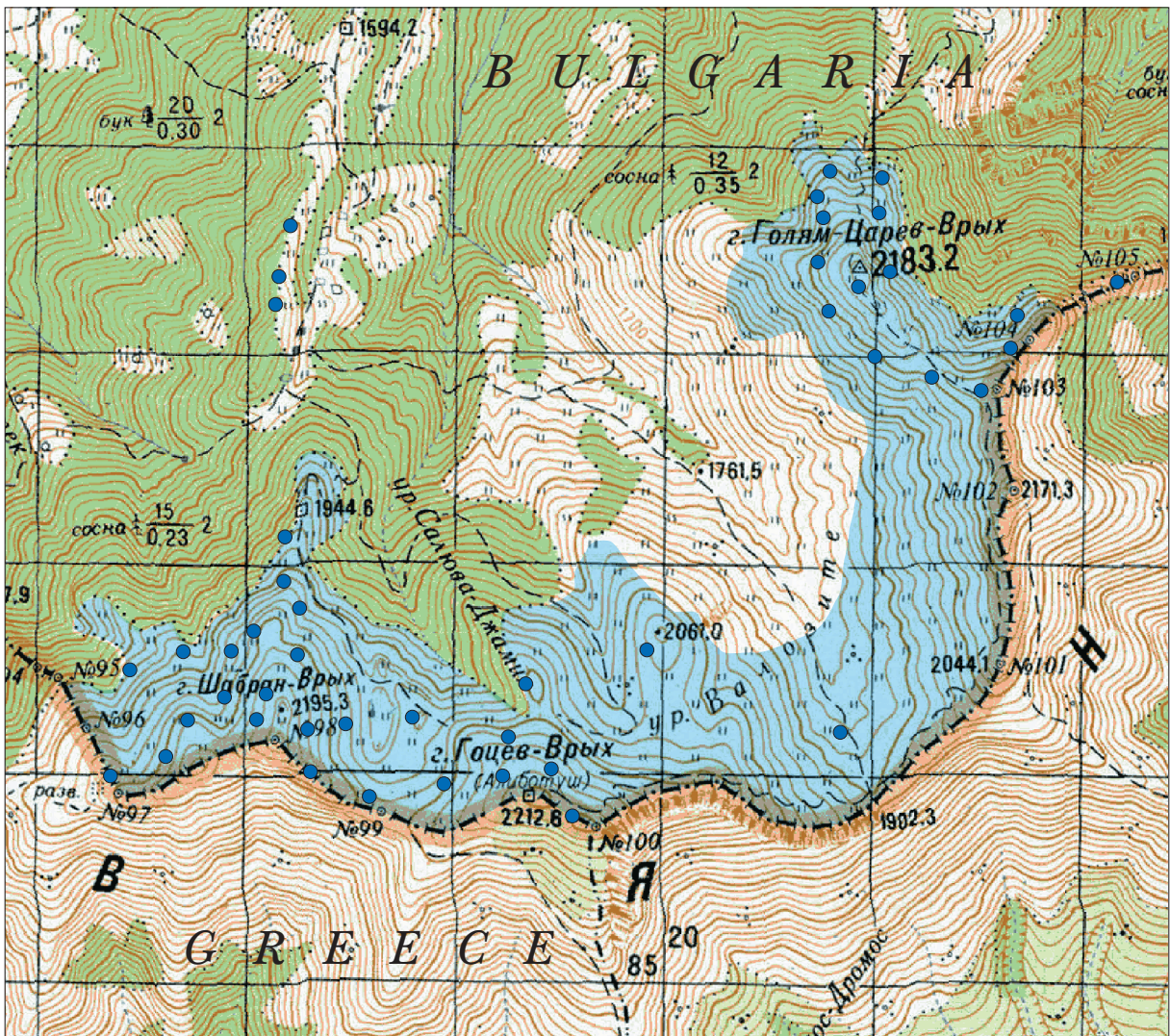
## 1. INTRODUCTION

The subalpine region of the Slavianka (Orvilos) Mts. (South-western Bulgaria, Northern Greece) (Figure 1) comprises the highest part of the mountain between 1900 and 2212 m including the highest peak – Gotzev Vruh /Alibotus. It covers an area of approximately 15 sq. km. The region represents a karstic marble area facing

north-east, north and north-west. There are many caves and precipices in the region, which have resulted from the karstic processes. The calcareous rocks cover 100 % of the territory. The climate is transitional Mediterranean with an important mountain influence, especially in the investigated highest part of the mountain (Georgiev 1991, Velez 2002). The Slavianka Mts. (besides Southern Pirin) are the warmest Bulgarian mountains. The

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**Figure 1:** Topographic map of subalpine area of the Slavianka Mts. (M 1 : 50 000). In light blue is a study area, in dark blue points are areas of relevés.

**Slika 1:** Topografska karta subalpinskega območja gorovja Slavjanka (M 1 : 50 000). Svetlo modro je prikazano obravnavano območje, temnomodre točke pa predstavljajo lokacije popisov.

permanent snow cover on the highest mountain parts continues only 90-100 days, while in Northern Pirin – 150 days (Vaptzarov et al.1989).

From a geobotanical point of view, the Slavianka Mts. belong to the Slavianka Mountain District – part of the Illyric (Balkan) province of the European deciduous forest region (Bondev 2002). The Slavianka Mts. are a very rich in endemic species. Bondev (2002) indicates 44 species – 38 Balkan and 6 local Bulgarian endemics.

Some data for the floristic diversity, phytogeography and vegetation of the Slavianka Mts. can be found in the works of Stojanoff (1922); Stojanov & Stefanoff (1922) and Dryanovski (1934).

In the mountains of Northern Greece and the Former Yugoslav Republic of Macedonia, similar herbaceous communities as in Slavianka Mts. are described, using the Braun-Blanquet methodology. There are no descriptions of such communities from Bulgaria so far. The most similar phytocoenoses in Bulgaria are described in the Pirin Mts. only by Simon (1958) and Mucina et al. (1990). The phytocoenoses described by Simon (1958) are typical alpine ones, while there is no alpine belt on the Slavianka Mts. The alpine and subalpine communities on calcareous screes, rock fissures and snow beds, described by Mucina et al. (1990) on the Pirin Mts. belong to

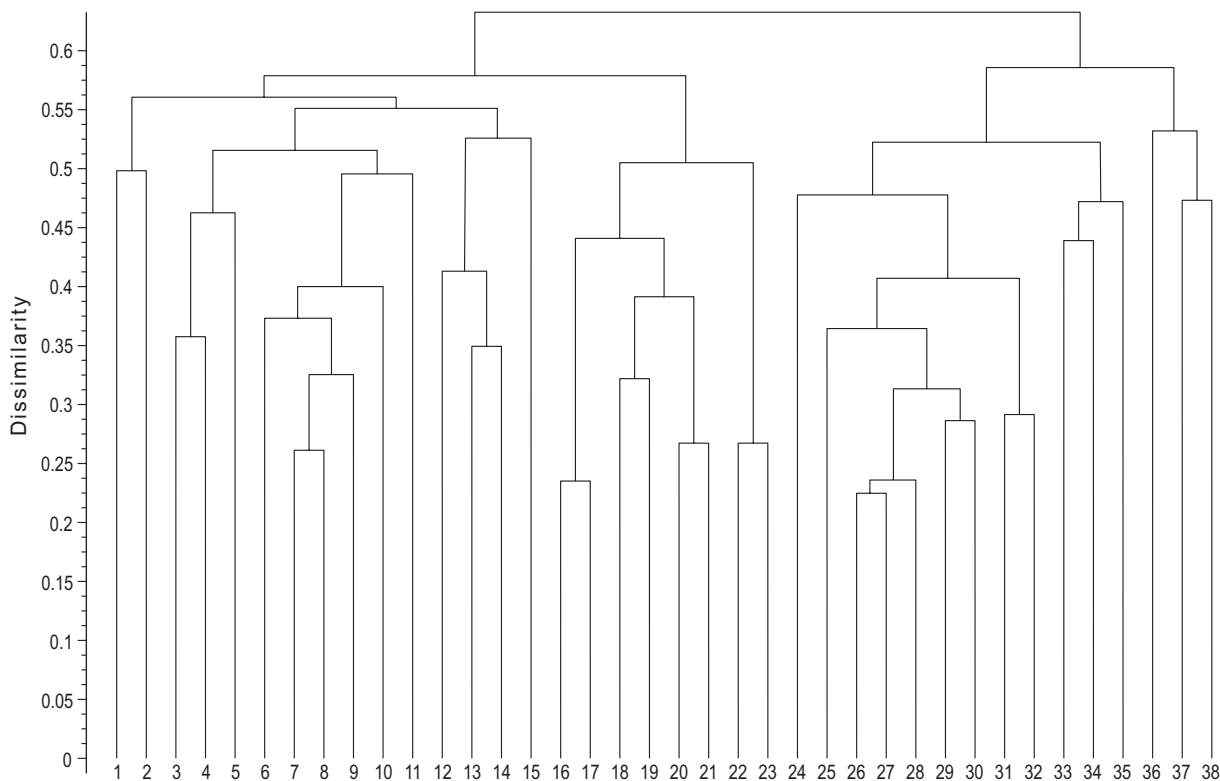


the classes *Thlaspietea rotundifolii* Braun-Blanquet 1948, *Asplenieta trichomanis* (Braun-Blanquet in Meier et Braun-Blanquet 1934) Oberd. 1977 and *Salicetea herbaceae* Braun-Blanquet 1947. Only one association (*Hieracio pannosi-Caricetum kitaibelianae* Mucina et al. 1990) among them has some similarities to the grasslands in the Slavianka Mts.

## METHODS

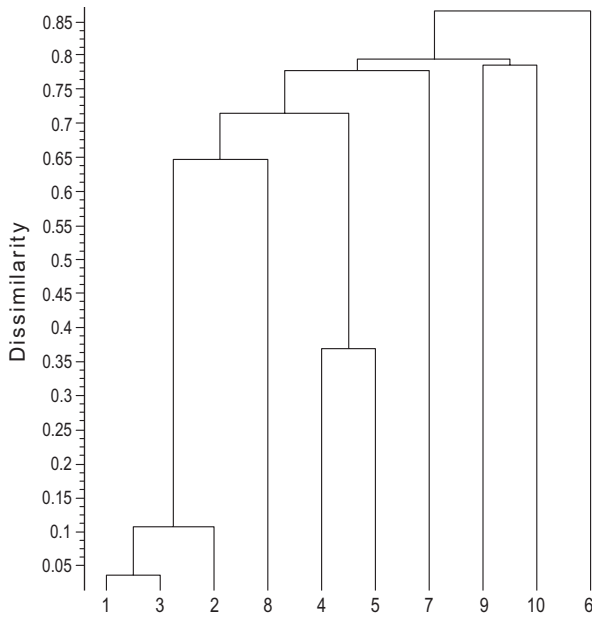
The principles and methods of the Zürich-Montpellier School (Braun-Blanquet 1964, Mueller-Dombois & Ellenberg 1974, Westhoff & Maarel 1973) were applied. We used plot size of 10x10 m and as a result of the sampling 46 relevés were made. At each sampling plot, a complete list of the present species (vascular plants) was recorded, together with their cover-abundance value according to the 7-degree Braun-Blanquet scale (Braun-Blanquet 1932). Eight out of 46 relevés dropped out as a result of the cluster analysis made in the SYN-TAX program (Figure 2). The diagnostic table includes 38 relevés (Table 1). They repre-

sent the new syntaxon described in this article. 8 relevés were not included in the phytocoenologic analysis, because they were not typical. Most of the excluded relevés were dominated by *Festucopsis sancta*. They have been made at a lower altitude – in the open calcareous areas in the coniferous belt of *Pinus heldreichii*. To facilitate the statistical computer programs the scale of Braun-Blanquet was used, only transformed into ordinal numbers (Westhoff & Maarel 1979). The computer software TurboVeg (Hennekens & Schaminée 2001) was used for digitalizing and storing the data. The sorting of the relevés was made in JUICE software (Tichý 2002). For the purpose of the numerical classification the TWINSpan method (Hill 1979) was applied, integrated in JUICE software. The results of the TWINSpan analysis were compared using cluster analysis according to the computer program SYN-TAX (Podani 2002). The average linkage method (UPGMA) was used and floristic similarity between relevés was evaluated according to the Horn index (Krebs 1999). This index was used also for assessment of similarity among the closest associations. Both dendrograms are presented in the paper (Figure 3).



**Figure 2:** Cluster analysis of the new association – the dendrogram.

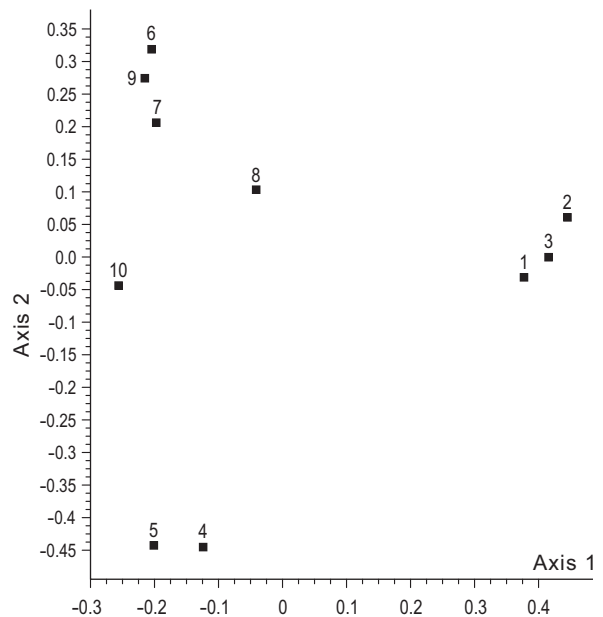
**Slika 2:** Klastrska analiza in dendrogram nove asociacije.



**Figure 3:** Cluster analysis of the most similar associations to the new association.

**Slika 3:** Klastrska analiza najbolj podobnih asociacij in obravnavane asociacije.

1. Ass. *Saxifraga ferdinandi-coburgi-Seslerietum achtarovii* subass. *typicum*; 2. Ass. *Saxifraga ferdinandi-coburgi - Seslerietum achtarovii* subass. *violetosum perinensis*, 3. The new association – total constancy (Nova asociacija-stalnost); 4. Ass. *Helianthemo - Seslerietum* Horvat 1960; 5. Ass. *Edraiantho - Helianthemum balcanici* Horvat 1935; 6. Ass. *Seslerio achtarovii-Festucetum variaie* Karagiannikidou et al. 2001; 7. Ass. *Agropyro sancti - Centauretum parilicai* Quezel 1989; 8. Ass. *Violo delphinanthae - Saxifragetum ferdinandi-coburgi* Quezel 1989; 9. Ass. *Astragalo pungentis - Caricetum kitaibelianaie* Karagiannikidou 1994; 10. Ass. *Hieracio-Caricetum kitaibelianaie* Mucina et al. 1990.



**Figure 4:** PCoA analysis of the most similar associations to the new association.

**Slika 4:** Analiza PCoA najbolj podobnih asociacij in obravnavane asociacije.

1. Ass. *Saxifraga ferdinandi-coburgii - Seslerietum achtarovii* subass. *typicum*; 2. Ass. *Saxifraga ferdinandi-coburgii - Seslerietum achtarovii* subass. *violetosum perinensis*, 3. The new association – total constancy (Nova asociacija-stalnost); 4. Ass. *Helianthemo - Seslerietum* Horvat 1960; 5. Ass. *Edraiantho - Helianthemum balcanici* Horvat 1935; 6. Ass. *Seslerio achtarovii - Festucetum variaie* Karagiannikidou et al. 2001; 7. Ass. *Agropyro sancti - Centauretum parilicai* Quezel 1989; 8. Ass. *Violo delphinanthae - Saxifragetum ferdinandi-coburgi* Quezel 1989; 9. Ass. *Astragalo pungentis-Caricetum kitaibelianaie* Karagiannikidou 1994; 10. Ass. *Hieracio- Caricetum kitaibelianaie* Mucina et al. 1990.

The synoptic similarity was evaluated using also PCo Analysis (Figure 4). Horn's index was also used for the PCo Analysis (Podani 2002).

The diagnostic species of published syntaxa were identified according to Horvat et al. (1974) and other referenced literature. The syntaxa's names and the names of their authors are given according to the International Code for Phytosociological nomenclature (Weber et al. 2000). The names of the plant taxa are given according to Delipavlov et al. (2003). The geographical elements of the taxa are given according to Asyov et al. (2006) except for the subspecies for which there are no data available in it. They are given according to Meusel et al. (1965). The plant life-forms of the species are given using the classification of Raunkiaer (1934).

## RESULTS

The analysis of the sampled phytosociological material manifests the existence of one single association, which covers the entire territory of the highest part of the Slavianka Mts.

The unique vegetation of the non-forest sub-alpine belt of the Slavianka Mts. is presented by the association below. It belongs to the syntaxonomical hierarchical position given below:

**Association *Saxifraga ferdinandi-coburgi - Seslerietum actarovii* ass. nova; nomenclatural type: Table 1, Rel. 7 holotypus hoc loco**

Table 1, rel.1–38, Table2, column 3.

Characteristic taxa: *Sesleria rigida* subsp. *achtarovii*; *Saxifraga ferdinandi-coburgi*; *Galium demis-*

*sum* subsp. *demissum*; *Centaurea napulifera* subsp. *nyssana*; *Pedicularis orthantha*; *Centaurea parilica*.

Differential taxa: *Sempervivum leucanthum*; *Anthyllis aurea*; *Petkovia orphanidea*; *Astragalus depressus*; *Viola perinensis*; *Vaccinium myrtillus*; *Primula elatior* subsp. *intricata*; *Crocus veluchensis*.

Dominant taxa: *Sesleria rigida* subsp. *achtarovii*; *Carex kitaibeliana*.

Constant taxa: *Sesleria rigida* subsp. *achtarovii*; *Carex kitaibeliana*; *Rhodax canus*; *Juniperus pigmaea*.

The syntaxonomic position:

Class *Elyno-Seslerietea* Braun-Blanquet 1948

Order *Onobrychido-Seslerietalia* Horvat 1949

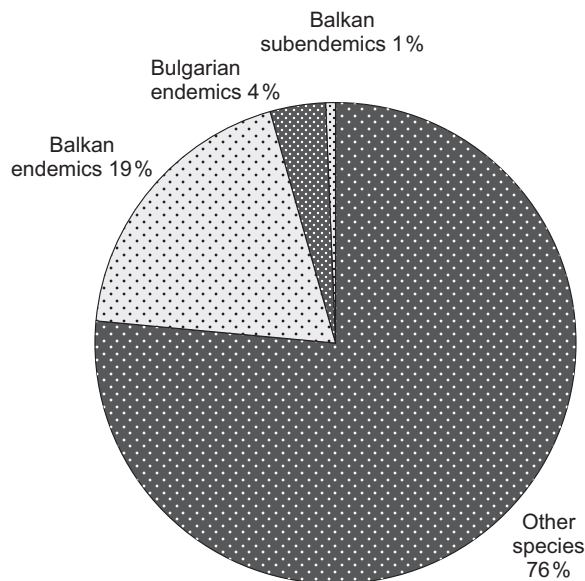
Alliance *Edraiantho-Seslerion* Horvat 1949

Association *Saxifraga ferdinandi-coburgi* - *Seslerietum actarovii* ass. nova

Subassociation *typicum*

Subassociation *violetosum perinensis* subass. nova

We established a new association designated as *Saxifraga ferdinandi-coburgi-Seslerietum actarovii* ass. nova, consisting of two subassociations: subass. *typicum* and subass. *violetosum perinensis* subass. nova. The phytocoenoses of the new association are characterized by the presence of vicariant species, by the extent of Mediterranean and Pontic-continental phytogeographical influence and by the number of endemic taxa (Figure 5).



**Figure 5:** The participation of endemics and subendemics in the phytocoenoses of the new association.

**Slika 5:** Delež endemita v subendemita v sestojih novopisane asociacije.

There is a main “nucleus” of species common to several associations described in Northern Greece (Falakron, Menikion and Pangeon Mts.) and Southern Macedonia (Yakupica Mts.). An essential variance between the individual associations exists concerning their complex of diagnostic species. *Saxifraga ferdinandi-coburgi-Seslerietum actarovii* belongs to *Elyno-Seslerietea*, *Onobrychido-Seslerietalia*, *Edrajantho-Seslerion* and confirms the presence of these syntaxa in Bulgaria. But it can be defined more accurately after future detailed studies are made of similar vegetation in Bulgaria including the Pirin Mts.

The high level of constant presence of the paleoendemic *Saxifraga ferdinandi-coburgi* underlines the connection of the flora and the vegetation in the Slavianka Mts. with the Rilo-Rhodopean center of endemism. This species occurs in some of the highest mountains in Northern Greece and Macedonia as well. It is comparatively rare there and in fact does not have an essential participation in the grassland vegetation, with the exception of the Falacron Mts. (Quezel 1989). *Saxifraga ferdinandi-coburgi* exists in the associations *Leontopodio-Potentilletum stobanovii* and *Hieracio Caricetum kitaibeliana* (Simon 1958, Mucina et al. 1990) as well. It was indicated by the authors as a diagnostic to class *Festuco-Seslerietea* (syn. *Elyno-Seslerietea*). These communities, however, are included in the class *Asplenietea trichomanes* (Braun-Blanquet in Meier et Braun-Blanquet 1934) Oberd. 1977.

Other diagnostic species, which emphasize the connection of the flora and the vegetation of the Slavianka Mts. with the northern (Rila and Rhodopi Mts.) center of endemism, are: *Pedicularis orthantha* (41 %); *Sempervivum leucanthum* (44 %). These two species, however, are not of diagnostic value in the described syntaxa from the mountains of Northern Greece and Macedonia (Horvat et al. 1974; Quezel 1989; Karagiannakidou 1994). The diagnostic species characterizing the influence of the Greek-Macedonian center of endemism, including the Slavianka Mts. and the mountains in Northern central Greece, are *Galium demissum* subsp. *demissum* (56 %); *Centaurea parilica* (29 %), *Petkovia orphanidea* (25 %) etc.

Following the ecological specificities of the environmental conditions, the analysis differentiated two groups of phytocoenoses, which were grouped in sub-associations. The typical subassociation (subass. *typicum*), nomenclatural type is identical with the nomenclatural type of the asso-





**Figure 6:** Picture of the new association: *Saxifraga ferdinandi-coburgi-Seslerietum actarovii* subass. *typicum*.  
**Slika 6:** Fotografija sestojane nove asocijacije *Saxifraga ferdinandi-coburgi-Seslerietum actarovii* subass. *typicum*.

ciation (Figure 6) It is distributed in places with very thin and not fertile soil. The phytocoenoses have a comparatively small coverage due to the emerging rocks including rock pieces of different size. Some diagnostic species to the association are chasmophytes. They have a higher frequency in comparison with some other ecological groups. Such species are: *Petkovia orphanidea* (43 %); *Sempervivum leucanthum* (74 %); *Paronychia kapela* (65 %); *Globularia cordifolia* (26 %); *Achillea ageratifolia* (44 %) etc. Since the phytocoenoses of the typical subassociation are found on open rocky and stony places, the tufts of species from *Poaceae* and *Cyperaceae* families have smaller coverage.

The phytocoenoses of the second subassociation take the flat or grooved places, where rock debris accumulates and soil formation is initiated. The rains water stays longer in these places and the phytocoenoses are developed in more mesophilous conditions. The complex of species indicating the presence of better and richer soils, which are found frequently in this group of phytocoenoses, includes: *Astragalus depressus* (80 %);

*Vaccinium myrtillus* (60 %); *Primula elatior* (60 %); *Crocus veluchensis* (27 %); *Viola perinensis* (53 %). Some of these species are spring ephemeroides, such as *Corydalis solida*, *Crocus veluchensis*, *Primula elatior* and *Muscari botryoides*. They grow in places sufficiently wet, because the moisture from the rain retained when it penetrates the limestone karstic rocks. The diagnostic species of this group is the local endemic for the Pirin Mts., Slavianka Mts. and Falacron Mts. The name-giving taxon is *Viola perinensis* – typical for these conditions. The subassociation: *violetosum perinensis* subass. nova. hoc loco, nomenclatural type: Table 1, rel. 9, holotypus (Figure 7).

## DISCUSSION

The studied vegetation of the subalpine zone of the Slavianka Mts. is found on open, rocky places with poor soils. The soils are rendzinas – shallow humus-carbonate ones – which embrace little pieces of the limestone basic rock (Ninov 2002).



**Figure 7:** Picture of the new association *Saxifraga ferdinandi-coburgi* - *Seslerietum actarovii* subass. *violetosum perinensis*.  
**Slika 7:** Fotografija sestojice nove asocijacije *Saxifraga ferdinandi-coburgi* - *Seslerietum actarovii* subass. *violetosum perinensis*.

The structure of the phytocoenoses is from open to almost closed, as the total vegetation coverage varies from 20 % to 90 %. The mean coverage is 58 %. The investigated phytocoenoses grow most frequently on slopes with north, north-east or north-west exposition. The emerging bedrock can be found at the surface in many places as large fragments of different sizes, from gravel to main rocks. In some sites the bare rock covers more than 70 % of the ground.

The phytocoenoses are characterized by a poor presence of trees and shrubs, excluding some solitary specimens, *Juniperus nana*, *Pinus cheldreichii* and *Chamaecytisus absinthioides* etc (Figure 8). They are typical for the upper limit of the forests and lower zone of the subalpine belt in the Slavianka Mts. The investigated phytocoenoses are not very rich in species. The number of species per relevé varies from 10 to 35 and the average number is 15. The main dominants are grasses (*Poaceae*), but also some species from the families *Primulaceae*, *Campanulaceae*, *Gentianaceae*. But frequent are also chamaephytes, such as *Rodax canus* (*Cistaceae*).

## SYNTAXONOMICAL POSITION OF THE GRASSLANDS IN THE SLAVIANKA MTS.

The phytogeographical, floristic and phytocoenological peculiarities of the Slavianka Mts. raise a question about the ordering of new associations to highest ranking syntaxa. The closest syntaxa from the Falacron Mts. are classified by Quezel (1989) as belonging to the class *Daphno-Festucetea* Quezel 1964 (Quezel 1967). This class has been described by him in the mountains of the thermo-Mediterranean zone of Greece. This decision about the grassland communities of the orophyte grassy belt is presented in the works on the Pangeon Mts. (Karagiannakidou et al. 2001) and Menikion Mts. (Karagiannakidou 1994). Shreiber (1998) supposes that the oro-Mediterranean grassland vegetation there belongs to the class *Festuco-Brometea*. He makes this conclusion because of the great differences between the grassland vegetation in the Falacron Mts. and the





**Figure 8:** Picture of the subalpine belt of the Slavjanka Mts – participation of trees (*Pinus heldreichii*) and shrubs (*Juniperus pygmaea*, *Chamaecytisus absinthioides*).

**Slika 8:** Fotografija subalpinskega pasu gorovja Slavjanka – sestoji dreves (*Pinus heldreichii*) in grmov (*Juniperus pygmaea*, *Chamaecytisus absinthioides*).

vegetation of the Greek mountains situated further South as well as the strong continental influence, expressed in the appearance of communities, dominated by species of the *Poaceae* family. They are characteristic of the forest-steppe landscapes in South-Eastern Europe, but he cannot decide on the alliance and the orders in which to place the described communities. On the basis of the predominance of diagnostic species from the class *Daphno-Festucetea* Quezel 1964 (Quezel 1967) in the subalpine grassland communities in the Menikion Mts., Pangeon Mts. and Falacron Mts., Karagiannakidou et al. (2001) reject this decision. At the same time, they discuss the great presence of many elements of the class *Elyno-Seslerietea* Braun-Blanquet 1948. According to them, the southern limit of the class on the Balkan Peninsula includes also Northern Greece. Karagiannakidou et al. (2001) accept the presence of elements from three classes in these mountains. It is a result of their intermediate location between central-European and sub-Mediterranean influence. Similar are the phyto-geographical conclusions made by Stefanović (1996) using the floristic analyses. This influence is determined

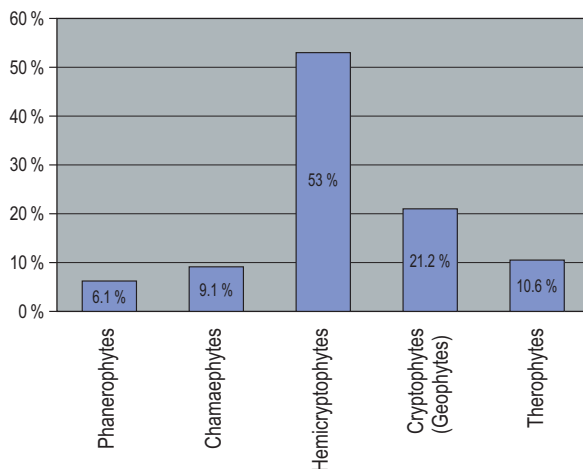
by the geographical position of the place and their altitude. For example, Raus (1987) on the basis of data given by Quezel (1967) for association *Anthyllido auraea-Achilleetum ageratifoliae* (*Daphno-Festucetea*) from the highest parts of Mt. Olympus classifies it as belonging to the class *Elyno-Seslerietea*. According to Karagiannakidou et al. (2001), the question concerning the borders of distribution and the contact areas of vegetation communities, belonging to the classes *Daphno-Festucetea* Quezel 1964, *Elyno-Seslerietea* Braun-Blanquet 1948 and *Festuco-Brometea* Braun-Blanquet & Tüxen ex Braun-Blanquet 1949, should be answered after intensive phytocoenological studies in all mountains of Northern Greece, including the Orvilos (Slavjanka) Mts.

It should be noted that one of the most characteristic special features of the class *Daphno-Festucetea* is the high occurrence of chamaephytes. Very often among them dominates *Astragalus angustifolius* subsp. *pungens*, which in the Slavjanka Mts. does not play a significant role. For example, for the associations described by Karagiannakidou et al. (2001) from the Pangeo Mts. an average of between 20 and 32 % chamaephytes



are given in the biological spectrum of those associations. In the recently described association from the Slavianka Mts., the chamaephytes are under 10 % (Figure 9). This fact, together with the northern geographical location as well as the floristic and phytogeographical influence of the Rilo-Rhodopean Mountain massif, which is stronger here, defines the belonging of the associations from the Slavianka Mts. most likely to class *Elyno-Seslerietea* Braun-Blanquet 1948, order *Onobrychido-Seslerietalia* Horvat 1949, alliance *Edrajantho-Seslerion* Horvat 1949.

The classification of the associations of alpine vegetation on limestone areas in South-Eastern Europe only to class *Elyno-Seslerietea* Braun-Blanquet 1948 is also subject of discussions. For example, Petřík et al. (2005) dispute the opinion of Oriolo (2001) that all limestone alpine and subalpine communities in Southern and Central Europe belong to the class *Elyno-Seslerietea*. They consider as more acceptable the approach of Ohba (1974), who in the Japanese mountains regards the typical, and sometimes poor in species alpine communities, as belonging rather to the class *Carici rupestris-Cobresietea bellardii* Ohba 1974. After their analyses, Petřík et al. (2005) separated alpine and sub-alpine grassland vegetation on calcareous and neutral bedrock in the Tatra Mts. into two classes. As an essential difference between the classes *Elyno-Seslerietea* and *Carici rupestris-Cobresietea bellardii* in the mountains of Southern and Central Europe, the authors indicated the presence of many endemic taxa in the first, and the predomination of species with circum-boreal and arctic-alpine distributions in the second. The arctic-alpine group includes species like *Saxifraga oppositifolia*, *S. paniculata*, *Silene acaulis*, *Carex rupestris*, *Elyna bellardii* and others. If we accept this separation, the question arises whether it is right to put the closest to the plant communities from the Slavianka Mts. alpine and sub-alpine communities into the Pirin Mts. (*Anthyllio-Seslerion klasterskyi* Simon 1958) within *Edrajantho-Seslerion* of Horvat et al. (1974) or, as proposed by Tzonev et al. (2009), to join them to the alliance *Oxytropido-Elynion* Braun-Blanquet 1949 of *Carici rupestris-Kobresietea bellardii* Ohba 1974. There are also some species from the group designated by Petřík et al. (2006) in the Pirin Mts., but on the other hand, the presence of many local endemics like *Papaver degenii*, *Thymus perinicus*, *Festuca pirinica* etc., confirms the decision of Horvat et al. (1974). It should be mentioned that the association de-



**Figure 9:** Spectrum of plant life-forms of the association *Saxifraga ferdinandi-coburgi - Seslerietum actarovii*.

**Slika 9:** Deleži življenjskih oblik v asociaciji *Saxifraga ferdinandi-coburgi - Seslerietum actarovii*.

scribed by Simon (1958), *Elynetum pirinicum* Simon 1958 nom. invalid (art. 34a), which is characterized by richness of mosses and lichens and poor species composition, was included into the alliance *Oxytropidi-Elynion* Braun-Blanquet 1949, described in the Alps. Later Rodwell et al. (2002) included the alliance *Oxytropidi-Elynion* Horvat 1949 into *Carici rupestris-Kobresietea bellardii* Ohba 1974. All these facts could lead to the conclusion that most alpine and subalpine grassland communities in Bulgaria on the limestone substrates belong to the class *Elyno-Seslerietea*. At the same time, the class *Carici rupestris-Kobresietea bellardii* probably includes not only communities with vascular plant species, but also communities rich in mosses and lichens. The vascular plants are *Elyna bellardii*, *Carex rupestris* and other in the alpine belt above 2500 m in the Pirin Mts. The investigated communities in the Slavianka Mts. should be included in the class *Elyno-Seslerietea*. This conclusion can become final decision after subsequent detailed studies of this vegetation in Bulgaria.

## COMPARISON OF THE GRASSLANDS IN SLAVIANKA WITH SIMILAR COMMUNITIES ON THE BALKAN PENINSULA

Some associations in Bulgaria are described in the Slavianka Mts. according to the dominant method. They are only named, without phyto-

coenotic descriptions in detail. These are: Ass. *Convolvulus suendermanii-Festucopsis sancta*; Ass. *Convolvulus suendermanii*; Ass. *Dryas octopetala*; Ass. *Festuca penzesii-Sesleria coerulea*; Ass. *Festuca penzesii-Stipa pulcherrima*; Ass. *Festuca penzesii-Astragalus angustifolius*; Ass. *Festucopsis sancta-Sesleria coerulea*; Ass. *Festucopsis sancta-Sesleria rigida*; Ass. *Festucopsis sancta-Stipa pulcherrima*; Ass. *Juniperus pygmaea* (Velchev & Bondev 1984a, b).

As their names show, most of those associations are found at opened places in the forest belt, where there are ecological optimums of species like: *Festucopsis sancta*; *Festuca penzesii*; *Convolvulus boissieri* subsp. *suendermanii*.

The cluster dendrogram (Figure 3) and the PCoA (Figure 4) demonstrate the similarity between the syntaxa of the Slavianka Mts. and those of other mountains.

The association *Hieracio-Caricetum kitaibeliana* Mucina et al. 1990 is the closest in the Pirin Mts. to the studied vegetation. It belongs to the alliance *Ramondion nathaliae* Horvat ex Simon 1958 (order *Potentilletalia caulescentis* Braun-Blanquet 1926; class *Asplenieta trichomanes* (Braun-Blanquet in Meier et Braun-Blanquet 1934) Oberd. 1977). This association includes subalpine grassland communities on the marbles in the Northern Pirin Mts. The association described by Mucina et al. (1990) has several common species with the grasslands of the Slavianka Mts., such as *Saxifraga ferdinandi-coburgi*, *Globularia cordifolia*, *Teucrium montanum*, *Paronichia kapela*, *Carex kitaibeliana*, *Rhodax canus*, *Achillea ageratifolia*. Most of them have wide distribution in the calcareous mountains of the Balkan Peninsula. However the characteristic species do not occur in the investigated vegetation. These are *Hieracium pannosum*, *Hypochaeris pelivanovici*, *Asperula suberosa*, *Carum rigidulum*, *Centaurea mannagettae*, *Allium minus*, *Micromeria cristata*. Another difference is the presence of typical species for *Asplenieta trichomanes* as *Asplenium ruta-muraria*, *Asplenium trichomanes*, *Kernera saxatilis*, as well as the diversity from mosses and lichens.

The associations from the alliance *Edraiantho-Seslerion* Horvat 1949 from some of the mountains in the Former Yugoslav Republic of Macedonia (FYROM) are close to the association in the Slavianka Mts. They inhabit open calcareous terrains, exposed to strong winds, on the high mountains mostly in the central part of the country. The association *Helianthemo-Seslerietum* Horvat 1960 from the Yakupitsa Mts. (Central Mace-

donia) demonstrates the highest similarity to the association in the Slavianka Mts. This similarity presumes the existence of vicariant syntaxa, in spite of the presence of many common species: *Globularia cordifolia* (V); *Paronichia kapela* (V); *Achillea ageratifolia* (IV), *Anthyllis aurea* (II); *Dryas octopetala* (II); *Carex kitaibeliana* (V). Most of these species form one common “nucleus” (calciphytes, oro-Mediterranean species and glacial relicts) on all calcareous mountains in the region (South Western Bulgaria, Northern Greece, Macedonia). However, the taxa, which give the name to the association discussed here, *Sesleria juncifolia* (V) and *Helianthemum scardicum* (V), do not occur in Bulgaria.

Other species also differ from those in the Slavianka Mts: *Edrajanthus graminifolius* (V); *Oxytropis urumovii* (I); *Carex ericetorum* (I); *Festuca rupicola* (IV), *Ranunculus oreophyllus* (II). On the other hand, most of the endemic species from the Slavianka Mts. do not occur in the Yakupitsa Mts: *Petkovia orphanidea*; *Centaurea parilica*, *Saxifraga ferdinandi-coburgi*, *Sesleria rigida* subsp. *achtarovii*, *Viola perinensis* etc. One floristic similarity, besides the “nucleus” from the calciphytes mentioned above, to the other close association *Edrajantho-Helianthemum alpestris* Horvat 1935, is the participation of *Saxifraga ferdinandi-coburgi*, but with very low presence. Despite their belonging to the same class – *Elyno-Seslerietea*, other associations from FYROM and countries from Former Yugoslavia (see Horvat 1930; 1949, Horvat et al. 1974; Lakušić 1966, Rajevski 1990 etc.) do not demonstrate any close similarity. They have not been discussed here.

Phytocoenological researches on the Slavianka Mts. show the great similarity (Figure 3, 4) of the subalpine grasslands there to those on the Falacron Mts. (Bozdag) in Northern Greece (Quezel 1989; Shreiber 1998). This similarity is not so strong with the communities on the Menikion (Serski Bozdag) Mts. (Karagiannakidou 1994) and Pangeon (Kushnica, Parnar Dag) Mts. (Karagiannakidou et al. 2001). In the latter two mountains, some associations of grassland vegetation are described (Table 2). They show a certain similarity to, as well as some essential differences from the vegetation of the Slavianka Mts. The difference between the Slavianka Mts. and other Greek high mountains increases the closer these mountains are to the Mediterranean Sea. For example, around about the Pangeon Mts. (which are southernmost in the region), only one



association has some similarities to the vegetation of the Slavianka Mts. – *Seslerio ahtarovii-Festucetum variae* Karagiannakidou & al. 2001. The other associations described by Karagiannakidou et al. (2001) have species diagnostic rather for the class *Festuco-Brometea*. The association *Seslerio ahtarovii-Festucetum variae* (Karagiannakidou et al. 2001) has many common species with the phytocoenoses of the Slavianka Mts.: *Sesleria rigida* subsp. *ahtarovii*, *Astragalus angustifolius* and *Carex kitaibeliana*. At the same time, it is possible to find some species which grow at lower altitude in the Slavianka Mts., such as *Euphorbia amygdaloides*, *Carex humilis*, *Brachypodium pinnatum*, *Dianthus petraeus* and others. Typically, there is the participation of some characteristic species for the xerothermic oak belt in the subalpine grasslands. This is due not only to the much lower altitude of the mountain – the highest peak Mati (Koznica) is at 1956 m, but also to the strong Mediterranean influence, which leads to remission and aridization of the climate. That influence decreases northwards, but again it is much stronger than on the Slavianka Mts. In the vegetation of the Menikion Mts., only one association (Karagiannakidou 1994) includes phytocoenoses that are close to the grassland communities in the Slavianka Mts. – *Astragalo pungentis-Caricetum kitaibeliana* (Karagiannakidou 1994). The phytocoenoses of this main association in the oro-Mediterranean zone of the mountain have species common with those in the Slavianka Mts.: *Sesleria rigida*, *Carex kitaibeliana*, *Rhodax canus*, *Teucrium montanum*, *Petkovia orphanidea*. At the same time, some of the local endemics of the Slavianka Mts. are missing on the Menikion Mts. (*Centaurea parilica*, *Galium demissum* subsp. *demissum*), as well as endemics from the center of endemism, situated north from the Slavianka Mts.: *Sempervivum leucanthum*, *Pedicularis ortantha*, *Saxifraga ferdinandi-coburgi*, *Viola perinensis*. On the other hand, vast (in comparison to the Slavianka Mts.) is the participation of *Astragalus angustifolius*. Many species could be found there, which do not occur in Bulgarian group of phytocoenoses (some of them do not occur in Bulgaria at all): *Sempervivum marmoreum*, *Festuca macedonica*, *Thymus cherleriodes*, *Sesleria tenerrima*, *Dianthus petraeus*.

The closest associations to the grassland vegetation of the oro-Mediterranean belt of the Slavianka Mts. are the ones described from the Falacron (Bozdag) Mts. These are the associations:

*Agropyro sancti-Centaureetum parilicae* and *Viola delphinanthae-Saxifragetum ferdinandi-coburgi* (Quezel 1989) and the community *Anthyllis montana* subsp. *jacquini-Androsacae villosa* (Shreiber 1998). The association *Agropyro sancti-Centaureetum parilicae* is spread at a lower altitude (1600–2020 m) than the Slavianka Mts. The diagnostic species: *Festucopsis sancta*, *Centaurea parilica*, *Thymus thracicus*, *Onobrychis alba* subsp. *calcareae*, *Potentilla cinerea*, *Genista depressa*, *Origanum vulgare*, *Achillea ageratifolia*, demonstrate a similarity to the communities with *Festucopsis sancta* in Bulgaria, occurring on open and rocky places in the Bosnian pine belt of the Slavianka Mts. Probably, due to the much stronger Mediterranean influence, some of the species occupying places at lower altitudes in the Slavianka Mts., in the Falacron Mts. have a phytocoenotical optimum at higher altitudes. This should be an object of additional research. A typical example for this phenomenon is the association *Viola delphinanthae-Saxifragetum ferdinandi-coburgi* Quezel 1989. This association is probably identical with the communities *Anthyllis montana* subsp. *jacquini-Androsacae villosa* (Shreiber 1998), due to the great similarity of its floristic composition. The oro-Mediterranean grassland vegetation of the Slavianka Mts. shows considerable syntaxonomical similarity with two associations on the Falacron Mts. One main group of species persists at constant high level in the syntaxa of the two mountains: *Rhodax canus*, *Globularia cordifolia*, *Carex kitaibelliana*, *Thymus thracicus*, *Petkovia orphanidea*, *Saxifraga ferdinandi-coburgi*, *Androsacae villosa*, *Achillea ageratifolia*, *Dryas octopetala*. At the same time, probably because of the climatic influence and specifics of the center of endemism, some diagnostic species to the phytocoenoses of the Falacron Mts. do not play a significant role in the Slavianka Mts. (*Anthyllis montana* subsp. *jacquini*) or generally they do not occur in the composition of grassland vegetation (*Viola delphinantha*, *Festuca kortitnicensis*). For example *Viola delphinantha* on the Slavianka Mts. is in the most northern part of its range of distribution. It can be found only in Parilski Dol Valley, where its individuals inhabit the stones as part of the composition of the chasmophytic vegetation in the forest belt. *Festuca kortitnicensis* and *Festuca panciciana* do not occur also in the Slavianka Mts. Characteristic is the difference in the participation of other grasses from *Poaceae*, which form a part and/or dominate in communities in the Falacron Mts. For example, the floristic

composition of the association *Festucopso sancti-Centauretum parilicae* includes dominants similar to those on the Slavianka Mts., except *Festucopsis sancta* and *Sesleria coeralns*. But especially for *Sesleria* sp. it the following fact should be noted. The more complete floristic work of Karagiannakidou et al. (1995) on the Falakron Mts. mentions three other species from the genus (including *Sesleria rigida* subsp. *achtarovii*), but not *Sesleria coerulans*. This species has not been indicated on the Orvilos Mts. (see Karagiannakidou et al. 1995) – the Greek part of the mountains. Here we should emphasize that a similar problem exists in the Slavianka Mts. as well, where Bondev (1991) indicated the communities of *Sesleria korabensis* as largely distributed. All the existing – and reviewed by us – *Sesleria* sp. herbarium materials from the herbariums in the Bulgarian Academy of Sciences and Sofia University, as well as the materials that we gathered, belong to *Sesleria rigida* subsp. *achtarovii* and *Sesleria latifolia* (at lower altitude). The only exceptions are two herbarium specimens, which were determined as *Sesleria korabensis*, but from 1500–1800 m altitude.

The question regarding the syntaxonomic relations between the subalpine grasslands in the high mountains from the geographical area of Macedonia (Bulgaria, Greece and FYROM) is still open. Still, the existence of syntaxonomical vicariants on isolated grassland “islands” should be adopted.

## ORIGIN OF INVESTIGATED VEGETATION IN THE SLAVIANKA MTS.

The analysis of the biological spectrum (Figure 9) of the plant life-forms demonstrates that it is a typical one for the subalpine grasslands in oro-Mediterranean mountains in the middle of Balkan Peninsula. Together with the high participation of typical Mediterranean geoelements (Figure 10), there are 25 % endemics. Some of these are Balkan endemics: *Viola perinensis* (38 %), *Campanula (Petkovia) orphanidea* (25 %), *Sesleria rigida* subsp. *achtarovii* (89 %), *Centaurea parilica* (29 %) etc. There are also some local Bulgarian endemics, such as *Bromus parilicus*, *Alyssum montanum* subsp. *regis-borisii*, *Silene flavescens* subsp. *stojanovii*, *Pulsatilla slaviankae* and *Aubrieta columnae* subsp. *pirinica*. Most of the Balkan endemics are distributed also in the subalpine parts of

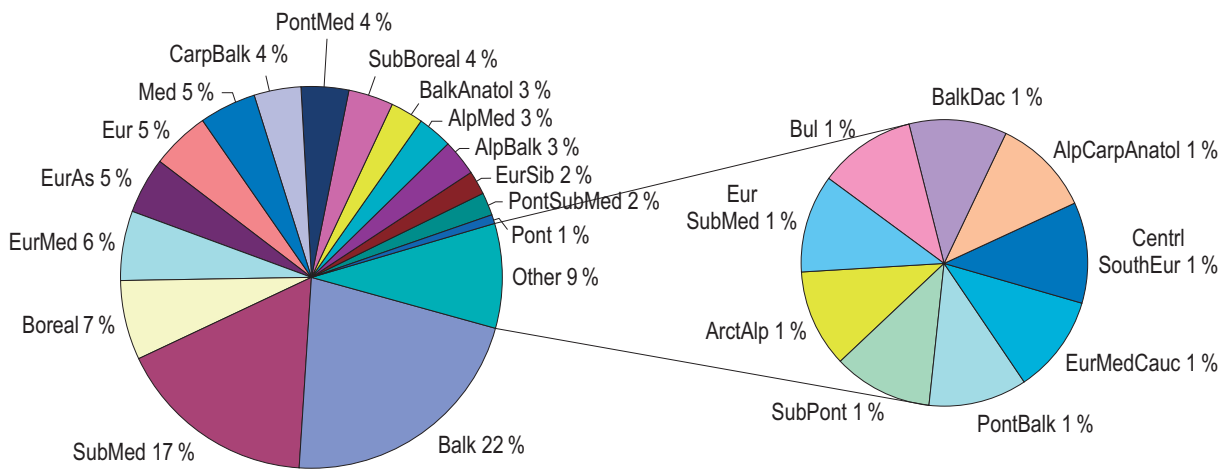
the mountains in South-western Bulgaria, central Northern Greece and Southern Macedonia – Mt. Pirin, Rhodopes Mts., Menikion Mts., Pangeo Mts., Falacron Mts., Yakupica Mts., Galitchica Ms., Pelister Mts. etc. The analysis of the flora and the endemics (Stefanović 1996) demonstrates that solely the Slavianka Mts. are the most typical oro-Mediterranean mountains in Bulgaria.

On the other hand, the Slavianka Mts. are located further north than the similar Northern Greek mountains and are the second highest. And they are different from the mountains in North-Eastern Greece. This difference is a bigger compared with the Macedonian mountains. The influence of the Dinaric Mountains (which are the connection with the Alps and Central Europe) is stronger there (see Stefanović 1996). They have many different plant endemics. These specificities of the flora reflect also on the vegetation, and especially on the high-mountain “island” isolated grassland areas (see Karagiannakidou et al. 1995, Stefanović 1996).

The Balkan endemics (species and subspecies) are not only present within these communities, they also play an important ecological role. Their centre of origin is in the limestone mountains in Northern Greece, South-Western Bulgaria, South-Eastern Serbia and Macedonia, described by Stefanoff (1943) as the Greece-Macedonian centre of endemism. According to Stefanović (1996) there are 116 oro-Mediterranean endemics in the mountains, of which 6 are local ones. Many of these endemic taxa, according to Stefanoff (1943) are conservative endemics, i.e. paleoendemics and relicts, and comparatively fewer of them are variational endemics. The first more important group includes species which were found in the grasslands on the Slavianka Mts.: *Petkovia orphanidea*; *Festucopsis sancta*; *Centaurea parilica*; *Galium demissum* subsp. *demissum*; *Potentilla apennina* subsp. *stojanovii*; *Onobrychis montana* subsp. *scardica*; *Saxifraga ferdinandi-coburgi*; *Erysimum comatum*; *Alyssum repens* subsp. *repens*; *Aubrieta columnae* subsp. *pirinica*. Most of these endemics are distributed mainly in this region, including parts of Macedonia, particularly Serbia and Montenegro, Bulgaria and Northern Greece. Their origin is a result of continuous isolation of their populations on the peaks covering small areas at high altitudes – “island isolation” (Karagiannakidou et al. 2001).

Some other endemics could be added to this group as well. They occur in larger areas in





**Figure 10:** Geographical elements in the floristic composition of the association *Saxifraga ferdinandi-coburgi-Seslerietum achatovii*: **AlpBalk** - Alpic-Balkanian; **AlpCarpAnatol** - Alpine-Carpathian-Anatolian; **AlpMed** - Alpine-Mediterranean; **ArctAlp** - Arctic-Alpine **Balk** - Balkan endemics; **BalkAnatol** - Balkan-Anatolian; **BalkDac** - Balkan-Dacic; **Boreal** - Boreal; **Bul** - Bulgarian endemics; **CarpBalk** - Carpathian-Balkan; **CentrSoutEur** - Central-South-European; **Eur** - European; **EurAs** - European-Asian; **EurMed** - European-Mediterranean; **EurMedCauc** - European-Mediterranean-Caucasian; **EurSib** - European-Siberian; **EurSubMed** - European-Sub-Mediterranean; **Med** - Mediterranean; **Pont** - Pontic (Black sea); **PontBalk** - Pontic (Black sea)-Balkan; **PontMed** - Pontic (Black sea)-Mediterranean; **PontSubMed** - Pontic (Black sea)-Sub-Mediterranean; **SubMed** - Sub-Mediterranean; **SubBoreal** - Sub-Boreal; **SubPont** - Sub-Pontic (Black sea).

**Slika 10:** Deleži geografskih elementov v floristični sestavi asociacije *Saxifraga ferdinandi-coburgi-Seslerietum achatovii*: **AlpBalk** - Alpsko-Balkanski; **AlpCarpAnatol** - Alpsko-Karpatško-Anatolijski; **AlpMed** - Alpsko-Mediterranski; **ArctAlp** - Arktično-Alpski; **Balk** - Balkanski endemit; **BalkAnatol** - Balkansko-Anatolijski; **BalkDac** - Balkansko-Dacijski; **Boreal** - Borealni; **Bul** - Bolgarski endemit; **CarpBalk** - Karpatsko-Balkanski; **CentrSoutEur** - srednje-južno Evropski; **Eur** - Evropski; **EurAs** - Evropsko-Azijski; **EurMed** - Evropsko-Mediterranski; **EurMedCauc** - Evropsko-Mediterranski-Kavkazijski; **EurSib** - Evropsko-Sibirski; **EurSubMed** - Evropsko-Submediteranski; **Med** - Mediteranski; **Pont** - Ponski (Črno morje); **PontBalk** - Ponsko (Črno morje)-Balkanski; **PontMed** - Ponsko (Črno morje)-Mediteranski; **PontSubMed** - Ponsko (Črno morje)-Submediteranski; **SubMed** - Submediteranski; **SubBoreal** - Subborealni; **SubPont** - Subponski (Črno morje).

mountain regions of South-Eastern Europe. Most of them are also conservative endemics: *Thymus thracicus* (44 %); *Pedicularis orthantha* (41 %); *Dianthus microlepis* (29 %); *Sempervivum leucanthum* (44 %); *Crocus veluchensis* (14 %); *Carex kitaibeliana* (77 %). All this floristic complex defines the high part of the Slavianka (Alibotush, Orvilos) Mts. as part of one very well presented paleoendemic refuge (a fact, observed as well by Stoyanoff (1941)) and also an old center of endemism, situated in the oro-Mediterranean areas of the southern part of the Balkan Peninsula. This centre of endemism in the Slavianka Mts. comprises not only the highest, but also the medium parts of the mountain and one essential part of it falls into the area of relict oro-Mediterranean Bosnian pine (*Pinus heldreichii*) forests. In the coniferous belt of this mountain, where conservative endemics dominate *Pinus heldreichii* and *Abies alba* subsp. *borisii-regis*, the paleoendemics like: *Viola delphinantha*, *Convolvulus boissieri* subsp. *suender-*

*mannii*, *Crepis schachtii*, *Bromus parilicus* and *Festucopsis sancta* are also observed. Probably, during the last glacial period, the main refuge zone in the Slavianka Mts. was situated at altitudes between 1000(1200)–1600 m. This zone was at a higher altitude on the Greek and Macedonian mountains, situated further southwards than the Slavianka Mts. The existence of a refuge zone in the mountains of Northern Greece, Bulgaria and Macedonia is confirmed by some palynological studies from Northern Greece and Southwestern Bulgaria (Bozhilova 1986, Tzedakis 1993, 1994, Tzedakis et al. 2002, Jalut et al. 2005). With the improvement of the climatic conditions, the irradiation of these species or their vicariant forms started to the north and also towards the highest sub-alpine belt. This led to the fact that the endemic species and subspecies of oro-Mediterranean origin are mixed with many boreal and arctic-alpine relict taxa like: *Juniperus pygmaea*, *Dryas ocopetala*, *Arctostaphylos uva-ursii* and oth-

ers, which survived on the highest parts of the mountains (Košanin 1924; Stojanoff 1930, Horvat 1952; Stefanović 1996). The present grassland communities in the sub-alpine zone, with their floristic composition, are a result of the mixing of endemics and relicts from the refuge in the contemporary forest belt and preserved glacial relicts in the non-forest zone – the highest part of the mountain. Although in the Slavianka Mts. arctic-alpine geoelements (19 % of the flora) exist, they are less numerous than, for example, on Mt. Pirin (27 %) and Mt. Rila (35 %) (see Stojanoff 1941). Their percentage however is higher than in the Northern Greek Mountains (see Karagiannakidou et al. 1995) – Falacron (Bozdag), Pangeo (Kushnica) and the Macedonian mountains (Horvat 1930, 1934, 1949, 1960) – Yakupica, Ostri Vruh and others.

## CONCLUSION

The new association *Saxifrago ferdinandi-coburgii-Seslerietum achtarovii* established in the Slavianka Mts. belongs to the orophyte grasslands in the subalpine belt of the mountains in the South part of the Balkan Peninsula. Its communities are included within the habitat 6170 Alpine and subalpine calcareous grasslands of the Habitat Directive (see Papastergiadou et al. 1997). This habitat is rare in Bulgaria and exists only in a few mountains – Pirin Mts., Central Stara Planina (Balkan Range) Mts. etc. This fact increases the nature conservation value of the subalpine belt in the Slavianka Mts. Many of the typical species in the new association are relicts or endemics- some of them local endemics. They are also protected according to the Bulgarian Biodiversity Act. The Slavianka Mts. are small, but unique mountains, which need special protection. The Alibotush Biosphere Nature Reserve, designated in the mountain, embraces mostly the forested areas, not subalpine grasslands. It is recommended that the strict nature reserve be expanded to include the grassland communities as well. These will ensure better conservation of the diverse vegetation of the Slavianka Mountains.

## ACKNOWLEDGEMENTS

The authors express their special thanks to Assoc. Prof. Dr. Marius Dimitrov (University of Forestry, Sofia) for the technical support, to Chavdar Gus-

sev and to Dr. Jonannis Tsiripidis (from the Aristotle University of Thessaloniki) for help with the literature sources and to Dimitrina Boteva for the improving of the English. We would also like to thank many of our colleagues and friends for their help received at different stages of this study.

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**Table 1:** Diagnostic table of a new grassland association *Saxifraga ferdinandi-coburgi* – *Seslerietum achtarovii* ass. nova from the Slavianka Mts.

|                                    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Number of relevés                  | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  |
| Plot sample area (m <sub>2</sub> ) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Altitude (m) X 10                  | 215 | 195 | 217 | 205 | 205 | 210 | 115 | 220 | 205 | 220 | 210 | 205 | 210 | 215 |
| Exposition                         | NE  | NE  | NW  | NE  | NE  | NE  | W   | 0   | 0   | E   | NE  | NE  | N   | E   |
| Slope (in degrees)                 | 70  | 5   | 30  | 45  | 35  | 10  | 30  | 0   | 0   | 0   | 40  | 50  | 45  | 50  |
| Coverage (%)                       | 20  | 50  | 50  | 45  | 50  | 50  | 55  | 30  | 50  | 40  | 45  | 50  | 55  | 50  |

| Diagnostic species to the association             | Life form element | Geographical | subassociation <i>typicum</i> |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|-------------------|--------------|-------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|
|   |                   |              | 2                             | 1 | 1 |   |   | 1 | 2 | 1 |   | 1 | 2 | 3 | 2 | 1 |
| <i>Sesleria rigida</i> subsp. <i>achtarovii</i>   | Ch                | Carp-Bal     | 1                             | 1 | 1 |   |   | 1 | 2 | 1 |   | 1 | 2 | 3 | 2 | 1 |
| <i>Saxifraga ferdinandi-coburgi</i>               | Ch                | Bal          | 1                             | 1 | + | + |   | + | 1 | + | 1 | 1 | 1 | + | + | 1 |
| <i>Galium demissum</i> subsp. <i>demissum</i>     | Cr                | Bal-Anat     |                               |   | + |   |   |   |   | r |   | + | r |   | 1 |   |
| <i>Centaurea napulifera</i> subsp. <i>nyssana</i> | Cr                | Pann-Bal     |                               |   |   | 1 | 1 | r |   | + |   |   |   |   |   |   |
| <i>Pedicularis orthantha</i>                      | Cr                | Bal          |                               |   | + | 1 | 1 | 1 | 1 | 1 | 1 | + |   | + |   |   |
| <i>Centaurea parilica</i>                         | Ch                | Bal          |                               |   |   | 1 | 1 | 1 |   |   |   |   |   |   | 1 |   |
| <i>Sempervivum leucanthum</i>                     | Ch                | Bul          |                               | 1 |   | 1 | 1 |   | r | + | 1 |   | 1 | + | 1 |   |
| <i>Anthyllis aurea</i>                            | Ch                | Bal          |                               |   |   |   | 1 |   | + | r | + | + |   | 1 |   |   |
| <i>Petkovia orphanidea</i>                        | Th                | Bal          | r                             | 1 | 1 | + |   |   | 1 | + | + | + |   |   | 1 |   |
| <i>Astragalus depressus</i>                       | H                 | subMed       |                               |   |   |   | + |   |   |   |   | + |   |   |   |   |
| <i>Viola perinensis</i>                           | Ch                | Bal          | +                             |   | 1 | 1 | 1 |   |   |   |   |   |   |   |   |   |
| <i>Vaccinium myrtillus</i>                        | Ph                | Boreal       |                               |   |   |   |   |   |   |   |   |   |   |   |   |   |
| <i>Primula elatior</i> subsp. <i>intricata</i>    | Cr                | Eur          |                               |   |   |   |   |   |   |   |   |   |   |   |   |   |
| <i>Crocus veluchensis</i>                         | Cr                | Bal          |                               |   |   |   |   |   |   |   |   |   |   |   |   |   |





| Number of relevés  |    |               | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|--|----|---------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|
| Diagnostic species to the alliance <i>Edraiantho-Seslerion</i> Horvat 1949 and order <i>Onobrychido-Seslerietalia</i> Horvat 1949                                      |    |               |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Dianthus microlepis</i>   | Ch | Bal           |   |   | 1 |   |   |   | 1 | + |   | 1  | +  | +  | 1  | 1  |
| <i>Achillea ageratifolia</i>   | Ch | Bal           |   |   |   |   |   |   |   | 1 | 1 |    | 1  |    | +  |    |
| <i>Paronychia kapela</i>   | H  | subMed        | 1 | 1 | + | 1 |   | 1 | 1 | 1 |   |    |    |    | +  | 1  |
| <i>Dryas octopetala</i>  | H  | Boreal        |   |   |   |   |   |   |   |   |   | 2  |    |    |    |    |
| <i>Potentilla apennina</i> subsp. <i>stojanovii</i>  | H  | Ap-Bal        | 1 |   |   |   |   | 1 |   |   |   |    |    |    |    |    |
| <i>Euphrasia salisburgensis</i>  | Th | subMed        |   |   |   |   |   |   |   |   |   |    |    |    | 1  |    |
| Diagnostic species to the class <i>Elyno-Seslerietea</i> Braun-Blanq. 1948   |    |               |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Carex kitaibeliana</i>  | Ch | subMed        |   |   | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2  | 2  |    | 2  | 1  |
| <i>Androsace villosa</i>   | Cr | Arct-Alp      |   | 1 |   |   |   | r | 1 | 1 | 1 |    |    |    |    |    |
| <i>Globularia cordifolia</i>   | H  | Alp-Carp-Anat | 2 |   |   | 1 |   | 1 |   | 1 | + |    |    |    |    |    |
| <i>Festucopsis sancta</i>  | Ch | Bal           |   |   |   | 1 | 2 |   |   |   |   |    |    | 1  |    |    |
| <i>Anthyllis montana</i> subsp. <i>jacquinii</i>   | Ch | Alp-Med       |   |   |   |   |   | 1 | + |   |   | +  |    |    |    |    |
| <i>Senecio papposus</i> subsp. <i>papposus</i>   | Ch | Carp-Bal      |   |   | + |   | + |   | + | r |   |    |    |    |    |    |
| <i>Draba aizoides</i>  | Ch | Bal           |   |   | + | 1 |   |   |   | + |   |    |    |    |    |    |
| <i>Onobrychis montana</i> subsp. <i>scardica</i>   | Ch | Carp-Bal      |   |   |   |   |   |   |   |   |   |    | +  |    | r  |    |
| <i>Poa alpina</i>  | Ch | Boreal        |   | 1 |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Linum alpinum</i> subsp. <i>alpinum</i>   | Ch | Alp-Med       |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Minuartia verna</i>   | Ch | subBoreal     |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| Diagnostic species to the class <i>Daphno-Festucetea</i> Quezel 1964, order <i>Daphno-Festucetalia</i> Quezel 1964 and alliance <i>Astragalo-Seslerion</i> Quezel 1964 |    |               |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Rhodax canus</i>  | H  | Pont          | + | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1  |    | 2  | 1  | 1  |
| <i>Thymus thracicus</i>  | Ch | subMed        |   | 1 |   | 1 |   |   |   | + |   |    |    |    |    |    |
| <i>Astragalus angustifolius</i> subsp. <i>pungens</i>  | Ph | subMed        |   | 2 | 1 | 1 |   |   |   |   |   |    |    | 1  | 2  | 2  |
| <i>Teucrium montanum</i>   | Ch | subMed        |   |   |   |   |   |   |   |   |   |    | r  |    |    |    |
| <i>Daphne oleoides</i>   | Ph | subMed        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| Other species  |    |               |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Juniperus pygmaea</i>   | Ph | Med           | 1 | 2 | 1 | 1 | + | 1 | 1 | r | r | r  | 1  | r  |    | 1  |
| <i>Hieracium pseudopilosella</i>   | Ch | Med           |   | r |   |   |   | 1 |   | r |   | +  |    | 1  | 1  | 1  |
| <i>Taraxacum pindicola</i>   | Ch | Bal           |   |   | + | r |   |   |   |   |   |    |    |    |    |    |
| <i>Muscari botryoides</i>  | Cr | Med           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Trinia glauca</i> subsp. <i>glauca</i>  | Ch | subMed        |   | + | + | + |   |   | 1 |   |   | +  |    |    |    |    |
| <i>Gentiana verna</i>  | Ch | Eur-As        |   |   |   | 1 |   | r |   |   | + | +  |    |    |    |    |
| <i>Saxifraga sempervivum</i>   | Ch | Bal           |   | 1 |   |   |   | r | 1 | + | + | +  |    |    |    |    |
| <i>Chamaecytisus absinthioides</i> subsp. <i>absinthioides</i>   | Ph | Bal           |   |   |   |   |   |   |   |   |   |    |    |    |    | 1  |
| <i>Rhinanthus wagneri</i>  | Ch | subMed        |   |   |   |   |   |   |   |   |   |    |    |    | 1  |    |
| <i>Pinus heldreichii</i>   | Ph | Ap-Bal        | r |   |   |   |   | r |   |   |   |    | r  |    |    |    |
| <i>Teucrium chamaedrys</i>   | Ch | subMed        |   |   |   |   |   |   |   |   |   |    |    | +  | 1  |    |
| <i>Veronica chamaedrys</i>   | Ch | Eur-As        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Arctostaphylos uva-ursi</i>   | H  | Boreal        |   |   |   | 1 |   |   | r |   |   |    | 1  |    |    |    |
| <i>Jurinea mollis</i>  | Ch | Pont-Med      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Erisimum comatum</i>  | Th | Bal           |   |   |   | 1 |   |   |   |   |   | +  |    |    |    |    |
| <i>Corydalis solida</i>  | Cr | Eur-Med-Cas   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Luzula luzuloides</i>   | Ch | Eur           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Alyssum repens</i> subsp. <i>repens</i>   | H  | Eur           |   |   |   | r |   |   |   |   |   |    |    |    |    |    |
| <i>Sedum acre</i>  | Ch | Eur-Med       |   |   |   |   |   |   |   |   |   |    |    |    |    | 1  |
| <i>Trifolium montanum</i>  | Ch | Spont         |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Dactylorhiza sambucina</i>  | Cr | Eur           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Euphorbia amygdaloides</i>  | Ch | Eur           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Scabiosa</i> sp.  | Th |               |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Botrychium lunaria</i>  | Ch | Boreal        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Ranunculus montanus</i>   | Ch | subMed        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Aubrieta columnae</i> subsp. <i>pirinica</i>  | Ch | Bal           |   |   | + | 1 |   |   |   |   |   |    |    |    |    |    |
| <i>Doronicum columnae</i>  | Ch | Pont-Med      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Polygala acarnanica</i>   | Ch | Bal           |   | r |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Myosotis</i> sp.  | Ch |               |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
| <i>Teucrium polium</i>   | Ch | Pont-Med      |   |   |   | + |   |   |   |   |   |    |    |    |    |    |
| <i>Syntrichia</i> sp.  |    |               |   |   |   |   |   |   |   | 1 |   |    |    |    |    |    |

| 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | Freq. | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | Freq. | Total |    |    |   |
|----|----|----|----|----|----|----|----|----|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-------|-------|----|----|---|
| 1  | +  |    | 1  | +  |    | 1  |    |    | 57    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       | 0     | 29 |    |   |
|    | 1  | 1  | 1  | 1  |    | 1  |    | 2  | 44    |    |    |    |    |    | r  |    |    |    |    |    |    |    |    |    |       | 7     | 26 |    |   |
|    | +  | r  | 1  |    | 1  | 2  | +  |    | 65    |    |    |    |    |    |    |    |    |    |    |    |    |    | +  |    |       | 7     | 36 |    |   |
| 2  |    |    |    |    |    |    |    |    | 9     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       |       | 0  | 5  |   |
|    |    |    |    |    |    |    |    |    | 9     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       |       |    | 0  | 5 |
|    |    |    |    |    |    |    |    |    | 4     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       |       |    | 0  | 2 |
|    |    | 3  | 3  | 3  | 2  | 2  | 2  |    | 74    | 3  | 1  | 2  | 1  | 3  | +  | 1  |    | 1  | 2  | 2  | 2  |    |    | 3  |       | 80    | 77 |    |   |
|    |    | 1  | 1  | +  |    |    |    |    | 35    |    |    |    |    |    |    |    |    |    |    |    |    |    | 2  | +  |       | 13    | 24 |    |   |
|    |    | 1  |    |    |    |    |    |    | 26    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       |       | 0  | 13 |   |
|    |    |    |    |    |    |    |    |    | 13    | 1  |    |    |    |    |    |    | 1  |    |    |    |    | 1  |    | 1  | +     | 33    | 23 |    |   |
|    |    |    |    |    |    |    |    |    | 13    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | +  | 1     | 13    | 13 |    |   |
|    | r  |    |    |    |    | +  |    |    | 26    | 2  | +  |    | 1  |    | +  |    |    |    | 1  | 1  |    |    |    |    |       | 40    | 33 |    |   |
|    | +  | r  |    |    |    |    |    |    | 22    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       |       | 0  | 11 |   |
|    |    |    |    |    |    |    |    |    | 9     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       |       | 0  | 5  |   |
|    | +  | 1  |    | 1  |    |    |    |    | 17    | 1  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       |       | 7  | 12 |   |
|    |    |    |    |    |    |    |    |    | 0     |    |    |    |    |    |    |    |    |    | +  |    |    |    | r  |    |       |       | 13 | 7  |   |
|    |    | 1  |    |    |    |    |    |    | 4     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       |       | 0  | 2  |   |
| 1  | 2  | 2  | 1  | 1  | 1  | 2  | 2  | 1  | 96    |    | 1  | 1  |    | 1  | 2  | +  |    | +  | 2  |    |    | 1  | 1  | 2  | 67    | 82    |    |    |   |
|    |    | +  | 1  |    | 1  |    | 1  | 1  | 35    | +  | 1  | 1  |    |    | 1  | +  | 1  |    |    | 1  |    |    | 2  |    |       | 53    | 44 |    |   |
|    |    |    |    |    |    |    |    |    | 26    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       |       | 0  | 13 |   |
|    |    |    |    | 1  |    | 1  |    |    | 13    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       |       | 0  | 7  |   |
|    |    |    |    |    |    |    | +  |    | 4     |    | +  |    |    |    | 1  |    |    |    |    |    |    |    |    |    |       | 13    | 9  |    |   |
| 1  |    |    | 2  |    |    |    | +  |    | 70    | 2  | 2  | 2  | 2  | 1  | +  |    | 2  | r  |    | 1  | +  | r  |    | +  | 80    | 75    |    |    |   |
| 1  | 1  |    |    |    | 1  | 1  | +  |    | 52    |    |    | 1  | 1  | 1  | 1  | 1  | +  | +  |    | 1  | +  | 1  |    |    | 53    | 53    |    |    |   |
| +  | +  | r  |    |    |    |    |    |    | 22    |    | +  | 1  | 1  | +  | +  |    | 1  | +  | 1  | 1  | 1  | +  | +  |    | 80    | 51    |    |    |   |
|    |    | 1  |    |    |    |    |    |    | 4     | 1  | 1  | 1  | 1  | 1  | 1  | 1  | +  | 1  |    |    |    |    | 1  |    | 67    | 36    |    |    |   |
|    |    | +  | 1  |    |    |    |    |    | 30    | r  |    |    | 1  | +  | r  |    |    |    |    |    |    |    | +  |    | 33    | 32    |    |    |   |
|    |    |    |    |    |    |    |    |    | 17    |    |    | 1  | 1  | 1  | 1  | 1  |    |    |    |    |    |    | 1  | 1  | 1     | 53    | 35 |    |   |
|    |    | +  |    |    |    |    |    |    | 30    |    | +  |    |    |    |    |    |    |    |    |    |    |    | r  | 1  | +     | 27    | 29 |    |   |
|    |    |    |    |    |    | 1  |    |    | 9     | 1  |    |    |    | +  | r  |    | r  | 1  | 1  |    | 1  |    |    |    | 47    | 28    |    |    |   |
| +  |    |    |    |    | 1  | 1  | 1  | 1  | 26    |    |    |    |    |    |    |    |    |    | r  | 1  |    |    |    |    | 13    | 20    |    |    |   |
| r  |    |    |    |    |    |    |    |    | 17    |    | r  | +  |    |    |    |    | r  |    |    |    |    |    |    |    | 20    | 19    |    |    |   |
|    |    |    |    |    |    | +  | +  |    | 17    | 1  |    |    |    |    |    |    | 1  | +  |    |    |    |    |    |    | 20    | 19    |    |    |   |
|    |    |    | 1  |    |    |    |    |    | 4     |    |    | 1  | 1  | 1  |    | +  |    |    |    |    |    |    |    |    | 27    | 16    |    |    |   |
| 1  |    |    |    |    |    |    |    |    | 17    |    |    |    |    |    |    |    |    |    |    |    |    |    | 2  |    | 7     | 12    |    |    |   |
|    |    |    |    |    |    | r  |    |    | 4     | 1  |    |    |    |    | +  |    |    |    |    |    |    | 1  |    |    | 20    | 12    |    |    |   |
|    |    |    |    |    |    |    |    |    | 9     |    |    |    |    |    |    |    |    |    |    |    |    |    | r  |    | +     | 13    | 11 |    |   |
|    |    |    |    |    |    |    |    |    | 0     | 1  | 1  | +  | 1  |    |    |    |    |    |    |    |    |    |    |    | 27    | 14    |    |    |   |
|    |    |    |    |    |    |    |    |    | 0     | +  |    |    | r  |    |    |    | r  |    | 1  |    |    |    |    |    | 27    | 14    |    |    |   |
|    |    | 1  | +  |    |    |    |    |    | 13    |    |    |    |    |    |    |    |    |    |    |    |    |    | +  |    | 7     | 10    |    |    |   |
|    |    |    |    |    |    |    | +  |    | 9     |    | 1  |    |    |    |    |    |    |    |    |    |    |    |    |    | 7     | 8     |    |    |   |
|    |    |    | 1  |    |    |    |    |    | 4     | +  |    |    |    |    |    |    |    |    | +  |    |    |    |    |    | 13    | 9     |    |    |   |
| +  |    |    |    |    |    |    |    |    | 4     |    |    |    | r  |    |    |    |    |    |    |    |    |    | +  |    | 13    | 9     |    |    |   |
|    |    |    |    |    |    |    |    |    | 0     |    |    | +  |    |    |    |    | r  |    |    |    |    |    |    |    | 13    | 7     |    |    |   |
|    |    |    |    |    |    |    |    |    | 0     |    |    | +  |    |    |    |    |    |    |    |    |    |    |    |    | 13    | 7     |    |    |   |
|    |    |    |    |    |    |    |    |    | 0     | r  |    |    |    |    |    | +  |    |    |    |    |    |    |    |    | 13    | 7     |    |    |   |
|    |    |    |    |    |    |    |    |    | 0     | +  |    | +  |    |    |    |    |    |    |    |    |    |    |    |    | 13    | 7     |    |    |   |
|    |    |    |    |    |    |    |    |    | 9     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 0     | 5     |    |    |   |
|    |    |    |    |    |    |    |    |    | 0     |    |    | 1  | +  |    |    |    |    |    |    |    |    |    |    |    | 13    | 7     |    |    |   |
|    |    |    |    |    |    |    |    |    | 4     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 7     | 6     |    |    |   |
|    |    |    |    |    |    |    |    |    | 0     | r  |    |    |    |    | 1  |    |    |    |    |    |    |    | r  |    | 13    | 7     |    |    |   |
|    |    |    |    |    |    |    |    |    | 4     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 0     | 2     |    |    |   |
|    |    |    |    |    |    |    |    |    | 4     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 0     | 2     |    |    |   |

**Table 2:** Synoptic table of related syntaxa with Slavianka Mt. phytocoenoses.

**Tabela 2:** Sinoptična tabela sintaksona z združbami s Slavjanke.

|  | 1   | 2   | 3   | 4  | 5   | 6   | 7   | 8   | 9   | 10  |
|--|-----|-----|-----|----|-----|-----|-----|-----|-----|-----|
| <i>Sesleria rigida</i> subsp. <i>achtarovii</i>                                  | IV  | V   | V   |    |     | III |     |     | IV  |     |
| <i>Saxifraga ferdinandi-coburgi</i>  | III | II  | III |    |     |     |     | IV  |     |     |
| <i>Galium demissum</i> subsp. <i>demissum</i>                                    | III | II  | III |    |     |     |     |     |     |     |
| <i>Centaurea napulifera</i> subsp. <i>nyssana</i>                                | II  | II  | III |    |     |     |     |     |     |     |
| <i>Pedicularis orthantha</i>   | II  | II  | II  |    |     |     |     |     |     |     |
| <i>Centaurea parilica</i>  | II  | II  | II  |    |     |     | IV  |     |     |     |
| <i>Sempervivum leucanthum</i>  | IV  | I   | III |    |     |     |     |     |     |     |
| <i>Anthyllis aurea</i>   | IV  | I   | III | II | II  |     | V   | V   | II  |     |
| <i>Petkovia orphanidea</i> ( <i>Campanula orphanidea</i> )                       | III | I   | II  |    |     |     | I   |     | III |     |
| <i>Astragalus depressus</i>  | I   | IV  | II  |    |     |     |     |     |     |     |
| <i>Viola perinensis</i>  | I   | III | II  |    |     |     |     |     |     |     |
| <i>Vaccinium myrtillus</i>   | I   | III | II  |    |     |     |     |     |     |     |
| <i>Primula elatior</i> subsp. <i>intricata</i>                                   | I   | IV  | II  |    |     |     |     |     |     |     |
| <i>Crocus veluchensis</i>  |     | II  | I   |    |     |     |     |     |     |     |
| <i>Dianthus microlepis</i>   | III | I   | II  |    |     |     |     |     |     |     |
| <i>Achillea ageratifolia</i>   | III | I   | II  | IV | II  |     |     |     | I   |     |
| <i>Paronychia kapela</i>   | IV  | I   | III | V  | IV  |     |     |     |     | III |
| <i>Dryas octopetala</i>  | I   |     | I   | II | II  |     |     |     |     |     |
| <i>Carex kitaibeliana</i> ( <i>Carex laevis</i> )                                | IV  | IV  | IV  | V  | V   |     | V   | IV  |     |     |
| <i>Androsace villosa</i>   | II  | I   | II  |    |     |     |     | IV  |     |     |
| <i>Globularia cordifolia</i>   | II  | I   | I   | V  | II  |     |     |     |     | III |
| <i>Festucopsis sancta</i>  | I   | II  | II  |    |     |     | V   |     | I   |     |
| <i>Anthyllis montana</i> subsp. <i>jacquinii</i>                                 | I   | I   | I   |    |     |     |     | IV  |     |     |
| <i>Senecio papposus</i> subsp. <i>papposus</i>                                   | II  | II  | II  |    |     |     |     |     |     |     |
| <i>Draba aizoides</i>  | II  | I   | I   |    |     |     |     |     |     |     |
| <i>Onobrychis montana</i> subsp. <i>scardica</i>                                 | I   |     | I   | IV | III | III |     |     | I   |     |
| <i>Poa alpina</i>  | I   | I   | I   | II | II  |     |     | III | III |     |
| <i>Minuartia verna</i>   | I   |     | I   |    | III |     |     |     | IV  | V   |
| <i>Rhodax canus</i> ( <i>Helianthemum canum</i> )                                | V   | IV  | V   |    |     |     | III | V   | IV  |     |
| <i>Thymus thracicus</i>  | II  | II  | III |    |     | IV  | IV  | III |     |     |
| <i>Astragalus angustifolius</i> subsp. <i>pungens</i>                            | I   | I   | I   |    |     | II  |     |     | V   |     |
| <i>Teucrium montanum</i>   | I   |     | I   |    |     |     | II  |     | III | III |
| <i>Daphne oleoides</i>   | I   | I   | I   |    |     | III |     |     | I   |     |
| <i>Juniperus pygmaea</i>   | IV  | IV  | IV  |    |     |     |     |     |     |     |
| <i>Hieracium pseudopilosella</i>   | III | III | III |    |     |     |     |     |     |     |
| <i>Taraxacum pindicola</i>   | II  | IV  | III |    |     |     |     |     |     |     |
| <i>Muscari botryoides</i>  | I   | IV  | II  |    |     |     |     |     |     |     |
| <i>Trinia glauca</i> subsp. <i>glauca</i>  | II  | II  | II  |    |     |     |     |     |     |     |
| <i>Gentiana verna</i>  | I   | II  | II  | II | III |     |     |     |     |     |
| <i>Saxifraga sempervivum</i>   | II  | II  | II  |    |     |     |     |     | II  |     |
| <i>Chamaecytisus absinthioides</i> subsp. <i>absinthioides</i>                   | I   | III | II  |    |     |     |     |     |     |     |
| <i>Rhinanthus wagneri</i>  | II  | I   | II  |    |     |     |     |     |     |     |
| <i>Veronica chamaedrys</i>   | I   | II  | I   |    |     |     |     |     |     |     |
| <i>Corydalis solida</i>  |     | II  | I   |    |     |     |     |     |     |     |
| <i>Luzula luzuloides</i>   |     | II  | I   |    |     |     |     |     |     |     |
| <i>Asperula aristata</i> subsp. <i>longiflora</i> ( <i>Asperula longiflora</i> ) | I   |     | I   | II | II  |     |     |     |     |     |



|  | 1 | 2 | 3 | 4   | 5   | 6   | 7 | 8 | 9 | 10 |
|--|---|---|---|-----|-----|-----|---|---|---|----|
| <i>Sesleria juncifolia</i>                           |   |   |   | V   |     |     |   |   |   |    |
| <i>Helianthemum scardicum</i>                        |   |   |   | V   | II  |     |   |   |   |    |
| <i>Carex rupestris</i>                               |   |   |   | II  |     |     |   |   |   |    |
| <i>Edraianthus graminifolius</i>                     |   |   |   | IV  | V   |     |   |   |   |    |
| <i>Saxifraga porophylla</i>                          |   |   |   | II  | III |     |   |   |   |    |
| <i>Euphorbia minima</i>                              |   |   |   | III |     |     |   |   |   |    |
| <i>Festuca rupicola</i>                              |   |   |   | IV  | II  |     |   |   |   |    |
| <i>Saxifraga marginata</i> var. <i>coryophylla</i>   |   |   |   | II  | II  |     |   |   |   |    |
| <i>Ranunculus oreophilus</i>                         |   |   |   | II  |     |     |   |   |   |    |
| <i>Anthyllis</i> sp.                                 |   |   |   | V   | IV  |     |   |   |   |    |
| <i>Draba</i> sp.                                     |   |   |   | V   | IV  |     |   |   |   |    |
| <i>Thymus boissieri</i>                              |   |   |   | II  | V   |     |   |   |   |    |
| <i>Trinia delechampii</i>                            |   |   |   | II  | II  |     |   |   |   |    |
| <i>Cerastium lanigerum</i>                           |   |   |   | II  | II  |     |   |   |   |    |
| <i>Allium scardicum</i>                              |   |   |   | II  | II  |     |   |   |   |    |
| <i>Aster alpinus</i>                                 |   |   |   | II  |     |     |   |   |   |    |
| <i>Silene multicaulis</i>                            |   |   |   | III | II  |     |   |   |   |    |
| <i>Minuartia setacea</i>                             |   |   |   | III |     |     |   |   |   |    |
| <i>Asyneuma</i> sp.                                  |   |   |   | II  | II  |     |   |   |   |    |
| <i>Dianthus petraeus</i> subsp. <i>integer</i>       |   |   |   | II  |     | III |   |   |   |    |
| <i>Primula veris</i>                                 |   |   |   | II  |     |     |   |   |   |    |
| <i>Koeleria eriostacya</i>                           |   |   |   | II  |     |     |   |   |   |    |
| <i>Pimpinella saxifraga</i>                          |   |   |   | II  | III |     |   |   |   |    |
| <i>Juniperus communis</i> subsp. <i>nana</i>         |   |   |   | II  | II  |     |   |   |   |    |
| <i>Leontodon hispidus</i>                            |   |   |   | II  |     |     |   |   |   |    |
| <i>Festuca glauca</i>                                |   |   |   | II  | II  |     |   |   |   |    |
| <i>Festuca trachyphylla</i>                          |   |   |   |     | II  |     |   |   |   |    |
| <i>Helianthemum balcanicum</i>                       |   |   |   | IV  |     |     |   |   |   |    |
| <i>Asperula dorfleri</i>                             |   |   |   | III |     |     |   |   |   |    |
| <i>Dianthus sylvestris</i> subsp. <i>tergestinus</i> |   |   |   | II  |     |     |   |   |   |    |
| <i>Oxytropis urumovii</i>                            |   |   |   | III |     |     |   |   |   |    |
| <i>Euphrasia minima</i>                              |   |   |   | III |     |     |   |   |   |    |
| <i>Pedicularis grisebachii</i>                       |   |   |   | III |     |     |   |   |   |    |
| <i>Dianthus jakupicensis</i>                         |   |   |   | III |     |     |   |   |   |    |
| <i>Minuartia baldaccii</i>                           |   |   |   | IV  |     |     |   |   |   |    |
| <i>Sesleria coerulans</i>                            |   |   |   | V   |     |     | V |   |   |    |
| <i>Hieracium hoppeanum</i>                           |   |   |   | II  |     |     |   |   |   |    |
| <i>Festuca varia</i>                                 |   |   |   | V   | II  |     |   |   |   |    |
| <i>Primula veris</i> subsp. <i>columnae</i>          |   |   |   | II  |     |     |   |   |   |    |
| <i>Ranunculus sartorianus</i>                        |   |   |   | II  |     |     |   |   |   |    |
| <i>Juniperus communis</i> subsp. <i>alpina</i>       |   |   |   | III |     |     |   |   |   |    |
| <i>Festuca coritnicensis</i>                         |   |   |   | II  |     |     |   |   |   |    |
| <i>Carduus tmoleus</i>                               |   |   |   | II  |     |     |   |   |   |    |
| <i>Hieracium pannosum</i>                            |   |   |   | III |     |     |   |   | V |    |
| <i>Asperula aristata</i> subsp. <i>nestia</i>        |   |   |   | II  |     |     |   |   |   |    |
| <i>Carex kitaibeliana</i> subsp. <i>capillata</i>    |   |   |   | II  |     |     |   |   | V |    |
| <i>Onobrychis alba</i> var. <i>calcarea</i>          |   |   |   | III |     |     |   |   |   |    |
| <i>Potentilla tomasiniana</i>                        |   |   |   | III |     |     |   |   |   |    |
| <i>Dianthus steffanofii</i>                          |   |   |   | II  |     |     |   |   |   |    |

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7   | 8   | 9   | 10 |
|---|---|---|---|---|---|---|-----|-----|-----|----|
| <i>Scabiosa rodopensis</i>                            |   |   |   |   |   |   | II  |     |     |    |
| <i>Genista rhodopea</i>                               |   |   |   |   |   |   | II  |     |     |    |
| <i>Origanum vulgare</i> var. <i>viride</i>            |   |   |   |   |   |   | II  |     | I   |    |
| <i>Linum tauricum</i>                                 |   |   |   |   |   |   | II  |     |     |    |
| <i>Saponaria bellidifolia</i>                         |   |   |   |   |   |   | II  |     |     |    |
| <i>Artemisia</i> cf. <i>campestris</i>                |   |   |   |   |   |   | II  |     |     |    |
| <i>Chondrilla urumoffii</i>                           |   |   |   |   |   |   | II  |     | I   |    |
| <i>Achillea ageratifolia</i> subsp. <i>aizoon</i>     |   |   |   |   |   |   | II  | III |     |    |
| <i>Sideritis scardica</i>                             |   |   |   |   |   |   | II  |     | II  |    |
| <i>Juniperus hemisphaerica</i>                        |   |   |   |   |   |   | II  |     |     |    |
| <i>Globularia meridionalis</i>                        |   |   |   |   |   |   | II  | II  | I   |    |
| <i>Stipa pulcherrima</i>                              |   |   |   |   |   |   | II  |     | III | II |
| <i>Peucedanum longifolium</i>                         |   |   |   |   |   |   | II  |     |     |    |
| <i>Festuca ovina</i> subsp. <i>duriuscula</i>         |   |   |   |   |   |   | II  |     |     |    |
| <i>Hypericum rumelicum</i>                            |   |   |   |   |   |   | II  |     |     |    |
| <i>Astragalus tymphresteus</i>                        |   |   |   |   |   |   | II  |     |     |    |
| <i>Onosma taurica</i>                                 |   |   |   |   |   |   | II  |     |     |    |
| <i>Asperula aristata</i> subsp. <i>tessala</i>        |   |   |   |   |   |   | II  |     |     |    |
| <i>Jurinea arachnoidea</i>                            |   |   |   |   |   |   | II  |     |     |    |
| <i>Phalangium liliago</i>                             |   |   |   |   |   |   | IV  |     |     |    |
| <i>Gladiolus iliricus</i>                             |   |   |   |   |   |   | III |     |     |    |
| <i>Orchis pyramidalis</i>                             |   |   |   |   |   |   | II  |     |     |    |
| <i>Thalictrum minus</i>                               |   |   |   |   |   |   | II  |     | I   |    |
| <i>Viola delphinantha</i>                             |   |   |   |   |   |   |     | IV  |     |    |
| <i>Festuca panciciana</i>                             |   |   |   |   |   |   |     | IV  |     |    |
| <i>Linum tracicum</i>                                 |   |   |   |   |   |   |     | II  |     |    |
| <i>Anthyllis vulneraria</i> var. <i>pulchella</i>     |   |   |   |   |   |   |     | III | II  |    |
| <i>Matthiola tristis</i> var. <i>thessala</i>         |   |   |   |   |   |   |     | II  |     |    |
| <i>Sempervivum marmoreum</i>                          |   |   |   |   |   |   |     |     | II  |    |
| <i>Festuca macedonica</i>                             |   |   |   |   |   |   |     |     | III |    |
| <i>Thymus cherlerioides</i>                           |   |   |   |   |   |   |     |     | III |    |
| <i>Sesleria tenerrima</i>                             |   |   |   |   |   |   |     |     | III |    |
| <i>Alyssum montanum</i>                               |   |   |   |   |   |   |     |     | I   |    |
| <i>Potentilla cinerea</i>                             |   |   |   |   |   |   |     |     | I   |    |
| <i>Acinos alpinus</i> subsp. <i>alpinus</i>           |   |   |   |   |   |   |     |     | III |    |
| <i>Dianthus petraeus</i> subsp. <i>orbelicus</i>      |   |   |   |   |   |   |     |     | II  |    |
| <i>Hypericum olympicum</i>                            |   |   |   |   |   |   |     |     | II  |    |
| <i>Coronilla varia</i>                                |   |   |   |   |   |   |     |     | I   |    |
| <i>Vincetoxicum hirundinaria</i> subsp. <i>nivale</i> |   |   |   |   |   |   |     |     | I   |    |
| <i>Thymys sibthorpii</i>                              |   |   |   |   |   |   |     |     | IV  |    |
| <i>Helianthemum nummularium</i>                       |   |   |   |   |   |   |     |     | III |    |
| <i>Euphorbia myrsinites</i>                           |   |   |   |   |   |   |     |     | II  |    |
| <i>Scleranthus annuus</i>                             |   |   |   |   |   |   |     |     | II  |    |
| <i>Potentilla argentea</i>                            |   |   |   |   |   |   |     |     | II  |    |
| <i>Carex humilis</i>                                  |   |   |   |   |   |   |     |     | I   |    |
| <i>Paronychia rechingeri</i>                          |   |   |   |   |   |   |     |     | I   |    |
| <i>Galium rhodopeum</i>                               |   |   |   |   |   |   |     |     | I   |    |
| <i>Silene ciliata</i>                                 |   |   |   |   |   |   |     |     | I   |    |
| <i>Hipochaeris pelivanovichii</i>                     |   |   |   |   |   |   |     |     |     | V  |

|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10  |
|--|---|---|---|---|---|---|---|---|---|-----|
| <i>Asperula suberosa</i>   |   |   |   |   |   |   |   |   |   | V   |
| <i>Carum rigidulum</i> agg.  |   |   |   |   |   |   |   |   |   | IV  |
| <i>Centaure mannagettae</i>  |   |   |   |   |   |   |   |   |   | IV  |
| <i>Alium minus</i>   |   |   |   |   |   |   |   |   |   | III |
| <i>Micromeria cristata</i>   |   |   |   |   |   |   |   |   |   | III |
| <i>Helianthemum tomentosum</i>   |   |   |   |   |   |   |   |   |   | III |
| <i>Sedum album</i>   |   |   |   |   |   |   |   |   |   | III |
| <i>Dianthus petraeus</i> subsp. <i>petraeus</i>                        |   |   |   |   |   |   |   |   |   | III |
| <i>Knautia</i> sp. ( <i>K. midzorensis</i> , according to the authors) |   |   |   |   |   |   |   |   |   | III |
| <i>Draba lasiocarpa</i>  |   |   |   |   |   |   |   |   |   | II  |

1. *Saxifraga ferdinandi-coburgii* - *Seslerietum achtarovii* ass nova subass *typicum*
2. *Saxifraga ferdinandi-coburgii* - *Seslerietum achtarovii* ass nova subass *violetosum perinensis*
3. Generally about 1 and 2
4. *Helianthemo* - *Seslerietum* Horvat 1960 (Yacupica Mt. – Central Macedonia), Acta Musei Macedonici Scient. Nat. 6: 163–203.
5. *Edraiantho* - *Helianthemum balcanici* Horvat 1935 (= *Carex laevis* - *Helianthemum balcanicum*) (Yacupica Mt. – Central Macedonia), 1. Ljet. Jug. Akad. Zn. umj. Zagreb. 47: 142–160.
6. *Seslerio achtarovii* - *Festucetum variae* Karagiannikidou & al. 2001 (Pangeo Mt. /Kushnica, Parnar dag/ – North Greece), Fito-sociologia, 38 (1): 25–54, 2001
7. *Agropyro sancti* - *Centauretum parilicae* Quezel 1989 (Falacron Mt. (Bozdag) – North Greece), Bios (Thessaloniki): 187–193.
8. *Violo delphinanthae* - *Saxifragetum ferdinandi-coburgi* Quezel 1989 (Falacron Mt. (Bozdag) – North Greece), Bios (Thessaloniki): 187–193.
9. *Astragalo pungentis*-*Caricetum kitaibeliana* Karagiannikidou 1994 (Menikion /Zmiinica, Serski Bozdag/ – North Greece) Ecologia Mediterranea XX (3/4) 1994: 73–84
10. *Hieracio*- *Caricetum kitaibeliana* Mucina & al. 1990 (Pirin Mt. – South-Western Bulgaria), Studia Geobotanica, 10: 15–58, 1990.

\*The diagnostic species to the associations according to cited authors, are Bold lines