Plant communities of the subalpine mires and springs in the Vitosha Mt.

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Abstract. The variability of mires (*Scheuchzerio-Caricetea fuscae*) and subalpine springs (*Montio-Cardaminetea*) was evaluated in the Vitosha Mt, a region with well developed wetland habitats. Fifty-three phytosociological relevés were classified using formal definitions, i.e. combination of species groups extracted from data set from throughout Bulgarian mountain wetlands. The major compositional gradient in the Vitosha mires was found to be the developmental gradient from initial, long-term sucessionally arrested stages of spring fens to the advanced species-rich vegetation of the *Sphagnum*-rich fens and the wet meadows. The unclear high-rank classification of Bulgarian subalpine fens, recently assigned to the *Caricion fuscae* alliance, is discussed.

Keywords: Balkans, bog, Bulgaria, fen, mire, phytosociology, syntaxonomy, vegetation

Introduction

The mires in the Vitosha Mt. belong to the habitats with an extraordinary importance in terms of species diversity and conservation in Bulgaria (Penev 1964; Nedeva 1975; Bondev & al. 1982; Apostolova & Meshinev 2001). As compared to other Bulgarian mires they are species-rich and of a rather large extend. However, their vegetation has never been evaluated in terms of Braun-Blanquet phytosociological approach (Braun-Blanquet 1964; Westhoff & Maarel 1973), what makes its insertion within the European context (Rodwell & al. 2002) impossible. Merely Soó (1957) tried to describe the plant communities of the Vitosha fens as a separate plant association. He studied Vitosha fens only briefly, the relevés are incomplete in term of species composition, the variability of his data set is not evaluated and the name that he chose (*Caricetum fuscae-Sphagnetum balcanicum*) is ambiguous and it is not valid.

The spring and mire communities were only marginally studied in Bulgaria. The majority of scarce studies concerns the list of vascular plants found in these habitats supplemented by a phytogeographical analysis (Jordanoff 1931; Stefanoff & Jordanoff 1931). The syntaxonomical evaluations are extremely rare (Marhold & Valachovič 1998; Roussakova

2000) and represent one of the most apparent gaps in European vegetation science. Stojanoff (1939), Petrov (1956), Filipovitch (1981, 1982), Bondev & al. (1982) and Filipovich & Stoyanova (1984) have studied the mire flora of the Vitosha Mt from the various points of view.

The aims of this study are (i) to describe the variation in spring and mire vegetation in the Vitosha Mountain and (ii) to classify this vegetation into the phytosociological units in the context of European phytosociological classification system. In order to classify the plant communities in Vitosha Mt. within this wide-range context, we collected data from all mountain regions in Bulgaria and processed them together. The resulting vegetation types are expected to be valid for a wide territory.

Material and methods

Study area

Vitosha, a dome-shape crystalline mountain is located southwards of the town of Sofia. The highest peak is Cherni Vruh (2290 m). Vitosha contains an old stable plutonic core. The mountain has raised within a several periods with non-equal amplitude during the Neogene. Large, more or less levelled plateau has been further modelled by cryogenic processes. This relief is suitable for runoff deceleration causing a formation of many mountain mires. Many springs in the high-mountain area give rise to the tributaries of rivers Strouma and Iskur. Together with the wide *Sphagnum*-dominated peat areas in the subalpine, some forested mires were formed within spruce forests and along the streams.

Vitosha Nature Park nowadays covers 26 606 ha. The most important Bulgarian peat area (783 ha) was designated as a reserve (Torfeno Branishte Reserve) in 1935. One of the first Bulgarian reserves, Bistrishko Branishte (designated in 1934), now a biosphere reserve, is also located in the Vitosha Mt.

About 1489 species of vascular plants and 313 bryophytes were found on the territory of Vitosha Mt. Some of them are relics and endemics (*Pinus peuce*, *Taxus baccata*, *Aquilegia aurea*, *Gentianella bulgarica*, *Jasione bulgarica*, *Minuartia bulgarica*, *Luzula deflexa*, etc.)

According to Bondev (1991) mixed deciduous, beech and spruce forests, followed by subalpine shrub and herb communities, cover the northern slopes. The southern slopes are different because of the calcareous bedrock and they are covered by oak forests and steppe-like communities.

About 61 habitat types were distinguished in Vitosha Nature Park, some of them represent the listed in the Annex I of the Bulgarian Biodiversity Low habitats.

Field data sampling

Phytosociological relevés were taken from all available springs and mires, which we found in Vitosha Mt. during our research. Petra Hájková, Michal Hájek and Iva Apostolova (further H+A) sampled this vegetation in June 2001; Rossen Tzonev and Anna Ganeva (further T+G) in June and July 2004. The relevés were placed in the central, the most homogeneous part of each spring or mire. We tried to cover all visible conspicuous vegetation and habitat types within each wetland complex. The standard relevé area was 16 m^2 (Chytrý & Otýpková 2003), with the exceptions of extremely small springs and, on the other hand, several large mires where some relevés of T+G had the size of 100 m^2. All vascular plants and bryophytes were identified and their cover was estimated using the nine-grade Braun-Blanquet scale (Maarel 1979). The same criteria were used in the field research in the other Bulgarian mountains, which was conducted by H+A during the years 2001–2004. The list of the localities of the relevés included into the analysis is available by the first author. For the classification purposes, we also computerised the data from spring fens published by Roussakova (2000) and stored them in the TURBOWIN database (Hennekens & Schaminée 2001). The nomenclature of vascular plants follows Kozhuharov & al. (1992) and the nomenclature of the bryophytes follow Ganeva & Natcheva (2003) and Natcheva & Ganeva (2005). The nomenclature of the syntaxa is in accordance to the Code of phytosociological nomenclature (Weber & al. 2000).

Data processing

A total number of 615 phytosociological relevés from the submontane to the subalpine wetlands of Bulgaria were exported into JUICE software (Tichý

2002). Some taxonomically unclear species were merged into one (*Soldanella chrysostricta* was coupled with *S. pindicola*). A polythetic, divisive classification that uses two-way indicator species analysis – TWINSPAN (Hill 1979) was applied. The resulting vegetation types roughly corresponded with the major, ecologically defined vegetation types. In the next steps, we tried to reproduce these vegetation types by the formal definitions using the combination of defined groups of species with the statistical tendency of joint occurrences in vegetation (Kočí & al. 2003). The species groups were created by the Coctail method (Bruelheide 1995), using the phi-coefficient (Chytrý & al. 2002). The resulting groups were combined by logical operators AND, OR and AND NOT; the strong dominance of some species was also used as a character in some cases. The great part of the high-mountain relevés was classified in this way. Further, we deleted the relevés from outside the Vitosha Mt and recalculated fidelity of each species to each vegetation type (Chytrý & al. 2002) using phi-coefficient (Sokal & Rohlf 1995) in resulting small data set from Vitosha Mt. The species in table were then sorted according to their fidelity to the vegetation type and the species, with a fidelity above 35 (phi-coefficient 0.35) in any association, were regarded as diagnostic. The relevés that remained unclassified were subsequently assigned to the associations by calculating similarity to relevé groups that had already been assigned to the associations using the positive fidelity-frequency index (Kočí & al. 2003) and by the number of diagnostic species. Finally, the diagnostic species were recalculated.

Results

The phytosociological relevés from Vitosha were classified within seven associations, which could be discerned at a broad geographical scale. Four of them represented mire, i.e. fen, vegetation; two of them spring vegetation and two relevés represented species-poor fallow wet meadows. The communities were identified with the following associations.

Drepanocladetum exannulati Krajina 1933

This association, documented from the Vitosha Mt only by one small relevé, represents the oligotrophic mires dominated by sedges and brown mosses indicating initial, albeit stable, and strongly waterlogged stages of mire formation (Hájek & Háberová 2001). It was described from siliceous substrates of the subalpine belt in the Western Carpathians (Krajina 1933). The communities are species-poor and formed by strongly dominating moss *Warnstorfia exannulata* accompanied by the low sedge *Carex nigra* and often also by *Juncus filiformis.* In contrast to other similar habitats in Bulgarian mountains, *Drepanocladetum exannulati* practically do not harbour any Balkan phytogeographical element and its species composition is a nearly identical one to those of Central-European subalpine fens. This is probably caused by a strong waterlogging and repeated disturbance of the habitats.

Primulo exiguae-Caricetum echinatae Roussakova 2000

The next vegetation type classified at the association level also represents successionally arrested initial stage of peat formation, but it is species-richer with an abundant occurrence of Balkan elements like *Primula farinosa* subsp. *exigua* (the best diagnostic species), *Pinguicula balcanica* (Fig. 1),

Fig. 1. *Pinguicula balcanica*

Fig. 2. *Pseudorchis frivaldii*

Pseudorchis frivaldii (Fig. 2) and *Cardamine rivularis*. The mosses indicating initial stages of mire formation in subalpine belts, i.e. *Warnstorfia sarmentosa*, *Sphagnum platyphyllum*, *Warnstorfia exannulata* and *Scapania irrigua* (outside the Vitosha), well characterise the bryophyte layer. The peat mosses forming elevated lawns and hummocks are rare. The occurrence of the spring species of the *Montio-Cardaminetea* class (Fig. 3) (*Saxifraga stellaris* subsp. *alpigena*, *Soldanella chrysostricta/pindicola*) is also a typical trait of this association. *Trichophorum caespitosum* forms conspicuous growths in some spring fens. This association was described from the Rila Mt (Roussakova 2000) and it occurs in the majority of the Bulgarian high mountains. *Carex echinata,* that gave the association name, is rare in our material from Vitosha and it is replaced here by *Carex nigra* with the same ecological demands.

Cirsio heterotrichi-Caricetum nigrae (Soó 1957) comb. nov. hoc loco

This is the typical association of the mires in the Vitosha Mt. It is probably linked to the previous associations along the succession-related moisture gradient. The group of *Molinion* species, formed by *Molinia caerulea* agg., *Succisa pratensis*, *Sanguisorba officinalis* and *Potentilla erecta* well differentiate this association from the previous two more waterlogged ones. This group combined with the presence of species typical for the Balkan subalpine spring fens (*Pinguicula balcanica*, *Dactylorhiza cordigera* subsp. *bosniaca*, *Gentianella bulgarica*, *Crocus veluchensis*, *Pseudorchis frivaldii*, *Sesleria comosa*) and the absence of the submontane-meadow *Molinietalia* species reliably characterises this association. As in the previous case, *Trichophorum caespitosum* can dominate in some localities. The peat mosses of the fen meadow habitats, *Sphagnum subsecundum* and *S. warnstorfii*, are dominating bryophytes. The original name *Carici fuscae-Sphagnetum balcanicum* is not valid because of its geographical epiteton as well as the incomplete relevés presented in the original paper. The new name proposed by us tries to express the restricted distribution range of this association.

Fig. 3. *Montio-Cardaminetea*, *Saxifragetum stellaris* (Rila)

We recorded the *Cirsio heterotrichi-Caricetum nigrae* association also in the Stara Planina Mts, namely below the peaks Kom (Western Stara Planina) and Vezhen (Central Stara Planina), in both cases without *Cirsium heterotrichum*. This species, however, occurs in the Serbian part of the mountain, which represents a link between Vitosha and Stara Planina. Due to a rather large part of the successional gradient occupied by this association, we were able to distinguish three subassociations within our material: first wet initial subass. *sphagnetosum subsecundi* transitional to the previous association, second typical without the character group of species and third, drier and successionaly advanced subass. *eriophoretosum vaginatae* (Table 1). The latter is transitional to the following association.

Bruckenthalio-Sphagnetum capillifolii ass. nov.

The end of the developmental gradient within Vitosha mires is occupied by the specific vegetation, which is formed by the high *Sphagnum capillifolium* hummocks. This peat moss is replaced by *S. warnstorfii* in two cases. The dry and extremely acid conditions on these hummocks are reflected by the occurrence of *Vaccinium myrtillus*, *V. vitis-idaea*, *V. uliginosum*, *Juniperus sibirica*, *Bruckenthalia spiculifolia*, *Homogyne alpina* and *Eriophorum vaginatum*. The habitats resemble miniature bogs, but the presence of fens species surviving from the previous stages indicates that the vegetation should be still assigned to the *Scheuchzerio-Caricetea fuscae* class. Even though this association often forms rather small patches, we recorded the very extensive plots of this vegetation especially in the Stara Planina Mts. The successional relationship to the previous association is evident from the plots of T+G (Table 1, relevés 23–29), where the species of two latter associations coexist in a fine spatial mosaic. The boundary of these two associations in the data set of relevés taken from large plots (about 100 m^2) therefore could be fuzzy.

The analogical communities could be found in other European high mountains. Hadač & al. (1969) decribed the analogical association – *Sphagno nemorei* (= *capillifolii*)-*Caricetum canescentis* from subalpine zone of the Western Carpathians. The comparative material is, unfortunately, extremely insufficient.

Saxifragetum stellaris Deyl 1940

The low-producing spring vegetation dominated by acrocarpous mosses and small vascular plants belongs to the *Saxifragetum stellaris* association described from Mt Pop Ivan in the Transcarpathian Ucraine (Deyl 1940). The name *Philonotido seriatae-Saxifragetum stellaris* Horvat 1949 used so far (Dierssen 1996; Roussakova 2000) should be rejected as a younger synonym and, according to Zechmeister & Mucina (1994) as invalid name. This association, which contains above all arctic-alpine spring species, very few Balkan elements (*Cardamine rivularis*) and no mire species, is probably distributed throughout the entire Europe, from boreal zone (Dierssen 1996) through eastern Carpathians and Balkans to southernmost Europe. Gil & Varo (1982) even reported, under other names, nearly identical communities from the Sierra Nevada Mountains in the southern Spain. The stands of *Saxifragetum stellaris* associations (Fig. 3) are among vegetation types very easily distinguishable by a specific physiognomy and by a constant species composition.

Two relevés (Table 1, relevés 42–43) were transitional ones to the *Angelico pancicii-Calthetum laetae* association. However, the occurrence of *Saxifraga stellaris* and the (sub)dominance of *Scapania undulata* in the moss layer are the features typical of the *Saxifragetum stellaris*. Three other relevés (Table 1, relevés 33–35) display the great cover of *Palustriella falcata* in the moss layer. Despite it, they were not assigned to *Cratoneuretum falcati* association due to absence of any other species of alkalophilous subalpine springs such are, for example, *Palustriella commutata*, *P. decipiens* and *Silene pusilla*.

Angelico pancicii-Calthetum laetae, assoc. nova

The second spring association is rather different from former in terms of its physiognomy and species composition. The springs are overgrown by luxuriant growths of *Caltha palustris* agg. (mostly *C. laeta*) forming a closed canopy in some cases. Such vegetation probably originated from the low-producing vegetation of the previous association after the fertilisation by pasture. The nutrients imported into the spring ecosystem during the pasture cycle in a vascular plant biomass and therefore this vegetation persists for dozens of years after the pasture cessation. The strong competitive ability of *Caltha* does not allow the existence of small spring species typical for *Saxifragetum stellaris*. Instead, the species of tall-forb and submontane meadow vegetation (*Angelica pancicii*, *Chaerophyllum hirsutum*) can grow there due to the improved nutrient availability. The moss layer is populated by shade-tolerating *Rhizomnium punctatum* instead of *Philonotis* species.

The *Angelico pancicii-Calthetum laetae* is the geographical vicariant of Central-European association *Calthetum laetae*, described by Krajina (1933) from the identical habitats in the Western Carpathians. The Eastern-Carpathian-Balkan and Southern-European elements like *Angelica pancicii, Pulmonaria rubra* and *Oenanthe fistulosa* seem to be the good differential species. The exact geographical boundary between these two associations could be found after detail investigations in eastern Carpathians. The analogical distribution pattern was found within communities dominated by *Cardamine amara* agg. (Marhold & Valachovič 1998).

In spite of *Caltha palustris* agg. dominance which is typical to *Calthion* wet meadow, this association belongs to the *Montio-Cardaminetea* class. The representation of *Mulgedio-Aconitetea* and *Molinio-Arrhenetheretea* species is not sufficient to assign this vegetation to any of these classes. The classification within the *Montio-Cardaminetea* class is consistent with other European surveys (Coldea 1997; Valachovič 2001).

Scirpetum sylvatici Ralski 1931

The last association found during our research in Vitosha Mts, recorded by T+G, represents species-poor vegetation of the nutrient-rich, fallow or extensively managed, wet meadows of the *Scirpetum sylvatici* association. The association is characterised by a strong dominance of *Scirpus sylvaticus* and by the absence of other species groups. The occurrence of *Scirpetum sylvatici* in the subalpine zone of Vitosha Mt probably represents the distribution limit of this submontane association. The species composition of *Scirpetum sylvatici* is nearly identical as in the rest of Europe.

Syntaxonomical synopsis

Class *Scheuchzerio-Caricetea fuscae* R. Tx. 1937
Order *Caricetalia fuscae* Koch 1926 emend. Br.-Bl. 1949
Alliance *Caricion fuscae* Koch 1926
Association *Drepanocladetum exannulati* Krajina 1933
Association *Primulo exiguae-Caricetum echinatae* Roussakova 2000
Association *Cirsio heterotrichi-Caricetum nigrae* (Soó 1957) comb. nov. (Neotypus: Table 1, relevé 12)
subassociation *typicum*, subass. nov. (Holotypus: Table 1, relevé 12)
subassociation *sphagnetosum subsecundi*, subass. nov. (Holotypus: Table 1, relevé 13)
subassociation *eriophoretosum vaginatae*, subass. nov. (Holotypus: Table 1, relevé 27)
Alliance *Sphagno recurvi-Caricion canescentis* Passarge 1964
Association *Bruckenthalio-Sphagnetum capillifolii* ass. nov. (Holotypus: Table 1, relevé 30)
Class *Montio-Cardaminetea* Br.-Bl. & R. Tx. ex Klika & Hadač 1944
Order *Montio-Cardaminetalia* Pawł. in Pawł. & al. 1928
Alliance *Philonotidion seriatae* Hinterlang 1992
Association *Saxifragetum stellaris* Deyl 1940
Alliance *Cratoneuro filicini-Calthion laetae* Hadač 1983
Association *Angelico pancicii-Calthetum laetae*, ass. nov. (Holotypus: Table 1, relevé 46)
Class *Molinio-Arrhenatheretea* R. Tx. 1937
Order *Molinietalia* Koch 1926
Alliance *Calthion* R. Tx. 1937
Association Scirpetum sylvatici Ralski 1931

Discussion

The species composition of Vitosha fens

The mires in the Vitosha Mt are unique within the Bulgarian mountain wetlands. It contains several species extremely rare in Bulgaria. The *Cirsio heterotrichi-Caricetum nigrae* association, which is typical association of Vitosha fens, harbours several Balkan endemics. Among them, *Cirsium heterotrichum* reaches the highest abundance just in Vitosha Mt. Some other more widely distributed Balkan endemics, namely *Gentianella bulgarica*, *Crocus veluchensis* and *Dactylorhiza cordigera* subsp. *bosniaca*, enters this ”Vitosha association” more often than other plant communities of Bulgarian subalpine fens occurring everywhere.

The group of *Molinion* species is the most important group of species that differentiate the ”Vitosha association” *Cirsio heterotrichi-Caricetum nigrae* from all others high-mountain ones. This can be explained by both rather low altitudes of subalpine fens and specific relief (see *Study area*) making the habitat conditions not so extreme and allowing the occurrence of species from submontane moist meadows. This could be also a reason why these species, together with *Potentilla erecta*, absent in the more extreme, waterlogged stages of the *Primulo exiguae-Caricetum echinatae* and *Drepanocladetum exannulati* associations. The second explanation, but not contradictory to previous, is the relic character of Vitosha Mt. Some *Molinion* species tend to be regarded as slight glacial relics in the European flora. In addition, the occurrence of boreal elements such as *Sphagnum warnstorfii* and *Salix lapponum* supports the hypothesis of relic character of the Vitosha fens.

Our data set suggests that the major compositional gradient in the Vitosha mires is the developmental gradient from initial, long-term sucessionally arrested stages to the advanced species-rich vegetation of the *Cirsio heterotrichi-Caricetum nigrae* association. However, the unsolved question remains whether succession from ”initial” to ”advanced” associations recently exist in the Vitosha mires. Nedeva (1975) suggests that the Vitosha fens developed from grassy, meadow communities after retarded water outflow. This could be true only of the *Cirsio heterotrichi-*

Caricetum nigrae association and its successor, the *Bruckenthalio-Sphagnetum capillifolii* association, but not of the *Primulo exiguae-Caricetum echinatae* and *Drepanocladetum exannulati* associations due to their spring character and total absence of the meadow species. This suggests that *Cirsio heterotrichi-Caricetum nigrae* is probably a result of convergent succession. A part of this association arose from the initial *Primulo exiguae-Caricetum echinatae* as indicated by the occurrence of *Warnstorfia exannulata* and *Sphagnum platyphyllum* in some relevés (see Table 1, relevés 9–18). Another part could develop by the paludification of the meadows as proposed by Nedeva (1975).

An international typology of Vitosha mires

Generally, mires are divided into three main groups, which seem to be valid across the entire world. Ombrotrophic, active raised bogs receive all the water and nutrients exclusively by rain. In contrast, fens are fed by groundwater, which is a source of nutrients. Fens are further divided into (i) poor fens, which are extremely poor in calcium, acidic and dominated by peat mosses and (ii) rich fens, which are rich in calcium, neutral or alkaline and dominated by brown mosses (*Bryidae*) or calcitolerant peat mosses. In spite of the occurrence of bog elements (*Trichophorum caespitosum*, *Vaccinium uliginosum, Eriophorum vaginatum*) and, on the other hand, rich fen indicators (*Eriophorum latifolium*, *Sphagnum warnstorfii*), all mires we investigated in the Vitosha Mt can be assigned as subalpine poor fens. *Sphagno capillifolii-Bruckenthalietum spiculifoliae* is the association that stays the nearest to the bog vegetation of the *Oxycocco-Sphagnetea* class, but the high number of fen indicators is dissonant with this classification. We therefore can reject the recent occurrence of the active raised bogs of the *Oxycocco-Sphagnetea* class in Vitosha Mt.

The classification approach

The results of the classification presented here are based on the Braun-Blanquet classification approach (Braun-Blanquet 1964; Westhoff & Maarel 1973), which stresses the floristic composition more than pure dominance. However, some undisturbed (unmanaged) highly producing wetlands (*Angelico pancicii-Calthetum laetae*, *Brachythecio rivularis-Cardaminetum balcanicae, Scirpetum sylvatici*) are defined primarily by a strong dominance of a character species. This is a case of species-poor communities lacking any other species group, but forming marked and sometimes ample vegetation. Towards the species-rich, nutrient limited wetlands the importance of the dominance weakens. There are many potential dominants, i.e. species reaching the cover above 25 %, in Bulgarian mountain wetlands. Their dominance does not indicate ecological conditions in many cases and it is only a result of competition. It seems to be true especially for the peat mosses (Hájková & al. pers. comm.). The populations of peat mosses, that have survived in the isolated Balkan mountain ranges from the glacial periods, have a specific genetic constitution (Natcheva & Cronberg 2003) and often display rather different habitat preferences than in Northern- and Central Europe (Hájková & al. pers. comm.). The similar discrepancies are evident also in the case of some vascular plants. Additionally, an enhanced cover of some vascular plants can be the effect of rapid clonal growth and can have only a short duration.

From these reasons we do not describe a particular facies dominated by various plants in the species-rich and nutrient-limited fen vegetation. The description of each community with a specific dominant species would lead to the inflation of the associations with a very narrow and only regionally valid indication value. From the same reasons, we identify the arrested initial stage of peat formation with an occurrence of Balkan elements and with the dominance of *Carex nigra* as the *Primulo exiguae-Caricetum echinatae* in spite of the fact that this association was originally defined as dominated by *Carex echinata* (Roussakova 2000). *Carex nigra* and *C. echinata* display the same responses to ecological factors and the significant joint occurrences everywhere in the Europe.

The dominance was not accepted as a priority classification character also in the case of fens with a high cover of *Trichophorum caespitosum*, contrary to Roussakova (2000). This vegetation type often forms only rather small patches in the Vitosha Mt. There is no species besides *T. caespitosum*, which shows significant fidelity to this vegetation type in Bulgaria. The *T. caespitosum* is a diagnostic species of the *Trichophoretum caespitosi* association described from boreal ombrotrophic bogs. Its ecological niche is however very wide and ranges from extremely acidic bogs to strongly calcareous fens (Gerdol & Tomaselli 1997).

The occurrence of *T. caespitosum* in boreal fens is, by analogy, not reflected in phytosociological classification (Dierssen 1996).

There is one serious problem, which we cannot solve in this study – the assignation of distinguished fen associations to higher-rank syntaxa, especially at the alliance level. Roussakova (2000) assigned subalpine fens of the Rila Mt. to the *Caricion fuscae* alliance. Rodwell & al. (2002) included small-sedge fens at high altitudes in the central Balkans into the *Narthecion scardici* alliance. The absence of *Narthecium scardicum* in Bulgaria does not imply the absence of this unit – alliance can have wider distribution range than the species which give its name. Nonetheless we have no reason to accept its distribution in Bulgaria. The alliance is not conceived as a Balkan vicariant of *Caricion fuscae*. It was originally expected to be restricted to the North Macedonia and Kosovo (Lakušić 1968). Kojić & al. (1998) also assumed its concurrent distributions with *Caricion fuscae* in Serbia. Horvat & al. (1974) does not accept this alliance at all, probably due to a fact that *N. scardicum* has a wide niche covering also serpentinite rocks. The *Drepanocladion exannulati* alliance is the third possibility how to classify Bulgarian high-mountains poor fens at the alliance level. This alliance was described from the Western Carpathians (Krajina 1933; Hájek & Háberová 2001) to express a very strike floristic difference between submontane *Caricion fuscae* meadows and subalpine spring fens. This alliance is not, however, respected in the recent survey of European alliances (Rodwell & al. 2002). The problem is further complicated by the occurrence of *Eriophorum latifolium, Primula farinosa* s.l. and *Sphagnum warnstorfii*. On the contrary to Bulgarian subalpine fens, these species behave as true calcicole species in Central- and Northern-European fens and they are diagnostic species of the *Sphagno warnstorfii-Tomenthypnion* alliance (Hájek & Háberová 2001). This confusion could be solved only by the phytosociological synthesis at the European level. In this study, we maintain the conception of Roussakova (2000) and place the subalpine poor fens into the *Caricion fuscae* alliance. It is in the concordance with the recent effort to unify the high-rank classification in Europe by preferring the ecologically characterised alliances over the regionally characterised ones (Willner 2002).

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Table 1. Phytosociological table of the spring and mire communities from Vitosha Mts. The cover codes of the nine-grade Braun-Blanquet scale are abbreviated (m = 2m, a = 2a, b = 2b). Relevés were classified by formal definitions derived from the large data-set of Bulgarian spring, mires and wet meadows; diagnostic species were then recalculated from this regional data-set (for details see text).

			111111111122222222	22333	33333334444	44444455	55
	1	2345678	9012345678901234567	89012	34567890123	45678901	23
Drepanocladetum exannulati							
Warnstorfia exannulata	**4**	b.++.3.	....+ba+.b.........	.....	...1....+..	a.......	..
Juncus filiformis	**1**	1......	.....m.............	.....	..+1.......	....	..
Primulo exiguae-Caricetum echinatae							
*Primula * exigua*	.	**+a1am**..	....+..............	....+	.1.........	....	..
Sphagnum platyphyllum	.	...**44am**	3a1+...............	.....	....	....	..
***Cirsio heterotrichi-Caricetum nigrae* (neotypus nom. rel. 12)**							
Carex nigra	3	33aa4b3	**434434b311b3a3baa34**	33aaa	.ba3a+b3...	.b......	..
Molinia caerulea	.	....	**+1a11+b.a..+a.a.4a1**	.....	....	......+.	..
Succisa pratensis	.	....	**++.b+a.aa++.+..+..1**	.....	....	....	..
Cirsium heterotrichum	.	....r..	**++111+r+++1..a.+..m**	.....	1..........	1.......	..
Potentilla erecta	.	....+.a	**+111a11+1a++ab1a11+**	1b+++	++.....1...	+a1.....	+.
Dactylorhiza cordigera s.l.	.	....	**++111++11+++++...1a**	.....	1.+.r.+1...	1++.....	..
Sanguisorba officinalis	.	.1.....	**..aa+.++..1.+...+..**	1....	....	1.......	..
Sphagnum warnstorfii	.	.b4....	**.+b1.....a1.53..a54**	55...	....	....	..
subass. sphagnetosum subsecundi							
Sphagnum subsecundum	.	b.1..a.	....3a545....+3..+.	1	....	....	..
Carex echinata	.	..+....	....++a.1+.........	...++	.+.........	....	..
Eriophorum angustifolium	.	....	....b.b.ba.........	..+..	....	.1......	..
Gentianella bulgarica	.	..+....	....+++1++.........	.....	.+.........	....	..

Table 1. Continuation

subass. eriophoretosum vaginatae							
&							
***Bruckenthalio-Sphagnetum capillifolii* (holotypus nom. rel. 30)**							
Eriophorum vaginatum	.	..1.+..	..+..........+3333b	**441a1**	1..........	1.......	..
Juniperus sibirica	.	....	.............+.+1..	**11+b+**	....	....	..
Bruckenthalia spiculifolia	.	....	...+........+++.a+.	**1.ab1**	....	....	..
Vaccinium myrtillus	.	....	.+.........1....+.	**1baa.**	....	....	.a
Vaccinium vitis-idaea	.	.+....+	............1....1	**11a1+**	++.........	....	..
Sphagnum capillifolium	.	....+..	....	**..555**	....	....	..
Homogyne alpina	.	..+....	....	**..111**	....	....	..
Saxifragetum stellatis							
*Saxifraga * alpigena*	.	+...mm.	....	.....	**m1.11b3bamm**	....	..
Philonotis seriata	+	a.1....	.....+.1..........	.....	**3a34+1b33..**	....	..
Dicranella palustris	.	.m.....	....	.....	**b1+..5bb...**	....	..
Epilobium alsinifolium	.	....	....	.....	**.1.1a1.....**	....	..
Soldanella chrysostricta/pindicola	.	++..+++	....	.....	**.+1.+++m.+.**	.1......	..
***Angelico pancicii-Calthetum laetae* (holotypus nom. rel. 46)**							
Caltha palustris agg.	.	.1.....	.....1.1.+.+.+.....	.....	1a..4b11b43	**43444435**	31
Rhizomnium punctatum	.	....	....	.....	.........++	**..+ma31.**	.1
Angelica pancicii	.	....	1	.....	..+.+....aa	**.+1+.1+a**	+.
Chaerophyllum hirsutum	.	....	....	.....	..+........	**1....111**	1.
Brachythecium rivulare	.	....	.....1............	.....	..1........	**..3a..1a**	..
Oenanthe fistulosa	.	....	....	.....	....	**1.+...1.**	+.
Pulmonaria rubra	.	....	....	.....	....	**..1..+..**	..
Scirpetum sylvatici							
Scirpus sylvaticus	.	....	.....+............	.....	....	..1a..+.	**44**
Other species sorted by frequency in the entire data set							
Cardamine rivularis	.	1m1..m+	.++m+++1..+...b..mm	.....	b1aa1a+bam+	m1++m+11	.+
Geum coccineum	.	+++...b	..11+..r..+++.1a1++	1+.+.	1+1..r+1..+	.b1a++++	1+
Pinguicula balcanica	.	+++1++.	1a..1++11+1.+....+m	.+.++	.+..r..m+..	....	..
Deschampsia caespitosa	.	1.+..aa	..33++.+..1..a13...	.1..+	..++.+..+.3	.+....1a	..
Eriophorum latifolium	.	..aa.33	.1..+.+1..3.4...1.a	11.ab	ba...1.....	a1......	..
Sesleria comosa	.	..++..1	.+..++++++..a.1+++.	aa.+.	a+......+..	....	..
Trichophorum caespitosum	.	+a.4b.a	a4..m.1.33a.3...133	.3.+b	.+.........	....	..
Veratrum lobelianum	.	.+.....	..11++.+++++.+.+...	.....	....	1.+..13+	+a
Allium sibiricum	.	.+....+	..11+.++1.1.+......	++...	.+...+.....	1+......	..
Crocus veluchensis	.	..+....	...+++++1+........	+.+++	.+.........	++......	..
Pseudorchis frivaldii	.	.+.+.+.	.+..1...++..m+...mm	+....	.+.........	....	..
Nardus stricta	.	..a1...	....1++a.+...m.....	..a1a	.1.........	....	..
Myosotis scorpioides agg.	.	....	.....+.+...1.......	.....	a...1.b...a	...1.1aa	a.
Taraxacum appeninum	.	..a..+.	.....+.+..........	.....	.++..r..++.	....a...	..
Alchemilla vulgaris agg.	.	....	..1....+..........	.....	.+b.b+....+	+a......	.+
Ligusticum mutellina	.	+.+...+	....	....+	.rr+.r.....	.a......	..
Festuca rubra agg.	.	..+....	....1++1.+...a.1...	.....	....+......	....	..
Luzula sudetica	.	..+....	....++++.+........	.....	.+...r.....	.+......	..
Cirsium appendiculatum	.	....	.............+.....	.....	.r+1.....+.	...1.+.+	.1
Agrostis canina	+	..1....	....+m.1..........	.....	..1+.+.....	....	..
Vaccinium uliginosum	.	....	....r..+.+..+.a....	b1...	.......1...	....	..
Anthoxanthum odoratum	.	+.1....	....++.+..........	.....	.........+..	.+......	..
Pellia neesiana	.	....	.....+.+..........	.....	.........a.	....a1.3	.a
Bryum pseudotriquetrum	1	.+.....	....+..+..........	.....	.1+........	....	..
Chiloscyphus polyanthos	.	..+....	.....+.+..........	.....	....1.....+	......+.	..
Polytrichum commune	.	....m..	....r..1......++.m.	.....	....	....	..
Sphagnum girgensohnii	.	....	..3a.....a1m.......	.....	....	3.......	..
Sphagnum teres	.	....	....11.....5..m...+	.....	....	....+...	..
Calliergon sarmentosum	.	.m.b...	.1.......1........	....+	....	....	..
Aulacomnium palustre	.	..a....	....1..11......+...	.....	....	....	..
Salix caprea	.	....	...+.......1.......	.....	....	......+.	+a
Sphagnum squarrosum	.	....	..............53..+	.....	.........a.	....	.a
Leontodon autumnalis	.	+......	....++...+........	.....	....	....	..
Palustriella falcata	.	.3.....	....	.....	343........	....	..
Sphagnum inundatum	.	.....++	.......+..3.......	.....	....	....	..
Climacium dendroides	.	....	...m++.+..........	.....	....	....	..
Ranunculus sartorianus	.	....	....++.+.r........	.....	....	....	..
Trifolium pratense	.	....	....++.+..........	.....	....	.+......	..
Salix lapponum	.	....	.....br..b......a..	.....	....	....	..
Carex curta	.	....	.....a.1...a......1	.....	....	....	..
Rumex alpinus	.	....	....	.....	..rr......+	.......+	..
Scapania undulata	.	....	....	.....	.........5m	....3+..	..
Poa trivialis	.	....	....	.....	.........++	...1..1.	..

Table 1. Continuation

Aneura pinguis	.	..+....	....	.....	.+..4......	....	..
Carex umbrosa	.	....	....+........+.....	1....	....	....	..
Palustriella decipiens	.	....	.....+.............	.....	....+1.....	....	..
Sagina saginoides	.	....	.....r.............	.....	.+...+.....	....	..
Lathyrus pratensis	.	....	...........a..+...+	.....	....	....	..
Picea abies	.	....	............+...1..	.....	....	....	.a
Luzula forsteri	.	....	.............+.+..m	.....	....	....	..
Bistorta major	.	....	...............+...	.....	+..........	.1......	..
Sphagnum centrale	.	....	................5a.	.....	....	......1.	..
Salix aurita	.	....	....	.....	..+.......+	......1.	..
Ranunculus montanus	.	+......	....	.....	....	.1......	..
Calliergon stramineum	.	..1....	.......+...........	.....	....	....	..
Sphagnum russowii	.	5	...............3...	.....	....	....	..
Scapania irrigua	.	....	....11.............	.....	....	....	..
Equisetum fluviatile	.	....	.....+.............	.....	....	......+.	..
Senecio nemorensis	.	....	.........r.........	.....	....	....	.1
Ranunculus repens	.	....	...........r.......	.....	....	....	1.
Drosera rotundifolia	.	....	............+....m.	.....	....	....	..
Trifolium spadiceum	.	....	............+......	.....	..+........	....	..
Dicranum bonjeanii	.	....	.................+.	.....	....	m.......	..
Poa palustris	.	....	....	.....	.....+.....	.+......	..

Species occurring in one relevé only: *Scapania paludicola* 4: a; *Philonotis fontana* 7:+, *Juncus effusus* 10: +; *Cerastium* sp. 11: +; *Hypericum maculatum* 12: +; *Parnassia palustris* 13: r; *Sphagnum palustre* 14: b; *Equisetum palustre* 14: +; *Calypogeia azurea* 14: +; *Calliergonella cuspidata* 14: +; *Juncus articulatus* 14: +; *Polytrichum formosum* 14: +; *Epilobium palustre* 15: r; *Juncus tomasii* 16: 1; *Trifolium repens* 16: r; *Campylium stellatum* 17: +; *Pseudorchis albida* 17: +; *Matricaria caucasica* 19: +; *Salix pentrandra* (E2) 20: +; *Carex pallescens* 22: +; *Sphagnum contortum* 22: +; *Polytrichum strictum* 30: b; *Pohlia nutans* 31: +; *Blindia acuta* 34: +; *Riccardia multifida* 34: +; *Luzula luzuloides* 35: b; *Saxifraga rotundifolia* 35: a; *Fontinalis antipyretica* 37: 1; *Plantago gentianoides* 41: +; *Asplenium adiantum-nigrum* 42: +; *Cladonia* sp. 42: +; *Sanionia uncinata* 43: m; *Phleum alpinum* 43: 1; *Geranium pratense* 43: +; *Poa annua* 43: +; *Sagina procumbens* 43: +; *Poa pratensis* 45: +; *Myosotis alpestris* 45: +; *Veronica chamaedrys* 45: r; *Eleocharis palustris* 46: 1; *Valeriana tripteris* 47: 1; *Lysimachia nummularia* 47: +; *Rhizomnium pseudopunctatum* 48: a; *Luzula sylvatica* 49: +; *Pteridium aquilinum* 52: +; *Galium palustre* 53: a; *Plagiomnium undulatum* 53: a; *Athyrium filix-femina* 53: 1.

Header data to the phytosociological table (number in table: locality; altitude; relevé area; cover total; cover of herb layer if available; cover of moss layer if available; year/month/day; authors. Explanations of author codes: H+A = Michal Hájek, Petra Hájková, Iva Apostolova; T+G = Rossen Tzonev, Anna Ganeva. The codes of Bulgarian forest taxation division are pointed for in brackets for some of T+G relevés.

Drepanocladetum exannulati

1: Vitosha – Stenata – NE slope above Aleko chalet; 1950 m a.s.l.; 2 m2; 70 %; 40 %; 70 %; 2001/06; H+A

Primulo exiguae-Caricetum echinatae

2: Vitosha – NE slopes of Cherni Vruh; 2200 m; 6 m2; 75 %; 60 %; 50 %; 2001/06; H+A

3: Vitosha – near to Zvezditsa hotel (176); 1850 m; 2 m2; 60 %; 2004/06/24; T+G

4: Vitosha – 1 km S from Cherni Vruh; 2150 m; 9 m2; 95 %; 50 %; 90 %; 2001/06; H+A

5: Vitosha – Chernoto Plato, springs of the Strouma River; 2150 m; 16 m2; 85 %; 80 %; 70 %; 2001/06; H+A

6: Vitosha – Torfeno Branishte Reserve – Trite Kladentsi; 1950 m; 4 m2; 70 %; 2004/07/09; T+G

7: Vitosha- Torfeno Branishte Reserve – Trite Kladentsi; 1950 m; 25 m2; 70 %; 2004/07/09; T+G

8: Vitosha – Torpheno Branishte Reserve – Sedloto; 2000 m; 100 m2; 100 %; 2004/07/09; T+G

Cirsio heterotrichi-Caricetum nigrae

9: Vitosha – the northern slope of the peak Selimitsa; 1800 m; 2 m2; 50 %; 2004/06/24; T+G

10: Vitosha – near to the peak Ostrets; 1750 m; 100 m2; 100 %; 2004/06/24; T+G

11: Vitosha – Konyarnika; 1700 m; 100 m2; 100 %; 2004/06/23; T+G

12: Vitosha – Konyarnika;1750 m; 100 m2; 100 %; 2004/06/23; T+G

13: Vitosha – W edge of the Torfeno Branishte Reserve 2 km N from Cherni Vruh; 1950 m; 6 m2; 95 %; 85 %; 60 %; 2001/06; H+A

14: Vitosha –Torfeno Branishte Reserve – spring on the plain Kapaklivets – NE from Sredets; 1900 m; 18 m2; 90 %; 80 %; 60 %; 2001/06; H+A

15: Vitosha –Torfeno Branishte Reserve – plain between mountains Sredets and Luvcheto; 1950 m; 10 m2; 95 %; 70 %; 90 %; 2001/06; H+A

16: Vitosha – Torfeno Branishte Reserve – springs 1.5 km E from Sredets near the track to Aleko chalet; 1920 m; 18 m2; 90 %; 80 %; 70 %; 2001/06; H+A

17: Vitosha – Torfeno Branishte Reserve – plain between mountains Sredets and Luvcheto; 1950 m; 15 m2; 97 %; 80 %; 90 %; 2001/06; H+A

18: Vitosha – Torfeno Branishte Reserve – plain between mountains Sredets and Luvcheto; 1950 m; 2 m2; 97 %; 80 %; 65 %; 2001/06; H+A

19: Vitosha – Konyarnika; 1700 m; 100 m2; 100 %; 2004/06/23; T+G

20: Vitosha – Ofeliite; 1500 m; 25 m2; 100 %; 2004/06/23; T+G

21: Vitosha – near to Zvezditsa hotel (210/10); 1850 m; 100 m2; 100 %; 2004/06/24; T+G

22: Vitosha – Souhoto Ezero; 1950 m; 100 m2; 25 %; 2004/07/09; T+G

23: Vitosha – the springs of the Mutnitsa River; 2000 m; 100 m2; 100 %; 2004/06/24; T+G

24: Vitosha – Torpheno Branishte Reserve – Sedloto; 2000 m; 100 m2; 100 %; 2004/07/09; T+G

25: Vitosha – near to the peak Ostrets; 1750 m; 100 m2; 100 %; 2004/06/24; T+G

26: Vitosha – near to Zvezditsa hotel – (121/10); 1800 m; 100 m2; 100 %; 2004/06/24; T+G

27: Vitosha – the southern slope of the peak Selimitsa; 1950 m; 25 m2; 100 %; 2004/06/24; T+G

Bruckenthalio-Sphagnetum capillifolii

28: Vitosha – near to Zvezditsa hotel (176); 1850 m; 100 m2; 100 %; 2004/06/24; T+G

29: Vitosha – near to Zvezditsa hotel (176/10); 1850 m; 100 m2; 100 %; 2004/06/24; T+G

30: Vitosha – Chernoto Plato, springs of the Strouma River; 2120 m.; 8 m2; 100 %; 40 %; 100 %; 2001/06; H+A

31: Vitosha – Chernoto Plato, springs of the Strouma River; 2100 m; 4 m2; 95 %; 50 %; 90 %; 2001/06; H+A

32: Vitosha – Chernoto Plato, springs of the Strouma River; 2120 m; 4 m2; 99 %; 60 %; 99 %; 2001/06; H+A

Saxifragetum stellatis

33: Vitosha – the southern slope of the peak Selimitsa; 1950 m; 4 m2; 95 %; 2004/06/24; T+G

34: Vitosha – Chernoto Plato, springs of the Strouma River; 2100 m; 2 m2; 97 %; 60 %; 95 %; 2001/06; H+A

35: Vitosha –Bistrishko Branishte Reserve; 2070 m; 4 m2; 90 %; 60 %; 80 %; 2001/06; H+A

36: Vitosha – NE slopes of Cherni Vruh; 2200 m; 5 m2; 80 %; 60 %; 60 %; 2001/06; H+A

37: Vitosha – Chernoto Plato, springs of the Strouma River; 2050 m; 6 m2; 90 %; 80 %; 70 %; 2001/06; H+A

38: Vitosha – Chernoto Plato, springs of the Strouma River; 2100 m; 3 m2; 90 %; 40 %; 85 %; 2001/06; H+A

39: Vitosha – the northern slope of the peak Selimitsa; 1800 m; 2 m2; 60 %; 2004/06/24; T+G

40: Vitosha – the southern slope of the peak Selimitsa; 1950 m; 1 m2; 60 %; 2004/06/24; T+G

41: Vitosha – Torfeno Branishte Reserve – Trite Kladentsi; 1950 m; 10 m2; 90 %; 2004/07/09; T+G

42: Vitosha – near to Zvezditsa hotel; 1700 m; 10 m2; 95 %; 2004/06/23; T+G

43: Vitosha – near to Aleko hotel; 1800 m; 4 m2; 80 %; 2004/07/09; T+G

Angelico pancicii-Calthetum laetae

44: Vitosha – Konyarnika; 1750 m; 10 m2; 90 %; 2004/06/23; T+G

45: Vitosha – Chernoto Plato, springs of the Strouma River; 2100 m; 15 m2; 85 %; 85 %; 1 %; 2001/06; H+A

46: Vitosha – Ofeliite; 1500 m; 25 m2; 90 %; 2004/06/23; T+G

47: Vitosha – Ofeliite; 1500 m; 10 m2; 90 %; 2004/06/23; T+G

48: Vitosha – Konyarnika; 1750 m; 10 m2; 95 %; 2004/06/23; T+G

49: Vitosha – near to Zvezditsa hotel; 1700 m; 10 m2; 80 %; 2004/06/23; T+G

50: Vitosha – near to Zvezditsa; 1700 m; 100 m2; 90 %; 2004/06/23; T+G

51: Vitosha – 0.5 km SSE from the Aleko chalet; 1850 m; 16 m2; 95 %; 95 %; 40 %; 2001/06; H+A

Scirpetum sylvatici

52: Vitosha – Ofeliite; 1500 m; 16 m2; 90 %; 2004/06/23; T+G

53: Vitosha – near to Zvezditsa hotel; 1700 m.; 50 m2; 90 %; 2004/06/23; T+G

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