New plant associations from Bulgarian mires

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Abstract. Phytosociological data from the Bulgarian mires below the timberline were gathered and analysed by TWINSPAN and DCA. As a result, a classification is proposed of the submontane mires into nine associations. Five associations occupying both extremes of the pH gradient have been identified with the associations being recognised also in other European countries, while three associations are described as new. Two new associations contain grassland species with South European distribution, the third one is characterised by the presence of species typical of intermittently wet mineral-rich soils.

Key words: Balkan, classification, fen, phytosociology, vegetation survey, wetlands

Introduction

An important gap in European vegetation science that impedes broad-scale syntheses of the vegetation diversity is the lack of data on some habitats in some European regions. Several apparent gaps relate to the mires in Bulgaria: a country with a high floristic and landscape diversity. Despite the fact that the Bulgarian mountains are comparable with other European mountains in regard to mire vegetation richness, there is an extreme scarcity of vegetation data on the Bulgarian mires. This sharply contrasts with the existing comprehensive data sets and vegetation surveys from regions in Central and West Europe. This gap is gradually filled out of late. First, some plant associations have been reported from the subalpine and alpine areas of the Rila (Roussakova 2000) and Vitosha (Hájek & al. 2005) mountains. Overall diversity of subalpine and alpine mire vegetation (i.e. mire vegetation above the timberline) has been analysed in the synthetic study of Hájková & al. (2006). However, all these data concern only high-mountain vegetation, while the mires below the timberline (hereinafter to be referred to as sub-mountain mires) are so far poorly studied.

During the period 2001–2007 we have collected phytosociological data from the sub-mountain mires, but these data have been utilised only in some ecological studies (Hájek & al. 2007; Hájková & Hájek 2007; Hájková & al. 2007, 2008) and no attempt has been made to present original data and to classify them into plant associations.

Why there is such an apparent gap in the knowledge of sub-mountain fens in Bulgaria? Bulgarian wetland scientists have rather been focused on lakes, reed beds, and tall sedge stands (see Kochev & Jordanov 1981; Michev & Stoyneva 2007). The majority of studies from sub-mountain fens only list the interesting vascular plants or bryophytes found in these habitats, supplemented by a phytogeografical analysis (e.g. Stefanoff & Jordanov 1931; Petrov 1958; Stefanoff & Petrov 1962; Jordanov & al. 1972; Natcheva 2005; Tzonev & Karakiev 2007).

The aims of this study are (i) to describe the variation in sub-mountain mire vegetation in Bulgaria, and (ii) to classify this vegetation into phytosociological units within the context of the European phytosociological classification system.

Methods

Vegetation plots were outlined in all types of inland mires and fen grasslands, where natural conditions support the target vegetation in Bulgaria. We explored ca 240 complexes of mires, springs or wet meadows within an altitudinal range between ca 300 m and 1700 m. Some of the studied sites have been generally known, but many of them were discovered randomly or with the help of old floristic data during our travels throughout the country. Altogether, we obtained 140 relevés which can be classified within the fen vegetation of the *Scheuchzerio-Caricetea fuscae* class and four relevés of bog pine woodlands, which are traditionally classified within the *Oxycocco-Sphagnetea* class. Plot size was mostly 16 m^2 in the case of fens, with the exception of extremely small patches of mire vegetation (for reasons see Chytrý & Otýpková 2003) and 50–225 m^2 in the case of bog woodlands. The relevés were always chosen in the central, the most homogeneous part of the mire. We have tried to cover all visible conspicuous vegetation and habitat types within each wetland complex. All vascular plants and bryophytes were identified and their cover was estimated using the nine-grade Braun-Blanquet scale (cf. van der Maarel 1979). The nomenclature of vascular plants follows Andreev & al. (1992) and the nomenclature of the bryophytes follows Ganeva & Natcheva (2003) and Natcheva & Ganeva (2005). Habitat nomenclature follows Hájek & al. (2006b). The nomenclature of the syntaxa is in accordance with the Code of Phytosociological Nomenclature (Weber & al. 2000).

Water pH and conductivity (both standardized at 20 °C) were measured by portable instruments (PH119 pH-meter and CM113 conductometer, Snail Instruments, Czech Republic) directly at the micro sites supplied best by water in the central part of the springs. A small shallow pit was dug and spring water was allowed to clarify before measurement. Whenever spatial variation of water pH or conductivity was observed, several replications were conducted and arithmetic means were calculated. Conductivity caused by H^+ ions was subtracted in acidic waters with pH < 5.5 (Sjörs 1952).

The phytosociological relevés were exported into JUICE software (Tichý 2002). A polythetic, divisive classification analysis TWINSPAN (Hill 1979) was applied. This analysis was stopped at the level of eight associations, as the newly appearing clusters were no longer easily interpretable. The result was compared with the Positive Fidelity-Frequency Index (Tichý 2005) of each species for each vegetation type, and with indirect ordination of the relevés. The resulting groups were also compared with plant associations recognised in other European countries. On the basis of this comparison, one vegetation type was merged with its most similar one, and another rare vegetation type, distinguished by TWINSPAN only at a much lower level but clearly discontinuously separated by DCA, was delimited. For presentation of full tables, some relevés were moved among the columns due to the Positive Fidelity-Frequency Index, or due to some formal criteria (for details see Discussion). As an indirect ordination technique we used Detrended Correspondence Analysis (DCA), with log-transformed species covers. Altitude, pH and conductivity were passively projected onto the ordination diagram.

Diagnostic species were calculated by *phi*-coefficient and the size of all groups was standardized to equal size of 10 % of the total data set (Tichý & Chytrý 2006). Zero fidelity was given to the species with high probability of random occurrence in the vegetation type (significance of Fisher´s exact test $P < 0.001$). In the synoptic table, we present all species with positive fidelity to some vegetation type and reaching significance of Fisher´s exact test $P < 0.001$. Furthermore, we recognised the species with fidelity to some vegetation type higher than $phi = 0.5$. In order to overcome the shortcoming that diagnostic species are dependent on the context, i.e. on the underlying data sets and comparisons (Chytrý & al. 2002), we also compared the diagnostic species valid for mire data set with the diagnostic species valid for the larger data set of Bulgarian vegetation, including subalpine and alpine wetlands (Hájková & al. 2006) and sub-mountain wet and intermittently wet grasslands (Hájek & al. 2008).

Results

Twinspan and DCA analysis

TWINSPAN analysis of the relevés of treeless fens distinguished the following groups of samples at the level of

eight clusters (Tables 1-4; Fig. 1): (1) poor fens with decreasing water table, (2) permanently wet, floating poor fens, (3) moderately rich fens dominated by *Sphagnum subsecundum*, (4) other moderately rich fens, (5) rich fens with calcium-tolerant *Sphagnum* species and calcicole species, (6) extremely peat-forming fens, (7) calcareous spring tufa-forming fens with *Palustriella commutata,* and (8) calcareous fens with decreasing water table, not located at plentiful springs, without tufa formation. As the third group was poorly differentiated in DCA (it is traditionally classified as subassociation within the fourth group), we merged groups 3 and 4 into one association. On the other hand, we accepted differentiation of a distinct vegetation type with *Schoenus nigricans, Sesleria uliginosa, Campyliadelphus elodes,* and juvenile *Cladium mariscus* from the latter group, which was suggested by TWINSPAN at lower divisions and by outlying position in DCA.

Syntaxonomical interpretation

The resulting nine vegetation types (eight from the fen data set, one from the bog woodland data set, Table 5) were syntaxonomicaly interpreted as follows (cluster numbers are in brackets):

Class: *Scheuchzerio-Caricetea nigrae* Tüxen 1937

Order: *Scheuchzerietalia palustris* Nordhagen 1937

Alliance: *Sphagno-Caricion canescentis* Passarge (1964) 1978

Association: *Carici echinatae-Sphagnetum* Soó 1944 (1)

Association: *Sphagno-Caricetum rostratae* Steffen 1931 (2)

Subassociation: *typicum*

Subassociation: *caricetosum limosae* Hájek & Háberová 2001

Alliance: *Caricion canescenti-nigrae* Nordhagen 1937[a]

Association: *Caricetum nigrae* Braun 1915 (3-4)

Subassociation: *sphagnetosum subsecundi* Steiner 1992 (3)

Subassociation: *caricetosum viridulae*, subass. nova[b] (4)

Subassociation: *typicum*, var. *Sphagnum teres*[c] (4)

Order: *Caricetalia fuscae* Koch 1926

Alliance: *Sphagno warnstorfii-Tomenthypnion nitentis* Dahl 1956

Association: *Geo coccinei-Sphagnetum contorti* ass. nova[d] (5)

Subassociation: *typicum*

Subassociation: *caricetosum lasiocarpae*, subass. nova [e]

Alliance: *Caricion davallianae* Klika 1934

Association: *Dactylorhizo cordigerae-Eriophoretum latifolii* ass. nova[f] (6)

Association: *Carici flavae-Cratoneuretum filicini* Kovács & Felföldy 1960 (7)

Association: *Eleochariti uniglumis-Caricetum distantis*, ass. nova[g] (8)

Association: *Junco subnodulosi-Schoenetum nigricantis* Allorge 1922[h] (8)

Class: *Oxycocco-Sphagnetea* Br.-Bl. & Tüxen ex Westhoff & al. 1946

Order: *Sphagnetalia magellanici* Kästner & Flössner 1933

Alliance: *Sphagnion magellanici* Kästner & Flössner 1933

Association: *Sphagno-Pinetum sylvestris* Kobendza 1930 [i]

Notes:

[a]Syn: *Caricion fuscae* auct., non Koch 1926

[b]Nomenclatural type: Tab. 1, Rel. 33

[c]Transitional vegetation towards *Geo coccinei-Sphagnetum contorti*

[d]Nomenclatural type: Table 2, Relevé 1

[e]Nomenclatural type: Table 2, Relevé36

[f]Nomenclatural type: Table 3, Relevé 16

[g]Nomenclatural type: Table 3, Relevé 48

[h]Syn.: *Orchido-Schoenetum nigricantis* Oberdorfer 1957

[i]Syn.: *Eriophoro vaginati-Pinetum sylvestris* Hueck 1931

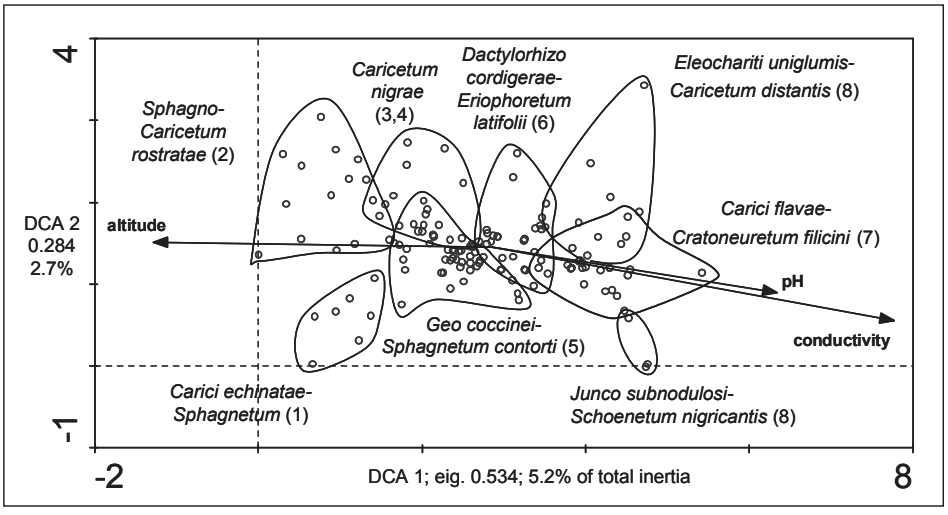

Fig. 1. DCA simple ordination plot of samples (1st and 2nd axis), with altitude, pH and conductivity passively projected onto the ordination diagram. Cluster numbers are in brackets.

Table 1. Phytosociological relevés of the *Sphagno-Caricion canescentis* and *Caricion canescenti-nigrae* alliances.

No. of relevés	0000000001	11111111122	222222223	333	3333334	444444
	1234567890	12345678901	234567890	123	4567890	123456
Diagnostic and differential species obtained from the entire data set						
Sphagno-Caricion canescentis						
Sphagnum flexuosum	**5+...55..3**	**..3.5454...**	.....+...	...	.....	.....a
Sphagnum fallax	**.4.a5..4..**	**55.+.....**	.....	...	.....	.....
Sphagnum magellanicum	**...1...a..**	**.....++...**	.....	...	.....	.....
Carici echinatae-Sphagnetum						
Sphagnum centrale	**b1b+1+...+**	.....	.....	...	.....	.....
Eriophorum vaginatum	**.a.1a..1..**	.....	.....	...	.....	.....
Bruckenthalia spiculifolia	**ba3.....1.**	.....	...+.....	...	.....	.....
Sphagnum russowii	**.2...2.2..**	.....	.....	...	.....	.....
Polytrichum strictum	**.1.+...1..**	.....	.....	...	.....	.....
Nardus stricta	**m1a++1ab11**	.....+.	.1+bmb1.1	...	111+++.	..+.+.
Sphagno-Caricetum rostratae						
Menyanthes trifoliata	.1.....	**bba3b3b....**	.....	.+.	45	.....
Carex rostrata	.....1...	**11ab1baaabb**	.1a.baa4.	+41	.a.a1am	..1...
subass. caricetosum limosae						
Carex limosa	.....	**mama.....**	.....	...	.....	.....
Lycopodiella innundata	.....	**.+1.....**	.....	...	.....	.....
Caricetum nigrae						
Juncus filiformis	.....	.....	**.1+.....**	**1.a**	**..+11..**	.....
Carex curta	....+.....	11...b1+.1.	**baa.1.1a.**	**.1b**	**a+1ab..**	**..1.1.**
Warnstorfia exannulata	1	...5...+411	**.1a.++b++**	**+.b**	**a.+.b..**	**+11...**
Eriophorum angustifolium	.....111..	.....1+1bb3	**+ab1.1..b**	**.1.**	**aa.3.a+**	**3.b..4**
Agrostis canina	+.1.+1+am1	+11.+.++.11	**a+1m++++1**	**aba**	**11m1+1.**	**b.+a+.**
subass. sphagnetosum subsecundi						
Sphagnum subsecundum	..a.....3a	.1b+.....4b	**555554343**	...	bbbb...	.....
subass. caricetosum viridulae, subass. nova						
Carex serotina	.....	.11.....	...r1.+.b	**43a**	.....	.....
subass. sphagnetosum teretis						
Sphagnum teres	......+...	.....b.3...	.....	...	**b34443a**	.....
Other vascular plant species						
Alliance species (*Sphagno-Caricion canescentis* and *Caricion canescenti-nigrae*)						
Carex echinata	mamaa.+1aa	..1.1..+.a.	11.a1+b+1	...	11a.a11	b++bba
Potentilla erecta	aaa+abbbaa	.1..a..a.1.	r1.1aa+.1	...	aa+1aa1	..+bb1
Carex nigra	3.3..a13..	.....1.11	.bab.a1.a	..a	b+.1...	+.3...
Epilobium palustre	..+....++1	.+.....+.+.	....+++a.	..r	++.+..+	m++..1
Luzula sudetica	..+...+.+.	.....	.+.1+++.+	...	.+.++++	..+.+.
Drosera rotundifolia	.1aa1...+.	aaa.1.b....	1	...	.....1.	.....
Viola palustris	.....	.....+.+.	.11..+...	...	...a...	.....
Aulacomnium palustre	.+a..++.b1	.....	.....+.1.	...	.a1+...	r..4a.
Straminergon stramineum	....+.....	a1+.+..+...	.1...+...	...	.+.+a..	.....
Sphagnum inundatum	...4.....	.....bb3	....a....	..a	.....	.....
Sphagnum palustre	.....1..	.+3.....	.....	...	.....3.	.....
Other mire species (*Scheuchzerio-Caricetea nigrae*)						
Eriophorum latifolium	a11+..b.+a	.....	...abb...	...	.a1.b.+	1
Dactylorhiza cordigera	..+.+.1.+.	....+.....	....+....	...	1.+.a.+	.....+
Veronica scutellata	.....	.....	.11...1..	b.1	..+....	.bm..+
Carex panicea	.....	.....	....+++..	a.+	.1..++.	..+...
Parnassia palustris	..r...+...	.....	....11...	...	11++...	.....
Potentilla palustris	.....	.....1.3...	3......3.	...	....a.a	..+...
Juncus articulatus	.....	.....	...r1....	a.+	.+.....	.a....
Philonotis caespitosa	.....	.....	......+..	...	......+	1+...+
Accidental species						
Galium palustre	.....+1	.....+.++	.+1.++1a.	.aa	1+a11.+	bam11m

Table 1. Continuation.

No. of relevés	0000000001 1234567890	11111111122 12345678901	222222223 234567890	333 123	3333334 4567890	444444 123456
Festuca rubra	m.1.+++..+	....	.+.1+..++	...	+.1+m.+	a.+11+
Juncus effusus	1++....+1a	....	+..1+++..	.+.	.++..+.	a+.+.1
Deschampsia cespitosa	+.+..+.+..	....	.+.++.++.	..+	.+++1..	a.+.+.
Geum coccineum	+.1....+ab	.........r	...11a.+.	...	...1+aa	.....b
Ranunculus acris	+........+	....	.+....1..	...	+..+1.r	1.++1+
Myosotis sicula	....	....	.+....1+.	1..	.+++a1+	..+.1.
Holcus lanatus	..1.....b+	....+.....	...+.....	...	..+..+.	1+.1+.
Molinia caerulea agg.	.a+aa.....	.+....b....	....	...	.....1.	....1.
Leontodon autumnalis	....	....	.1..++...	+.r	++..+..	.....
Anthoxanthum odoratum	..+..+..+.	....	....+....	...	.....+.	...+1.
Equisetum fluviatile	......1...	.......a...	....	..m	..m+...	..+.a.
Hieracium caespitosum	+.r.....+.	....	....	...	.....r.	...+a.
Juncus tomasii	..+.....+.	....	...1r....	...	....1..	.....+
Geum rhodopaeum	......a...	.......a...	.+....1..	...	.b.....	..+...
Caltha palustris	1	....	....	...	1...1..	.+a..a
Alchemilla vulgaris agg.	.........+	....	....+....	.r.	....a..	..+..a
Trifolium spadiceum	....	....	....+.1..	...	..1.a..	..r.+.
Carex leporina	....	....	......+..	.+.	..+....	1.+.1.
Pinus sylvestris	...+......	......+..r.	....	..r	......r	.....
Ranunculus nemorosus	......a...	....	.+....+..	...	.+.....	..+...
Lysimachia vulgaris	....	....+.....	+........	...	.....1+	...+..
Prunella vulgaris	....	....	...1+.+..	...	+.....	...+..
Vaccinium vitis-idaea	b....1+...	....	....	...	.+.....	.....
Carex pallescens	..r.....	....	....+.+..	...	.....	...+..
Crepis paludosa	....1.....	....	....	...	.....1a	....+.
Ranunculus flammula	....	....	......+..	+.+	.....	.a....
Oenanthe silaifolia	....	....	......+..	...	.+..+..	....+.
Rumex acetosa	....	....	......+..	...	.....+.	+..+..
Cynosurus cristatus	....	....	......+..	...	.....	.+..1+
Equisetum palustre	....	....	.......+.	...	....1+1	.....
Other bryophyte species						
Calliergonella cuspidata	.........+	....	.+..+.11.	+.+	..1+..a	3++aaa
Climacium dendroides	....	....	......++.	1.1	.+++1.+	1.+1++
Polytrichum formosum	....	.+1........	.+.....	...	a..+...	.....

Species occurring in 1-3 relevés only: *Danthonia decumbens* 3: 1, 23: +, 42: r; *Hypericum tetrapterum* 3: r, 42: +, 45: +; *Carex flava* 4: 1, 5: +, 27: +; *Pseudorchis frivaldii* 4: +, 5: +, 7: 1; *Succisa pratensis* 5: 1, 6: +, 43: 1; *Oenanthe banatica* 10: 1, 39: +, 45: a; *Picea abies* 12: +, 13: +, 27: +; *Trifolium hybridum* 12: +, 34: +, 44: +; *Equisetum arvense* 15: r, 42: 1, 43: 1; *Trifolium pratense* 31: +, 32: +, 44: 1; *Ranunculus repens* 39: +, 41: +, 45: +; *Crocus veluchensis* 2: +, 4: r; *Veratrum lobelianum* 2: +, 5: 1; *Lycopodiella inundata* 12: +, 13: 1; *Mentha arvensis* 24: 1, 25: +; *Stellaria graminea* 24: +, 41: +; *Polygonum bistorta* 24: +, 46: +; *Myosotis nemorosa* 27: +, 39: 1; *Filipendula ulmaria* 29: +, 42: +; *Briza media* 31: +, 42: +; *Euphrasia hirtella* 31: +, 46: +; *Cardamine acris* 32: +, 34: a; *Glyceria notata* 36: r, 39: a; *Scirpus sylvaticus* 40: 1, 42: +; *Scutellaria galericulata* 40: +, 42: +; *Lysimachia nummularia* 41: 1, 44: +; *Mentha longifolia* 44: 1, 45: +; *Hieracium vulgatum gr.* 2: +; *Populus tremula* 13: +; *Carex vesicaria* 22: 1; *Carex elata* 22: +; *Carex lepidocarpa* 23: +; *Soldanella rhodopaea* 27: 1; *Cirsium appendiculatum* 27: +; *Sagina procumbens* 27: r; *Ranunculus montanus* 28: a; *Eleocharis quinqueflora* 30: +; *Glyceria fluitans* 31: 1; *Trifolium repens* 32: a; *Euphrasia rostkoviana* 34: +; *Chaerophyllum hirsutum* 34: +; *Lathyrus pratensis* 34: +; *Leontodon hispidus* 34: +; *Veronica beccabunga* 34: r; *Juncus alpinoarticulatus* 35: a; *Alisma plantago-aquatica* 35: +; *Lycopus europaeus* 35: +; *Alopecurus aequalis* 36: +; *Veronica serpyllifolia* 36: r; *Juncus bufonius* 37: +; *Eleocharis palustris* 37: +; *Equisetum sylvaticum* 40: +; *Ranunculus auricomus* 41: 1; *Juncus conglomeratus* 41: 1; *Poa trivialis* 41: +; *Cardamine rivularis* 41: +; *Lychnis flos-cuculi* 42: +; *Linum catharticum* 42: +; *Lythrum salicaria* 42: +; *Viola canina* 42: r; *Acer pseudoplatanus* 42: r; *Carex flacca* 42: r; *Cardamine matthiolii* 43: 1; *Angelica pancicii* 43: +; *Cirsium heterotrichum* 43: +; *Euphrasia pectinata* 44: +; *Trifolium patens* 44: +; *Cerastium holosteoides* 44: +; *Epilobium obscurum* 44: r; *Holcus mollis* 45: m; *Cardamine amara subsp. balcanica* 45: 1; *Vicia cracca* 46: +; *Dicranum bonjeanii* 3: 1, 9: 1, 46: +; *Polytrichum commune* 6: +, 18: 1, 22: +; *Sphagnum platyphyllum* 21: 1, 26: 1, 36: +; *Aneura pinguis* 28: +, 42: +, 46: +; *Bryum pseudotriquetrum* 31: 1, 37: +, 43: +; *Philonotis fontana* 37: 1, 42: 1, 44: 4; *Sphagnum contortum* 39: +, 44: r, 45: +; *Sphagnum squarrosum* 10: b, 43: +; *Hamatocaulis vernicosus* 10: a, 45: 1; *Sphagnum denticulatum* 28: +, 30: 3; *Plagiomnium elatum* 29: +, 41: a; *Plagiomnium ellipticum* 40: 1, 44: +; *Atrichum undulatum* 42: 1, 46: +; *Sphagnum warnstorfii* 43: 1, 46: a; *Sphagnum girgensohnii* 2: 1; *Lophocolea heterophylla* 3: 1; *Brachythecium*

Table 1. Continuation.

mildeanum 3: +; *Hypnum lindbergii* 29: r; *Plagiomnium undulatum* 34: a; *Philonotis seriata* 34: a; *Ditrichum cylindricum* 36: +; *Campylium stellatum* 38: +; *Hypnum pratense* 38: r; *Amblystegium riparium* 38: r; *Marchantia polymorpha* 39: 1; *Calliergon cordifolium* 39: 1; *Brachythecium rivulare* 40: a; *Calliergon giganteum* 41: 5; *Riccardia multifida* 42: +; *Drepanocladus aduncus* 44: +; *Bryum weigelii* 44: +; *Brachythecium* sp. 44: +; *Pellia neesiana* 45: +; *Plagiomnium affine* 45: +

Table head

No: Locality; Year; Month; Day; Area (m^2); Altitude (m); Aspect (degrees); Slope (degrees); Cover total (%); Cover herb layer (%); Cover moss layer (%); Longitude; Latitude. n= not recorded

1: Sredna Gora, saddle 1.5 km ESE from the Golyam Bogdan peak; 2002; 7; 2; 16; 1490; n; 2; 100; 80; 98; 242842; 423609
2: Western Stara Planina, Petrohan Pass, mire complex; 2003; 6; 26; 16; 1377; 315; 3; 100; 60; 95; 230721; 430704
3: Sredna Gora, 0.6 km SE from the Golyam Bogdan in the direction to the Maly Bogdan peak; 2002; 7; 2; 16; 1510; n; 3; 100; 90; 40; 242811; 423608
4: Western Stara Planina, Petrohan Pass, mire complex; 2003; 6; 26; 16; 1377; 315; 5; 90; 40; 80; 230721; 430704
5: Western Stara Planina, Petrohan Pass, mire complex; 2003; 6; 26; 16; 1393; 315; 3; 100; 50; 100; 230729; 430706
6: Vitosha Mt., 3 km S of Zlatni Mostove, close to road; 2006; 7; 1; 16; 1463; 23; 2; 100; 40; 100; 231423; 423604
7: Central Rhodopes, Shiroka Polyana, ca 1 km S from the settlement; 2005; 6; 30; 16; 1547; 45; 5; 100; 75; 90; 240844; 414523
8: Central Rhodopes, mire at NEE margin of the Shiroka Polyana reservoir; 2001; 6; 29; 16; 1590; n; 0; 100; 60; 100; 241207; 414610
9: Sredna Gora, 0.6 km SE from the hill Golyam Bogdan in the direction to the Maly Bogdan peak; 2002; 7; 2; 16; 1510; n; 10; 90; 70; 80; 242811; 423608
10: Sredna Gora, saddle 1.5 km ESE from the Golyam Bogdan peak; 2002; 7; 2; 12; 1475; n; 4; 95; 65; 90; 242844; 423612
11: Central Rhodopes, Smolyanski lakes, Bistroto lake, floating island; 2005; 7; 2; 16; 1541; n; 0; 98; 40; 95; 244041; 413718
12: Central Rhodopes, Smolyanski lakes, 2.3 km SSW from Snezhanka peak (1926); 2001; 7; 7; 25; 1458; n; 0; 100; 60; 100; 243954; 413660
13: Central Rhodopes, Smolyan, Smolyanski lakes, ca 2 km S from the Smolyanski lakes chalet; 2005; 7; 2; 15; 1498; n; 0; 95; 40; 95; 243954; 413660
14: Central Rhodopes, Smolyanski lakes, Bistroto lake, floating island; 2005; 7; 2; 16; 1541; n; 0; 90; 60; 80; 244041; 413718
15: Central Rhodopes, Smolyan, 2 km S from the town, Amzovo Reserve; 2005; 7; 1; 16; 1201; 0; 0; 100; 35; 100; 244141; 413342
16: Central Rhodopes, Chairi lakes; 2001; 7; 3; 16; 1500; n; 0; 100; 70; 100; 242817; 413817
17: Central Rhodopes, Chairi lakes; 2001; 7; 3; 16; 1500; n; 0; 100; 60; 100; 242817; 413817
18: Central Rhodopes, Shiroka Polyana, ca 1 km S from the settlement; 2005; 6; 30; 16; 1544; 0; 0; 100; 65; 100; 240851; 414528
19: Central Rhodopes, mire at NEE margin of the Shiroka Polyana reservoir; 2001; 6; 29; 2; 1590; n; 0; 95; 35; 95; 241207; 414610
20: Central Rhodopes, 2 km S from Shiroka Polyana, close to junction to Dzhenevra; 2001; 6; 29; 16; 1550; n; 0; 95; 80; 90; 240859; 414505
21: Central Rhodopes, mire at NEE margin of the Shiroka Polyana reservoir; 2001; 6; 29; 9; 1590; n; 0; 90; 75; 80; 241207; 414610
22: Central Rhodopes, Reserve Kupena above the town of Pesthera; 2004; 6; 24; 16; 1360; 0; 0; 95; 70; 75; 241858; 415908
23: Central Rhodopes, Shiroka Polyana, close to junction towards the Longurlii settlement; 2005; 6; 30; 16; 1543; n; 0; 100; 50; 95; 240817; 414557
24: Central Rhodopes, Shiroka Polyana, Dospatski Pass; 2005; 6; 30; 16; 1591; 0; 0; 100; 60; 90; 240759; 414706
25: Stara Planina, Vezhen-Teteven part, 3.6 km SE from the peak Vezhen, Ravna reka; 2002; 7; 4; 16; 1465; n; 0; 95; 75; 90; 242603; 424340
26: Central Rhodopes, between Mugla and Smolyan, close to road, SW slopes of Orela hill; 2005; 7; 1; 15; 1554; 23; 5; 95; 65; 90; 243120; 413538

Table 1. Continuation.

27: Central Rhodopes, 2 km S from Shiroka Polyana, close to junction to Dzenevra; 2001; 6; 29; 25; 1550; n; 1; 95; 90; 75; 240859; 414505
28: Central Rhodopes, Shiroka Polyana, close to junction towards the Longurlii settlement; 2005; 6; 30; 15; 1549; 135; 5; 80; 40; 70; 240838; 414552
29: Central Rhodopes, Chairi lakes; 2001; 7; 3; 16; 1500; n; 0; 90; 75; 80; 242817; 413817
30: Stara Planina, Vezhen-Teteven part, 3.6 km SE from the peak Vezhen, Ravna reka; 2002; 7; 4; 8; 1465; n; 0; 75; 45; 70; 242609; 424341
31: Central Rhodopes, SEE margin of the Shiroka Polyana reservoir; 2001; 6; 29; 8; 1580; n; 2; 90; 85; 5; 241149; 414540
32: Central Rhodopes, Smolyanski lakes, 2.3 kmSSW from Snezhanka peak (1926); 2001; 7; 7; 16; 1458; n; 0; 90; 80; 70; 243954; 413660
33: Central Rhodopes, W edge of the Shiroka Polyana reservoir; 2001; 6; 29; 16; 1544; n; 0; 85; 80; 40; 240917; 414623
34: Mt Vitosha, 3 km S of Zlatni Mostove, close to road; 2006; 7; 1; 16; 1463; 45; 2; 85; 60; 60; 231421; 423606
35: Central Rhodopes, close to the Beglika reservoir; 2005; 6; 30; 16; 1530; 90; 10; 90; 70; 80; 240723; 414929
36: Central Rhodopes, Smolyanski lakes, close to the bus end-station; 2005; 7; 2; 16; 1548; n; 0; 98; 50; 95; 244034; 413721
37: Central Rhodopes, 1 km S from the Shiroka Polyana reservoir; 2001; 6; 29; 16; 1545; n; 0; 95; 70; 95; 240845; 414525
38: Central Rhodopes, 2.5 km N from the Mugla village, close to fountain by the path to Lednitsata; 2001; 7; 5; 25; 1732; n; 5; 95; 85; 85; 243111; 413740
39: Central Rhodopes, Batak, spring fen near S margin of the Batak reservoir; 2004; 6; 25; 16; 1172; n; 0; 100; 80; 95; 240956; 415608
40: Central Rhodopes, Batak, spring fen near S margin of the Batak reservoir; 2004; 6; 25; 16; 1173; 315; 5; 100; 98; 30; 240958; 415608
41: Mt Sredna Gora, 0.6 km from the hill Beliya Kamak, close to the village Koprivshtica; 2002; 7; 1; 20; 1313; n; 0; 90; 85; 40; 242400; 423812
42: Mt Sredna Gora, saddle 1 km SE from the Golyam Bogdan peak; 2002; 7; 2; 4; 1489; n; 0; 70; 65; 5; 242818; 423607
43: Central Rhodopes, close to Beglika settlement; 2005; 6; 30; 16; 1532; 135; 5; 100; 80; 90; 240849; 415026
44: Stara Planina (Western), Yablanitsa - Tichov dol, valley of Bakovska reka; 2007; 6; 20; 16; 800; 360; 2; 90; 60; 80; 233638; 425213
45: Central Rhodopes, Smolyan, ca 1 km SE from the Smolyanski lakes chalet; 2005; 7; 2; 16; 1491; n; 0; 95; 75; 80; 244031; 413701
46: Sredna Gora, Kadarski rat, spring area of the river Kriva reka, 2 km NNE from the Golyam Bogdan peak; 2002; 7; 2; 25; 1375; n; 3; 95; 90; 30; 242714; 423728

Table 2. Phytosociological relevés of the *Sphagno warnstorfii-Tomenthypnion nitentis* alliance.

```
No. of relevés                 00000000011111111112222222222333 3333
                               12345678901234567890123456789012 6345

Diagnostic and differential species obtained from the entire data set
Geo coccinei-Sphagnetum contorti
Sphagnum contortum             a13.31..b1+1a.3a1+aaa3444.a3aa+4 bb4a
Myosotis nemorosa              ....1.+.1.11..1....1.+1.....11++ ++1+
Luzula sudetica                .+.+1+..+.+++..++++++1++++.+.+++ +...
Carex flava                    +..+....a.r+.+.+1..a.1a..+.1+11. .1..
Geum coccineum                 ra1b.a..1baab+ba.+a+11.+++.+..+1 ....
Parnassia palustris            +a++ar1.a.1m11.111+1111++.m1.+11 111.
Crepis paludosa                .a1a+...1..1..a1...+.1.a....aa.. ...1
Hamatocaulis vernicosus        +1+..1.b.1..b..1........+.1....+ a...
Epilobium palustre             ++..+1+.++++++++..+++.+.+...++.+ ..+r

subass. caricetosum lasiocarpae
Carex lasiocarpa               ............................... a13b
Carex buxbaumii                ...............................1 1..a
Pedicularis palustris          ................................ .2+.
Calliergon giganteum           ................................ 2...
```

Table 2. Continuation.

No. of relevés	000000000111111111122222222333 3333
	123456789012345678901234567890123 6345
Other vascular plant species	
Other alliance species (*Sphagno warnstorfii-Tomenthypnion nitentis*)	
Sphagnum teres	4531b.....+..... ....
Tomenthypnum nitens	.....+.....1... ...+
Sphagnum warnstorfii	a..... ....
Other species of calcareous fens (*Caricion davallianae*)	
Eriophorum latifolium	+a+a1.a1ab+.a.a1aa1b133b1aab.aba ab+.
Succisa pratensis	a.+r+.1111.aa.....b.1b++1.+.+.. ....
Juncus articulatus	.+.++.1aa.1.++.1++..1a++.1m1.1a. ....
Blysmus compressus	.....+...+.+4.....+....1. ....
Carex lepidocarpa	.++....1.....+....+. ....
Juncus alpinoarticulatus	.....+....1..a1..... ....
Triglochin palustris	.....m1..... .+.1
Pinguicula balcanica	.....+..1...+..... ....
Campylium stellatum	.+.....b.....+.....+.b1+11. ...4
Aneura pinguis	..+....+.....+....+....1+.... +.1+
Fissidens adianthoides	.....+...3. .b.a
Other mire species (*Scheuchzerio-Caricetea nigrae*)	
Carex echinata	1aaaaabb1a1aa.aa11a11aamaaa31aab a1+1
Agrostis canina	++.1+..+...++.+1+.1++11+a1+1..1m +...
Aulacomnium palustre	.++a1.+aa..ba..1..a+.+..1a.b..a1 +b+.
Carex panicea	b111..1....+...1b.1....11ba3.1+a 1a.1
Carex rostrata	.aa.1a..1..1.+.3.+.1b..a.....11 +ab1
Carex nigra	...1..+.+.3a.aa.1a..b+.1.+..+.1. ....
Eriophorum angustifolium	ba+1.3.....b.....a.....b1..b..1 1..1
Drosera rotundifolia	+11.....1..+.....++.+.....a.... 1..a
Ranunculus flammula	...+....r....+.+.....+.+.1.1.... +...
Carex serotina	..a+.....11..bb.....b..a.... a...
Veronica scutellata	.r...+1.....r.....+.r..... ..+.
Carex hartmanii	.....+11.1.... .+..
Potentilla palustris	.+1+.....a..... ....
Carex curta	.....a.....+..... ..+.
Philonotis fontana	.....1ab.+1ba.b+.11b1+++1...a.+ ...+
Bryum pseudotriquetrum	++..1...+.+++1.111.1....1+....a. ++++
Warnstorfia exannulata	a.1.....1+.1.1aa...+...+..... +...
Philonotis caespitosa	+++++1.....1.+..... +...
Sphagnum subsecundum	...a..331..b...3.....a.b.... 3...
Riccardia multifida	.+.....++..+.....+...+. +...
Straminergon stramineum	.+.....+...+.... ....
Accidental species	
Potentilla erecta	+11a111b+1a.a+a11a11+1a11+a1+1aa 1a++
Galium palustre	1+..1a++1a++1++++.++1111++.+++++ +.+.
Festuca rubra	1+.11++1m+m+1...+r111...1+.+.1++ +++.
Holcus lanatus	++.+1+1111.+1.....1+..++11++.++1 +++1
Juncus effusus	+..++1+1+m11a.....a1.+a+.m++.+++ +.++
Prunella vulgaris	.+..+.+a1.++.a.++.++a+.+.+r+.+++ +..+
Nardus stricta	...+..+++.1+11++m+.+a+1+1m.+..+. ..+.
Ranunculus acris	...11++1++a.++.+..++...+.1.+..11 .11.
Myosotis sicula	+1++.+.+.+..1+.1+++.1..++1r1.... ....
Anthoxanthum odoratum	.+.+m.r11.++.....+...+.+.+.++1 1+++
Briza media	...1a...1..+...+...+..++.+++.+11 11++
Dactylorhiza cordigera	...++....1+..+++..1a++.+.a...+.+ +...
Cynosurus cristatus	....1.++1+...+....++...+.+.+..+1 +++.
Alchemilla vulgaris agg.	....1...baaa.1aa..3.+1+.....+++. .+..
Caltha palustris	....+ar..b+.1..+..1.+11a.....+.1 +.+.
Lysimachia vulgaris	.+++..++.....+.++r..1+ ++++
Rumex acetosa	...++..+.1.r+.....+....+.+.+..++ +++.
Carex pallescens	...+1+.+++++1....r.+.+..1+...+.. ....

Table 2. Continuation.

No. of relevés	000000000111111111122222222223333 3333 123456789012345678901234567890123 6345
Hieracium caespitosum	...+1..+r+.r.....++...r.+.r..++ .++.
Scirpus sylvaticus	...11.1.......a1.....+.a.+a+1++. .+..
Lychnis flos-cuculi	....1...+1.1.....11...+.+....++ ++..
Linum catharticum	.1+.+...+.........+.........+1. +++1
Trifolium spadiceum	....1...r+...+.1..++.....r.+...+ ....
Juncus tomasii	....++..++..+.....++.+..1+..... ....
Mentha arvensis	...++.................+.+....++ .++1
Filipendula ulmaria	....1...+..+..++.......1..+.b1.. ....
Oenanthe banatica	.....+..+a.11.....11.+1..... ....
Molinia caerulea agg.	......+1...+.......+....a.a..... ++.+
Deschampsia cespitosa	+....+...+1.+......+..+.....1... ....
Equisetum palustre	.1++b.........+.......a.......+ ...+
Pinus sylvestris	rrr...r.............r.r.r.... ....
Juncus conglomeratus	...m..1...+...........+a.....1. .+..
Lythrum salicaria	...1+..+.................+.+ .++.
Polygonum bistorta	...1+..............+.....+.+ ++..
Trifolium pratense	....+.r+.....+.........+....+. .+..
Ajuga reptans	....+....r.r...........+....+. .++.
Cardamine matthiolii	............+.r....+.........+. .+++
Hypericum tetrapterum	.....++..+..+.....1........+.... ....
Lycopus europaeus	..rr................+..r....+ ....
Cruciata glabra	....+...+...+.....+.........+.. ....
Cerastium holosteoides	....+...+......+...........++. ....
Carex hirta	......++....+r.............+.. ....
Leontodon hispidus	........+.+.................+. .++.
Oenanthe silaifolia	....+........+.+.........r...... ....
Rhinanthus rumelicus	....+........+.............+. ..+.
Plantago lanceolata	....+.......................+. .++.
Scutellaria galericulata	....+.......................+ .r+.
Danthonia decumbens	......+................+.+..+. ....
Silene asterias	........+.....+...........1+.. ....
Ranunculus repens	........rr...+........+..... ....
Phragmites australis	...........a.................. .++1
Trifolium hybridum	............1.++...+..... ....
Equisetum fluviatile	....1.......................+ +...
Stellaria graminea	....+...+...+.............. ....
Sagina procumbens	....+...r....r............. ....
Lathyrus pratensis	....+.........+............ ..+.
Holcus mollis	.....m...a........a........... ....
Equisetum arvense	.......+a.....1............. ....
Festuca pratensis	.......+++.................. ....
Veratrum lobelianum	........+..+..+............ ....
Luzula pillosa	........+..r.........r..... ....
Euphrasia hirtella	........+.........+.........+ ....
Mentha longifolia	.........+..1.........1..... ....
Leontodon autumnalis	............+......+.....+ ....
Geum rivale	........................++.. .+..
Other bryophyte species	
Calliergonella cuspidata	++11++++.1baa.+a.+1+3ab1+aa+aa1+ ++11
Climacium dendroides	.r.+a+.+1..b1.+1+.a+.+.+.11+111. .1..
Plagiomnium elatum	...+++r.....+..+......+...r.3111 +a11
Atrichum undulatum	....1+..b..r+..a..r......+..... ....
Brachythecium rivulare	.........b.111.+..1...a..+..... ....
Plagiomnium ellipticum	.........+.+.......1++.....+.... ....
Marchantia polymorpha	....1...+....1+....1....... ....
Chiloscyphus polyanthos	.....a.........+.....+........+. +...
Hypnum lindbergii	..........1..3..4a..1..... ....
Calliergon cordifolium	..............+.......+.1..... ....

Species occurring in 1-2 relevés only: *Pedicularis palustris* 33: a, 34: +; *Calliergon giganteum* 36: a; *Equisetum sylvaticum* 1: 1, 3: r; *Menyanthes trifoliata* 3: +, 36: a; *Acer pseudoplatanus* 3: r, 29: +; *Poa trivialis* 5: +, 9: +; *Carex acuta* 5: +, 24: 1; *Poa sylvicola*

Table 2. Continuation.

5: +, 34: +; *Genista tinctoria* 5: r, 26: r; *Epilobium roseum* 5: r, 32: +; *Festuca rupicola* 5: r, 32: +; *Cardamine amara subsp. balcanica* 6: +, 19: +; *Carex leporina* 7: +, 13: +; *Senecio pancicii* 11: +, 22: +; *Dactylorhiza incarnata* 13: +, 33: +; *Primula farinosa s. farinosa* 14: +, 17: a; *Ranunculus nemorosus* 15: +, 16: +; *Eleocharis quinqueflora* 17: a, 36: 1; *Lysimachia nummularia* 23: +, 26: +; *Petasites hybridus* 29: +, 30: 1; *Luzula multiflora* 33: +, 35: +; *Eriophorum gracile* 3: 1; *Galium rivale* 5: +; *Poa palustris* 6: +; *Carex acutiformis* 7: +; *Isolepis setacea* 7: +; *Danthonia alpina* 7: r; *Betula pendula* 7: r; *Rhinanthus minor* 8: +; *Carex punctata* 8: +; *Gymnadenia conopsea* 8: r; *Primula elatior* 9: +; *Poa pratensis* 10: +; *Agrostis capillaris* 11: m; *Taraxacum apenninum* 11: r; *Epilobium nutans* 11: r; *Campanula patula* 12: +; *Euphrasia pectinata* 14: 1; *Eleocharis palustris* 14: +; *Taraxacum officinale* 14: r; *Euphrasia species* 16: +; *Gentiana utriculosa* 16: +; *Utricularia minor* 18: a; *Pseudorchis frivaldii* 19: r; *Scabiosa lucida* 20: r; *Ranunculus sartorianus* 21: 1; *Vicia cracca* 26: +; *Lycopus exaltatus* 26: +; *Ranunculus polyanthemos* 26: r; *Alnus glutinosa* 27: 1; *Mentha * verticillata* 27: 1; *Genista germanica* 28: +; *Euphrasia rostkoviana* 28: +; *Bruckenthalia spiculifolia* 28: +; *Centaurea jacea agg.* 30: +; *Trifolium montanum* 30: +; *Angelica sylvestris* 30: +; *Pyrola rotundifolia* 30: +; *Gentiana asclepiadea* 30: +; *Luzula luzulina* 30: +; *Veronica beccabunga* 30: +; *Orchis elegans* 31: +; *Carex flacca* 32: +; *Festuca arundinacea* 32: +; *Luzula campestris* 33: +; *Carex appropinquata* 34: 1; *Carex paniculata* 34: 1; *Trifolium velenovskyi* 34: +; *Equisetum * moorei* 35: 1; *Salix fragilis* 36: r; *Pellia neesiana* 6: +, 19: +; *Cratoneuron decipiens* 21: 1, 30: a; *Scleropodium purum* 4: +; *Plagiomnium undulatum* 5: +; *Cirriphyllum piliferum* 9: r; *Scapania undulata* 11: +; *Sphagnum centrale* 12: a; *Rhizomnium punctatum* 19: +; *Brachythecium mildeanum* 20: 1; *Scapania irrigua* 20: +; *Dicranum bonjeanii* 20: +; *Sphagnum platyphyllum* 26: a; *Philonotis tomentella* 28: 1; *Scorpidium cossonii* 28: 1; *Amblystegium riparium* 31: +; *Drepanocladus aduncus* 31: +; *Fontinalis antipyretica* 36: +

Table head

No: Locality; Year; Month; Day; Area (m^2); Altitude (m); Aspect (degrees); Slope (degrees); Cover total (%); Cover herb layer (%); Cover moss layer (%); Longitude; Latitude. n= not recorded

1: Rila Mts, 2.2 km WSW from Govedarci, the valley of Cherni Iskar river; 2002; 6; 23; 25; 1213; n; 1; 90; 50; 80; 232648; 421508

2: Central Rhodopes, Batak, spring fen near S margin of the Batak reservoir; 2004; 6; 25; 16; 1172; 315; 5; 95; 70; 85; 240957; 415608

3: Central Rhodopes, Batak, spring fen near S margin of the Batak reservoir; 2004; 6; 25; 16; 1173; 360; 2; 85; 45; 75; 240957; 415607

4: Central Rhodopes, Batak, spring fen near S margin of the Batak reservoir; 2004; 6; 25; 16; 1164; 225; 5; 90; 85; 30; 240957; 415610

5: Central Rhodopes, Batak, near S margin of the Batak reservoir; 2005; 6; 29; 16; 1164; 90; 15; 90; 80; 70; 240957; 415610

6: Mt Sredna Gora, Debeli Del, 2 km ESE from the Belya Kamak; 2002; 7; 1; 25; 1353; n; 2; 98; 95; 20; 242412; 423841

7: Stara Planina, Golema Planina, close to the Vila Krsta lonely house, by the path to ridge; 2006; 7; 2; 16; 1128; 135; 3; 70; 50; 40; 233116; 425537

8: Stara Planina, Kaloferska planina, Panitsite - 500 m SSE from agriculture houses; 2004; 7; 2; 16; 769; 90; 7; 90; 80; 80; 245910; 423931

9: Western Stara Planina, Petrohan Pass, mire complex; 2003; 6; 26; 16; 1405; n; 3; 95; 60; 80; 230730; 430724

10: Mt Sredna Gora, 1 km ESE from the hill Beliya Kamak, close to the village Koprivshtica; 2002; 7; 1; 16; 1319; n; 5; 100; 95; 35; 242411; 423816

11: Western Stara Planina, SEE slopes of the Maly Kom peak; 2003; 6; 25; 16; 1619; 90; 25; 95; 90; 50; 230549; 430929

12: Western Stara Planina, Petrohan Pass, mire complex; 2003; 6; 26; 16; 1395; n; 1; 90; 75; 70; 230731; 430709

13: Mt Sredna Gora, Beliya Kamak,3.8 km E from the Koprivshtitsa village, south slopes, pastures; 2002; 7; 1; 20; 1261; n; 3; 90; 80; 60; 242354; 423802

14: Rila Mts, S foothills of the Kostenets divide, between Cherna Mesta and Valcha Polyana,

Table 2. Continuation.

Bukata; 2003; 7; 6; 16; 1665; 293; 1; 90; 80; 60; 234711; 420508
15: Osogovska planina, 500 m from the Osogovo chalet; 2003; 6; 27; 16; 1603; 135; 3; 90; 85; 30; 223749; 421208
16: Rila Mts, S foothills of the Kostenec divide, between Cherna Mesta and Valcha Polyana, Manashitsa; 2003; 7; 6; 10; 1628; 23; 5; 95; 70; 90; 234629; 420450
17: Rila Mts, S foothills of the Kostenets divide, between Cherna Mesta and Valcha Polyana, Bukata; 2003; 7; 6; 16; 1665; 180; 5; 90; 80; 70; 234711; 420508
18: Rila Mts, S foothills of the Kostenets divide, between Cherna Mesta and Valcha Polyana, Bukata; 2003; 7; 6; 16; 1665; 23; 30; 80; 70; 20; 234709; 420508
19: Mt Sredna Gora, Debeli Del, 6 km E from the Koprivshtitsa village; 2002; 7; 2; 16; 1323; n; 2; 90; 80; 40; 242449; 423834
20: Western Stara Planina, Petrohan Pass, mire complex; 2003; 6; 26; 16; 1380; n; 1; 80; 70; 30; 230722; 430711
21: Rila Mts, Kostenets divide, between Christo Smirnenski chalet and Belmeken, SW slopes of Slavov Vrah; 2003; 7; 6; 16; 1898; 203; 3; 95; 85; 90; 234733; 420751
22: Western Stara Planina, Petrohan Pass, mire complex; 2003; 6; 26; 10; 1390; 315; 2; 85; 70; 70; 230734; 430705
23: Western Stara Planina, Gintsi village, below Petrohan Pass, close to road; 2003; 6; 24; 6; 1192; n; 3; 95; 80; 85; 230623; 430627
24: Central Rhodopes, Batak, near S margin of the Batak reservoir; 2004; 6; 25; 16; 1137; 315; 2; 85; 75; 60; 241015; 415615
25: Mt Sredna Gora, 0.6 km from the hill Beliya Kamak, close to the village Koprivshtitsa; 2002; 7; 1; 16; 1298; n; 0; 90; 80; 65; 242407; 423806
26: Central Rhodopes, Batak, spring fen near S margin of the Batak reservoir; 2004; 6; 25; 18; 1131; 0; 0; 85; 70; 45; 240954; 415626
27: Pirin, Razlozhka Kotlovina, Krusheto, close to Predel saddle; 2004; 8; 13; 15; 1085; 45; 5; 85; 75; 50; 232135; 415238
28: Rhodopes, fens close to Batak reservior, 7 km W from the town of Batak; 2001; 6; 27; 16; 1111; n; 1; 90; 80; 80; 240928; 415648
29: Komshtitsa, Srebarna reka valley, between two small brooks; 2006; 6; 30; 16; 1213; 90; 5; 90; 70; 70; 230042; 430949
30: Komshtitsa, Srebarna reka valley, between two small brooks; 2006; 6; 30; 12; 1213; 23; 15; 75; 50; 50; 230042; 430949
31: Samokovsko pole, 0.5 km SE from the Prodanovtsi village, 1-2 km W from the Samokov, close to road; 2005; 7; 4; 16; 926; n; 0; 90; 85; 60; 233152; 422022
32: Central Rhodopes, Batak, between water reservoir and road, fen complex; 2005; 6; 29; 16; 1104; 180; 5; 90; 75; 60; 240929; 415654
33: Central Rhodopes, Batak, between water reservoir and road, fen complex; 2005; 6; 29; 16; 1103; 0; 0; 90; 70; 80; 240931; 415653
34: Samokovsko pole, close to the Samokov, close to road; 2006; 6; 29; 16; 916; 360; 20; 95; 85; 80; 233152; 422019
35: Samokovsko pole, close to the Samokov, close to road; 2006; 6; 29; 16; 916; n; 0; 80; 60; 60; 233152; 422019
36: Samokovsko pole, close to the Samokov, close to road; 2006; 6; 29; 16; 916; n; 0; 95; 70; 90; 233153; 422017

Table 3. Phytosociological relevés of the *Caricion davallianae* alliance.

No. of relevés	00000000011111111112222	2222223333333333444	4444444555555	555
	12345678901234567890123	4567890123456789012	3456789012345	678
Diagnostic and differential species obtained from the entire data set				
Dactylorhizo cordigerae-Eriophoretum latifolii				
Palustriella decipiens	..1+.....1....b3.b	.....	.....	...
Mentha longifolia	...+1.+.+...+.+r.+++11+	.r..1a.+.....1.1.	...+.....	...
Plagiomnium elatum	.b.+.b..+++3a+a3+a..1a1	.+...a..+.....a3...	.1..+.....	...
Trifolium pratense	..++++.+..1+++..r1++1..	.+.+.....+..	..+.....++..	...
Alchemilla vulgaris agg.	+1++...a31a..+.a.1.+1+a	....+1.....	.....	...
Philonotis fontana	ab.bb+aaa.b+...1....1b.	.....	.....	...
Scirpus sylvaticus	.b....+..aa1a+++b.a..+.	.....+.....	.....1.	...
Cardamine acris	...+.....+...a1+1	.....r.....	.....	...
Caltha palustris	+1++.a.a..+a..++.1.a+..	.....	.+.....	...
Cynosurus cristatus	+1r+1.....1.++++++..+++	...+.....	+..r.+.++...+	...
Eleocharis palustris	.....+m.+..++....1..+.m	1.....+.....	.1.a.....+..	...
Plantago lanceolata	.....++....++.+.+1.+.+	.++r.....	+.+..+.....+	...
Carici flavae-Cratoneuretum filicini				
Blysmus compressus	1..a....b.+.....3.ma.b	1baaa1m1amba.++ba1.	.a.31.+..1b..	...
Palustriella commutata	.....+.....+a.....	b...331.ba3.ab..b4b	1.1++.....	...
Scorpidium cossonii	.....	.453..a...+.....b..	.....	...
Pinguicula balcanica	.....	11a1..+...1.....+..	.....	...
Philonotis calcarea	.....b1a..b.3..a	.b.1b+.11.11..++a.1	...+..a.1....	...
Linum catharticum	.+.+.+....+..+++.11+..+	+++r+..+.++1+++.+++	.....+..+...	...
Tussilago farfara	.....	..+.....+.a+	.....	...
*Mentha * verticillata*	.....1.....	...+..+..1...+.a...	.....	...
Equisetum arvense	.+.+.+...1+.++.1.+..+.+	..+.+++...+1+++.1.	..+.....+.	...
Carex lepidocarpa	.....a1.....+.	1..13.11.+1+....1.1	.+...1..a+..+	.+.
Eleochariti uniglumis-Caricetum distantis				
Gratiola officinalis	.....1.....	.....	+....a.a+...b	...
Mentha aquatica	.....	.....+....+.+....	.+.a1.1.1.1..	...
Eleocharis uniglumis	.....+....+m....+.1....	.+.+..+.....+.mm..	m1..m++11++b.	+..
Potentilla reptans	.....	.....+.	..+...r...++.	...
Carex distans	.....+.....+....	...1.....+.....a11a	a.3+11+.1aa1a	++1
Carex hirta	.....+.....++....+	.....+.	+.1+...++..+.	...
Cirsium canum	.....+.....+.....+....	.....	..+++r++.1a.1	ra+
Junco subnodulosi-Schoenetum nigricantis				
Schoenus nigricans	.....	.....	.....	bbb
Sanguisorba officinalis	.....a.....	.....	.....+..	+1+
Orchis elegans	.....+.....+....	.....	+.....+..+	+r+
Sesleria uliginosa	.....	.....	.....	.2+
Campylium elodes	.....	.....+	.....	.3a
Pulicaria dysenterica	.....+....	.....++...a+	.....a...+1.	+++
Teucrium scordium	.....	.....	.....+..	+.r
Species diagnostic for more clusters (obtained from the entire data set)				
Eleocharis quinqueflora	.+.1.....++....+...1++	a1mam.bm+maaa1a1m+.	m..1+m+a1ba1m	a.m
Juncus inflexus	...1.+.....+..+...+++..	...++.1r.+.+++..+1.	+.+m+11.a.+a.	.r.
Juncus articulatus	+++1..a++++aa1++aa+aa++	1.+a1+m1+aa11a++1++	b131aa+a1aaa1	bm1
Carex flacca	.....	...a.....a1..1.+1.+	....++.....	+a+
Other vascular plant species				
Alliance species (*Caricion davallianae*)				
Eriophorum latifolium	ab1am1rb113bbb3b1.a.abb	aa113b113+11baa+1a.	.b....a.a+...	ra+
Parnassia palustris	+1+11..+a+1.1+1.+1.1.11	+++1.++1+.+11.1+11a	.1.1..1.....	r+r
Succisa pratensis	...a....1+..+a.....	.....1a..1a.a....	1+..r++.b1...	++a
Epipactis palustris	.....r..a1.....	..r...r..1..+..1...	.+.+..b.1..+.	+aa
Carex flava s.s.	..3....1.+..+a.b....1+1	....+1..+.....	.....	...
Triglochin palustris	.....r....	...+.....+.1....	.....+1..	r.+
Dactylorhiza incarnata	.....	.++.....1...	.+.....	...
Polygala amarella	.....	+.....+.....+..	.....	...
Campylium stellatum	+.+a....1a.....1.a....	3..3..a334334ba.b+.	+b+.13..3.11+	a.a
Aneura pinguis	.+.+1.....+.++.1.+.+...	..++...++..++.+.++.	.....	...

Table 3. Continuation.

No. of relevés	000000000111111111112222 123456789012345678901 23	2222223333333333444 4567890123456789012	4444444555555 3456789012345	555 678
Fissidens adianthoides	...+.....1...1.....	...+....a.....4....	.a...a.....	...
Chara species	.....	..+.....aa.....	.....	...
Other mire species (*Scheuchzerio-Caricetea nigrae*)				
Carex panicea	.+.a.1.1.11a11...1....1	1a11baab1aa1aabaa..	ab..131baa1.b	a11
Carex echinata	aaaab111aab+aa11.ab1.a1	.+..+..11.++..1+...	a+.+.1b11...+	...
Carex serotina	.+.a...+.....+..1+a.	+.++1..1a.+1....+..	.....1+....1.	...
Dactylorhiza cordigera	1.+.1+.+1..+.++a...+1.+	....++..+.....+...	.....	...
Agrostis canina	1..+..1..+1.+..+1.....	.....+.....r+..	.+...+.1.+..+	...
Epilobium palustre	++.++..+..rm..+.....+.+	.....+...	.....	...
Carex nigra	3.1+...1..1.....	.aa.....+.....	.....	...
Utricularia minor	.....	..+...++...1.....	.....	...
Carex hartmanii	.....b.....a.....	.....a.....	.....	...
Veronica scutellata	.+....m+..++..+.++.....	.....	...+...+.....	...
Bryum pseudotriquetrum	++a1..+.+11+b+1a1+1a1a+	+++1+++a+.+b.+++1a.	1+..+1+b++.+1	+.+
Hamatocaulis vernicosus	...b....+.3.....+....a.	.....1.....	.....3.....	...
Warnstorfia exannulata	a.b.1..+.....	.....	.....	...
Riccardia multifida	...+.....+.....	.....+r.....	.....	...
Accidental species				
Ranunculus acris	.1.++.+a+.1+1+.++11.1+1	.1.1++r..+...+.11+.	1ra.1++++++.+	11+
Potentilla erecta	a.++a..a11a.+1a1+..+.1a	+a++a+r1.+++...++..	.1..+...1a...	1++
Prunella vulgaris	..11+.+++.+.++++r111.++	.1++...r+++....1+..	+.+..++1...+1	+++
Festuca rubra	11+++m+.+.1+.+++.++...+	.+.+++..+++.....++.	.+...++..++..	+m1
Holcus lanatus	.a.+1++.++1+1++++a1....	.....+...+.+.++..	+..+.+11+..++	...
Galium palustre	1+.+a+1++++++++++..++.	.+.....+.1...	+..+..r1.....	...
Molinia caerulea agg.	.....aa....1aa....a.	a..1..+b.b1a....1.3	1a..+a.1ab..a	11a
Briza media	....+1.m1+.+++1+1+.....	++.1.....1+..+++1b.	..+.+....+...	...
Mentha arvensis	...+.a....++a.+..+a.+.+	.....+.....++.	b...+1.a.+111	+r+
Juncus effusus	+1..++..a++.++.+a+.+++.	.....+..+....	1..+...+...1.	...
Equisetum palustre	+....1.....b1a.++.b.1..	.+m.+.....++1m...	.+.....1+..	...
Lythrum salicaria	...+..+..+1.+.+...1..+.	.....+.....+...1.	.+.....1+.1+.	++r
Anthoxanthum odoratum	.+.+.+++..1..+.++1..+1+	...+.....	+....+.+....+	...
Deschampsia cespitosa	+.....+..+...+...+.+	.+.+1....+.....+...	..+.++.+.+..+	...
Hypericum tetrapterum	...++1..r..++...++.r...	.....+++.r+.	...+..+....+.	...
Myosotis sicula	.a+..+11+.+1....+1..1++	.....	+..+...+.....	...
Epilobium parviflorum	......+....+++...+..1..	.+++.....+.++..	...++...+....	...
Ajuga reptans	.....1+...++++..b.+.1	.+.++.....+...	....+.....	...
Lysimachia vulgaris	.....++..+..+...++.....	.....+1....	.....++...	+1+
Geum coccineum	a1+.a..ba.a.....+.r+	..r..r.....	.....	...
Ranunculus repens	.+.++.+....+.....+.1+..	.....+.....	...+...+..+..	...
Festuca pratensis	.....+.....+.++.+..	.....+.....+.	+.....+1.+	.+.
Leontodon hispidus	.....+.....+	+..+...1.+.+.....+.	.....+.....	+1+
Leontodon autumnalis	..+.....1...++.+	.+.....+.....+...	..+....+....+	...
Agrostis stolonifera	.....+.....++...+	...+.....	+.+.+.....1..	.++
Trifolium hybridum	++.....+....+.....++..	.....	1....1.+....+	...
Hieracium caespitosum	.a.++..+..+..+...1....+	.....+.....	.....r.....	...
Lychnis flos-cuculi	.+.+.+..+.+1++...1.....	.+.....	.....	...
Carex pallescens	.+.+...11....+.+r+...++	.....	.....	...
Rumex acetosa	.+...+.++.++.++..++....	.....	.....	...
Phragmites australis	.....	...+.....+....+.+..	.+.....+.+	.11
Nardus stricta	+++....+.....1..+...	.....+.....r...	.....	...
Cerastium holosteoides	.+....+...+++....+...+.	.....	+.....	...
Lycopus europaeus	...+..+....r....+.....	.....+....	...+.....++.	...
Danthonia decumbens	...+.....++.....	.....+...+.....	.....+.+....1	...
Lysimachia nummularia	.....+.....1+.....+.+	.....	.....+...1.+	...
Crepis paludosa	.....a..+..+....+.1a+	.....b.....	.....	...
Carex acutiformis	.....+....	.....+..+...b..+..	....3....1...	.+.
Cardamine matthiolii	.+r.....++.....r.....	.r.....r...	.....	...
Trifolium repens	.....+.....+..+++	.....+.....	.....+.	...
Trifolium patens	.1...+1...a.+.....	.....	+.....+	...
Juncus conglomeratus	.....+1.....1...+...	.....+....	.....1.+...	...
Lotus corniculatus	.....+...	...r.....++.....	..r.....+	..+

Table 3. Continuation.

No. of relevés	000000000111111111112222 123456789012345678901 23	2222223333333333444 4567890123456789012	4444444555555 3456789012345	555 678
Luzula sudetica	++r+...+.....	........+.....	.....	...
Lathyrus pratensis	+...1........+......+.+	.....+.....	.....	...
Carex rostrata	..a....1.......1.....a.	........+......+...	.....	...
Juncus tomasii	.......+1......+...+++.	.....	.....	...
Taraxacum sect. Ruderalia	............+.......r.	..........r.....	..+.r+.....	...
Ononis arvensis	.....	...1.....+......++.	....+.....	..1
Cirsium creticum	.....	............+.1..a.	......a....1.	..+
Trifolium spadiceum	1a.....1...........+.+	.....	.....	...
Oenanthe silaifolia	.1.....a..+......r..1..	.....	.....	...
Poa trivialis	......+.....+.....+....	..............r....	........+....	...
Carex leporina	......+.........+.+...	.....	+......+.....	...
Carex paniculata	..................a.+	....1b....+.....	.....	...
Pinus sylvestris	.....	r.+....+..r+.....	.....	...
Ranunculus polyanthemos	.....	.+...+........+...	....r.....+	...
Taraxacum species	.....	.r...........+..r	.....+.r	...
Ranunculus nemorosus	..+....+.....	........+.....	.....	..+
Cirsium appendiculatum	..r.1.....	....r+.....	.....	...
Oenanthe banatica	...+a...+.....	.....	...r.....	...
Poa sylvicola	......+.........+.....	.....	.....++.	...
Filipendula ulmaria	.......a.+1.....	.....	.....1..	...
Sagina procumbens	.......1..r......+.+...	.....	.....	...
Stellaria graminea	.......+r......+.r.....	.....	.....	...
Euphrasia hirtella	.......+.........+..+.+	.....	.....	...
Festuca arundinacea	..................+....	.........+.....	.....	+.+
Equisetum ramosissimum	.....	+..+......+.....	.....	..+
Rhinanthus rumelicus	.....	.....	+.1.....	+.+
Myosotis nemorosa	+...r.........+.....	.....	.....	...
Ranunculus flammula	.+.....+..+.....	.....	.....	...
Picea abies	.r.....	....r......+.....	.....	...
Veratrum lobelianum	..+....1......+.....	.....	.....	...
Geum rivale	....1.....	.....+.........+...	.....	...
Epilobium alsinifolium	....r....r.........+...	.....	.....	...
Carex acuta	.....3.....	.....	.a.........+.	...
Galium rivale	.....r.....	.....	.....++.	...
Bromus racemosus	......1.........+.....	.....	...+.....	...
Rhinanthus minor	......+.....+....+.....	.....	.....	...
Glyceria notata	......+.........+.....	.....	...1.....	...
Juniperus communis	........r.....	..r.........r.....	.....	...
Equisetum fluviatile	............1..+.....a.	.....	.....	...
Myosotis caespitosa	............+....+.....	..............r...	.....	...
Achillea millefolium	..............+......+	.....r.....	.....	...
Alnus glutinosa	..............+.....	.......+...+.....	.....	...
Agrostis capillaris	..............+.+...	.....	.....+.	...
Veronica beccabunga	..............+.r...	..............1...	.....	...
Plantago major	..................r...	.....	..+.....+..	...
*Equisetum * moorei*	.....	...1.....r.....	.....	..a
Cirsium ligulare	.....	...+..r...r.....	.....	...
Cardamine rivularis	.....	........r.....	...r..+.....	...
Rosa species	.....	...........r....r.	......r.....	...
Carex elata	.....	.....	.....a..	a.+
Other bryophyte species				
Calliergonella cuspidata	ab3bbb4ababbba3ba3+a334	...1aa.1+....11.aa.	5a43ab4abab+b	1.a
Aneura pinguis	.+.+1.....+.++.1.+.+...	..++...++..++.+.++.	.....	...
Climacium dendroides	b11+..+b1+a.++11+b.....	.....	.....	...
Cratoneuron filicinum	..............+..a..	.+.1.+.+.......b.a.	..+.a.1.....	+..
Brachythecium rivulare	....+....+.........+.+	.....+.....	.....1..	...
Plagiomnium ellipticum	ba..a.....	.....	.....	...
Atrichum undulatum	....b.....1....+.....	.....	.....	...
Drepanocladus aduncus	.........+.b+.....	.....	.....	...
Brachythecium mildeanum	...........+....+.....	..............+.	.....	...

Species occurring in 1-2 relevés only: *Juncus alpinoarticulatus* 3: a, 39: +; *Soldanella pindicola* 3: 1, 8: +; *Euphrasia pectinata* 4: r, 39: +; *Pedicularis palustris* 6: a, 44: +; *Galium verum* 6: r, 23: r; *Eriophorum angustifolium* 9: 1, 12: +; *Cruciata glabra*

Table 3. Continuation.

9: +, 16: +; *Salix cinerea* 10: +, 17: 1; *Viola canina* 10: r, 16: r; *Poa compressa* 14: +, 20: +; *Dactylorhiza saccifera* 15: +, 42: +; *Carex umbrosa* 16: 1, 32: +; *Carex punctata* 16: 1, 54: a; *Knautia arvensis* 16: +, 18: +; *Arrhenatherum elatius* 16: +, 21: r; *Euphrasia minima* 20: +, 25: +; *Polygala vulgaris* 25: r, 26: +; *Prunella laciniata* 28: +, 55: +; *Crataegus species* 31: r, 36: r; *Centaurea jacea agg.* 39: +, 45: a; *Eupatorium cannabinum* 42: 1, 49: r; *Dorycnium herbaceum* 42: +, 58: +; *Isolepis setacea* 43: m, 54: m; *Serratula tinctoria* 44: +, 55: +; *Juncus compressus* 45: +, 53: 1; *Berula erecta* 46: +, 49: +; *Alisma plantago-aquatica* 46: +, 54: +; *Thymus pulegioides* 50: +, 55: +; *Trifolium fragiferum s. bonannii* 50: +, 56: +; *Plantago altissima* 50: +, 57: r; *Holoschoenus vulgaris* 51: 1, 54: +; *Pycreus longus* 53: 1, 54: +; *Genista tinctoria* 57: +, 58: +; *Cardamine amara subsp. balcanica* 5: 1; *Taraxacum apenninum* 5: +; *Carex cespitosa* 6: 1; *Menyanthes trifoliata* 7: 4; *Veronica anagallis-aquatica* 7: m; *Scutellaria galericulata* 7: +; *Hypericum maculatum* 7: +; *Lemna minor* 7: +; *Euphrasia liburnica* 7: +; *Sparganium erectum* 7: +; *Persicaria hydropiper* 7: r; *Rhinanthus gracilis* 8: +; *Juniperus sibirica* 8: r; *Drosera rotundifolia* 9: +; *Gymnadenia conopsea* 9: r; *Filipendula vulgaris* 10: +; *Avenula pubescens* 10: r; *Carex spicata* 12: +; *Cirsium rivulare* 15: b; *Trifolium velenovskyi* 16: 1; *Luzula multiflora* 16: +; *Trifolium dubium* 18: 1; *Euphrasia picta* 18: +; *Juncus tenuis* 18: r; *Euphrasia rostkoviana* 19: +; *Salix caprea* 20: +; *Rumex sanguineus* 20: +; *Rhinanthus wagneri* 21: +; *Listera ovata* 23: r; *Gymnadenia densiflora* 28: +; *Geum rhodopaeum* 32: +; *Vicia cracca* 32: r; *Taraxacum officinale* 34: +; *Valeriana simplicifolia* 34: +; *Centaurium erythraea* 35: +; *Pyrus pyraster* 36: r; *Typha angustfolia* 37: +; *Poa pratensis* 39: +; *Fraxinus excelsior* 42: +; *Hieracium species* 42: +; *Frangula alnus* 42: +; *Ostrya carpinifolia* 42: +; *Quercus pubescens* 42: r; *Inula ensifolia* 42: r; *Carex appropinquata* 44: +; *Carex disticha* 44: +; *Leucanthemum vulgare* 45: +; *Carum carvi* 45: +; *Medicago lupulina* 45: r; *Agrimonia procera* 46: r; *Plantago media* 47: r; *Epilobium hirsutum* 49: +; *Galium uliginosum* 49: +; *Geranium palustre* 53: 1; *Kochia laniflora* 53: +; *Carex muricata* 54: 1; *Thelypteris thelypteroides* 54: 1; *Osmunda regalis* 54: +; *Agrimonia eupatoria* 54: r; *Polygonum species* 54: r; *Ophioglossum vulgatum* 55: 1; *Ononis spinosa* 55: +; *Cynodon dactylon* 55: +; *Dactylis glomerata* 57: r; *Allium oleraceum* 57: r; *Cirsium pannonicum* 58: +; *Euphrasia stricta* 58: +; *Platanthera bifolia* 58: +; *Cladium mariscus* 58: +; *Aulacomnium palustre* 1: +, 17: 1; *Marchantia polymorpha* 2: a, 5: a; *Chiloscyphus polyanthos* 4: +, 11: r; *Hypnum lindbergii* 16: 1, 32: a; *Brachythecium rutabulum* 16: +, 45: +; *Tomenthypnum nitens* 1: +; *Bryum pallens* 4: +; *Marsupella species* 4: +; *Cephaloziella divaricata* 4: +; *Pohlia nutans* 4: +; *Plagiomnium undulatum* 5: r; *Plagiomnium affine* 8: b; *Dicranum bonjeanii* 8: +; *Calliergon giganteum* 11: 1; *Blindia acuta* 31: +; *Eucladium verticillatum* 42: a; *Pellia endiviifolia* 42: +; *Bryum pallescens* 42: +; *Homalothecium lutescens* 45: 1; *Eurhynchium hians* 45: +; *Philonotis caespitosa* 50: a; *Philonotis marchica* 54: 4; *Campylium chrysophyllum* 55: 1

Table head

No: Locality; Year; Month; Day; Area (m^2); Altitude (m); Aspect (degrees); Slope (degrees); Cover total (%); Cover herb layer (%); Cover moss layer (%); Longitude; Latitude. n= not recorded

1: SW Rila Mts, N slopes of Kilero Mt; 2004; 8; 8; 18; 1640; 360; 10; 95; 85; 70; 231320; 420540

2: Pirin Mts, Dobrinishte, Beludo brook valley, close to Gotse Delchev chalet; 2003; 6; 29; 16; 1234; n; 10; 95; 90; 80; 233260; 414621

3: Rila Mts, Kostenets divide, between Christo Smirnenski chalet and Belmeken reservoir; 2003; 7; 6; 10; 1828; 180; 7; 90; 80; 70; 234715; 420659

4: Stara Planina (Central), southern slopes of the Orlovets peak, above the Anton village; 2005; 7; 8; 16; 1279; 180; 2; 90; 65; 75; 241528; 424501

5: Stara Planina, Vezhen-Teteven part, 2.6 km NW from the village Klisura, Chaydutski dol; 2002; 7; 3; 9; 1263; n; 0; 98; 95; 80; 242605; 424254

6: Rila Mts, Dospey, 1 km E from village; 2007; 6; 27; 16; 1046; 360; 2; 90; 80; 40; 233135; 421827

7: Stara Planina, Kaloferska planina, Panitsite - 300 m S from agriculture houses; 2004; 7; 2; 16; 776; n; 0; 90; 85; 80; 245901; 423933

8: Rila Mts, S foothills of the Kostenets divide, between Cherna Mesta and Valcha Polyana, Manashitsa; 2003; 7; 6; 16; 1603; 270; 5; 95; 90; 70; 234619; 420440

9: Mt Sredna Gora, Debeli Del, 2 km ESE from the Beliya Kamak; 2002; 7; 1; 16; 1329; n; 30; 100; 95; 50; 242412; 423825

10: **Mt** Lozen, Rusamski Livadi; 2007; 6; 26; 16; 976; 360; 3; 85; 75; 30; 233305; 423251

11: Pirin Mts, Dobrinishte, Beludo brook valley, close to Gotse Delchev chalet; 2003; 6; 29; 16; 1248; n; 0; 95; 90; 80; 233301; 414628

12: Rila Mts, Dospey village, 1 km E from village; 2007; 6; 27; 16; 1046; 90; 1; 95; 80; 90; 233135; 421827

13: Plana Planina, 1 km E of Zheleznitsa village; 2005; 7; 4; 16; 976; 225; 10; 90; 70; 70; 232244; 423212

14: Mt Vitosha, close to the motorest Yarema; 2006; 6; 29; 16; 1285; 135; 5; 80; 75; 30; 231950; 423033

15: Komshtitsa, between village and Srebarna reka valley; 2006; 6; 30; 12; 1085; 135; 5; 90; 85; 60; 230013; 430852

16: Central Rhodopes, between Smolyan and Smolyanski lakes, left from the road; 2005; 7; 2; 16; 1368; 113; 25; 100; 95; 80; 244005; 413623

17: Pirin Mts, Razlozhka Kotlovina, Krusheto, close to Predel saddle; 2004; 8; 13; 16; 1125; 315; 1; 70; 60; 15; 232137; 415231

18: Rila Mts, S foothills of the Kostenets divide, between Cherna Mesta and Valcha Polyana; 2003; 7; 6; 16; 1403; 225; 10; 90; 80; 80; 234531; 420416

19: Stara Planina (Central), between Zlatitsa town and Chelopech village; 2004; 6; 22; 16; 693; 90; 5; 80; 80; 15; 240642; 424223

20: Stara Planina, Kozyata Stena Reserve, S slopes of Kozya Stena; 2004; 8; 18; 12; 1535; 135; 7; 85; 50; 70; 243307; 424711

Table 3. Continuation.

21: Central Rhodopes, 2.5 km N of Mugla village, red tourist path, close to the sheep-cote; 2005; 7; 1; 16; 1682; 180; 15; 90; 70; 80; 243104; 413729
22: Central Rhodopes, Smolyan, ca 1 km SE from the Smolyanski lakes chalet, below the road; 2005; 7; 2; 16; 1495; 90; 5; 100; 75; 90; 244008; 413658
23: Central Rhodopes, 2 km N from the Mugla village, close to the red tourist path, before the saddle; 2005; 7; 1; 16; 1679; 158; 10; 95; 80; 80; 243055; 413731
24: Pirin Mts, Razlog, Krusheto site; 2007; 6; 22; 16; 1015; 360; 3; 70; 50; 60; 232337; 415122
25: South Pirin Mts, Popovi Livadi, below the road to the town of Petrich; 2005; 7; 9; 16; 1433; n; 0; 90; 70; 80; 233801; 413252
26: South Pirin Mts, Popovi Livadi, below the road to the town of Petrich; 2005; 7; 9; 10; 1433; 90; 5; 90; 40; 80; 233801; 413252
27: Pirin Mts, Razlozhka Kotlovina, Krusheto, between Predel saddle and the town of Razlog; 2004; 8; 13; 16; 1008; 360; 6; 90; 70; 70; 232341; 415144
28: Central Rhodopes, 2.5 km N from the Mugla village, close to fountain by the path to Lednitsata; 2001; 7; 5; 25; 1730; n; 2; 90; 80; 70; 243108; 413743
29: Central Rhodopes, 2 km N from the Mugla village, close to the red tourist path, before the saddle; 2005; 7; 1; 16; 1652; 113; 20; 90; 80; 60; 243054; 413725
30: Pirin Mts, Razlozhka Kotlovina, Krusheto, between Predel saddle and the town of Razlog; 2004; 8; 13; 16; 1012; 45; 5; 60; 40; 20; 232348; 415143
31: Stara Planina (Central), N from the Anton village, green tourist path; 2005; 7; 6; 16; 1039; 180; 25; 80; 65; 50; 241651; 424448
32: Central Rhodopes, close to Beglika settlement; 2005; 6; 30; 16; 1532; 90; 12; 90; 75; 80; 240847; 415027
33: Pirin Mts, Razlozhka Kotlovina, Krusheto, between Predel saddle and the town of Razlog; 2004; 8; 13; 16; 1006; 360; 3; 85; 70; 70; 232358; 415142
34: Pirin Mts, Razlog, Krusheto site; 2007; 6; 22; 16; 990; 360; 3; 95; 60; 90; 232342; 415135
35: Stara Planina (Central), N from the Anton village, green tourist path; 2005; 7; 6; 16; 1039; 180; 35; 75; 50; 60; 241651; 424448
36: Lozen Planina, Nenova Cheshma site; 2006; 6; 27; 16; 956; 203; 10; 90; 60; 70; 232916; 423430
37: Pirin Mts, Razlozhka Kotlovina, Krusheto, close to the road to Javorov chalet; 2005; 7; 9; 16; 1061; n; 0; 80; 60; 50; 232432; 415131
38: Znepole region, Godetch, close to the village Shuma,close to road to Sofia; 2006; 6; 30; 16; 731; 180; 3; 95; 75; 90; 230601; 425923
39: South Pirin Mts, Popovi Livadi, below the road to the town of Petrich; 2005; 7; 9; 16; 1435; 158; 10; 80; 70; 60; 233758; 413254
40: Pirin Mts, Razlozhka Kotlovina, Krusheto, between Predel saddle and the town of Razlog; 2005; 7; 9; 16; 1074; 45; 2; 90; 60; 80; 232342; 415144
41: Lozen Planina, above the village of Lozen; 2004; 6; 23; 9; 933; 270; 40; 90; 75; 80; 232901; 423529
42: Stara Planina (Central), Yasenovo village, in calcareous canyon NW from village; 2005; 6; 29; 8; 524; 270; 50; 70; 50; 30; 251846; 424140
43: Stara Planina (Central), Vasil Levski - Gavrashtitsa; 2005; 6; 28; 16; 662; 180; 3; 90; 80; 85; 245523; 423821
44: Sofia region, close to the Tsraklevtsi village; 2006; 6; 28; 16; 796; n; 0; 90; 80; 40; 230910; 425710
45: Ruy Planina, Filipovtsi, margin of the village; 2005; 7; 5; 16; 776; 180; 5; 95; 90; 60; 224412; 424851
46: Lozen Planina, 1 km E from Lalina Mogila peak; 2004; 6; 23; 12; 1025; 180; 2; 70; 60; 50; 233001; 423440
47: Pirin Mts, Razlozhka Kotlovina, Krusheto, between Predel saddle and the town of Razlog; 2005; 7; 9; 16; 1074; 45; 5; 75; 60; 25; 232342; 415144
48: Stara Planina, Vasil Levski village - between village and Gavrasthitsa brook; 2004; 7; 3; 16; 715; 180; 3; 85; 75; 60; 245525; 423818
49: Lozen Planina, 1 km E from Lalina Mogila peak; 2004; 6; 23; 12; 1020; 180; 5; 90; 80; 80; 233002; 423441
50: Stara Planina, Vasil Levski - Rosova Mogila, 2 km NNW from village, between V. Levski and Shushitsa; 2004; 7; 3; 16; 625; 135; 7; 90; 75; 75; 245250; 423749
51: Stara Planina, Vasil Levski village - between village and Gavrasthitsa brook; 2004; 7; 3; 16; 721; 180; 5; 95; 85; 60; 245523; 423820
52: Sofia region, Tsraklevtsi; 2007; 6; 21; 16; 760; n; n; 90; 85; 10; 230904; 425709
53: District Kazanlak, western margin of the Dunavtsi village; 2005; 6; 28; 16; 409; 0; 0; 95; 90; 25; 251714; 423918
54: Struma valley, close to Kolarovo; 2007; 6; 24; 16; 275; n; n; 80; 70; 60; 230706; 412238
55: Stara Planina, Vasil Levski - Vezhdata, 2 km NNW from village, between V. Levski and Shushitsa, pond; 2004; 7; 3; 16; 598; 180; 5; 85; 80; 25; 245318; 423752
56: District Kazanlak, eastern margin of the Dunavtsi village; 2004; 6; 22; 16; 426; n; 0; 80; 75; 15; 251638; 423934
57: District Kazanlak, eastern margin of the Dunavtsi village; 2004; 6; 21; 16; 412; n; 0; 90; 80; 30; 251725; 423919
58: District Kazanlak, eastern margin of the Dunavtsi village; 2004; 6; 22; 16; 425; n; 0; 85; 75; 30; 251637; 423934

Table 4. A shortened synoptic table of species percentage occurrence in all treeless sub-mountain mire associations and the comparison of diagnostic species valid for the mire data set with the diagnostic species valid for the large data set of Bulgarian vegetation, including subalpine and alpine wetlands and sub-mountain wet and intermittently wet grasslands.

Group No.	1	2	3	4	5	6	7	8
No. of relevés	10	11	25	36	23	19	13	3
Carici echinatae-Sphagnetum								
Sphagnum centrale (!!)	**70 ****	.	.	3	.	.	.	.
Eriophorum vaginatum	**40 ****	.	.	.	.	.	.	.
Bruckenthalia spiculifolia	**40 ****	.	4	3	.	.	.	.
Sphagnum russowii	**30 ****	.	.	.	.	.	.	.
Polytrichum strictum (!!)	**30 ****	.	.	.	.	.	.	.
Nardus stricta (!)	**100 ****	9	60	61	26	11	.	.
Sphagnum fallax (!!)	**40 ****	27	.	.	.	.	.	.
Sphagnum flexuosum (!!)	**50 ***	**45 ***	8	.	.	.	.	.
Sphagno-Caricetum rostratae								
Carex limosa (!!)	.	**36 ****	.	.	.	.	.	.
Menyanthes trifoliata (!!)	10	**64 ****	12	6	4	.	.	.
Carex rostrata (!!)	10	**100 ****	60	50	17	11	.	.
Caricetum nigrae								
Juncus filiformis	.	.	**28 ****	.	.	.	.	.
Carex curta (!!)	10	55	**60 ****	8	.	.	.	.
Warnstorfia exannulata	10	45	**60 ***	31	17	.	.	.
Eriophorum angustifolium (!!)	30	55	**60 ***	36	9	.	.	.
Sphagnum subsecundum	30	45	**52 ***	25	.	.	.	.
Agrostis canina (!)	80	73	**88 ***	64	35	16	38	.
Geo coccinei-Sphagnetum contorti								
Sphagnum contortum (!!)	.	.	12	**86 ****	.	.	.	.
Myosotis nemorosa (!)	.	.	8	**47 ****	13	.	.	.
Luzula sudetica	30	.	52	**67 ***	22	5	.	.
Carex flava (!)	20	.	4	**47 ***	39	16	.	.
Geum coccineum	50	9	36	**67 ***	43	11	.	.
Parnassia palustris (!!)	20	.	24	**83 ***	74	84	23	3/3
Crepis paludosa (!)	10	.	12	**39 ***	30	5	.	.
Hamatocaulis vernicosus (!!)	10	.	4	**33 ***	22	5	8	.
Epilobium palustre (!)	40	27	52	**64 ***	43	5	.	.
Dactylorhizo cordigerae-Eriophoretum latifolii								
Palustriella decipiens	.	.	.	6	**26 ****	.	.	.
Mentha longifolia (!)	.	.	8	8	**57 ****	32	8	.
Plagiomnium elatum (!!)	.	.	8	44	**70 ****	26	15	.
Trifolium pratense	.	.	12	19	**61 ****	16	23	.
Alchemilla vulgaris agg.	10	.	20	44	**65 ****	11	.	.
Philonotis fontana (!)	.	.	12	**56 ***	**57 ****	.	.	.
Scirpus sylvaticus	.	.	8	39	**52 ***	5	8	.
Cardamine acris	.	.	8	.	**26 ***	5	.	.
Caltha palustris	10	.	20	44	**57 ***	.	8	.
Cynosurus cristatus (!)	.	.	16	44	**65 ***	5	46	.
Eleocharis palustris	.	.	4	3	**35 ***	11	23	.
Plantago lanceolata	.	.	.	11	**39 ***	16	31	.
Carici flavae-Cratoneuretum filicini								
Blysmus compressus (!!)	.	.	.	17	35	**89 ****	46	.
Palustriella commutata (!!)	.	.	.	.	13	**63 ****	31	.
Scorpidium cossonii (!!)	.	.	.	3	.	**32 ****	.	.
Pinguicula balcanica	.	.	.	8	.	**37 ****	.	.
Philonotis calcarea (!!)	.	.	.	.	26	**63 ****	23	.
Linum catharticum (!!)	.	.	4	31	48	**79 ****	15	.
Tussilago farfara (!)	.	.	.	.	.	**21 ****	.	.
*Mentha * verticillata* (!)	.	.	.	3	4	**26 ****	.	.
Eleocharis quinqueflora (!!)	.	.	4	6	35	**89 ***	**85 ***	2/3
Equisetum arvense (!)	.	9	8	8	48	**58 ***	15	.
Carex lepidocarpa (!!)	.	.	4	14	13	**53 ***	38	1/3

Table 4. A shortened synoptic table of species percentage occurrence in all treeless sub-mountain mire associations and the comparison of diagnostic species valid for the mire data set with the diagnostic species valid for the large data set of Bulgarian vegetation, including subalpine and alpine wetlands and sub-mountain wet and intermittently wet grasslands.

Group No.	1	2	3	4	5	6	7	8
No. of relevés	10	11	25	36	23	19	13	3
Eleochariti uniglumis-Caricetum distantis								
Gratiola officinalis (!!)	.	.	.	.	4	.	**38 ****	.
Mentha aquatica (!!)	.	.	.	.	.	16	**46 ****	.
Eleocharis uniglumis (!!)	.	.	.	.	22	32	**77 ****	1/3
Potentilla reptans	.	.	.	.	.	5	**31 ****	.
Carex distans (!!)	.	.	.	.	9	32	**85 ****	3/3
Carex hirta (!!)	.	.	.	14	17	5	**46 ****	.
Cirsium canum (!!)	.	.	.	.	13	.	**69 ***	3/3
Juncus inflexus (!!)	.	.	.	.	30	**53 ***	**69 ***	1/3
Juncus articulatus (!!)	.	.	24	58	**91 ***	**95 ***	**100 ***	3/3
Junco subnodulosi-Schoenetum nigricantis								
Schoenus nigricans (!!)	.	.	.	.	.	.	.	**3/3 ****
Sanguisorba officinalis (!!)	.	.	.	.	4	.	8	**3/3 ****
Orchis elegans (!!)	.	.	.	3	9	.	23	**3/3 ****
Sesleria uliginosa (!!)	.	.	.	.	.	.	.	**2/3 ****
Campylium elodes (!!)	.	.	.	.	.	5	.	**2/3 ****
Pulicaria dysenterica (!!)	.	.	.	.	4	21	23	**3/3 ****
Teucrium scordium	.	.	.	.	.	.	8	**2/3 ****
Carex flacca (!!)	.	.	4	3	.	**37 ***	15	**3/3 ****
Species with frequency > 25% in the entire data set								
Carex echinata	90	36	80	97	91	42	62	.
Potentilla erecta	100	36	72	97	70	68	31	3/3
Calliergonella cuspidata	10	.	60	92	100	47	100	2/3
Eriophorum latifolium	70	.	32	86	91	95	31	3/3
Galium palustre	20	27	80	83	83	16	31	.
Festuca rubra	60	.	60	72	70	47	38	3/3
Ranunculus acris	20	.	44	56	74	53	85	3/3
Carex panicea	.	.	36	56	48	89	77	3/3
Bryum pseudotriquetrum	.	.	12	53	87	84	77	2/3
Holcus lanatus	30	9	28	72	70	26	62	.
Juncus effusus	60	.	52	69	65	11	31	.
Prunella vulgaris	.	.	20	64	74	47	54	3/3
Climacium dendroides	.	.	56	61	65	.	.	.
Myosotis sicula	.	.	48	53	57	.	23	.
Briza media	.	.	8	50	52	53	23	.
Anthoxanthum odoratum	30	.	16	53	57	5	31	.
Dactylorhiza cordigera	40	9	24	44	57	21	.	.
Carex nigra	50	27	48	42	22	16	.	.
Molinia caerulea agg.	40	18	8	25	26	47	62	3/3
Campylium stellatum	.	.	4	28	30	68	69	2/3
Deschampsia cespitosa	40	.	52	22	26	26	46	.
Succisa pratensis	20	.	4	50	22	26	54	3/3
Carex serotina	.	18	28	25	30	47	23	.
Aulacomnium palustre	60	.	32	58	9	.	.	.

Diagnostic species of individual vegetation types were determined using the *phi*-coefficient of association (* Φ> 0, ** Φ > 0.5). Species, the occurrence concentration probability of which in the given vegetation type does not differ from random at $P < 0.001$, are excluded from the list of the diagnostic species. Cluster numbers are the same as in the **Results**. Symbols "!!" and "!" indicate the species that has reached high fidelity ($\Phi > 0.5$ or $\Phi > 0.3$, respectively) to the association also in the context of all available vegetation data from Bulgaria.

Table 5. Phytosociological relevés of the *Sphagno-Pinetum sylvestris* association. The species are sorted by layers and by decreasing frequency.

No. of relevés	1234
Bryophytes and lichen	
Sphagnum magellanicum	b41b
Polytrichum strictum	1aba
Sphagnum capillifolium	4.31
Aulacomnium palustre	+1+.
Pleurozium schreberi	.+1+
Dicranum scoparium	1.+.
Sanionia uncinata	+.+.
Sphagnum fallax	..bb
Sphagnum teres	..+1
Cladonia species	1...
Sphagnum inundatum	1...
Blepharostoma trichophyllum	+...
Sphagnum flexuosum	.b..
Polytrichum commune	.+..
Sphagnum subsecundum	..+.
Sphagnum fuscum	...b
Polytrichum formosum	...1
Calliergon stramineum	...+
Warnstorfia exannulata	...+
Herbs and low shrubs	
Vaccinium myrtillus	3a+a
Vaccinium vitis-idaea	311a
Eriophorum angustifolium	aa1a
Potentilla erecta	11a1
Bruckenthalia spiculifolia	+1+1
Eriophorum vaginatum	a.1a
Carex nigra	a.11
Carex rostrata	.aaa
Nardus stricta	1.1.
Geum coccineum	1..+
Deschampsia caespitosa	+.+.
Festuca rubra	+..+
Carex echinata	.a+.
Equisetum fluviatile	..1a
Eriophorum latifolium	..++
Epilobium palustre	..++
Juncus effusus	..++
Molinia horanszkyi	.3..
Drosera rotundifolia	.1..
Menyanthes trifoliata	.1..
Geum rhodopaeum	..b.
Ranunculus nemorosus	..1.
Salix cinerea juv.	..+.
Hieracium caespitosum	..r.
Potentilla palustris	...a
Carex curta	...a
Agrostis canina	...+
Galium palustre	...+
Rubus idaeus	...+
Trees and shrubs	
Picea abies	4aba
Pinus sylvestris	13b3
Juniperus communis	+1..
Sorbus aucuparia	.1..
Betula pendula	.+..
Juniperus sibirica	..+.
Salix aurita	...+

Table head

No: Locality; Year; Month; Day; Area (m^2); Altitude (m); Aspect (degrees); Slope (degrees); Cover total (%); Cover tree layer (%); Cover shrub layer (%); Cover herb layer (%); Cover moss layer (%); Longitude; Latitude. n= not recorded

1: Central Rhodopes, NEE margin of the Shiroka Poljana reservoir; 2001/06/29; 50; 1590; 0; 0; 98;60;5;60;90; 241207;414610

2: Central Rhodopes, Chairi lakes; 2001/07/03; 100; 1500; 0; 0; 95;40;20;60;90; 242817;413817

3: Central Rhodopes, Shiroka Polyana; 2005/06/30; 225; 1547; 180; 5; 95;30;10;50;80; 240844;414523

4: Central Rhodopes, W margin of the Shiroka Polyana reservoir; 2001/06/29; 100; 1544; n; 1; 100;25;10;65;95; 240851; 414528

Context-dependence of diagnostic species

Some species diagnostic of *Carici echinatae-Sphagnetum* turned out to be unvalid for differentiation of the association within the entire vegetation, as they also occur in the high mountains (*Bruckenthalia spiculifolia, Eriophorum vaginatum, Nardus stricta, Sphagnum russowii*). The remaining set of diagnostic species consists only of four bryophytes, but they are of high diagnostic value (Table 4). Analogous results have been obtained for the moderately rich fens of the *Caricetum nigrae* association, where only three species (all are vascular plants) are diagnostic species valid in the wide context of Bulgarian vegetation. Still poorer correspondence between the diagnostic species obtained from the mire data set and that obtained from the large data set, including (sub) alpine wetlands and sub-mountain wet and intermittently wet grasslands, was found in the case of extremely rich fens of *Dactylorhizo cordigerae-Eriophoretum latifolii* and rich fens of the *Geo coccinei-Sphagnetum contorti* (Table 4). Grassland species differentiated these two associations in the fen data set. On the other hand, diagnostic species obtained from the fen data set matched those obtained from the large data set in floating poor fens of the *Sphagno-Caricetum rostratae* association and in all three associations of calcareous fens (*Carici flavae-Cratoneuretum filicini*, *Eleochariti uniglumis-Caricetum distantis*, *Junco subnodulosi-Schoenetum nigricantis*).

Discussion

Our results show that Bulgarian landscape below the timberline harbours well-developed fen vegetation of the *Scheuchzerio-Caricetea fuscae* class. We also distinguished one woodland type (Table 5) which is tradition-

ally classified within the *Oxycocco-Sphagnetea* class, although the truly ombrotrophic bogs that form a core of this class are absent in Bulgaria, due to unfavourable climatic conditions (Hájková & al. 2006; Hájková & Hájek 2007). Sub-mountaine fen vegetation can be easily classified within the major ecological types (aliances in the syntaxonomical system) known also from other European regions (Hájek & al. 2006b), but the beta diversity and mutual delimitation of the associations within these major ecological groups of fens differ in some cases.

Poor fens

Poor fens defined as acidic, species-poor fens, rich in bryophytes and dominated by calcium-intolerant *Sphagnum* species from the sections *Cuspidata* and *Sphagnum* (*Sphagno-Caricion canescentis* alliance), were divided into two types differing by water regime (Table 1). The same results have been obtained from the analysis of the Central European fens (e.g. Rybníček & al. 1984; Dítě & al. 2007). The species diagnostic for the poor fens in Bulgaria correspond to these in Central Europe, especially when the diagnostic species obtained from the total data set including high-mountain vegetation are considered. There is a clear floristic link between the *Carici echinatae-Sphagnetum* association and the high-mountain *Bruckenthalio spiculifolii-Sphagnetum capiliifolii* association in Bulgaria (cf. Hájek & al. 2005) caused by an altitudinal shift of diagnostic *Sphagnum* species, as compared to Central Europe (Hájková & Hájek 2007). The transitional type between poor fens (*Sphagno-Caricion canescentis*) and moderately rich fens (*Caricion canescentis-nigrae*) is represented by vegetation dominated by *Sphagnum subsecundum*. In Bulgaria, poor fens occur in the Rhodopes (Smolyan lakes, Chairi lakes, Shiroka Polyana, Amzovo, Batak dam), Stara Planina (Petrohan Pass), Vitosha, and the highest parts of the Sredna Gora Mts.

Moderately rich fens

A set of diagnostic species for this vegetation type (the *Caricetum nigrae* association) matches absolutely that of the Central and West European moderately rich fens (Table 1). However, there are some differences too. In Bulgaria, *Carex serotina* reaches a high cover in the disturbed moderately rich fens in some regions, and some calcicole species occur more frequently in the Bulgarian moderately rich fens (e.g. *Eriophorum latifolium, Parnassia palustris*). This is probably caused by ecotypic adaptation of local populations caused by different region histories, i.e. distribution of refugia with respect to the substrate acidity (Hájková & al. 2008). The occurrence of calcicole species in the Bulgarian moderately rich fens therefore does not indicate some particular abiotic conditions and for this reason we did not interpret it as a reason to describe a new association. Similar vegetation, i.e. moderately rich fens dominated by *Sphagnum subsecundum* with an occurrence of *Eriophorum latifolium*, is described from Croatia as the *Drosero-Caricetum echinatae* association (Horvat 1950; Trinajstič 1973). However, Croatian vegetation does not differ substantially from the *Caricetum nigrae* association too.

Distribution and altitudinal range of moderately rich fens corresponds to the distribution of poor fens. Apparently, moderately rich fens are located mostly in the Rhodopes. They occur also below peak Vezhen in the Stara Planina Mts.

Rich and extremely rich fens

Rich fens with calcium-tolerant *Sphagnum contortum* (*Geo coccinei-Sphagnetum contorti*, Fig. 2) and extremely rich fens dominated by *Eriophorum latifolium*, but without *Sphagnum* mosses (*Dactylorhizo cordigerae-Eriophoretum latifolii,* Fig. 3) are the vegetation types that reveal the largest differences between Bulgaria and the rest of Europe. First, their species composition is enriched by many grassland species from neighbouring habitats. This is due to the fact that the rich and extremely rich fens, being at the central part of the pH/calcium gradient, are not so strongly limited by phosphorus shortage, iron oversupply, or competitive ability of calcium-avoiding *Sphagnum* species, as the habitats from the extremes of the pH/calcium gradient (Rozbrojová & Hájek 2008). Grassland species can get established here, especially when the water level drops below the soil surface (Hájek & al. 2006b). Analogically, the West Carpathian extremely rich fens (Central Europe) are enriched with some Carpathian species that have their optimum or secondary distribution centre in wet or mesophilous grasslands (e.g. *Cirsium rivulare, Cruciata glabra, Valeriana simplicifolia*, e.g. Poulíčková & al. 2005; Hájek & al. 2006b). Presumably, the species composition of these habitats is influenced more strongly by vicinism (see Zonneveld 1995), but further analyses are needed to confirm this hypothesis. Second, both Bulgarian associations are somewhat depauperated, as compared to Central and West European rich and extremely rich fens. Some species with boreal distribution still occurring in Central Europe either do not grow in Bulgarian fens (e.g. *Carex chordorrhiza, C. dian-*

Fig. 2. *Geo coccinei-Sphagnetum contorti* association.

Fig. 3. *Dactylorhizo cordigerae-Eriophoretum latifolii* association.

dra, C. dioica, Paludella squarrosa, Meesia triquetra, e.g. Steiner 1992; Dítě & al. 2007), or are very rare in the rich fens below timberline (*Sphagnum warnstorfii*). Third, a clear floristic differentiation between rich fens with calcium-tolerant *Sphagnum* species and extremely rich fens without *Sphagna* found in Central Europe (Hájek & al. 2006b) have not been distinctly reproduced by TWINSPAN classification of the Bulgarian data set, and some relevés without *Sphagnum* fell within the *Geo coccinei-Sphagnetum contorti* defined specifically by *Sphagnum* presence. For this reason, we applied the formal criterion of *Sphagnum* occurrence or absence and made *a posteriori* changes in the TWINSPAN classification, in order to allow for a better transferability of our classification among the countries (compare Bruelheide & Chytrý 2000). Fourth, the number of associations within rich fens (the *Sphagno warnstorfii-Tomenthypnion nitentis* alliance) and extremely rich fens (peat-forming part of the *Caricion davallianae* alliance) is lower in Bulgaria, as compared to the Central, West and North Europe, apparently due to the absence of some boreal species. A lower number of mire associations in a climatically less favourable region were also found on finer scale, i.e. within one country, by Hrivnák & al. (2008).

The *Geo coccinei-Sphagnetum contorti* association includes also relict fens with *Carex lasiocarpa* and *C. buxbaumii* s.s. found close to the towns of Batak and Samokov. However, this vegetation type was not clearly differentiated by TWINSPAN or by DCA. Despite this, we decided to reflect its uniqueness at least at the level of subassociation (Table 2).

Rich and extremely rich fens are widely distributed in Bulgaria, from Mt Osogovo and Western Stara Planina Mts (Petrohan Pass, Komsthitsa), through Vitosha and Lozen mountains, the foothills of Rila and Pirin Mts and Mt Sredna Gora, towards the Central Rhodopes (Smolyan) and Central Stara Planina (Kalofer, Anton).

Calcareous fens

Further along the pH/calcium gradient, calcareous fens resemble ever more those in Central Europe, but still differ more than the poor fens. All three associations of calcareous fens are well differentiated from other Bulgarian vegetation not only within the fen data set, but also within the large data set, suggesting a high degree of individuality of the habitat. Calcareous fens have three distribution centres in Bulgaria: the southern foothills of the Stara Planina Mts (Dunavtsi, Vasil Levski, Shuma villages), the calcareous foothills of the Pirin Mts (Krushe, Popovi Livadi) and Mt Lozen. Two isolated localities of calcareous fens were also found in the Rhodopes (Mugla, Beglika).

There are two conspicuous traits of the Bulgarian calcareous fens. The *Carici flavae-Cratoneuretum* association and to a great extend also the *Junco subnodulosi-Schoenetum nigricantis* have nearly the same species composition like in the rest of Europe. On the other hand, some vegetation types miss completely in Bulgaria. The *Caricetum davallianae* Dutoit 1924 association, which is rather common in the Alps and in the West Carpathians (e.g. Dítě & al. 2007) does not occur in Bulgaria, and its diagnostic species are either absent in Bulgaria (*Carex davalliana, C. dioica, Equisetum variegatum, Pedicularis sceptrum-carolinum, Pinguicula vulgaris*), or are confined to very different habitats (*C. hostiana, Primula farinosa*). This absence could be explained by the link of some of these species to cooler habitats, but further analyses will be necessary to this end.

In spite of the high coincidence level between Bulgarian and Central European fens, we recognised one vegetation type the evaluation of which would require description of a new association (*Eleochariti uniglumis-Caricetum distantis*, Fig. 4). This vegetation type lacks many species confined to spring outflows that characterise the *Carici flavae-Cratoneuretum* association, and it also lacks the species diagnostic of *Junco subnodulosi-Schoenetum nigricantis*. It is enriched by some subhalophilous and grassland species, but is often dominated by *Eleocharis quinqueflora* and still belongs to the *Caricion davallianae* alliance. Its species composition clearly and unambiguously differs from the original description of both *Eleocharitetum quinqueflorae* (Lüdi 1921) and *Carici distantis-Eleocharitetum quinqueflorae* (Mucina & al. 1993) associations. However, it should be borne in mind that identical vegetation could be reported also from other South European countries under these names. The association is probably not confined to Bulgarian territory only. In Bulgaria, *Eleochariti uniglumis-Caricetum distantis* has a distribution centre at the southern foothills of the Stara Planina Mts (Vasil Levski, Dunavtsi, Tsraklevci), but it occurs also in Mt Lozenska and in the Krushe locality below the Pirin Mts. The occurrence close to Kolarovo village in the Struma Valley, one of the warmest regions in Bulgaria, suggests a certain Submediterranean affinity of the association.

Our results show that some rare vegetation types, important from conservational and phytogeographical viewpoint, may be obscured in numerical classification, even if they are well delimited in other countries. This holds for *Junco subnodulosi-Schoenetum nigricantis* in our case. Examples can be also found in other vegetation types, such as the wet meadows of the *Calthion palustris* alliance, where the *Cirsietum rivularis* association, common in Central Europe, is extremely rare in Bulgaria (Hájek & al. 2006a). The inconsistency in TWINSPAN classifications of the same vegetation even between neighbouring countries is well documented by Bruelheide & Chytrý (2000). A possible way to overcome this shortcoming is to create formal definitions of the associations (e.g. Kočí & al. 2003; Dítě & al. 2007; Hrivnák & al. 2008). In Bulgaria this method was successfully applied to high-mountain wetland vegetation (Hájková & al. 2006), but our efforts to create formal definitions for submontane fens too was rather unsuccessful and we do not present them in this paper. It is largely caused by the division of intra-specific populations of some species into ecotypes in Bulgaria (Hájková & al. 2008), and especially is due to the insufficient number of relevés from other than fen vegetation types available from the submontane regions. For this reason, it will be probably impossible to create formal definitions for submontane fen vegetation in Bulgaria until a larger phytosociological database is created for the country.

Fig. 4. *Eleochariti uniglumis-Caricetum distantis* association.

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