The diversity of mire and spring vegetation in Bulgaria

Why is interesting to study Bulgarian mires, springs and wet meadows?

Skupina pro výzkum rašelinišť
Mire ecology working group

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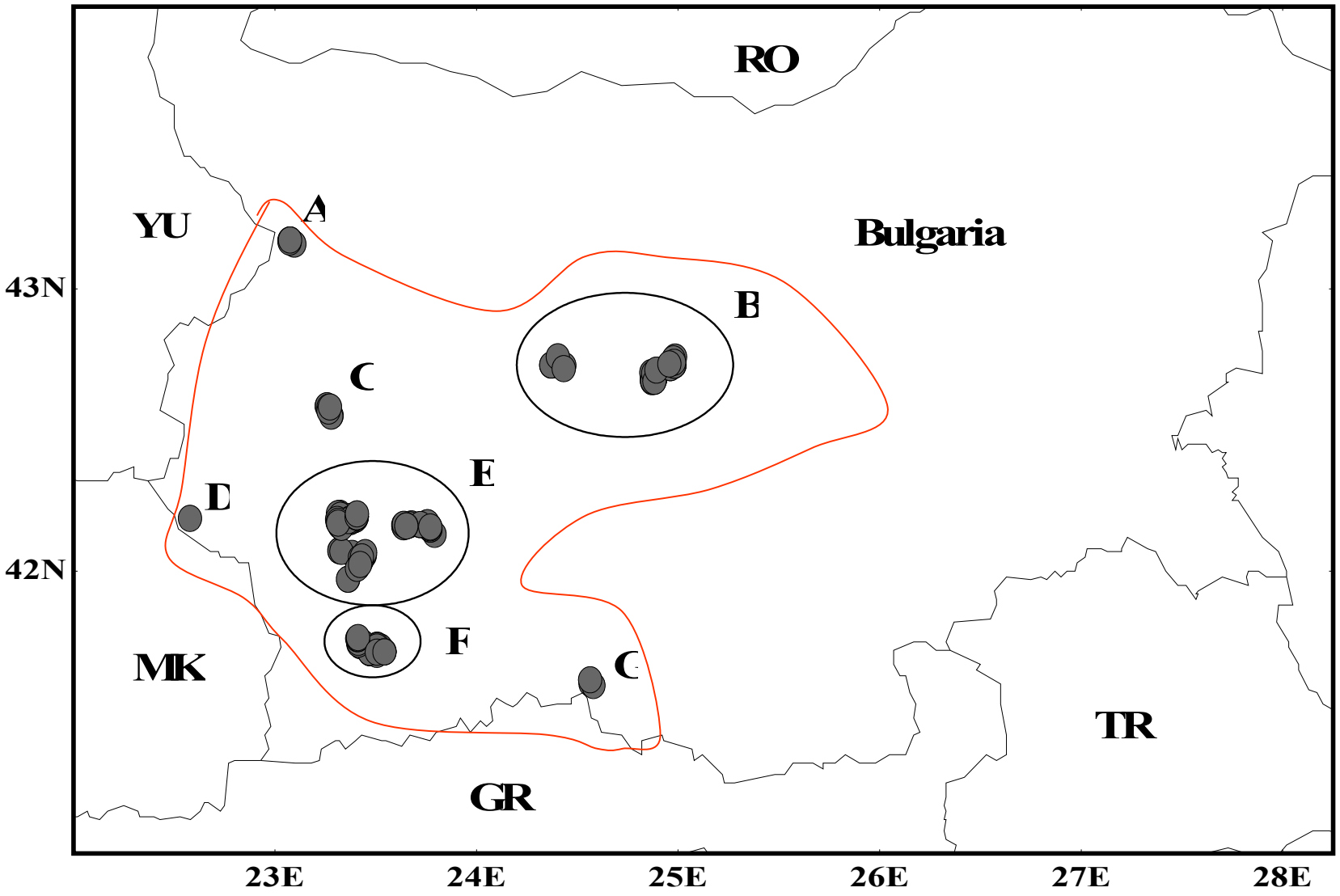
Co-authors and co-workers: Petra Hájková, Iva Apostolova, Martin Kočí etc.

The study area



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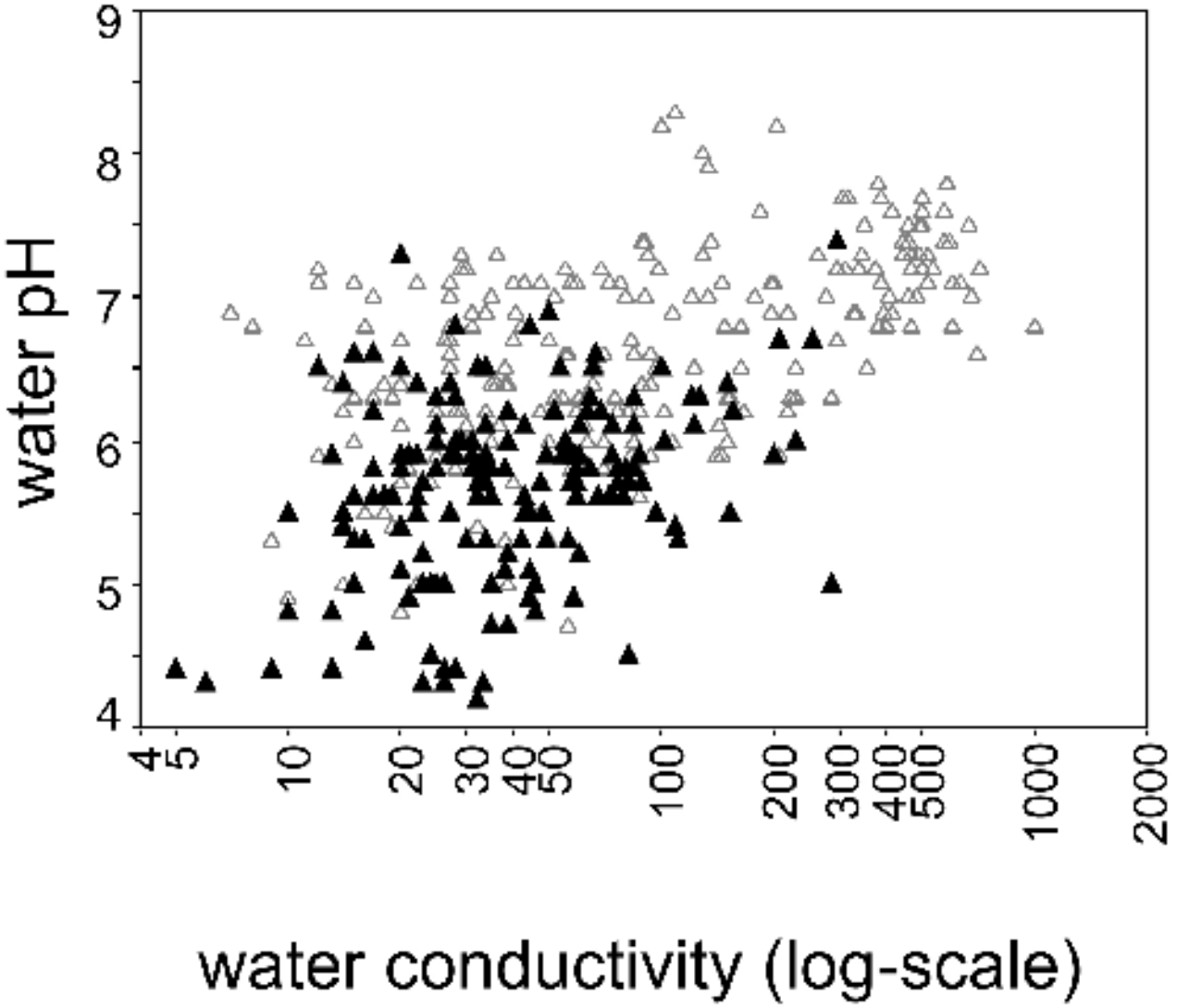
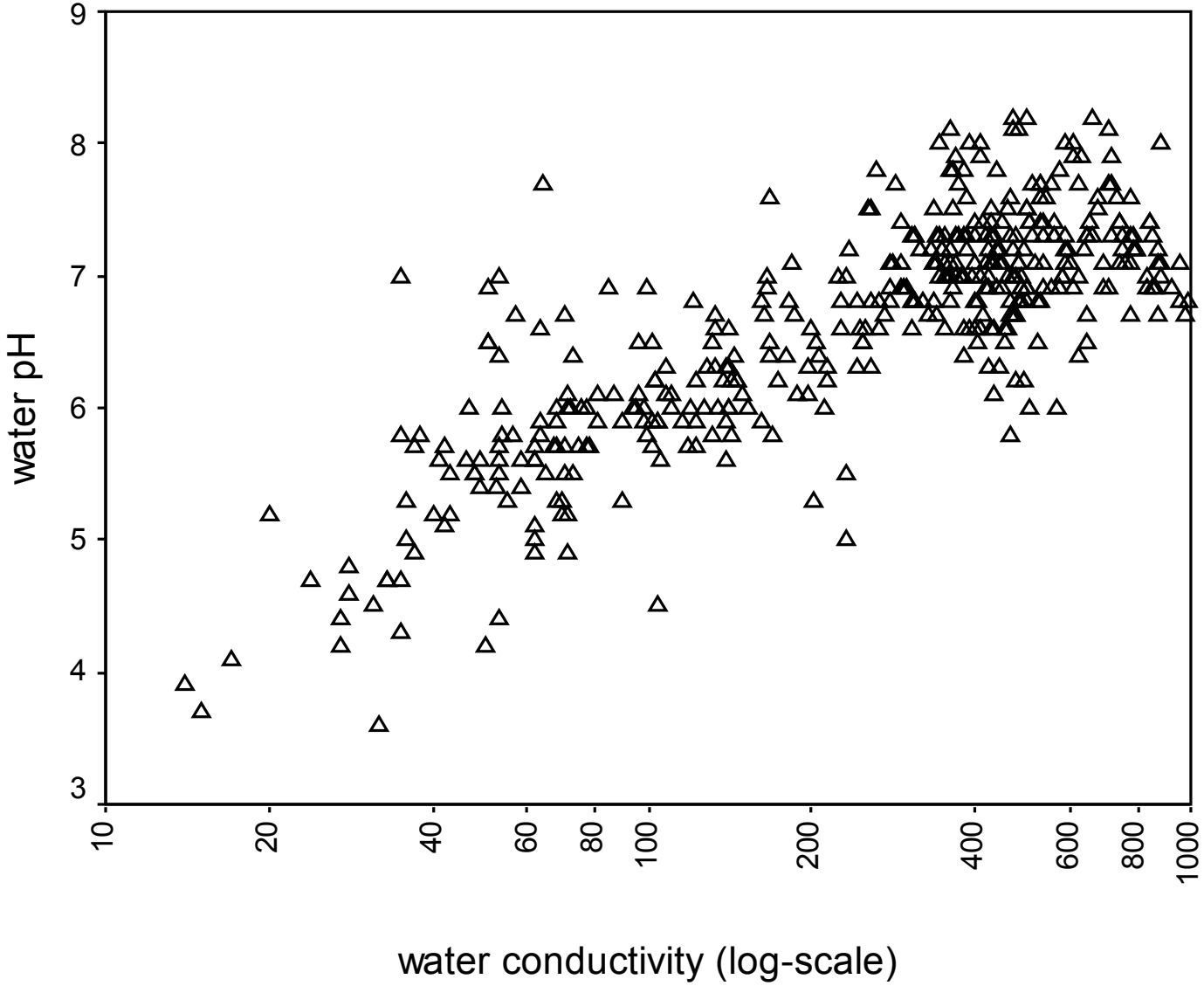
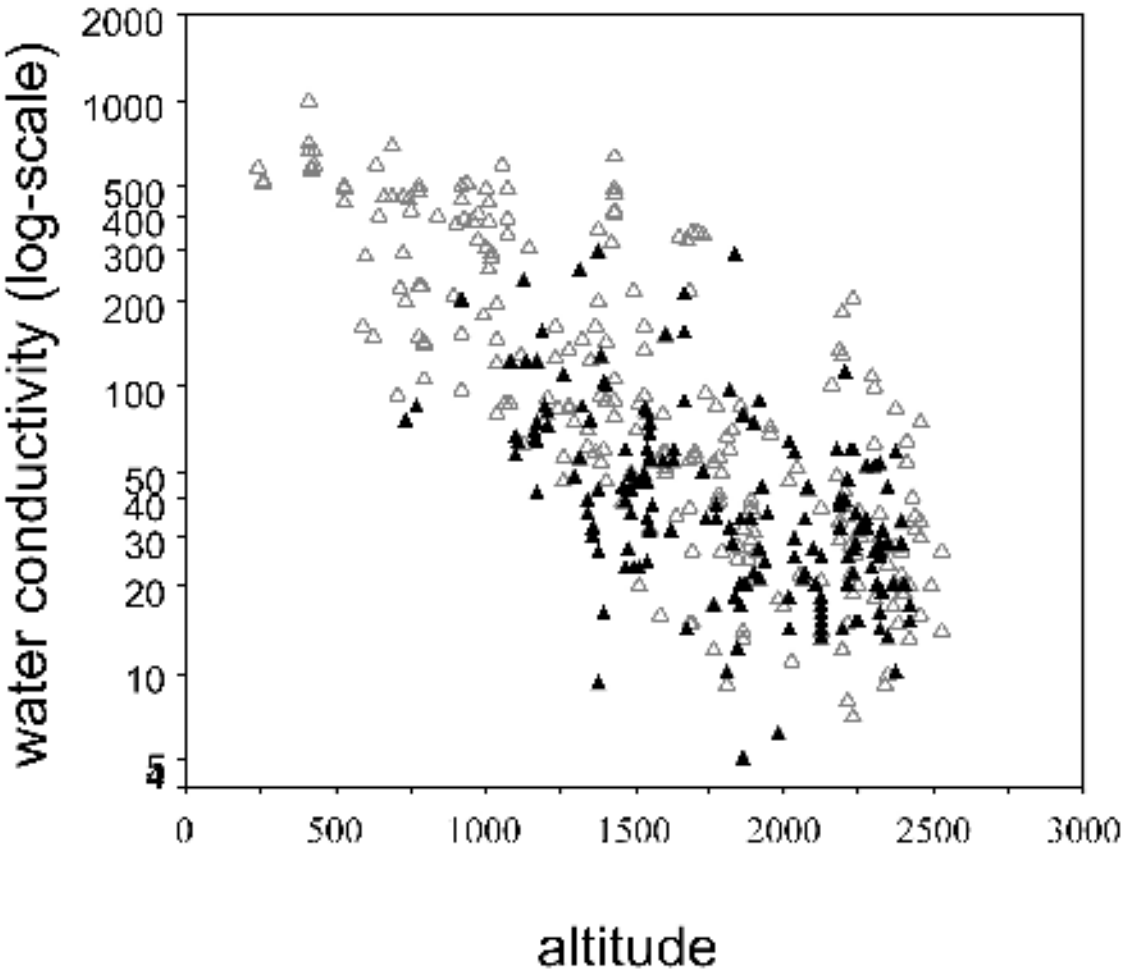

water pH
9
8
7
6
5
4
4
5
10
20
30
40
50
100
200
300
400
500
1000
2000
water conductivity (log-scale)

For a comparison – in the West Carpathians (Central Europe), the correlation between water pH and conductivity is tight and these factors correlate well with species composition.



Reasons? In Bulgaria, much more closer correlation occurs between water conductivity and altitude, especially in the lowest alitudes where high evaporation determines higher concentration of salts and minerals. Moreover, the highest altitudes are mostly crystallinic and pH is determined here mostly by the rate of water flow (i.e. water aeration).



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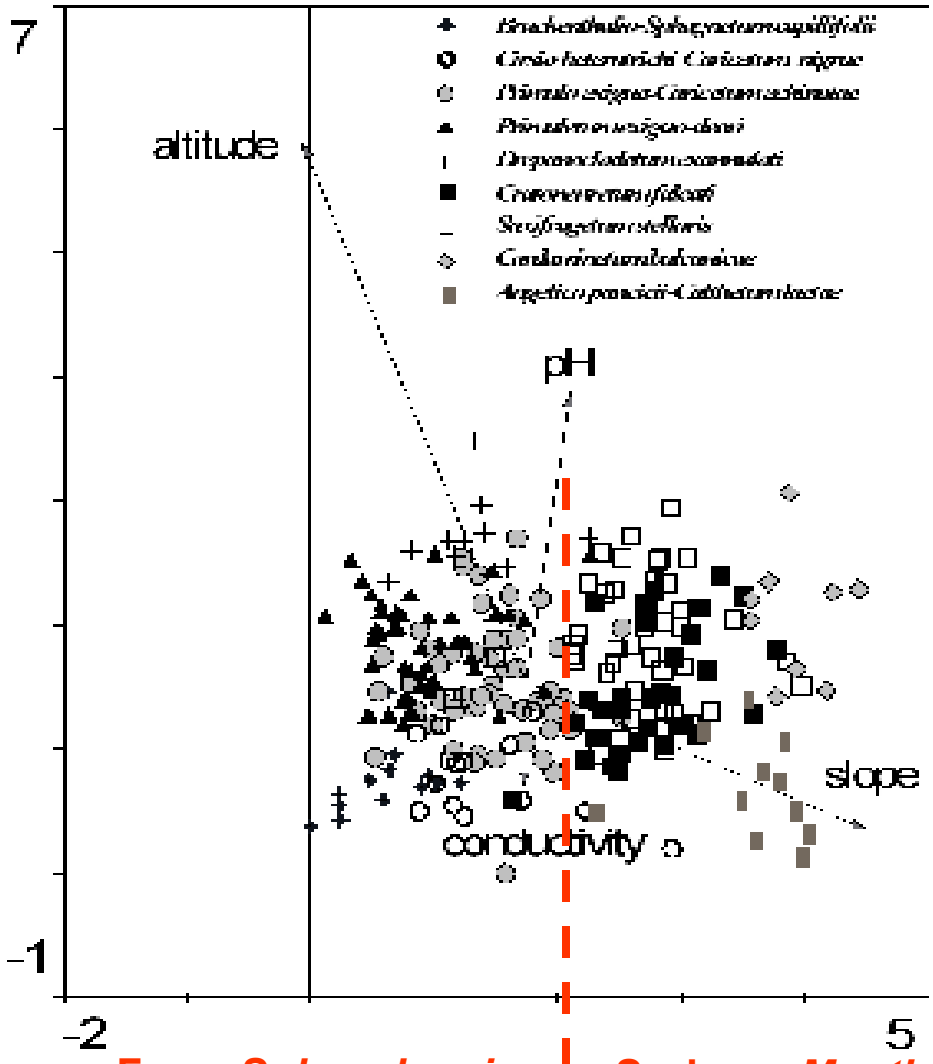
	altitude	slope	water pH	w. cond.
entire data set				
1st DCA (6%; 0.57)	-0.89***	0.10*	n.s.	0.51***
2nd DCA (4%; 0.39)	0.16**	0.40***	0.18***	n.s.
3rd DCA (2.5%; 0.24)	-0.12*	0.29***	0.24***	0.35***
sub-mountain subset				
1st DCA (6.1%; 0.48)	-0.69***	0.43***	0.31***	0.60***
2nd DCA (2.9%; 0.30)	-0.32***	-0.49***	n.s.	0.17*
3rd DCA (2.8%; 0.21)	n.s.	n.s.	n.s.	n.s.
high-mountain subset				
1st DCA (8.2%; 0.49)	-0.23***	0.43***	n.s.	n.s.
2nd DCA (4.4%; 0.26)	0.61***	-0.24**	0.35***	-0.18**
3rd DCA (3.5%; 0.21)	-0.37***	-0.22**	-0.38***	-0.24***
high-mountain fen subset				
1st DCA (7.8%; 0.29)	0.28***	n.s.	0.38***	n.s.
2nd DCA (6.6%; 0.25)	0.71***	-0.39***	-0.31***	-0.22*
3rd DCA (4.7%; 0.18)	0.21*	n.s.	n.s.	n.s.
high-mountain spring subset				
1st DCA (7.5%; 0.41)	-0.57***	n.s.	-0.53***	-0.58***
2nd DCA (5.5%; 0.30)	0.48***	-0.30**	n.s.	-0.37**
3rd DCA (4.3%; 0.23)	0.26*	n.s.	n.s.	n.s.

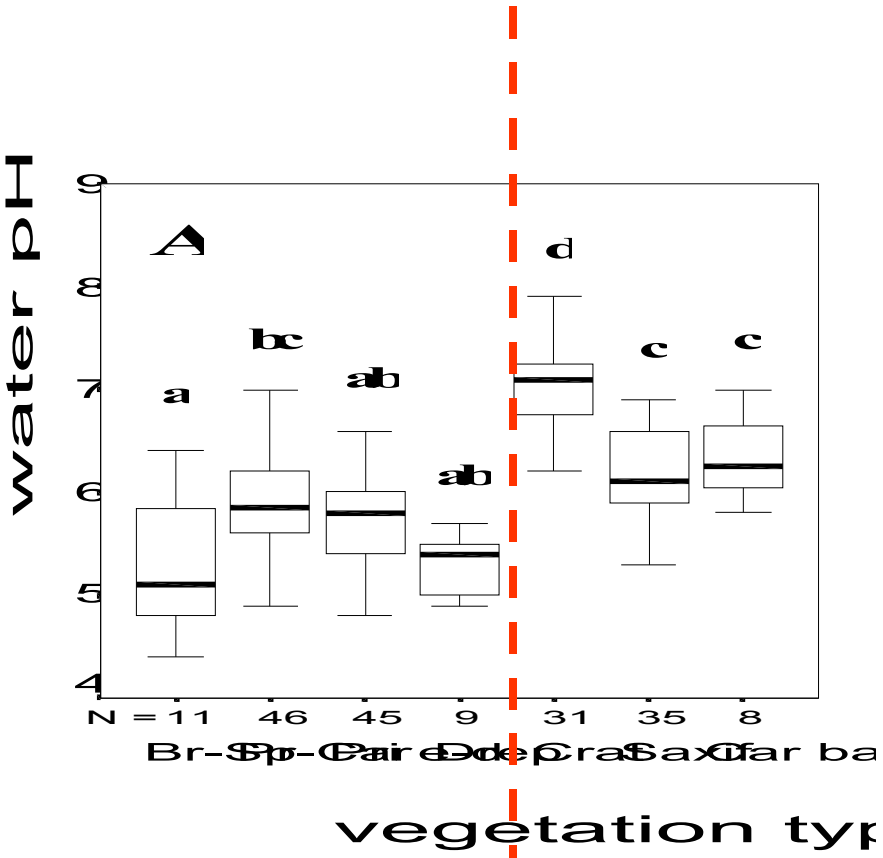
Major determinants in floristic variation: correlation with the first axis of indirect ordination

Wetlands above the timberline: the two major gradients in species composition and their correlation with measured environmental factors



Fens: *Scheuchzerio-Caricetea fuscae*

Springs: *Montio-Cardaminetea*



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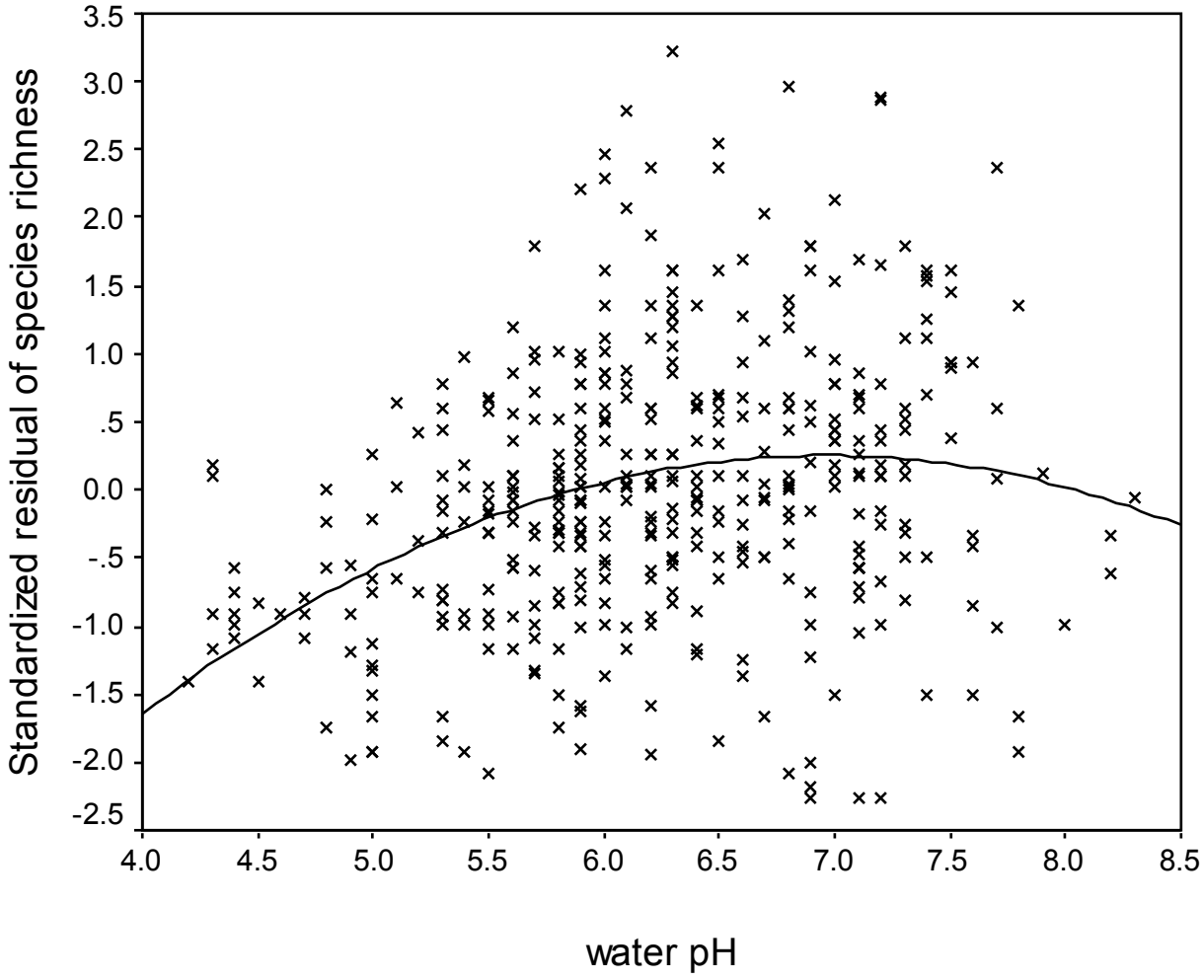
Correlation between water pH and species richness (standardized at the equal plot size): the entire data-set.



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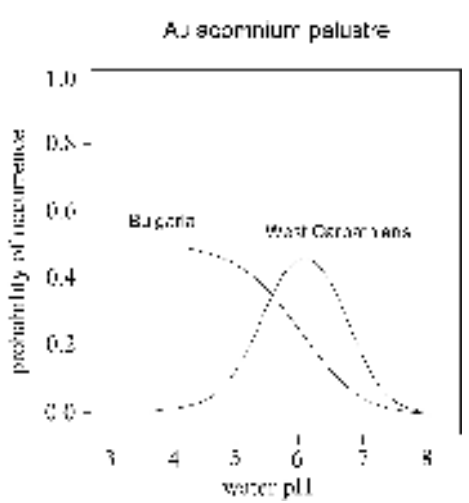
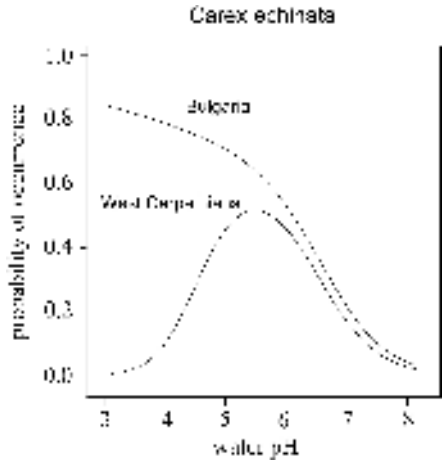
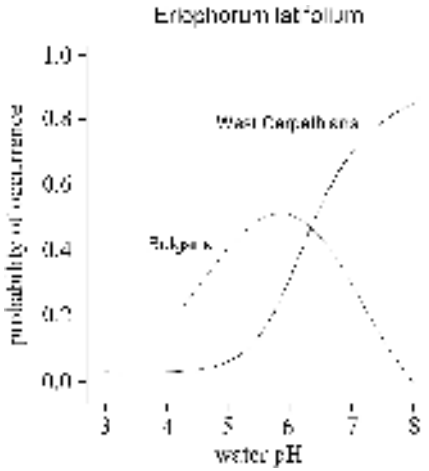
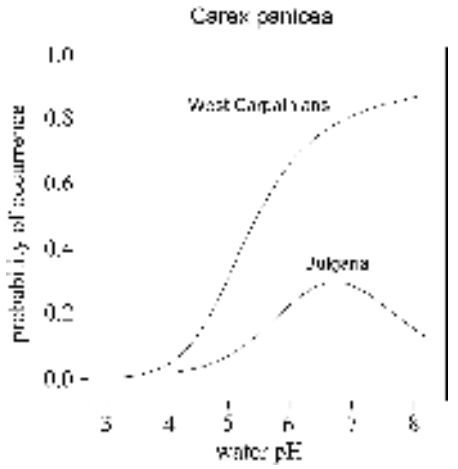
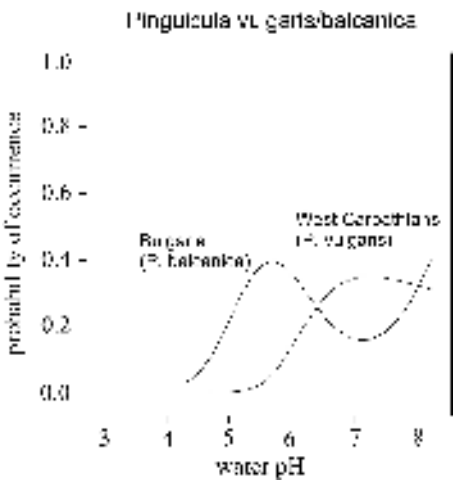
Species response curves (GAM, 4 d.f.) of mire species to water pH: a comparison between the West Carpathians (Central Europe) and Bulgaria. Identical species as well as closely related taxa are considered.

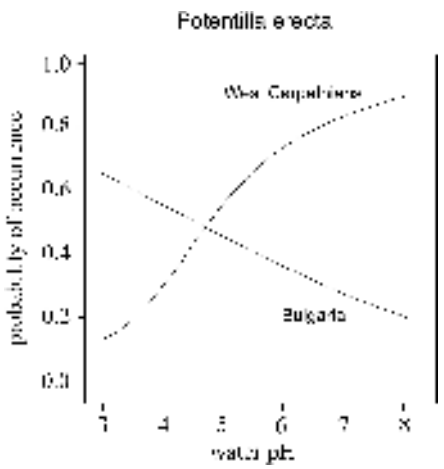




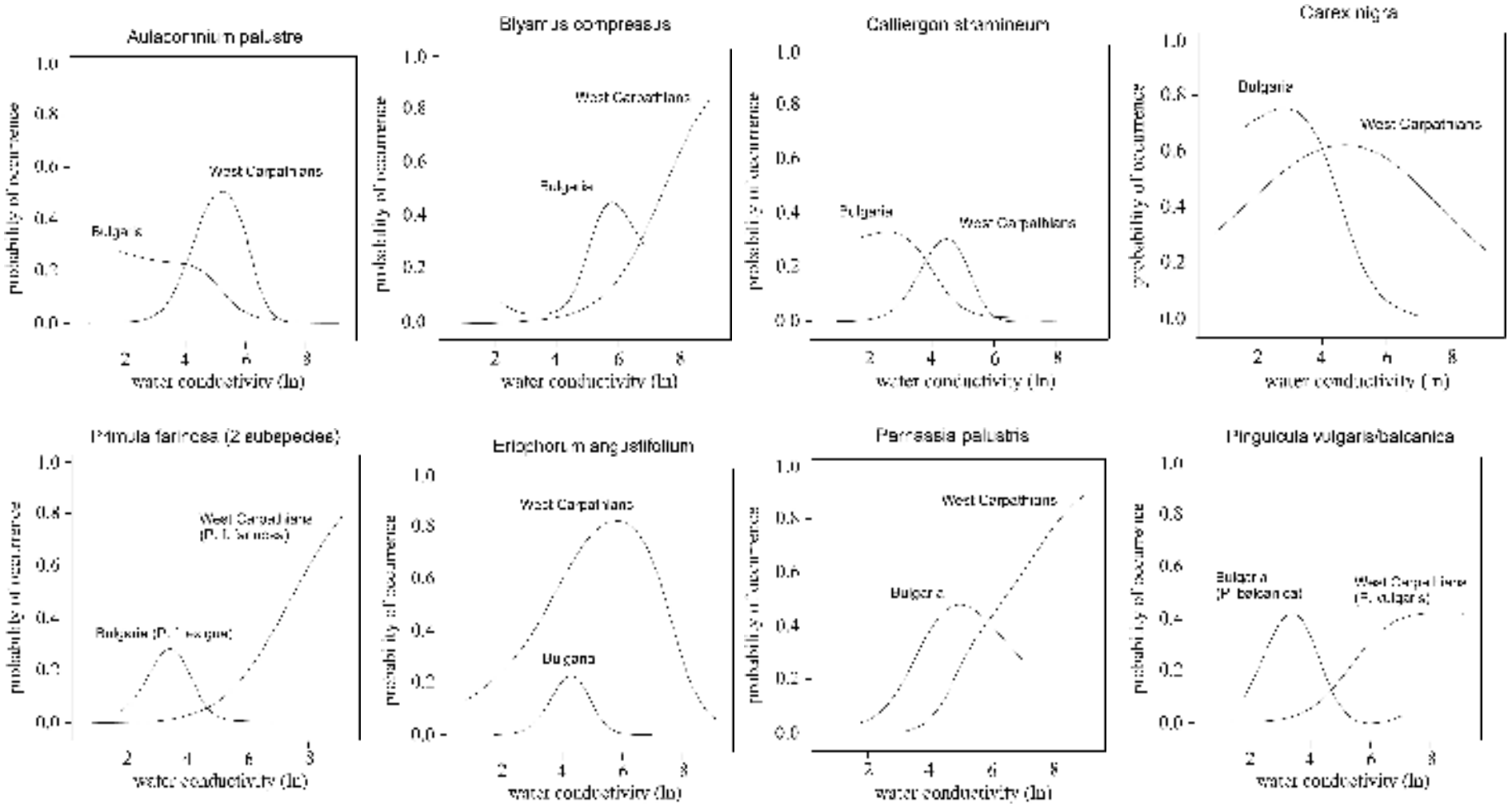








Species response curves of mire species to water conductivity, approximating total mineral richness: a comparison between the West Carpathians (Central Europe) and Bulgaria. Identical species as well as closely related taxa are considered.



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***Saxifragetum stellaris* (*Philonotido-Saxifragetum stellaris*)**

Nearly identical species composition across Europe (Alps, East Carpathians, Pyrenees, Scandinavia, Bulgaria)

Primuletum exiguo-deori

25% of total species composition of relevé are Balkan endemics.

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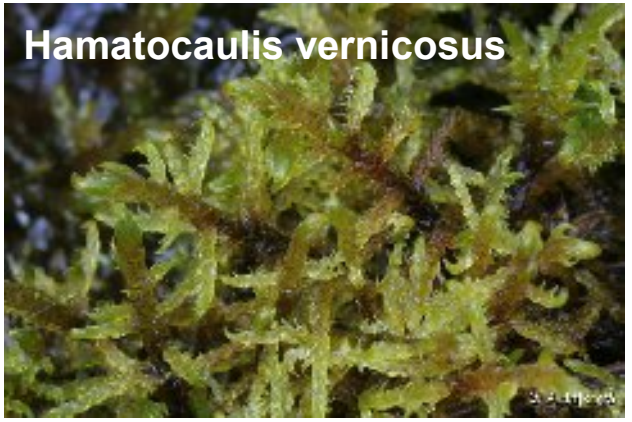
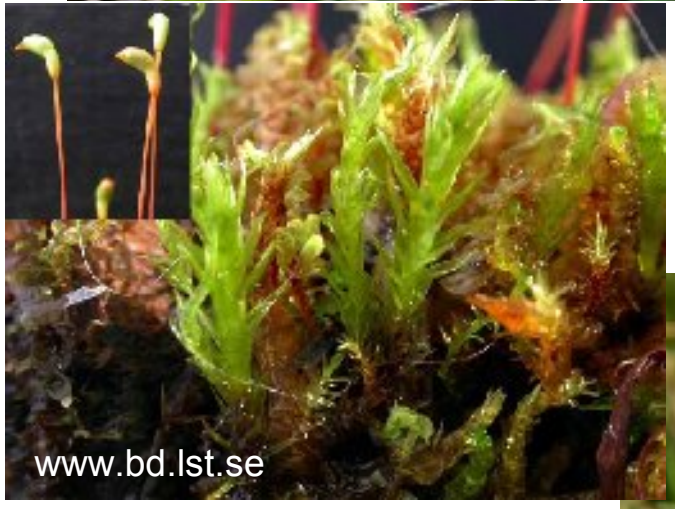




Meesia longiseta

Eriophorum gracile

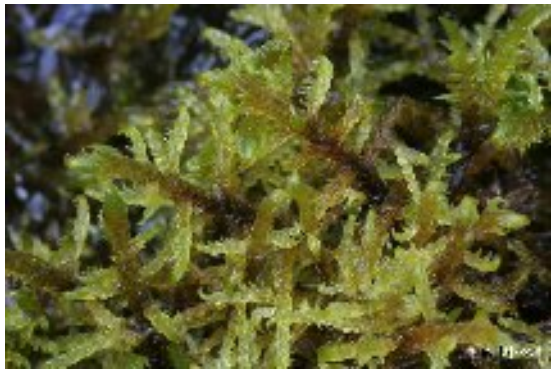
Cx. buxbaumii s.s.

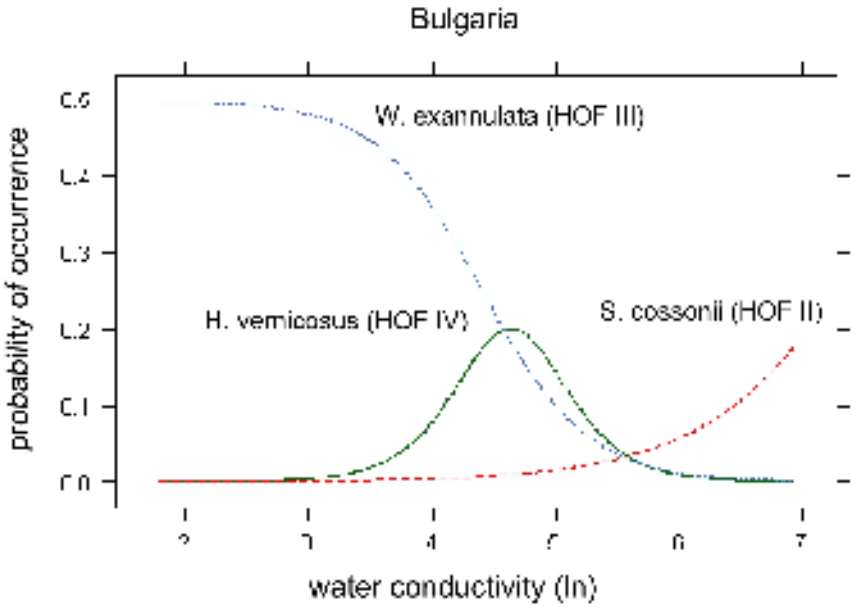
Cx. lasiocarpa

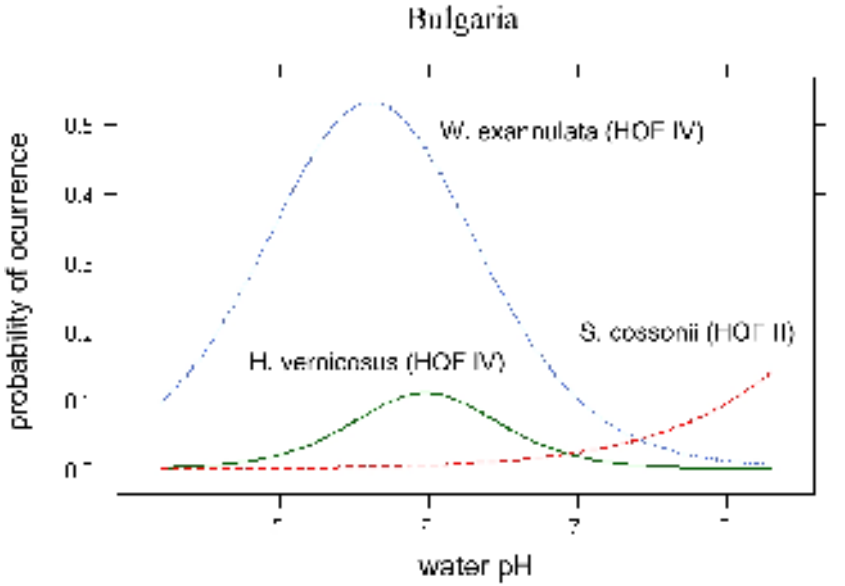
Bulgarian fens and Natura 2000

Priorite habitats and species:

- petrifying springs with tufa formation
- *Cladium mariscus* fen habitat
- bog woodland
- *Drepanocladus (Hamatocaulis) vernicosus*
- *Meesia longiseta*
- *Vertigo angustior*







***Sphagnum*-dominated shrubby poor fens (*Bruckenthalio-Sphagnetum capillifolii*)**
The community develops from subalpine spring fens through peat accumulation by *Sphagnum* species. *Bruckenthalia spiculifolia*, *Eriophorum vaginatum* and *Vaccinium* sp. div. constantly occur in the herb and lower shrub layer. This vegetation type occur in Stara Planina, Vitosha and scarcely also in Rila Mts.

Subalpine fen grasslands of the Vitosha Mt (*Cirsio heterotrichi-Caricetum nigrae*)
The community has a distribution centre in Vitosha Mt. The species of intermittently wet soils such as *Molinia caerulea* agg., *Succissa pratensis*, *Sanguisorba officinalis*, *Cirsium heterotrichum* and *Potentilla erecta* differentiate this association well from other subalpine fen types. *Sphagnum warnstorfii* and *S. subsecundum* often dominate in bottom layer.

Primula exigua subalpine fens (*Primulo exigue-Caricetum echinatae*)
This is the most frequent fen type in the Bulgarian high-mountains. Species with Balkan distribution (e.g. *Pinguicula balcanica*, *Primula farinosa* subsp. *exigua*) are more common in this community than in others.

High-altitude fens with snow-bed species (*Primuletum exiguo-deori*)

This visually attractive and floristically diverse community occupies the most extreme habitats at high altitudes above 2200 m a.s.l. in the central parts of Rila and Pirin (without *Primula deorum*). Species that overlap to snow beds are important indicators of this fen type (e.g. *Primula deorum, Plantago gentianoides, Gentiana pyrenaica* or *Carex bulgarica*).

High-altitude fens with snow-bed species (*Primuletum exiguo-deori*)

This vegetation type is floristically the most different from that of temperate and boreal fens.

***Warnstorfia exannulata* species-poor acidic fens (*Drepanocladetum exannulati*)**

The community is characterised by a strong dominance of *Warnstorfia exannulata*. In the herb layer, if present, *Juncus filiformis* and/or *Carex nigra* dominate. Balkan endemics are absent or are represented by only one species. The typical habitats are shores of Rila and Pirin shallow lakes.

Carex nigra, the dominant species

Subalpine springs with *Palustriella* species (*Cratoneuretum falcati*)

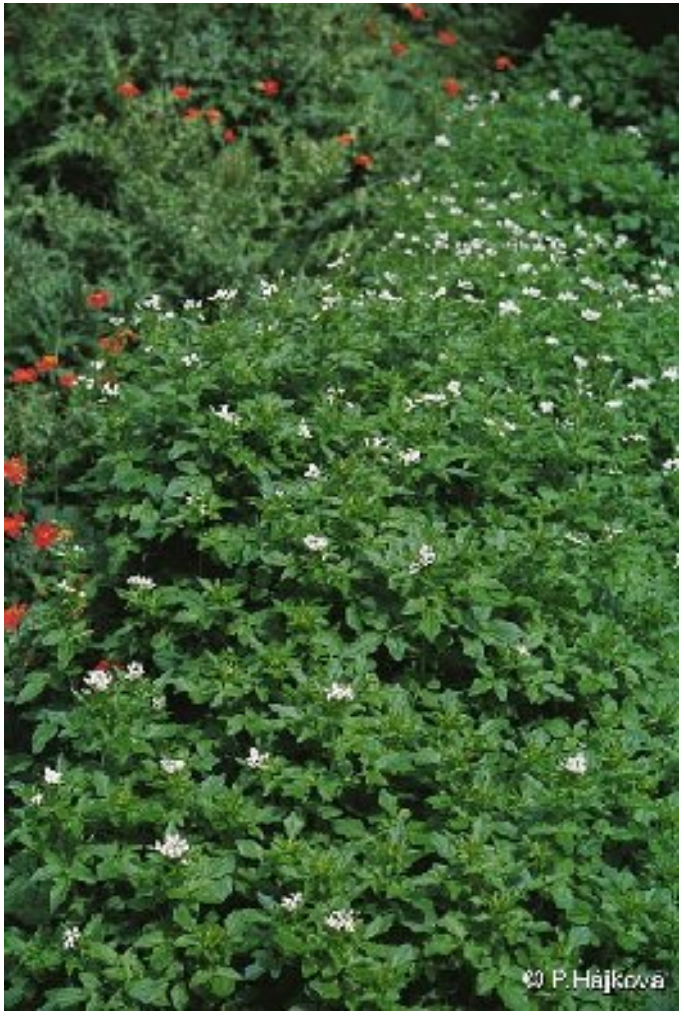
Springs with *Palustriella* species (mostly *P. decipiens, P. falcata*) prefer steeper slope, where water pH is constantly high due to water aeration and/or the mineral supply is rather high. This community was recorded in marble part of the Pirin Mt, scarcely in the Rila Mt and in the Central Stara Planina Mt. The herb layer is characterised by *Silene pusilla, Viola biflora* and, in the marble part of Pirin Mt, also by *Carex ferruginea*.

Saxifraga stellaris acid subalpine springs (_Saxifragetum stellaris_)

The mineral-poorest and acidic springs exhibit a broad distribution range including Rila, Pirin and Vitosha Mts, Central Rhodopes and entire Stara Planina Mt. *Philonotis seriata* and *Saxifraga stellaris* are typical dominants of this rather species-poor vegetation.

***Cardamine balcanica* mountain springs (*Brachythecio rivularis-Cardaminetum balcanicae*) and *Caltha palustris* forb-rich mountain springs (*Angelico pancicii-Calthetum laetae*)**

These communnities are highly-productive and dominated by vascular plants. The species composition is pauperised due to the strong dominance of *Cardamine amara* subsp. *balcanica* and *Caltha palustris* agg. *Angelico pancicii-Calthetum laetae* is confined to lower altitudes above the timberline (1700 – 1800 m a.s.l.) and harbours a great share of Balkan endemics.



Extremely-rich fens (*Caricion davallianae*): Tufa-forming spring rich fens (*Carici flavae-Cratoneuretum*)

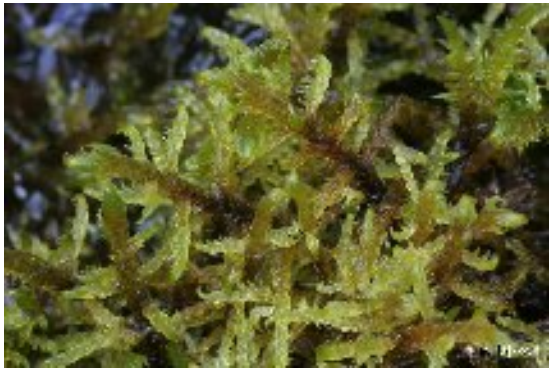
Spring fens fed by calcium-rich water. Intense or scarce superficial precipitation of calcium carbonate as well as high pH cause the dominance of *Cratoneuron commutatum* in a moss layer and the occurence of typical malacofauna.

Schoenus nigricans alkaline fens (_Orchido-Schoenetum nigricantis_)

Extremely mineral-rich (subhalophilous) fens of the Kazanlak basin dominated by *Schoenus nigricans* and *Caricion davallianae* species (*Sesleria uliginosa, Parnassia palustris, Epipactis palustris, Eleocharis quinqueflora, Carex distans, Eriophorum latifolium*). *Campylium* species (*C. elodes, C. stellatum*) occur in a moss layer.

The snail species new to science (*Bulgarica lozekii*) was described from these fens.

Brown-moss community dominated by *Eriophorum latifolium* (new association?)
This community is probably a vicariant to the Carpathian association *Valeriano simplicifoliae-Caricetum flavae*. It represents rich spring fens lacking any *Sphagnum* species, dominated by brown mosses (*Campylium stellatum, Drepanocladus vernicosus, Calliergonella cuspidata, Fissidens adianthoides*) and harbouring rich-fen species as well as Balkan- and South-European species of waterlogged meadows in the herb layer. No calcium carbonate precipitates, *Cratoneuron commutatum* absents.



Moderately-rich fens (mostly *Sphagno warnstorfii-Tomenthypnion*)

The community, widely distributed in submontane regions of Bulgaria, is characterised by the co-occurrence of calciphytes, namely *Eriophorum latifolium*, and calcitolerant *Sphagnum* species (*S. contortum*). *Drepanocladus vernicosus* is also the typical species of the moss layer. Habitat of rare relic species!

Poor fens (*Sphagno recurvi-Caricion canescentis*)

Below the timberline, poor fens are rare and they are confined to terrestrialised lakes in the Rhodopes and to extremely-poor springs in the Petrohan pass (Western Stara Planina). This vegetation type is characterised by the dominance of *Sphagnum recurvum* agg.; the species composition is nearly identical to Central-European poor fens.

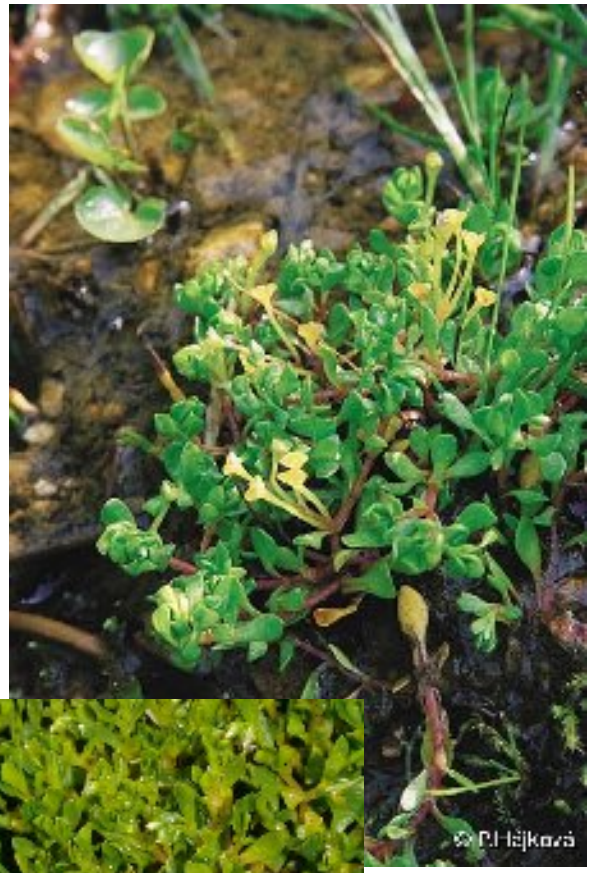
Bog woodlands,
Eriophoro vaginati-Pinetum sylvestris

Rhodopes, Shiroka Polyana region

Sphagnum fuscum

Calthion meadows

Submontane *Montia* springs (*Stellario alsines-Montietum*)



Submontane travertine springs (without fen species): *Lycopodo-Cratoneurion commutati*

Cladium „reed beds“ without fen species

Conclusion

-The vegetation of Bulgarian nutrient-poor wetlands (springs and mires) is unique,diverse and well-preserved.

- Even if mires are at their distributional limit in Europe there, they are very important in terms of maintaining European biodiversity and deserve a protection

- Bulgarian mires are noteworthy due to relic character and many local specifities which are probably connected with long-term isolation of populations of many mire species