

MOUNTAIN WETLAND VEGETATION CHANGES FOR THIRTEEN YEARS IN VITOSHA MOUNTAIN (BULGARIA)

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Abstract

This study presents a sample of the high-mountain wetland vegetation changes over a 13-year period in Vitosha Nature Park. We re-survey the vegetation at the same locations, that were ensured by a 10m buffer delimited around each 2006 coordinates and within this buffer sampling plots were re-located in 2019. We re-confirm all the previous high-mountain wetland vegetation plots, but detected changes of vegetation composition as: 1) an increase in both cover and diversity of vascular plants accompanied by decreasing of bryophytes mainly at the expense of *Sphagnum* species for the sub-alpine mires of *Scheuchzerio-Caricetea fuscae*; and 2) a reverse tendency towards an increase in the cover and diversity of bryophytes in the lower mountain belts for the wet meadows of class *Molinio-Arrhenatheretea*. According to the observed plant species composition changes for this 13-year period in Vitosha Mtn., the sub-alpine mire vegetation “tend to get dryer”, while lower wet meadow grasslands have become closer to mire vegetation. The high-mountain wetlands preservation is important for both the biodiversity conservation and for the long-term monitoring on vegetation and climate perspectives.

Key words: mountain mires, mountain wet meadows, vegetation change, vegetation revisited

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Introduction. Wetlands provide a variety of important ecosystem services [1]. Balkan mountain wetlands support high biodiversity including endemic species [2, 3]. The standardized methodology for vegetation sampling [4] gives opportunity for spatial and temporal comparative studies. Historically collected vegetation data has turned out to be a valuable source of information for the biodiversity changes [5], however, in Bulgaria re-survey studies are currently at the beginning. Climate change is one of the global biodiversity threats [6, 7]. While a range of ecosystems are at risk from climate change, the high-mountain vegetation is among the most vulnerable ones because it is determined by relatively narrow range of the climatic parameters. WANG et al. [8] attribute wetland shrinkage to increased evapotranspiration and reduced precipitation over the past two decades. The predictive models of BAATAR et al. [9] show that under potential ongoing drought and rising temperatures, *Scheuchzeria-Caricetea fuscae* vegetation will be threatened with a loss of more than 80% of its current range at European level, which makes mires extremely endangered ecosystems [10]. Considering the mire ecosystems and especially the high-mountain's wetlands vulnerability, we focused on the territory of Vitosha Mtn. which includes one of the biggest peat areas in Bulgaria. The recent data on climate change on the territory of the mountain shows a trend of an increased mean annual temperature for the period 1980–2023, while the precipitation remains stable (https://www.meteoblue.com/en/climate-change/vitosha_bulgaria_725846, accessed 17.03.2024). The mires in the Vitosha Mtn. were assigned as sub-alpine poor fens fed by ground waters and belonging to the habitats with an extraordinary importance in terms of species diversity and conservation in Bulgaria [11]. Using vegetation plot data collected two times by the same protocol and at the same locations over a period of 13 years, we aimed to find out if there are any changes in (1) species composition, or (2) in the ratio between vascular plants and bryophytes, and (3) what is the direction of any eventual change.

Materials and methods. The study sites are situated in the Vitosha Mtn. (42.57°N; 23.29°E, with highest peak Cherni vrah, 2290 m) (Fig. 1). The main mountain territory is a Nature Park since 1936 (IUCN category II). The Vitosha Mtn. relief above the tree line and its crystalline structure provides suitability for runoff deceleration and supports the formation of many mountain wetlands, including the Torfeno Branishte Nature Reserve (the “Peat-land” Reserve, 1935, IUCN category I) with territory of 783 ha, at the highest plateau of the mountain.

Vegetation data collection was performed in 13 years distance (2006–2019). The altitude of sample plots range between 1444 and 1969 m. We compared phytosociological plot data collected following standard methodology [12], at the same locations with the same plot size of 16 m². Considering that the 2006-year coordinates have accuracy less than 4 m, we re-sampled all the 2019 vegetation data within a 10-meter buffer around the old coordinates (see Fig. 1), choosing the most homogeneous section of the vegetation. All vascular plant and bryophyte



Fig. 1. Map of Bulgaria with delineated study area location (Vitosha Mtn.). The fragment of study area with the location and 10-meter (red circles) and 20-meter (blue circles) buffers around each vegetation plot coordinates of 2006 are shown in the inserted picture

species within the plots were identified and their cover was estimated. The species cover estimation in 2006 sampling was according to the nine-grade Braun-Blanquet scale transformed to median percentage values [13]. During the 2019 field research we applied percentage coverage estimation for the species cover. Except for plot 6, vegetation plots from 2006 were unpublished. The vascular plant and the bryophyte nomenclatures follow well accepted sources in Bulgaria [14–16]. The 2006 collected plots were subjectively classified (affiliated) to alliance level based on the diagnostic species presence according to both national and European literature [11, 17, 18]. The vegetation changes assessment was carried out on a pairwise comparison of 12 historical (2006) and 12 current (2019) plots by Detrended correspondence analysis (DCA), in terms of their distribution in the ordination space and floristic similarities expressed by distances and supported by a cluster analysis (using Euclidian distance and Ward's method of group linkage clustering), performed by PC-Ord [19]. We also compared the changes of the: total vegetation cover, covers of herb layer and bryophyte layer, *Sphagnum*-species cover, total species number, vascular and bryophyte species number. The total vegetation cover and herb and bryophyte layers cover for the 2019 plots were estimated in the field. The *Sphagnum*-species cover was calculated as a sum of individual *Sphagnum*-species covers.

Results. All the revisited 12 plots were confirmed in 2019 as wetland vegetation as surveyed in 2006. A total number of 119 species were identified in 2006: 82 vascular plants and 37 bryophytes. In 2019 we registered 122 species: 97 vascular

plants and 25 bryophytes. The 74 species were common for both samplings – 62 vascular plants, 12 bryophytes, which is 62% of the floristic diversity in 2006 and 61% in 2019.

The studied vegetation represents two main types of high-mountain wetlands – mires and wet mountain meadows, *Scheuchzerio-Caricetea fuscae* R. Tx. 1937 and *Molinio-Arrhenatheretea* R. Tx. 1937, respectively. For the class *Scheuchzerio-Caricetea fuscae*, we identified two alliances: *Sphagno recurvi-Caricion canescentis* Passarge 1964 (plots 2 and 6) and *Caricion fuscae* Koch 1926 (plots 1, 3, 4, 9 and 10). Class *Molinio-Arrhenatheretea* was represented by alliances *Calthion* R. Tx. 1937 (plots 5, 7 and 8) and *Molinion caeruleae* Koch 1926 (plots 11 and 12). According to DCA and cluster analyses based on the full species composition (Fig. 2), the most similar in species composition are plot pairs 4, 7, 3 (*Caricion fuscae*) followed by pair 11 (*Molinion*), pair 9 (*Caricion fuscae*) and pairs 2 and 6 (*Sphagno recurvi-Caricion canescentis*). The greatest dissimilarity was detected for two plot couples of *Calthion* – plots 5 and 8. Plot number 5 from 2006 represents *Filipendula ulmaria* dominated plant community which cover was significantly decreased in 2019 (from 88% to 2%). The central part of ordination space was occupied by *Caricion fuscae* and *Molinion* vegetation. For those two vegetation types weaker changes were observed.

The total vegetation cover of *Scheuchzerio-Caricetea fuscae* plots did not change during the years, but the cover of herb layer increased while the bryophyte cover layer and *Sphagnum*-species cover decreased (Fig. 3.1). Total species number slightly increased (not shown) owing to vascular plants. For the *Molinio-Arrhenatheretea* plots (Fig. 3.2) we did not detect significant change in overall vegetation cover, as for the *Scheuchzerio-Caricetea fuscae* plots neither for the herb layer cover. But we detected an increase of bryophyte- and *Sphagnum*-species covers and increased number of vascular and bryophyte species (Fig. 3.2).

Discussion. Our research established the high-mountain wetlands changes in the mountain wetlands for a period of 13 years. Within the *Caricion fuscae*, the largest number of plots in 2006 (1, 3, 9, 10) could be affiliated to the association of *Cirsio heterotrichi-Caricetum nigrae* (Soó 1957) [11]. It is the vegetation that combined species typical for the Balkan subalpine spring fens (e.g. *Pinguicula balcanica*, *Dactylorhiza cordigera* subsp. *bosniaca*, *Gentianella bulgarica*, *Crocus veluchensis*, *Pseudorchis frivaldii*, *Sesleria comosa*) and *Molinion* species [11]. Based on our results (Fig. 2), the central position of *Cirsio heterotrichi-Caricetum nigrae* in the ordination space and its floristical similarities with the *Molinion* vegetation plots, we can confirm it as the “core” vegetation type of the high-altitude mires in Vitosha Mtn. [11]. We interpreted the *Sphagno recurvi-Caricion canescentis* vegetation by *Bruckenthalio-Sphagnetum* Hájek et al. [11] (plot 2) and *Carici echinatae-Sphagnetum* Soó 1944 (plot 6; the only one published plot collected in 2006) [17]. The *Bruckenthalio-Sphagnetum capillifolii* vegetation is floristically close to the bog vegetation of the *Oxycocco-Sphagnetum*

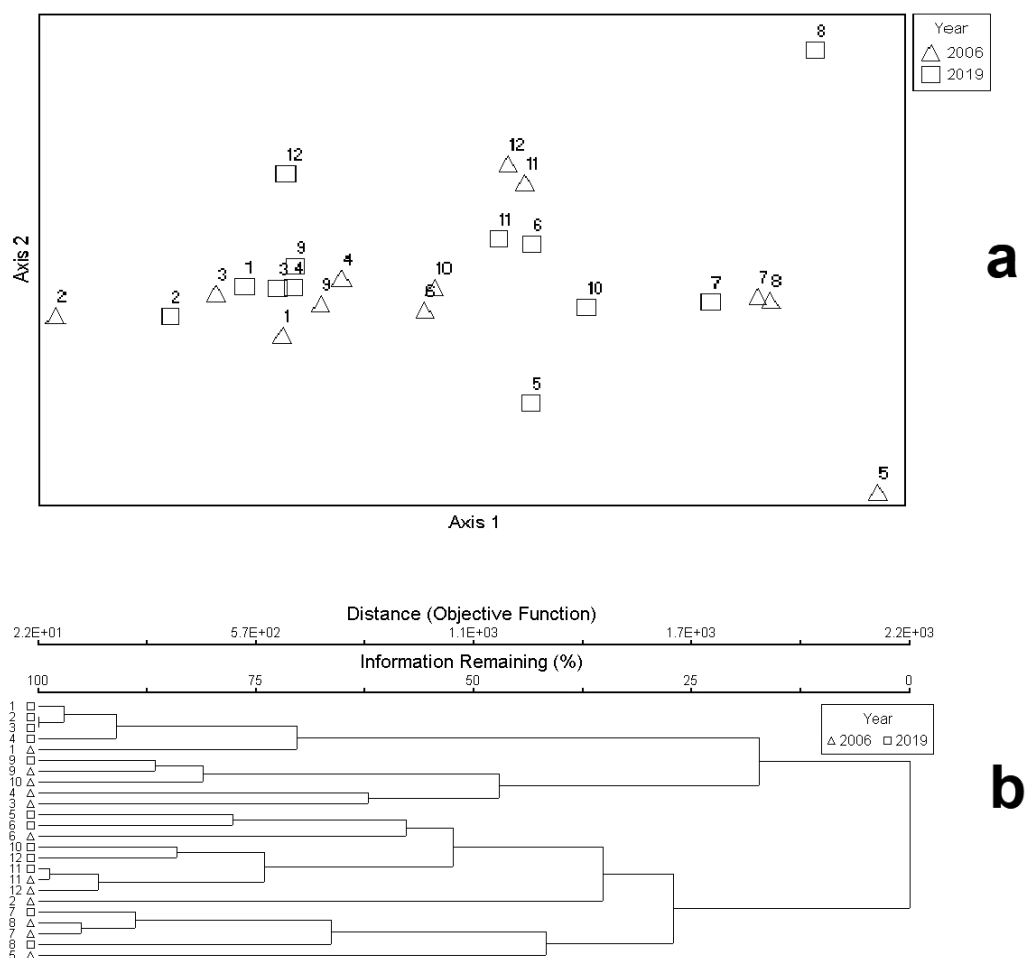


Fig. 2. Species composition similarities between re-surveyed 12 couples of plots (2006–2019) from Vitoshka Mtn. wet vegetation. a) DCA-ordination diagram; b) Dendrogram of species composition similarities explained by the Euclidian index. Equal numbers represent same location

class. The subalpine *Sphagnum*-dominated shrubby poor fen communities of *Bruckenthalio-Sphagnetum capillifolii* developed through peat accumulation by *Sphagnum*-species are successional the most advanced type compared to the other poor fen vegetation not studied by us. In the lower mountain parts, wet vegetation of *Molinio-Arrhenatheretea* and especially the *Calthion palustris* and *Molinion caeruleae* plots often harbour typical species for fen vegetation [11, 17] which makes delimitation of these alliances difficult especially based on few plots. Our results reveal that studied vegetation of *Molinio-Arrhenatheretea* exhibits obvious changes over this 13-year period, especially for the bryophytes cover. Although we did not detect severe changes in vegetation structure and composition, the future scenarios are not optimistic. ILCHEVA et al. [20] prognosed decrease

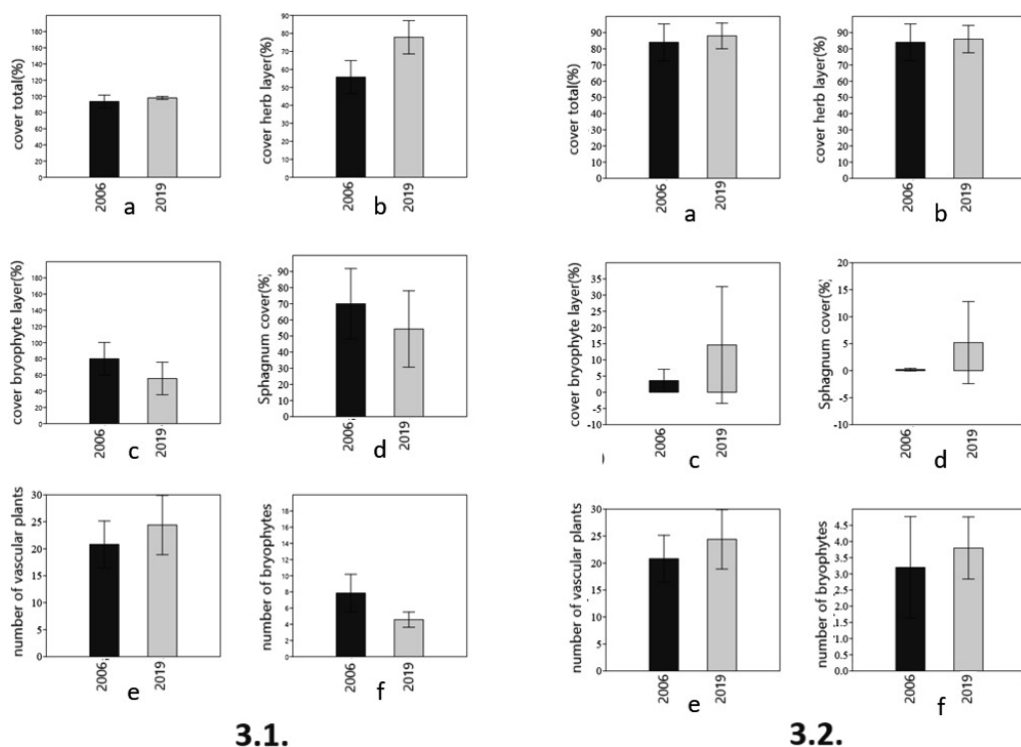


Fig. 3. Changes in vegetation cover and plant diversity of 3.1. *Scheuchzerio-Caricetea fuscae* plots and 3.2 *Molinio-Arrhenatheretea* plots: a – total cover; b – herb layer cover; c – bryophyte layer cover; d – *Sphagnum*-species cover; e – vascular plants number; f – bryophyte species number

of rainfall and increase in the mean annual temperatures for the highest altitudes causing drought in the summer. The model of Vitosha water bodies trend shows that nowadays about 13% of the peat complexes are considered in unsatisfactory condition [20]. The monitoring and mitigation of this trend is of an urgent need, as was shown by our vegetation observations.

Conclusions. We found a different response of the sub-alpine mires vs. mountain wet meadows in Vitosha Mtn. over the 13-year period: The sub-alpine mire vegetation tends to be more arid, including more vascular species with a reduction of peat-forming mosses, while the mountain wet meadows tend to be enriched with bryophytes and especially with *Sphagnum*-species. All observed vegetation types are fed by groundwater which means that not only a decrease in precipitation, but also a decrease in the thickness and retention time of the snow cover is crucial for their survival. Given the limited area, even greater shrinkage and disappearance of the smaller spots can be predicted. Their preservation is important not only for the biodiversity conservation, but also for the potential for long term monitoring.

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