

# **Current state and recent successional trends of coastal and inland sand dune vegetation in Bulgaria**

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Ph.D. Dissertation

The protection of the vulnerable sand dune habitats requires scientific exploration and understanding of their modifications and processes in order to form the basis of appropriate conservation and management strategies. Therefore, the limited available data on sand dune habitats in Bulgaria and their high conservation value motivated the research in this dissertation.

*CHAPTER 1* reveals the first overview of the floristic diversity of Bulgarian coastal dunes in terms of the presence of typical psammophytic or non-psammophytic plant species. It aims to find out if changes occurred in sand dune flora over time, based on original sampling and existing data from previous studies. Original floristic data from 154 phytosociological plots sampled in 12 large dune systems during 2017 and all available literature sources were compiled to derive a list of vascular plants mentioned for Bulgarian coastal dunes between 1905 and 2016. All vascular plants were assigned to one of five groups, according to their general habitat preference: 1) psammophytes, 2) weeds and ruderals, 3) grass- and shrubland plants, 4) forests plants and 5) alien (including invasive) species. The full species list comprises of 501 taxa and the highest number of species was compiled from publications after 1990. Across all studied dune complexes, grass- and shrubland plants were most abundant, while other non-psammophyte species groups showed low presence. A comparison of data from 2003 and 2017 showed that species richness of psammophytes decreased over time, which is in contrast to the average number of weeds and ruderals, and particularly to species richness of grass- and shrubland species. Results show that a core group of characteristic psammophytes remains constant through studied time periods. Alien (including invasive) species are limited but there is an alarming recent increase in their number.

*CHAPTER 2* aims to identify how far the dune habitats in one of the largest dune complexes in Bulgaria are affected by the penetration of non-psammophytes and if there is an upward trend in their number. Vegetation was sampled during the growing seasons of 2013, 2014 and 2015 at 162 plots along 12 transects systematically situated to cover three different habitats: embryonic, white and grey dunes. A total 207 plant species were registered. They were classified into five groups as follows: psammophytes – 38, weeds and ruderals – 36, plants typical of grasslands and

shrublands – 95, plants typical of forests – 18 and alien (including invasive) species – 20. Results show that grey dunes contain the highest percentage of non-psammophytic plants, which decrease towards white and embryonic dunes. The studied coastal area is still less influenced by non-psammophytes and the high floristic and habitat diversity deserve further effective protection.

*CHAPTER 3* aims to determine the current vegetation characteristics of dune habitats from the Bulgarian Coast, in terms of species richness and cover of typical psammophytes and different non-psammophytic plant groups and to analyze what is their respond to certain environmental drivers. Data were collected at 12 dune systems. The research was focused on embryonic, white and grey dunes. The field work was conducted during July and August 2017. Vegetation was sampled at 154 phytosociological plots (5 m × 5 m). To understand how vegetation responds to different drivers the correlation of defined species groups richness and cover to: 1) soil pH and EC values; 2) distance from inland to the sea; 3) range of different categories of land cover in the surrounding area was analyzed. In order to track temporal vegetation changes the cover of defined species groups was compared between 2003 and 2017. A total number of 269 vascular plants, 12 bryophytes and 5 lichens were registered. The strongest presence in all dune types, both in species richness and in cover, had the group of grass- and shrubland plants, weeds and ruderal plants had significant cover in grey dunes, while richness and cover of forest and alien plants was negligible among studied dune habitats. The comparison of data from 2003 and 2017 revealed a substantial decline in cover of psammophytes. Results showed, that grey dunes were the most affected by the penetration of non-psammophytes.

*CHAPTER 4* aims to extend the knowledge on the floristic diversity, vegetation, ecology and threats of habitat 2340 \*Pannonic inland dunes in Bulgaria. Fieldwork was conducted in 2018 and data were sampled at 35 phytosociological plots from 5 localities along the Danube in NW Bulgaria. A total number of 132 vascular plants and 7 bryophytes were registered. Each vascular plant was assigned to one of two groups: (1) typical plants – 39 species, and (2) non-typical plants – 93 species. The total vegetation cover in the relevés was generally high, and the share of typical and non-typical plants was quite similar. The association *Bassia laniflorae-Brometum tectorum* was reported for the first time for Bulgaria and it was presented in all localities. The substantial presence of non-typical plants registered in this study revealed a successional trend towards ruderalization, which has significantly affected the autochthonous flora and vegetation of inland dunes in Bulgaria.