

Floristic, microclimatic, pedological and geomorphological features of the Balinovac doline on North Velebit (Croatia)

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Abstract

A deep karst area of the Velebit mountain range has abundant in large dolines (sinkholes) – karst depressions with frequent temperature inversions resulting in vertical inversions of the plant cover. Although the initial research dates back to the fifties of the twentieth century (Horvat 1952-1953), the dolines of the Dinaric karst have not undergone a systematic multidisciplinary research until today. It is for this reason that floristic, microclimatic, pedological and geomorphological research of the Balinovac doline on North Velebit was carried out during 2008 and 2009. The research goal was to determine the correlation between the flora, microclimate, soil, geomorphological features of the doline and the selected ecological parameters affecting its floristic composition. Plants along the north-south profile were listed, and five points were determined at which soil pits were analysed for the purpose of determining the soil type and collecting samples for laboratory analyses. The temperature and the relative air humidity were continuously measured for the period of one year. For the purpose of comparison with the results of the laboratory pedological analyses and the field-measured values, the recorded plant species were assigned indicator values of the selected ecological parameters according to Landolt (1977). The research results confirmed the presumed temperature inversion affecting the vertical formation and composition of the flora in the doline.

Key Words

Balinovac doline, flora, microclimate, soil, geomorphology, ecological parameters

Introduction

The Balinovac doline is situated on the territory of the National Park North Velebit. It is located in the south-western part of Modrić-dolac between the peaks of Velika kosa (1622 m), Balinovac (1601 m) and Veliki Zavižan (1676 m), and it is 120 m deep. The vegetation of this area phytogeographically belongs to the lower sub-alpine belt of the Illyric province in the Euro-Siberian – North American region. A botanical station and a part of the Velebit botanical garden are located in its north-eastern part (Bertović 1979). A circular botanical educational trail runs through the doline at the altitude of some 1,470 m, splitting into sections that lead to the surrounding peaks. In the vicinity of the Balinovac doline is a mountain lodge Zavižan and Croatia's highest-placed meteorological station (Bertović 1979). The doline was formed in intensely tectonized, karstified layers of limestone from the upper Jurassic period, while its western part facing Balinovac is composed of Jelar beds (Paleogene/Neogene). In addition to karstification, on the steeper slopes of the doline one can observe intense slope processes, and occasional erosion in places where the parent material is covered in soil. Owing to its altitude, the studied area has a humid boreal climate (Df). The mean annual temperature of the nearby meteorological station Zavižan (1594 m) is 3.5°C (February -4.0°C, July 12.1°C), and the mean annual precipitation is 1 827 mm. The median annual relative humidity is 81% (Perica *et al.* 2002).

Methods

On 23 and 24 July 2008, all of the plants found alongside the north-south profile of the Balinovac doline were listed. Uncertain specimens were collected and photographed for the purpose of subsequent identification, and were stored in the Herbarium of the Croatian Natural History Museum. The plants were identified according to the standard keys and iconography (Domac 1994; Javorka and Csapodi 1991; Pignatti 1982; Tutin *et al.* 1964-1980, 1993), and the nomenclature was coordinated with the Flora Croatica Database (Nikolić 2010). All of the determined plant taxons were assigned indicator values for humidity, pH value, nutrients, humus, light, temperature, continentality, and life forms were also determined, for the majority of the taxons according to Landolt (1977). An indirect gradient analysis was carried out on the basis of these data. Alongside the profile, altogether five points were determined at the bottom and on the slopes of the

northern and southern exposition (Table 1; Figure 1). At these points, soil samples were collected from the soil pits at the depths of up to 20 cm, and were then analysed for humus content, nutrients (P and K), coarse fragment and pH value. Types of soil were determined on the basis of the results of the analysed parameters and field observations. Thermohygrographs were set up at the same points, for the purpose of continuous measuring of temperature and relative air humidity for the period of one year.

Table 1. Exposition and altitude of measuring points.

Point	Exposure	Altitude (m)
MD-1	S	1513
MD-2	S	1476
MD-3	-*	1434
MD-4	N	1465
MD-5	N	1500

*doline bottom

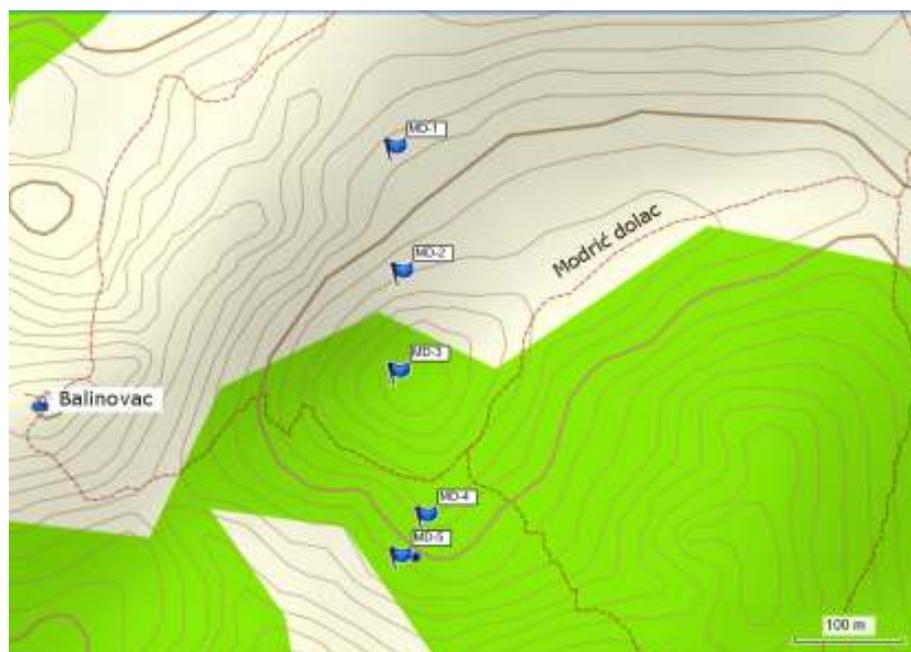


Figure 1. Balinovac doline map with measuring points.

Results

The average values of the air temperature at the measuring points range from 6.06°C at the bottom of the doline (MD-3) to 7.32°C at the top of the southern exposition slope (MD-1). These values are higher than the multi-annual average at the meteorological station Zavižan. The average values of the air temperature in the warmest month – July (13.78 -14.57°C) are also higher compared to the multi-annual average. Nevertheless, an air temperature inversion typical of the mountain dolines was registered, resulting in a vegetation inversion. According to the literary data (Skorup *et al.* 2008), there is a possibility of occurrence of short-term negative air temperature values at the bottom of the doline; however, it was not registered in the vegetation period within this measurement. The relative air humidity is higher on the northern exposition slopes (84-86%), as expected; however, this is insignificant compared to the southern exposition slopes (80-81%).

It has been established that 149 plant taxons grow on the studied part of the Balinovac doline, in three main soil types: haplic Cambisol, colluvic, rhodic; mollic, umbric Leptosol, calcareic and leptic, calcic Luvisol, abruptic, skeletal, clayic. The analysis of the life forms of all of the plant taxons identified at the research points shows the prevalence of hemicryptophytes, with their share exceeding 50% and being somewhat higher on the southern exposition slope. Based on the indirect gradient analysis of the ecological parameters, it has been determined that half-shade habitats with arid soils poor in nutrients and humus, in which plants of the mountainous belt mostly grow, dominate the southern exposition slope. Shady habitats prevail on the northern exposition slope, with more humid soils, richer in nutrients and humus, in which plants of the sub-alpine belt mostly grow. According to the indirect gradient analysis, the bottom of the doline is predominated by the habitats with the transitive values of the ecological parameters compared to the southern and northern exposition slopes.

Conclusion

The microclimatic measurement has confirmed the presupposed vertical structure of the values and the temperature inversion typical of mountain dolines. The recorded vertical structure and composition of the flora is also in line with the aforesaid; therefore, the upper, marginal parts of the southern exposition slope are predominated by the warmer and sunlit habitat types, with cooler and more humid ones prevailing at the bottom and on the northern exposition slope, as confirmed by the indirect gradient analysis results.

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