# CHANGES IN SOIL PH ALONG THE ZONATION OF CRYPTOGAMOUS SYNUSIA AT BUGAC (HUNGARY)

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The characteristic zonation of lichens and mosses was studied in the open Juniperus forest of sand hills at Bugac (Kiskunság National Park, Hungary). Changes in species composition and abundance of cryptogams throughout the zones were detected. As an effect of cryptogam succession, changes in soil pH values were measured.

## INTRODUCTION

Cryptogamous synusia have a leading role in the initial stages of succession of vegetation, especially in sandy areas.

In the open Juniperus communis forest of Bugac (Kiskunság National Park, Hungary) a characteristic pattern of cryptogams can be found around the individual juniper trees (Gallé 1976). As a result of succession, a fairly regular zonation of the cryptogams has been formed under the shelter of the canopy. The closer the zone to the trunk, the richer is in species and higher in species abundance. This, to a certain extent a retarded process of cryptogamous succession, results a rather small-scale pattern of zonation. It has different effects on microhabitat, particularly on soil characteristics. Under such circumstances, a definite gradient of soil pH can be detected along the transect crossing the subsequent zones.

## MATERIAL AND METHODS

Bugac is situated in central Hungary in the territory of the Kiskunság National Park, on alluvial calcareous sand from the Danube River.

The relief formed during the Holocene. Bugac is an area of sandy hills with relative heights of 3-10 m. The annual mean temperature is 10.6°C, annual mean precipitation is 510 mm. The zonal vegetation ofthis rather continental region is forest steppe. On the sand hills (or dunes), as a result of secondary succession, sparse stands of Juniperus communis and Populus alba are typical (Simon 1979, Tölgyesi 1979, Simon & Rajkai 1985).

The soil formation in this area is in an initial stage; the sandy soil has low organic matter content and water holding capacity, so the limiting factors of succession are the low level of soil moisture and nutrients, especially N (Snakin et al. 1984).

In the characteristic belt of cryptogams surrounding the junipers, one can distinguish between 2-4 zones which differ from one another in species composition, species richness and abundance. Most often, three zones (Tortella-dominated, lichen-dominated, and Hypnum-dominated) can be observed. The width of the zones depends on the height of junipers and also on the microrelief.

We selected a well-developed four-staged zonation for the present study. It is situated at the foot of a NE slope on a medium-sized dune, and it was shaded by tall trees. Due to this special position, more species were found here than usual. The transect crossing the zones was about 6 m long and the width of the different zones was 1.5 - 1.5 - 1.0 - 2.0 m.

In July, 1985, pH measurements were made in the four zones under field conditions. We measured in dry soil at a depth of 5 cm, where soil moisture content made it possible, and after watering in mositened soil at a depth of 1 cm. For the measurements, the "in situ" ionometric method developed in the Soil Institute of the Soviet Academy of Sciences was employed (Zykina et al. 1978). Glass electrodes, Ag/AgCl reference electrode and, as a detector, an I-102 ionometer were used.

## RESULTS

The results are summarized in Table 1. As seen, the first zone, which represents the first successional stage from the bare sand, is characterized by the presence and dominance of extremely xerotherm species (Tortella inclinata and Diploschistes muscorum) with a cover of about 50%.

In the subsequent stages, the species richness increases. Species diversity reaches its maximum in the third zone. At the same time, a gradual shift of species is associated with an increase in total cover. It is worth mentioning that in the fourth stage the dense moss layer of Hypnum cupressiforme and Thuidium abietinum covers entirely the soil surface, and on this carpet a second layer of lichens has been formed. The lasting existence of such a zonation is likely due to the gradually weakened sheltering effect of junipers.

The zonation os cryptogams is accompanied with a pH gradient in the soil, which is the result of acidic substances produced by lichens and mosses; the beginning of a slight biological activity and the formation of humic materials in the soil. This process is the first step of soil development. The decrease in pH values during succession is more definite in the upper horizon of the soil, although the biotic effect of cryptogams can be detected at a depth of 5 cm as well. In this case the range of pH alteration is narrower. In the initial stage of succession (Tortella- and Diploschistes-dominated zone) the soil pH is the same as that of bare sand. The greatest change takes place when succession proceeds from the second to the third stage, where a leap can be measured in the pH of the soil.

Table 1. Changes in species composition, abundance and soil pH in the different zones of cryptogamous synusia at Bugac, on 5-6. 7. 1985.

| Zones (successional stage) | Species present | Cover (%) | Mean pH values (based on 6 measurements each) | | | |
|---|---|---|---|---|---|---|
| | | | 5 cm moisture = 2% | | 1 cm moisture = 6% | |
| bare sand | | | | | 7.96 | s = 0.70 |
| I. | Tortella inclinata | 50 | | | | |
| | Diploschistes muscorum | 7 | 8.04 | s = 0.20 | 8.00 | s = 0.16 |
| | Cladonia magyarica | 5 | | | | |
| II. | Tortella inclinata | 60 | | | | |
| | Cladonia magyarica | 70 | | | | |
| | Diploschistes muscorum | 15 | 7.90 | s = 0.09 | 7.82 | s = 0.25 |
| | Cladonia convoluta | 5 | | | | |
| | Toninia coeruleo-nigricans | 2 | | | | |
| III. | Tortella inclinata | 40 | | | | |
| | Diploschistes muscorum | 30 | | | | |
| | Cladonia magyarica | 20 | | | | |
| | Cladonia convoluta | 40 | 7.69 | s = 0.41 | 7.19 | s = 0.23 |
| | Parmelia pokornyi | 1 | | | | |
| | Hypnum cupressiforme | 10 | | | | |
| | Thuidium abietinum | 5 | | | | |
| | Tortula ruralis | 1 | | | | |
| IV. | Thuidium abietinum | 60 | | | | |
| | Hypnum cupressiforme | 40 | 7.33 | s = 0.29 | 7.07 | s = 0.32 |
| | Cladonia furcata | 20 | | | | |
| | Cladonia convoluta | 10 | | | | |

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