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The Effect of Animal Disturbance on the Spatial Pattern and Dynamics of Leucobryum juniperoideum (Brid.) C. Muell

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Abstract. In forest communities on radiolarian bedrock where the shrub layer is missing and the soil surface is very narrow the bryophyte and lichen species living in the ground appear with big dominance and have great importance forming a continuous cryptogamic layer there, but the pattern of it is influenced mainly by the disturbance of wild animals. The dynamic of spatial pattern changes most directly in the cases of the dominant bryophyte species, one of which is *Leucobryum juniperoideum* in the examined area in the Bükk mountains.

Introduction

The forest communities growing on radiolarit bedrocks are special habitats for bryophyte species because the shrub layer is almost completely missing and the acidic soil and radiolarian chert bedrock provide favourable conditions for many bryophyte species.They occur with great dominance and diversity in these areas where a bryofloristic examination was carried out. (Pénzes Kónya–Orbán 2000). One of these places has got a special importance, it can be found near Felsőtárkány, on the North Western slope of Csák-Pilis mountain. This community is Deschampsio-Fagetum, where some perennial bryophyte species appear with great dominance: about 80 percent of the soil surface is covered by bryophytes (Fig.1).

The observation of the spatial pattern and the dynamics of bryophyte species has been carried out since 1999 in permanent quadrats and as it happened in the same way in other areas of the Bükk mountains, the growing disturbance of wild animals can be observed among the vascular plant species and for bryophyte species, mainly by way of treading.

This forest habitat type with thin soil layer and with little number

of shrubs and the density of the animals is emerging every year, wich is a disturbance danger for plants.

Radiolarian bearing rocks are widely distributed in mountain ranges exposing geological units of oceanic affinities and radiolarites have special physical and chemical features which have been examined for about 25 years (Racki–Cordey 2000) These rocks are prone to rubbling in a similar way as dolomites and may cause the fragmentation and the entire destruction of the vegetation close to the surface.

In the examined area the number of species is low but their absolute cover value of them is high. The dominant species of the sampling area is *Leucobryum juniperoideum* (Brid.) C. Muell which has been considered as a rare species in Hungary with one floristic data (Boros 1968, Orbán–Vajda 1983), but several occurrences have been discovered recently (Pénzes Kónya 2003).

As the type of bedrock and the dominant bryophyte species are worth for further examinations, the aim of the study is to discover and detect the degradation-regeneration processes during which the spatial pattern of *Leucobryum juniperoideum* changes as a consequence of the repeated and growing disturbance.

Materials and methods

12 permanent quadrats were chosen, the size of them are 30 × 30 cm, divided into 10 × 10 cells. Four quadrats are touched with their one side, so they form sample blocks. The locality of blocks was chosen randomly.

The cover of bryophyte species was estimated in each cell using the following scale that consisted of three values. **1:** The cover of the bryophyte species is less than 30% in the cell. **2:** The cover of the bryophyte species is between 30% and 70% in one cell. **3:** The cover of the bryophyte species is above 70% in the cell.

The cover data of the bryophyte species were recorded once a year. The cover estimation values were analysed using spatial pattern analyses, the method was the Paired Quadrat Variance, PQV (Dale 1999) as the spatial pattern and spatial distribution of bryophytes are close to the two-dimensional distributions and almost all of their growing forms are patchy in space, only the scale of pattern is different. In the method we applied it is persumed that the cover variance of the neighbouring cells is less than of those that are not neighbours (Dale 1999). If there is any repeated spatial pattern in the data, the peaks of variance show the presence of patches at a given spatial scale which can be presented by diagramms. Another

type of examination was directed to the anatomical-morphological response of *Leucobryum juniperoideum* to the repeated and emerging disturbance of wild animals and to examine the regeneration capacity of the species. Microscopic examinations were done and photographs were taken about them.

Results

It can be observed from the results (Fig.2 a, b, c) that the number of bryophyte species is low, but the relative percent cover of them is high, it is near 90–100% the dominant species of the area is *Leucobryum juniperoideum* and at the same time the changes of this species int he cover is the most intensive on the basis of the cover estimation in 12 quadrats in three years The other bryophyte species which occupy less space in the area have not as much changes in their cover values in the three years' period.

If we observe the spatial distribution of *Leucobryum juniperoideum* during three years (Fig.3) it can be seen from the results of PQV pattern analysis that the cushion growing form which was the tipical spatial appearance of *Leucobryum juniperoideum* in the first year (smoothly repeated peaks in variance along distance scale, Fig.4), confused for the third year, the cushions were fragmented which is manifested in the little peaks of the diagram of the third year. The disturbance of big wild animals and the extremely dry spring can be among the causes of this dynamics of the drastically changed spatial pattern of *Leucobryum juniperoideum.*

Considering the previous observations the assumption was that the absolute cover of *L. juniperoideum* slowly decreases, the big cushions are fragmented and the species is getting dangerously destroyed. But the regenerative capacity of the species provided another direction of the process of pattern dynamics.

The type of disturbance when big wild animals like deers and mouflons overturn whole cushions of *Leucobryum juniperoideum*, induces some special morphological and anatomical processes. It seems at first sight that these cushions or fragments are entirely destroyed and dead, especially the ones turned to the soil surface with their top. If we examine them after some weeks it can be observed that they are strongly connected to the ground. Fig.4 and 5 shows the bottom and the top of these turned cushions. During the further regeneration processeses on the top side which was originally on the ground surface green, new leaves are developing while at the bottom of the cushion which was originally directed to the top leaves are getting yellowish-brown and rhizoids are growing to the soil surface.

If we observe the morphological features during the regeneration processes of the turned cushions of *Leucobryum juniperoideum* on microscopical photographs (Fig.6) we can see special morphological processes during which apical rhizoids are growing from the leaf apex which are the formations of the green cells (Yamaguchi 1993) among the hyaline cells and when the cushion turns these rhizoids grow longer and thick. On the other side in the cells of old leaves protonema-like cell groups are growing and new leafy stems are formed (Fig.7). In many cases the taxa of Leucobryum form caducous leaves that function in asexual reproduction. These particular caducous leaves are defined as gemmae (Yamaguchi 1993). This type of regeneration process is getting faster in the rainy periods and it slows down in dry seasons. At this time the permanent disturbance and the rock fragmentation is very dangerous for the dominant bryophyte species, *Leucobryum juniperoideum*, because the regeneration processes are slower than the intensity of the disturbance. Considering these results and the type of the special extended habitat of *Leucobryum juniperoideum* the area is worth to treat in a special conservational way as other forest communities on radiolarian bedrock in the Bükk mountains.

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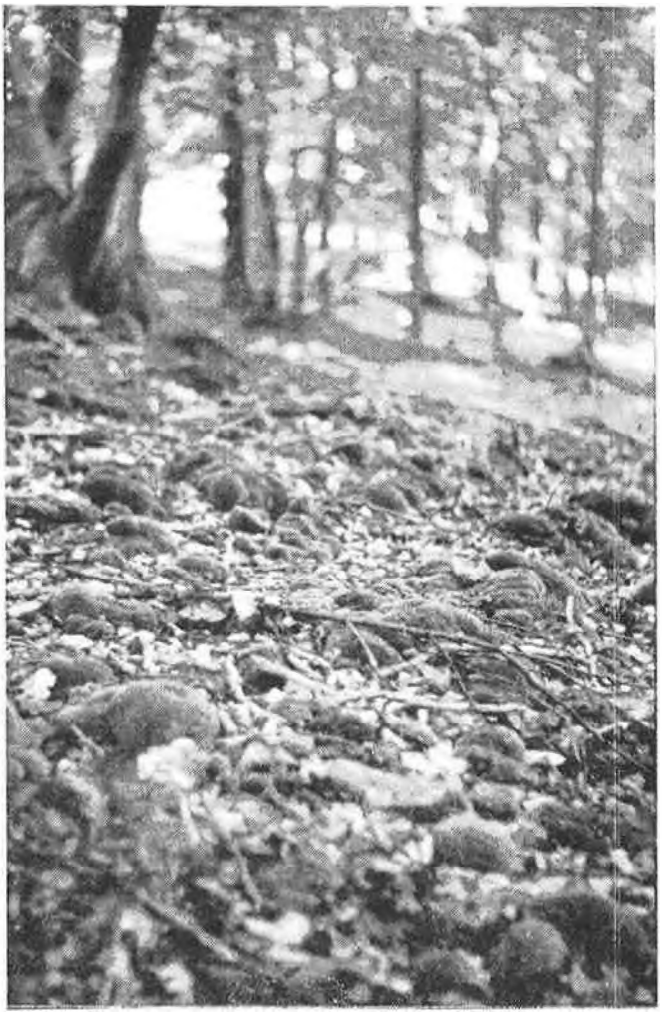

Fig.1 The community Deschampsio-Fagetum with the great dominance of *Leucobryum juniperoideum.*

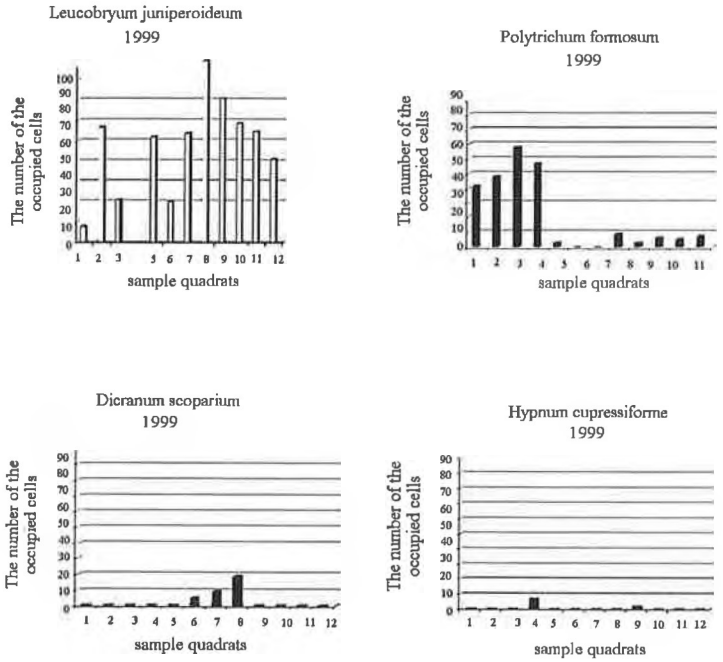
Leucobryum juniperoideum
1999
The number of the occupied cells
sample quadrats
Polytrichum formosum
1999
The number of the occupied cells
sample quadrats
Dicranum scoparium
1999
The number of the occupied cells
sample quadrats
Hypnum cupressiforme
1999
The number of the occupied cells
sample quadrats

Fig.2a

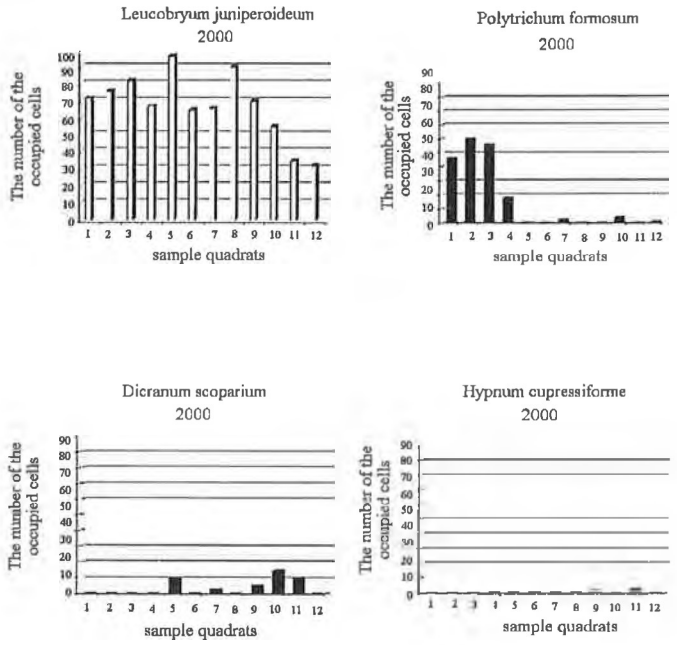
Leucobryum juniperoideum
2000
The number of the occupied cells
sample quadrats
Polytrichum formosum
2000
The number of the occupied cells
sample quadrats
Dicranum scoparium
2000
The number of the occupied cells
sample quadrats
Hypnum cupressiforme
2000
The number of the occupied cells
sample quadrats

Fig.2b

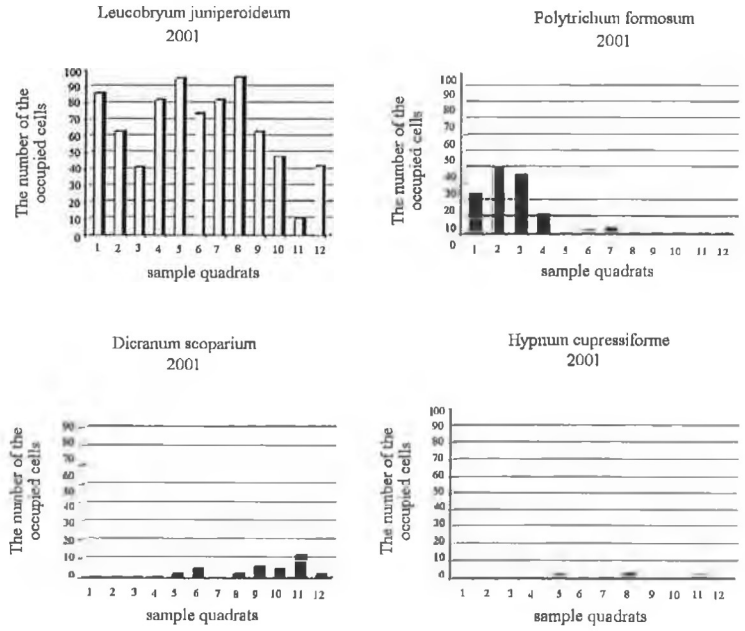

Fig.2c

Fig.2 a, b, c The results of the cover estimation of bryophyte species during three years in the permanent quadrats.

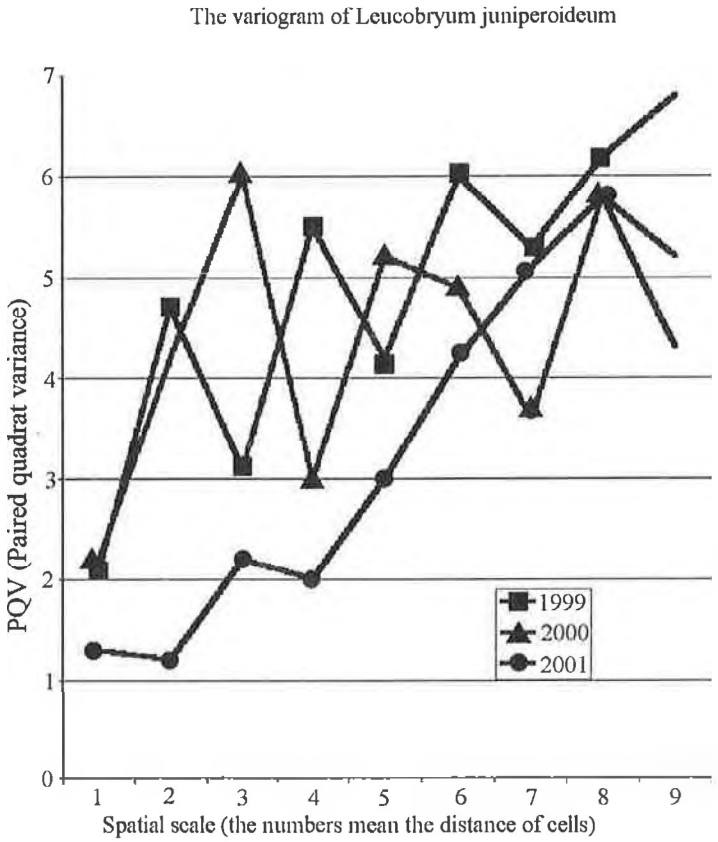

Fig.3 The result of the spatial pattern analysis (PQV) of *Leucobryum juniperoideum* in a permanent quadrat on the basis of three years.

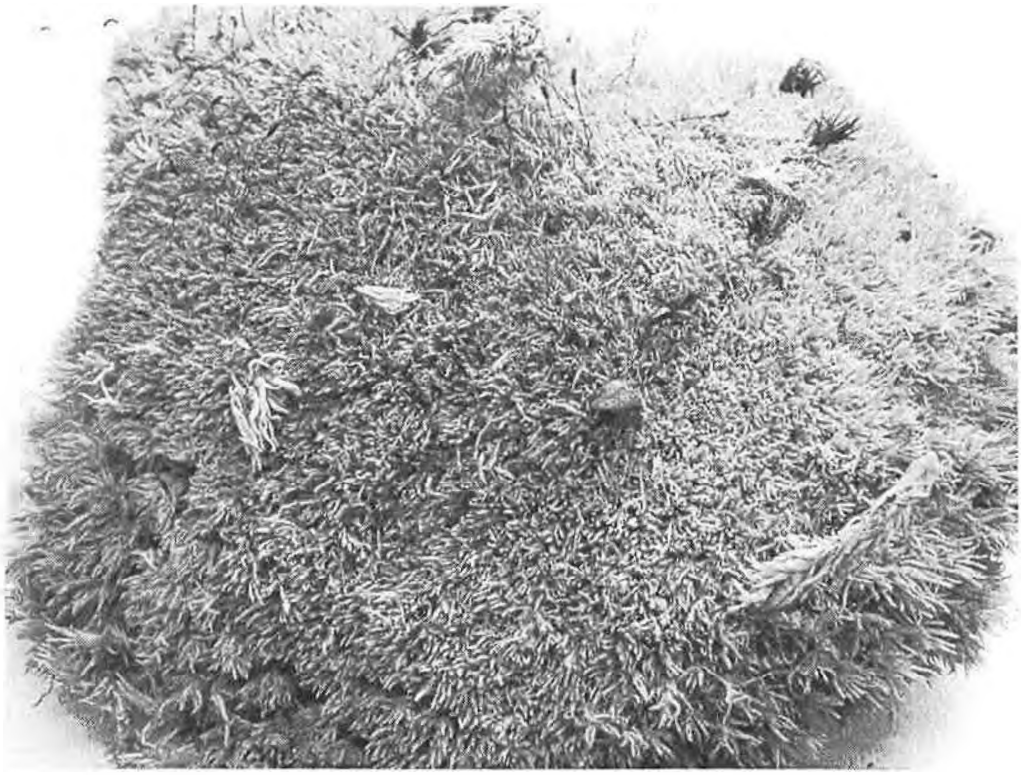

Fig.4 The original top of the turned cushion of *Leucobryum juniperoideum* There are many rhizoids growing to the surface among the leaves in order to fix this side to the ground.

Fig.5 The original bottom of the turned cushion. New branchlets are growing up from the old, brownish leaves.

Fig.6 The rhizoids growing from the leaf apex of *L. juniperoideum*.

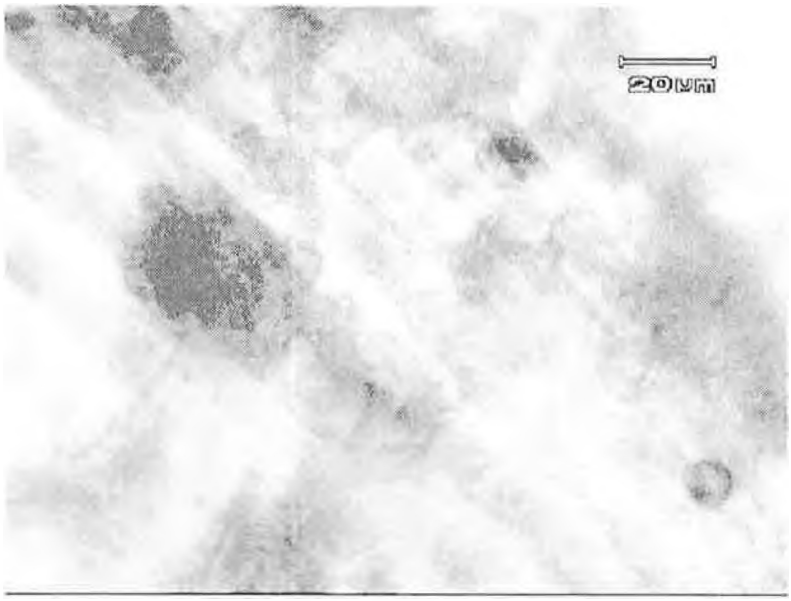

Fig.7 Protonema-like cell groups are developing in the leaf cells toward the upper side of the cushion. It can be probably the start of the development of caducous leaves.