Sauteria 9, 1998 IAL 3 - Proceedings 165-172

ECOPHYSIOLOGICAL BACKGROUND OF MICROHABITAT PREFERENCE BY SOIL-LIVING LICHENS IN A SAND GRASSLAND - FOREST MOSAIC; STUDY PLAN AND INITIAL RESULTS

Ökophysiologische Parameter der bodenbewohnenden Flechten und Moose im Spiegel der Standortwahl der Arten: Forschungsplan und einige vorläufigen Ergebnisse

by

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Key words: Forest-steppe vegetation, soil-living lichens, mosses, water relations, photosynthesis.

Schlagwörter: Waldsteppenvegetation, bodenbewohnenden Flechten, Moose, Wassergehalt, Photosynthese.

Summary: In Hungary soil-living lichen and moss species occur in different microhabitats in a seminatural vegetation mosaic of sand grassland and juniper-poplar scrub. These microhabitats differ markedly in light intensity, soil pH and water availability. Our research program, started in 1996, aims to answer the following question: what is the ecophysiological background of the microhabitat preference of the species? The following species are involved: *Cladonia furcata* (HUDS.) SCHRAD., *C. convoluta* (LAM.) P. COUT., *C. rangiformis* HOFFM., *C. magyarica* VAIN., *Parmelia pokornyi* (KOERB.) SZAT., *Hypnum cupressiforme* HEDW., *Tortella inclinata* (HEDW.F.) LIMPR., and *Tortula ruralis* (HEDW.) GAERTN. et al. This paper presents the study plan and preliminary results on the water relations and photosynthetic light response of the species.

Zusammenfassung: In Ungarn treten bodenbewohnende Flechten- und Moosarten in verschiedenen Mikrohabitaten in einem halbnatürlichen Vegetationsmosaik von Sand-Grasland und Wacholder-Pappel-Strauchland auf. Die Mikrostandorte unterscheiden sich deutlich in der Lichtintensität, dem Boden-pH und der Wasserverfügbarkeit. Unser Forschungsprogramm, das 1996 begonnen wurde, zielt auf die Beantwortung folgender Frage: Was ist der ökophysiologische Hintergrund der Mikrostandortwahl der Arten? Folgende Arten wurden berücksichtigt: *Cladonia furcata* (HUDS.) SCHRAD., *C. convoluta* (LAM.) P. COUT., *C. rangiformis* HOFFM., *C. magyarica* VAIN., *Parmelia pokornyi* (KOERB.) SZAT., *Hypnum cupressiforme* HEDW., *Tortella inclinata* (HEDW. F) LIMPR. und *Tortula ruralis* (HEDW.) GAERTN. et al. Die vorliegende Arbeit stellt den Forschungsplan und vorläufige Ergebnisse über die Wasserverhältnisse und die Lichtabhängigkeit der Photosynthese der Arten vor.

Introduction

In a seminatural sand grassland - juniper poplar scrub vegetation mosaic soil living lichen and bryophyte species occur in different microhabitats. Our study started in 1996 aims to answer the following two questions. What is the exact nature of the species' microhabitat preference? How is this reflected in the ecophysiological properties of the lichens and mosses? This publication presents the research scheme and some preliminary results.

Materials and Methods

o) Study site

The study site is located on the Danube Plain near the village Csévharaszt. The area is covered by calcareous coarse alluvial sand, that winds turned into a dune-land during the Holocene period. After extensive deforestation in historic times, the original forest - steppe vegetation has been replaced by a sand grassland - juniper poplar *(Juniperus communis* L., *Populus alba* L.) scrub mosaic. In this xerothermic drought adapted vegetation soil-living lichens and mosses may reach considerable cover, where species occur in a range of microhabitats differing in light intensity, soil pH and water availability.

o) Species

Cryptogams characteristic or abundant in the vegetation mosaic had been chosen for this study. These were the following soil-living, mostly fruticose lichen species (a concise ecological description is also given for each):

Cladonia convoluta (LAM.) P. COUT.: frequent on the Great Hungarian Plain in extremely dry habitats developed on calcareous sand;

Cladonia furcata subsp. *subrangiformis* (SANDST.) PISUT.: a xerothermic species widespread in dry temperate grasslands on the Great Hungarian Plain and on the hills;

Cladonia magyarica VAIN.: a xerothermic species endemic on the Great Hungarian Plain;

Cladonia pyxidata (L.) HOFFM.: common species throughout Hungary;

Cladonia rangiformis HOFFM.: a rather variable species, most widespread in hilly regions. In the sand vegetation of the plains it appears under juniper trees;

Parmelia pokornyi (KOERB.) SZAT.: a typical xerothermic lichen in the sand areas of the Great Hungarian Plain and on the south-facing slopes of hills.

The following moss species were studied:

Hypnum cupressiforme HEDW.: a very variable species prevalent in forests, grasslands and in rock grasslands. At our site it forms thick mats under juniper canopies;

Tortella inclinata (HEDW.F.) LIMPR.: typical in dry sunny biotopes mainly on calcareous soil;

Tortula ruralis (HEDW.) GAERTN. et al.: in the study site it is typical in the extremely dry open grassland.

For more information on species properties or the cryptogamic flora of the study site see ORBÁN (1991), SIMON and SZERÉNYI (1975) and VERSEGHY (1994).

o) Methods

Most ecophysiological parameters were measured in laboratory on samples collected in the field. Net photosynthesis was determined by using an ADC LCA-2 Infrared Gas Analyser (Analytical Development Company, Hoddesdon, UK) with a special cryptogam sample chamber. Thallus dessication dynamics was followed in laboratory at 25°C, 50% relative air humidity and 120 mmol m^{-2} s^{-1} light intensity on thalli wetted with water spraying. For coenological studies we use both the quadrat method and line transects laid across different habitat patches.

Results and discussion

o) Coenological status and microhabitat preference of the species

To identify the small-scale coenological status of each lichen and moss species a detailed study of the sand grassland - juniper-poplar scrub vegetataion mosaic is under way. In the grassland patches 2x2 m permanent quadrats are placed out quasi randomly and examined using classical (Central European) coenological methods. In addition, line transects running from the juniper - poplar scrub to the open grassland are established, and the occurrence and cover of cryptogam and vascular species are recorded. To identify ecological differences between microhabitats, measurements on light intensity, soil water content and soil pH are also planned along these transects. The first transect revealed a fairly sharp change in species composition under the edge of the juniper canopy as one moves away from a juniper shrub to the grassland.

o) Plant Water relations

Interspecific differences in thallus water relations are tested, as assimilation rate is usually strongly influenced by thallus hydration. We hypothesize that species able to remain sufficiently wet for a longer period may also photosynthetize longer, and thus reach higher growth rate, than the others. Thallus water content and desiccation dynamics are compared for each species. Our initial tests revealed that mosses may reach much higher thallus water content than lichens, with *Hypnum cupressiforme* having a very high value (Table 1). GREEN and LANGE (1994) reported similar differences between mosses and lichens. Although mosses lose water more easily than lichens, they may remain moist enough to assimilate for a longer time (t_{50} values higher) due to the higher initial water content. Among lichens, *Cladonia rangiformis* reached the highest water content and t_{50} values that is in agreement with its shady microhabitat. Despite their very similar morphology, *C. furcata* from the open patches and *C. rangiformis* from juniper shade differ significantly in their water relations. The photosynthetic activity as the function of thallus hydration will also be compared.

o) Photosynthesis

The microhabitats occupied by these cryptogams differ in light intensity. Thus, light response curves for each species are recorded. Our first results show that these cryptogams - even species of high-light grassland sites - basically behave as shade plants, as light saturation occurs at light intensities 1/6-1/3 of full sunlight and compensation points are also rather low (Table 2). For both parameters, mosses have considerably lower values than lichens. Surprisingly, *Hypnum cupressiforme* growing in the shade of juniper shrubs does not differ from the other two moss species of sunny patches. *Cladonia magyarica* reaches the highest compensation and the second highest saturation light intensity (Table 1), that is in agreement with the casual observation, that this species regularly occupies the most open and sunny grassland patches.

Photosynthetic [CO_2]-, temperature- and thallus water content response curves will also be determined for each cryptogam species. Weather conditions differ markedly between seasons in this semiarid temperate biotope: winter is cold often with substantial snow cover, spring and autum is regularly mild and wet, while two-month-long drought periods are common in summer. To test the existence of seasonal photosynthetic acclimation in these cryptogams, the ecophysiological meauserements will be repeated seasonally.

o) Tolerance of prolonged desiccation

In summer, weeks may pass without rain, when dew is the only source of water for these cryptogams. Tests will be made on how long these species are able to tolerate long-term desiccation. During these, samples stored in dry place for different duration will be rewetted and the photosynthetic response curves and clorophyll content will be determined. We suppose, that species with greater tolerance of lengthy desiccation may have an advantage over others during unusually dry summers frequent in the 1980s and 1990s.

Conclusions

Preliminary results of a study on the relationships between microhabitat preference and ecophysiological properties of soil-living cryptogams in a xeric vegetation mosaic suggest substantial differences between sympatric mosses and lichens, while less variation occurs within these groups. Even species of the most sunny sites behave as shade plants according to the photosynthetic light response curves. This is so probably because these cryptogams are moist enough to photosynthetize when light intensity is low (e.g. at dawn or under cloudy sky). Performing the study plan outlined above will provide a better understanding of the functional background of the coexistence of these cryptogamic species. Until know, semiarid temperate habitats have been relatively little covered in studies dealing with lichen ecophysiology (KAPPEN 1988).

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This research is supported by the Hungarian Science Foundation (OTKA grant T019274).

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Table 1: Water relations parameters for several sand grassland - juniper scrub lichen and bryophyte species; WC = thallus water content in the percentage of the wet thallus weight, t_{50} = time needed for the loss of the half of the thallus water content. Within columns, values with the same superscript are not significantly different ($p<0.05$). Results of one way ANOVAs with LSD test for comparison of means. Measuremets were made on samples from late spring collections.

Species	Habitat	WC (%)	t_{50} (min)
LICHENS			
Cladonia convoluta	grassland	54.2^{a}	98.3^{a}
C. furcata ssp. *subrangiformis*	grassland	49.7^{a}	99.3^{a}
C. magyarica	grassland	54.8^{a}	116.7^{a}
C. rangiformis	juniper shade	76.3^{b}	186.7^{b}

Parmelia pokornyi	grassland	51.3^{a}	121.3^{a}
MOSSES			
Hypnum cupressiforme	juniper shade	88.1^{c}	251.7^{c}
Tortella inclinata	grassland	79.0^{b}	216.0^{c}
Tortula ruralis	grassland	60.5^{a}	112.7^{a}

Table 2: Comparison of photosynthetic light response curve parameters for several sand grassland - juniper scrub lichen and bryophyte species. Within columns, values with the same superscript are not significantly different (at the $p<0.05$ probability level). Results of one way ANOVAs with LSD test for comparison of means. Measuremets were made on samples from late spring collections.

Species	Habitat	Light compensation (µmol photons $m^{-2}s^{-1}$)	Light saturation (µmol photons $m^{-2}s^{-1}$)
LICHENS			
Cladonia convoluta	grassland	72^{a}	415^{a}
C. furcata ssp. *subrangiformis*	grassland	115^{ab}	604^{b}
C. magyarica	grassland	217^{c}	525^{b}
Parmelia pokornyi	grassland	139^{b}	477^{ab}
MOSSES			
Hypnum cupressiforme	juniper shade	21^{a}	364^{a}
Tortella inclinata	grassland	40^{a}	415^{a}
Tortula ruralis	grassland	25^{a}	332^{a}