Ecological Questions 21/2015: 39–44 http://dx.doi.org/10.12775/EQ.2015.006

Epigeic lichens of different development stages of forest growing on the heathland

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Abstract. The study deals with the occurrence of epigeic lichens on the study plots with a varying percentage of *Calluna vulgaris* (L.) in different forest development stages on the heathland Glinki near the southern boundary of Toruń. Five plots were established in the gradient of the increasing density of pine. A total of 17 lichen species were identified, typical of this type of habitats, mainly from the genus of *Cladonia*, including e.g.: *Cladonia arbuscula*, *C. furcata*, *C. gracilis*, *C. uncialis* as well as *Cetraria aculeata*, *C. islandica*, and also *Stereocaulon condensatum* and *Trapeliopsis granulosa*. Two species, i.e. *Cladonia digitata* and *C. portentosa* occurred only on the heath. The light availability and the trophic status of the substrate determine this kind of distribution of lichens.

Key words: heathlands, afforestation, epigeic lichens, psammophilous grasslands.

1. Introduction

In the natural conditions of Central Europe, heath ecosystems are considered to be ecological sites, and consequently – refugia of biodiversity. On the one hand, artificial afforestation of heaths has positive effects reflected in the increased forest production area at the expense of the so-called wastelands (Dyrektor Generalny Lasów Państwowych, 2012), on the other hand, however, the afforestation of heaths results in the disappearance of these ecosystems, which contributes to the biodiversity reduction. Without a doubt, heaths are also an excellent study area where processes of natural succession can be observed. Heaths are also analysed in respect of climate changes and an increase in the trophic status of terrestrial habitats (Alatalo, 2014).

Replacement of these ecological systems by cultivation of trees was studied by, inter alia, Nienartowicz et al. (2002, 2009), Rode (1999a, b), Stefańska-Krzaczek and Fałtynowicz (2014, 2013) and von Oheimb et al. (2008). Nevertheless, one should remember that an increase in the woodland area can be achieved not only through artificial regeneration, but also through self-sowing plants spreading on heaths in the process of natural succession. This is a less invasive way of afforestation as it allows the coexistence of forest stands and heaths for a long time. The co-occurrence takes place at least in the initial phases of the development, followed latter by expansive and uncontrolled growth of self-sown plants, which causes the withdrawal of heaths and other non-forest communities.

On the other hand, the preservation of heaths is conducive to the occurrence of epigeic lichens, also within the city limits (cf. Adamska, 2013).

The objective of this study was to compare the contribution of epigeic lichens at the study plots with varied habitat conditions.

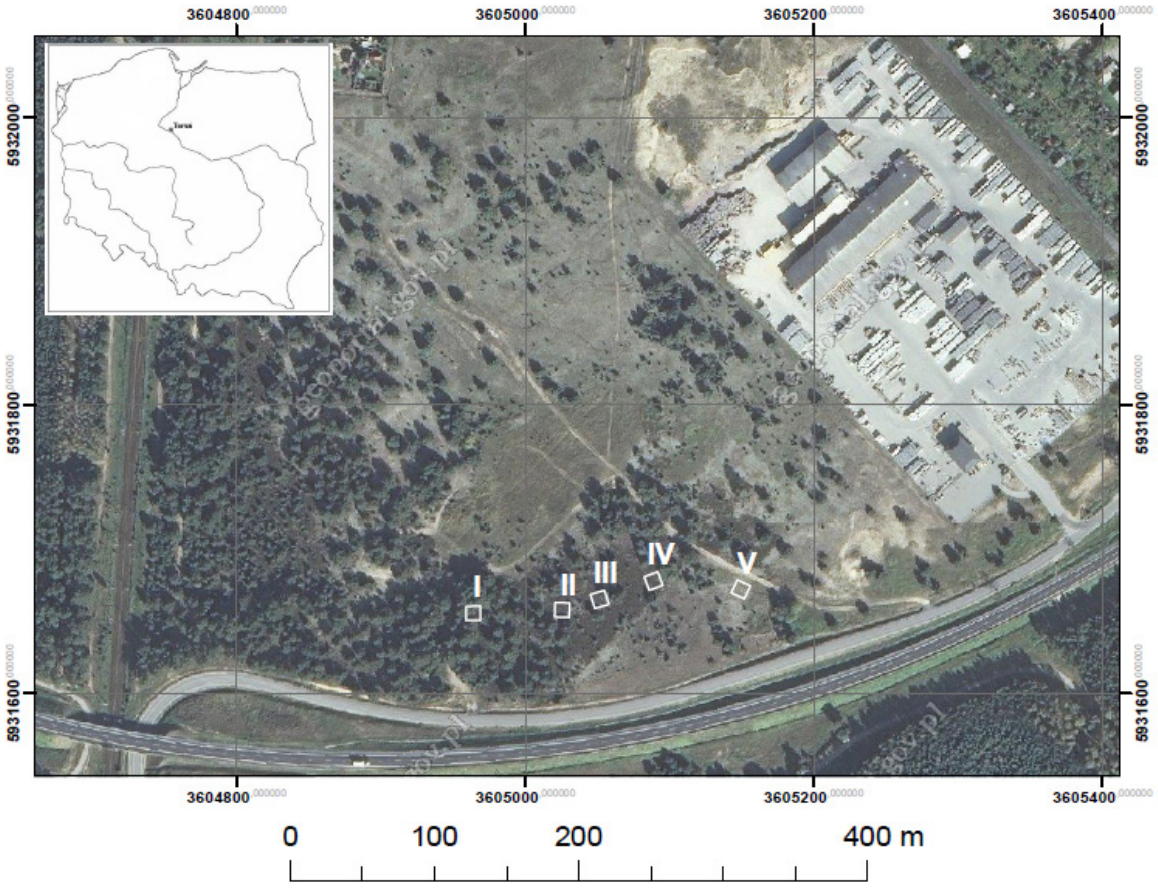

Figure 1. Location of plots I-V in the study area

2. The study area

The research was conducted in the vicinity of the southern border of Toruń city in the district of Glinki, near the village of Mała Nieszawka (Fig. 1). Sandy soils occur in the area covered with heaths. Scots pine *Pinus sylvestris* (L.) occurring on heaths comes mostly from self-seeding. No maintenance treatments have been implemented. In places where the canopy of trees is less dense and hence more light is available, abundant development of the common heather *Calluna wulgaris* (L.) was observed. Five plots (study sites) were selected on the heath (Fig.1) with an area of 100 m^2 each. The plots were located within a short distance from each other and represented different stages of the forest developing as a result of natural regeneration.

3. Methods

The distribution of trees and the vertical projection of the canopy, as well as the area covered by forest litter, psammophilous grasslands and heather were plotted on Figure 2.

The location of the study sites was presented using the ArcGIS 9.3.1 software and the aerial photographs available on the website (www.geoportal.gov.pl). Furthermore, a database for each study plot was compiled. The databases were used to create distribution maps of heather and individual trees with their canopy, and the area covered by the former and the latter was calculated.

Lichenological studies were carried out in 2014 at five study plots, each with an area of 100 m^2. Data on the species composition and the abundance of terricolous (epigeic) lichens were collected from all identified habitats at the study plots.

Lichens were identified using standard lichenological methods (e.g. Smith et al., 2009). Nomenclature of taxa follows mostly Diederich et al. (2015), except for *Clado-*

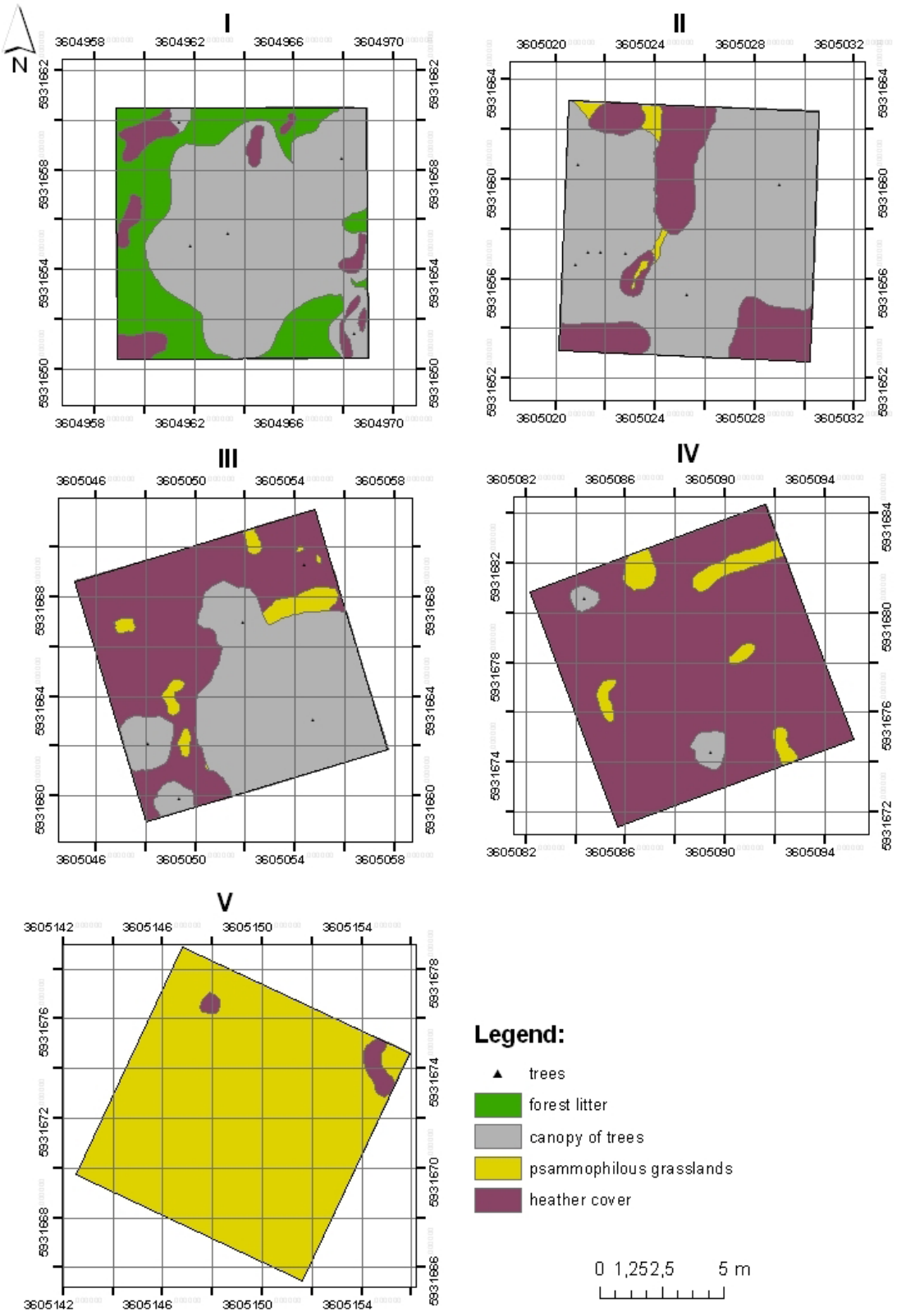

Figure 2. The study plots in the Glinki district in Toruń

nia arbuscula s.l. (Piercey-Normore et al., 2010) and *C. uncialis* (Santesson et al., 2004).

The obtained lichenological data were analysed using the numerical methods included in the software MVSP 3.1 (Kovach, 2003).

4. Results

The study sites were described in terms of habitat conditions (Table 1).

Table 1. Description of the study sites

number of the experimental plots	heather cover [m^2]	canopy of trees [m^2]	psammophilous grasslands [m^2]	forest litter [m^2]
I	8.10	63.57	0.00	30.34
II	22.96	83.91	1.93	0.00
III	46.78	52.05	4.58	0.00
IV	92.49	254	6.55	0.00
V	2.15	0.00	99.31	0.00

The vertical projection of crowns at site I was over 60% of the total land cover. This was the only site with a well-developed groundcover – ca. 30 m^2. The area covered by common heather *Calluna vulgaris* (L.) did not exceed 10 m^2. The largest land cover by the canopy of trees was observed at site II. Despite the cover of ca. 80%, the typical forest groundcover was not observed at site II, while the heather covered over 20% of the site. At site III, the areas covered by heather and the canopy of trees were similar, i.e. 46.78% and 52.05% of the total site's area, respectively. The psammophilous grassland covered up to 5 m^2 at site III. The common heather *Calluna vulgaris* (L.) occurred most abundantly at site IV – over 90% of the land cover. Two small specimens of the Scots pine *Pinus sylvestris* (L.) were found at this site, with the total canopy cover of up to 3m^2. The percentage cover of psammophilous grasslands in the total land cover was estimated at ca. 6.5%. Site V was significantly different from the other sites due to the significant dominance of the psammophilous grassland. No trees occurred at site V and the contribution of heather was insignificant – ca. 2%. For all the study sites, the total land cover of all categories was over 100 m^2. This results from the mutual penetration of land-cover categories identified at the study sites and the canopy of trees.

A total of 17 epigeic lichen species were identified during the lichenological research: *Cetraria aculeata* (Schreb.) Fr., *Cetraria islandica* (L.) Ach., *Cladonia arbuscula* (Wallr.) Flot. subsp. *beringiana* Ahti [*C. arbuscula* subsp. *squarrosa* (Wallr.) Ruoss], *C. cervicornis* (Ach.) Flot., *C. ciliata* Stirt., *C. cornuta* (L.) Hoffm., *C. deformis* (L.) Hoffm., *C. digitata* (L.) Hoffm., *C. foliacea* (Huds.) Willd., *C. furcata* (Huds.) Schrad. subsp. *furcata, C. glauca* Flörke, *C. gracilis* (L.) Willd., *C. phyllophora* Hoffm., *C. portentosa* (Dufour) Coem., *C. uncialis* (L.) F. H. Wigg., *Stereocaulon condensatum* Hoffm., *Trapeliopsis granulosa* (Hoffm.) Lumbsch.

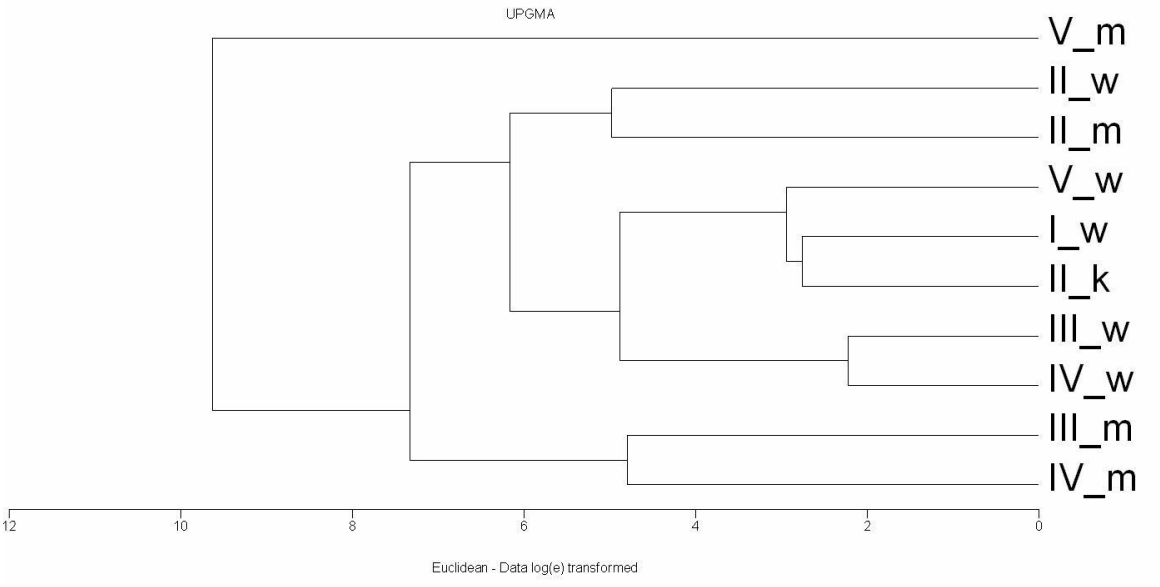

Figure 3. Classification of the study sites based on the presence of lichens: I-V – study sites, m – psammophilous grasslands, k – canopy of trees, w – heather cover

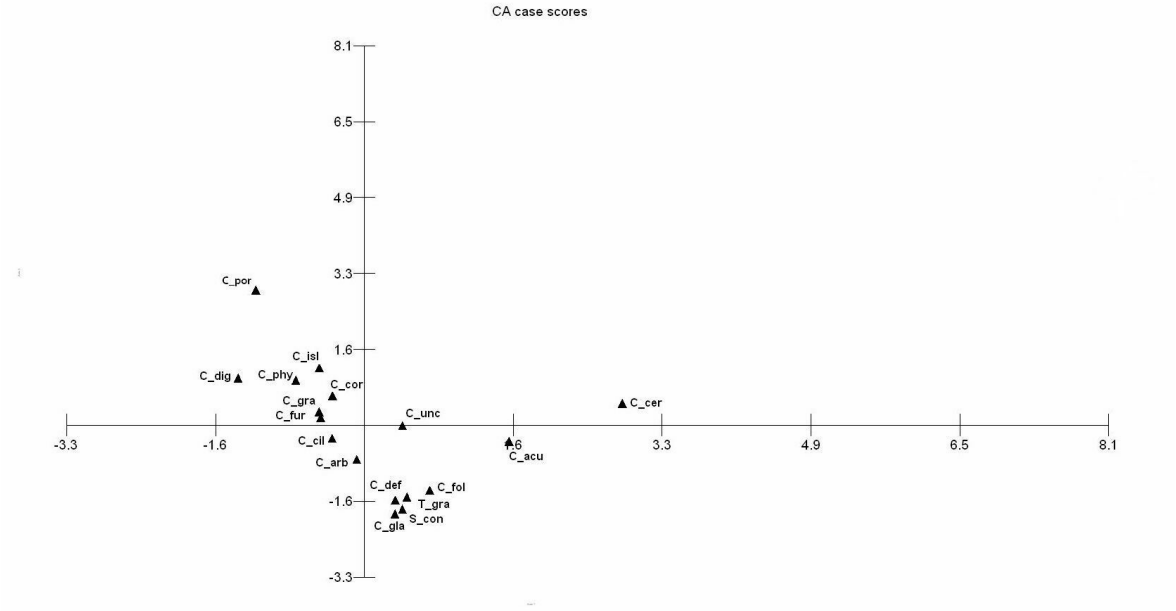

Figure 4. Correspondence Analysis (CA) for data on the occurrence of lichens in the gradient of habitat conditions; *Cetraria aculeata* – C_acu, *C. islandica* – C_isl, *Cladonia arbuscula* – C_arb, *C. cervicornis* – C_cer, *C. ciliata* – C_cil, *C. cornuta* – C_cor, *C. deformis* – C_def, *C. digitata* – C_dig, *C. foliacea* – C_fol, *C. furcata* – C_fur, *C. glauca* – C_gla, *C. gracilis* – C_gra, *C. phyllophora* – C_phy, *C. portentosa* – C_por, *C. ucinalis* – C_unc, *Stereocaulon condensatum* S_con, *Trapeliopsis granulosa* –T_gra

The largest number of lichen species was identified at site V on the psammophilous grassland – 13 taxa, while only 2 lichen species occurred on small fragments with *Calluna vulgaris*. At site II, on the other hand, 8 taxa were identified in patches with heather and this is the largest number of lichen species compared to the other sites. At site I, only one lichen species was found − *Cladonia furcata* in a plant community with heather. As it appears from Figure 3, plots IV and V are similar to each other regarding the contribution of lichens associated with psammophilous grasslands and heaths. Although the largest contribution of heather was determined at site IV, the species composition of lichens in patches with *Calluna vulgaris* is not different from any other site with much smaller percentage occurrence of heather. No lichen thalli occurred in patches with forest litter, and only 2 species with a small cover-abundance were found under the canopy of trees (Fig. 3).

The following species are largely or exclusively associated with psammophilous grasslands: *Cetraria aculeata, Cladonia cervicornis, C. deformis, C. foliacea, C. glauca, C. uncialis, Stereocaulon condensatum* and *Trapeliopsis granulosa*. They were placed on the right side of the ordination diagram. *Cladonia digitata* and *C. portentosa* occurred only on heaths, while *Cetraria islandica* and *Cladonia phylophora* occurred in large numbers on heaths, but also on psammophilous grasslands which were placed on the left side of the ordination axis. The fertility of the substratum and the light conditions account for the arrangement of the species on the diagram and are represented by the 1st ordination axis (Fig. 4).

5. Conclusion

The differences in the species composition and the cover-abundance of epigeic lichens at the study plots are connected with the presence of psammophilous grasslands, rather than patches of heather. Most of the identified species of lichens occurred both on the grassland and on the heath. No lichens occurred on the litter and under the canopy of trees, except for single apothecia of two species. The light availability and the trophic status of the substrate determine this kind of distribution of lichens.

Acknowledgements

The authors express our sincere gratitude to an anonymous Reviewer for valuable remarks and suggestions.

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