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The lichen flora of the Malbork Castle (N. Poland)

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In the present study 32 species of lichens were found. The most numerous were crustose lichens, which are typical of rocks. The follwing species which are known to occur rarely in Poland were identified: *Acarospora* cf. *umbilicata* and *Lecidella* cf. *carpathica*. Two species of the genus *Lepraria* were also noted; among them *Lepraria caesioalba* had not been reported previously from Poland. The non-uniform distribution of lichens in the castle area, mainly the presence of "lichen deserts" was, probably associated with human activities. The most frequent occurring lichens were synanthropic, easily spreading species, e.g. *Caloplaca citrina*, *Lecanora albescens* and *L. dispersa*.

Key words: lichen flora, Malbork Castle.

INTRODUCTION

The process of succession on rock surfaces is initiated by pioneer organisms – lichens. Lichens cause a process of physical and chemical weathering of mineral layers. Hyphae penetrate between the particles of the rocks and induce mechanical weathering. This process can be intensified by the freezing of the water in the thallus which leads to tiny rock cracks (G a r c i a - R o w e, S a i z - J i m e n e z 1988; M o d e n e s i, L a j o l o 1988; N i m i s, Z a p p a 1988; L i p n i c k i, W ó j c i a k 1995).

However, lichenic substances, which are specific compounds produced by lichens, cause a much stronger biodeterioration of the substrate. About 350 of these substances have been discovered so far; depsides, depsidones, dibenzofurans etc. are among them (E l i x et al. 1984; H a w k s w o r t h 1994).

Chemical weathering of the rock can be caused for example by the action of carbon dioxide and biochemical substances (including oxalic acid). The degree

of importance of CO_2 is not known yet, but it seems to be less significant than the activity of other factors (A s c a s o et al. 1982; S e a w a r d, G i a c o b i n i 1988; G e h r m a n n et al. 1988; R o c c a r d i, B i a n c h e t t i, 1988; N i m i s, Z a p p a 1988). However, oxalic acid (probably secreted by the mycobiont) is capable of dissolving soil SiO_2 and converting various silicates into oxalates. A particularly strong impact of oxalic acid can be observed in the case of lichens present on limestones. A variety of products are formed as a result of the reaction between this substance and the rock. Their type depends on the presence of cations (mainly Ca, Fe and Mg), and the state of rock hydration (A s c a s o, G a l v a n 1976; A s c a s o et al. 1982; N i m i s, Z a p p a 1988).

Lichen-caused deterioration is particularly important in the case of lichens growing on buildings and historical monuments. Their chemical and mechanical action significantly accelerates stonework damage. To protect monuments, lichens are removed from the surfaces colonized by them, and measures are taken to prevent their growth and renewed expansion. On the other hand, rare species can be found on walls e.g. monuments are a suitable substrate for montane lichens in lowland areas. Cleaning of the walls sometimes destroys the only localities of rare species.

The objective of this paper is to present the lichen flora of the Malbork Castle. Such investigations have not been carried out in Poland before, although similar studies are known from other European countries (e.g. D e r u e l l e et al. 1979).

STUDY AREA, MATERIALS AND METHODS

The building of the Malbork Castle, which is a O-class monument, began in the 70's of the 13th century and was completed in the middle of the 15th century. It is a three-part fortress, the biggest one of this type in Europe (H a f t k a, M i e r z w i ń s k i 1992). The study area was limited by defence walls. In places where the walls had been destroyed their old route determined on the basis of maps was adopted as the boundary of the area investigated.

During the investigations carried out from 1994 to 1995, localities were marked on the plan of the castle, making an inventory of each one of them. A total of 109 localities were chosen for studies (Fig. 1). In addition the exposure and kind of substrate were described. In some cases additional notes were made regarding the substrate and characteristics features of the locality.

The lichen species were divided into two morphological groups: crustose (S) and foliose (L) and the following ranges were adopted for particular categories when specifying the frequency of occurence: 1-3 occasional, 4-10 — rare, 11-55 — frequent, 56-80 — common. Because of the specifity of the place investigated,

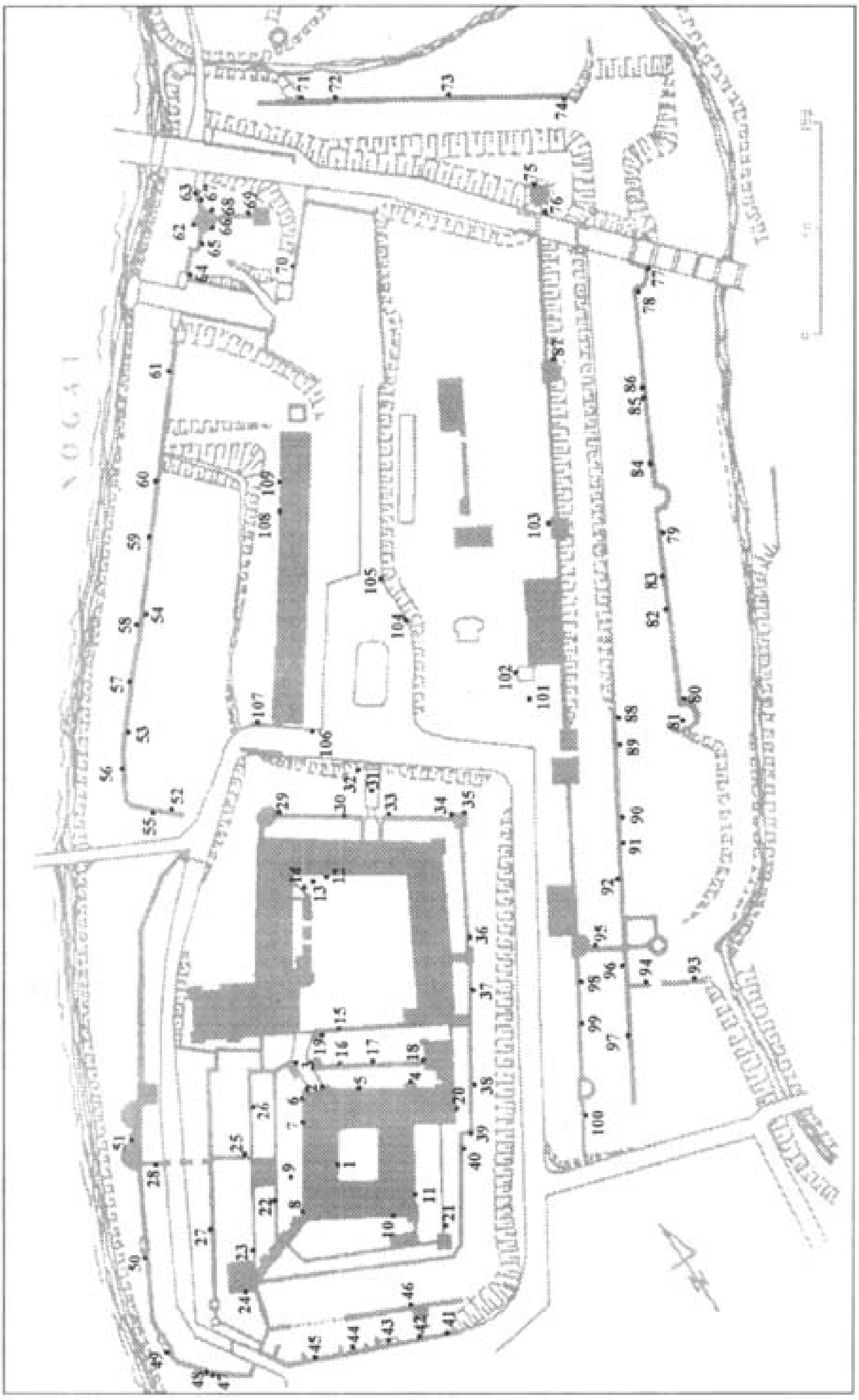

Fig. 1. Distribution of sites (1, 2, 3... – site numbers) in the Malbork Castle (H a f t k a, M i e r z w i ń s k i 1992, modified)

mainly epilithic species were found. The list of lichen species is given in alphabetical order. Each of the species is described by giving its morphological form, frequency of occurrence and number of localities (Table 1).

Lichen species were identified according to Nowak, Tobolewski (1975), Purvis et al. (1992) and species of the genus *Lepraria* following Orange (1995). Species names have been adopted according to Fałtynowicz (1993). The herbarium specimens have been deposited at Gdańsk University.

CHARACTERISTIC OF LICHENS

Thirty two lichen species and some unidentified taxa of the genus *Verrucaria* in the area were found. The group of identified lichens included 2 species of the genus *Lepraria*; among which *L. caesioalba* had not been recorded in Poland before. Probably it is not a rare species. Nevertheless, it is necessary to verify herbarium materials.

Table 1

A list of lichen species found in the Malbork Castle

Species	Morphological form	Frequency	Number of site
Acarospora fuscata (Nyl.) Arnold	S	O	9, 15, 91
A. cf. *umbilicata* Bagl.	S	O	91
Buellia nivalis (Anzi) Zahjbr.	S	F	25, 26, 33, 34, 36, 38, 56, 63, 70, 72-74, 77-79, 84, 86, 92, 96, 107
Caloplaca arenaria (Pers.) Müll. Arg.	S	R	12, 48, 50, 53-56, 59
C. citrina (Hoffm.) Th. Fr.	S	C	5-8, 11, 16-18, 20, 21, 26, 29-32, 34, 38, 39, 41-46, 50, 52-64, 66-70, 72-77, 79-83, 85, 87, 89, 91-100, 103-105, 107-109
C. decipiens (Arnold) Blomb et Forss.	L	F	4, 5, 10, 20, 24, 30, 32, 45-48, 52, 55-60, 62, 70, 76, 80, 83, 88-91, 98, 101, 103
C. holocarpa (Hoffm.) Wade	S	R	25, 29, 30, 53, 60, 84
C. saxicola (Hoffm.) Nordin	L	T	1, 2, 5, 8, 10, 11, 17, 19, 22, 25-27, 30, 31, 35-38, 43, 46, 48, 49, 51, 55-58, 61-63, 66, 68, 73-76, 78, 82, 87, 89-91, 99, 102, 103, 105, 106, 108
C. sp.			47, 52, 80, 100
Candelariella aurella (Hoffm.) A. Zahlbr.	S	T	4, 29, 40, 52, 53, 55, 59, 60, 65, 70, 77, 83, 91
C. vitellina (Hoffm.) Müll. Arg.	S	O	9, 13, 91
Catillaria cf. *minuta* (Massal.) Lettau	S	O	7

cont. 1

Lecanora albescens (Hoffm.) Flk.	S	C	1, 3-10, 17, 19, 20, 21, 24-27, 29-32, 34, 36, 38-41, 43-48, 50-64, 66-70, 73-77, 80-83, 85, 89, 91-93, 95-98, 100-104, 106-109
L. campestris (Schaerer) Hue	S	O	16
L. dispersa (Pers.) Sommerf.	S	C	2, 4, 5, 8, 10-13, 16, 17, 20, 24, 29, 30, 32, 36-38, 40, 41, 43, 45-48, 50, 52-59, 61-63, 65, 66, 70, 73-77, 80, 87, 92, 94, 96, 97, 99, 104, 105, 107, 109
L. muralis (Schreber) Rabenh.	S-L	R	9, 14, 15, 52, 57, 65, 91, 104
Lecidella cf. *carpathica* Koerber	S	O	91
L. stigmatea (Ach.) Hertel et Leuckert	S	R	12, 29, 38, 50, 57, 91, 107
Lepraria caesioalba (B. de Lesd.) Laundon	S	O	7
L. lobificans Nyl.	S	R	5, 8, 9, 27, 67, 71
Neofuscelia loxodes (Nyl.) Essl.	L	O	15
Parmelia sulcata Taylor	L	O	15
Phaeophyscia nigricans (Flk.) Moberg	L	O	55
P. orbicularis (Necker) Moberg	L	F	1, 4, 13, 16, 21, 24, 29, 30, 48, 55-57, 59, 91
Physcia adscendens (Fr.)	L	R	2, 5, 13, 37, 48, 56, 58, 59, 91
P. caesia (Hoffm.) Fürnrohr	L	R	9, 15, 48, 54, 58, 91
P. tenella (Scop.) DC. in Lam. et DC.	L	O	91
Physcia sp.	L		38, 55
Physconia grisea (Lam.) Poelt	L	R	52, 56-59
Protoparmelia badia (Hoffm.) Hafellner	S	O	38
Rinodina gennarii Bagl.	S	F	16, 17, 25, 29, 30, 32, 36, 38, 43, 46, 51-53, 55-58, 70, 75, 77, 83, 89, 91, 93, 103, 107-109
Sarcogyne regularis Koerber	S	O	12
Xanthoria calcicola Oxner	L	O	58
X. parietina (L.) Th. Fr.	L	F	1, 2, 8, 23, 27, 29, 30, 32, 38, 46, 48, 50, 56, 58, 59, 106
Verrucaria sp.	S		6, 7, 12, 13, 15, 28, 32, 34, 39, 41, 43-47, 49, 50, 52-56, 59, 60, 64, 70, 73, 74, 77, 79, 80, 83-85, 89, 92, 94, 100, 107, 109

Explanations: S – crustose, L – foliose; C – common, F – frequent; O – occasional, R – rare

Taking into account their thallus morphology, crustose lichens increase rock weathering in comparison with foliose and fruticose lichens whose thalli adjoin the substrate over a smaller area. There were crustose and foliose species in the area investigated, while fruticose lichens were not found. The group of crustose lichens, which is typical of rocks, prevailed. Figure 2 presents the proportions of particular morphological forms in the Malbork Castle lichen flora.

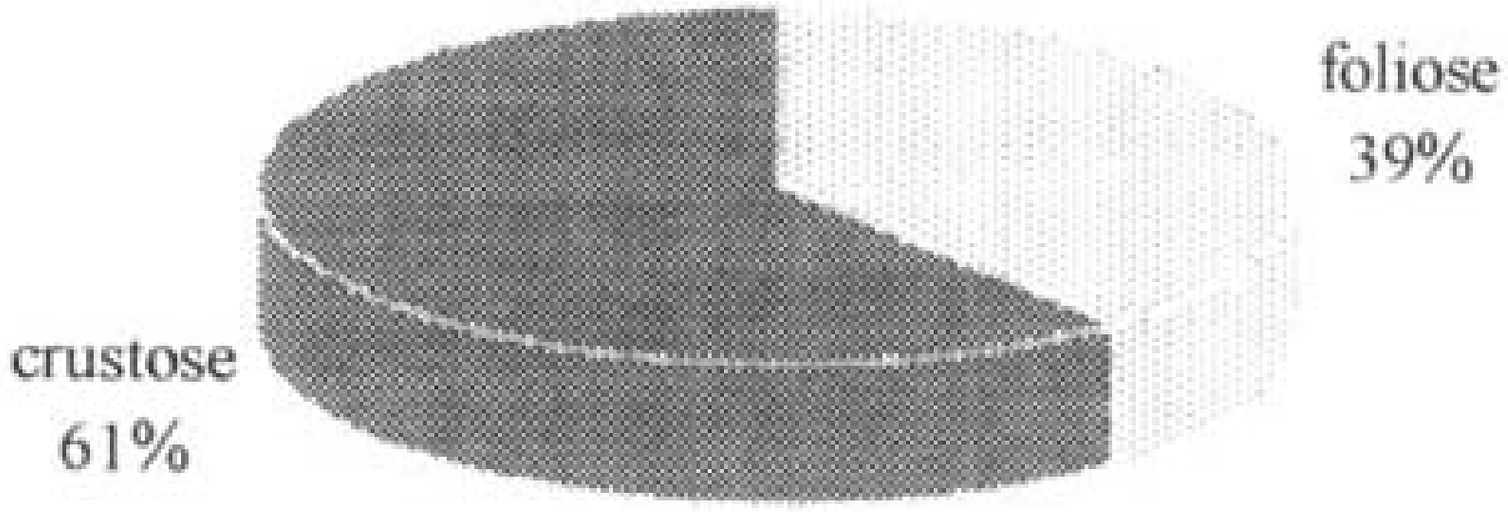

Fig. 2. Proportions of particular morphological forms in the lichen flora of the study area

The identified species were divided into 4 categories according to their frequency of occurrence. Lichens that occured occasionally constitute the largest group. Some of them are very rare in Poland, e.g. *Acarospora* cf. *umbilicata* and *Lecidella* cf. *carpathica*. However, the majority of taxa which occured occasionally in the castle are very common in Poland, e.g. *Parmelia sulcata* and *Phaeophysica nigricans*. The species of this group never appear alone; in general, in localities colonized by them more taxa exist. Strong insolation is the common feature of these localities, and it seems to be essential to lichen development. Furthermore they grow on bricks and mortar, which are easier to settle on than e.g. granite.

Common species, e.g. *Caloplaca citrina*, *Lecanora albescens* and *L. dispersa* are the pioneer species colonizing rocks. The lichens mentioned above colonized 50% or so of localities in the castle area. Fałtynowicz (1994) classified *Lecanora albescens* and *L. dispersa* as anthropogenic lichens, i.e. those which come into being as a result of human activity. They colonize localities of different insolation; strong sunlight is not necessary for their development. They tolerate shade, but some differences can be observed between them – *Lecanora dispersa* occured less frequently in shaded places than the other two taxa.

Lichens were not uniformly distributed in the castle area. "Lichen deserts" were found. They were probably caused by repair works, which had been conducted in the past years. Because of the recent renovation, the walls, seemingly very old, provided quite a new substrate. The majority of them were several years old, but there were also parts which were several dozen of years old. The oldest ones were first of all: Plauen rampart, remains of the northern wall, part of the western walls and parts of the High and Medium Castle. The

richness of the lichen flora in particular localities confirmed this, e.g. Plauen rampart, which was protected from human activity, is a perfect habitat for lichens at present. Sixteen species were found in locality 91 which is 50% of their total number in the castle area.

A similar situation was observed in the case of the western defence wall. The richness of the flora in localities 52-60 was striking. Lichens from 11 genera were found there. The variety of species (there were 19 in all) and their numbers distinguish these localities. It is worthy to note that this wall did not require repair, so it was not exposed to human pressure. An additional factor that could influence the development of the rich lichen flora is the characteristic position of these localities. The western defence wall is in close proximity to the Nogat (arm of the Vistula River) and is exposed to the direct activity of climatic factors from the Vistula Marsh-lands. Since westerly winds predominate in Malbork, they could undoubtedly influence the enrichment of the rock substrate and of the flora as well. The localities were colonized by pulverophilous species, mainly by e.g. *Phaeophyscia orbicularis*, *P. nigricans*, *Physcia adscendens* and *Physconia grisea*.

Lack of human activity is not always favourable for the development of lichens. A poor lichen flora was found on the northern defence wall, actually the remains of it. This was caused by a progresive succession and appearance of vascular plants. Mosses and vascular plants probably suppressed the development of most of the lichens. The remainder of them are not numerous either. In localities 71 and 72 *Buellia nivalis*, *Caloplaca citrina* and *Lepraria lobificans* were noted.

Some of the localities were characterized by a very poor lichen flora. The presence of only one species was noted in 9 localities (3, 22, 28, 33, 35, 42, 71, 86, 88). It is difficult to determine what the cause of this was because there were different environmental conditions there.

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Flora porostów zamku malborskiego (Polska Północna)

Streszczenie

Zamek malborski stanowi trójczłonowy zespół warowny, budowany od lat siedemdziesiątych XIII wieku do połowy XV stulecia. Jest zabytkiem klasy „0" i największym tego typu obiektem w Europie. Na jego murach zanotowano obecność 32 gatunków porostów; 61% ogólnej flory stanowią porosty skorupiaste, pozostałe – to formy listkowate Na terenie zamku rozmieszczone są nierównomiernie; stwierdziłam „pustynie porostowe", których istnienie jest spowodowane ingerencją człowieka. Z największą częstotliwością wystąpiły: *Caloplaca citrina*, *Lecanora albescens* i *L. dispersa*.