

LICHEN MAPPING IN KOMÁROM, NW HUNGARY

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For air pollution lichen mapping of Komárom (NW Hungary) 50 lichen taxa were collected at 84 sites between October 1997 and April 1999. Except for 3 species (*Caloplaca decipiens*, *Evernia prunastri*, *Physcia tenella*) all are new for the investigated area, as it was lichenologically poorly known before. The occurrence of the most frequent species (*Amandinea punctata*, *Lecanora hagenii*, *Phaeophyscia orbicularis*, *Physcia adscendens*, *P. tenella*, *Xanthoria parietina*) correlates with the dominating dust pollution. Two different zones can be distinguished on the basis of the lichen flora. These are situated in the highly built-up central and in the surrounding areas.

Key words: air pollution, lichen mapping, Komárom, Hungary

INTRODUCTION

A correlation between the presence and absence of lichens and air pollution in and around cities was first suggested by Turner and Borrer (1839). Since that time several books and chapters of books (e.g. Ferry et al. 1973, Gilbert 1970, 1973, Hawksworth and Rose 1976, Galun and Ronen 1988) have been published on this relation. The various fields of this subject studied until recent times, as it is found in several pages of reviewed papers in "Recent literature on lichens and air pollution" (e.g. Henderson 1999, 2000). The importance of these investigations is the best shown by Cislighi and Nimis (1997), who compared the distribution of lichens to the distribution of mortality by lung cancer. Some hope for rehabilitation of a better environment is suggested by Hawksworth and McManus (1989) who presented the recolonization of lichens in London due to the cleaner air.

In Hungary bioindication studies by lichens were carried out in Debrecen (Felföldy 1942), Szeged (Gallé 1979), Budapest and its surroundings (Farkas 1982, Lókös 1983, Farkas et al. 1985, Farkas 1990), Debrecen (Toldi 1986), Szombathely and its surroundings (Kiss 1990), Miskolc (Vánca and

Vánca 1990), Szolnok (Malatinszki 1992), Vác (Szabados 1993) and Gyöngyös (Pallos 1996). The air pollution situation in Komárom was only known from chemical analysis. A single lichen specimen (*Caloplaca decipiens*, Balás 1939) was known from the BP Lichen Herbarium only. Solymosi (1978) published 11 epiphytic lichen species (*Calicium pusillum*, *C. subtile*, *Evernia prunastri*, *Graphis scripta*, *Lecanora carpinea*, *Peltigera horizontalis*, *Physcia tenella*, *Physconia pulverulenta*, *Ramalina fastigiata*, *Rinodina exigua*, *R. pyrina*) from the Komárom area during his studies along Danube. Nearby areas in Slovakia were studied by Pišút in 1964, Rusko (1978) and Lackovičová (1997a, 1997b). A common result of the above studies was that due to increasing air pollution several species disappeared from the area.

Therefore we decided to study the lichen flora and distribution in Komárom, to compare the lichenological and chemical data of air pollution, to establish zones of air pollution on the basis of epiphytic lichen dis-

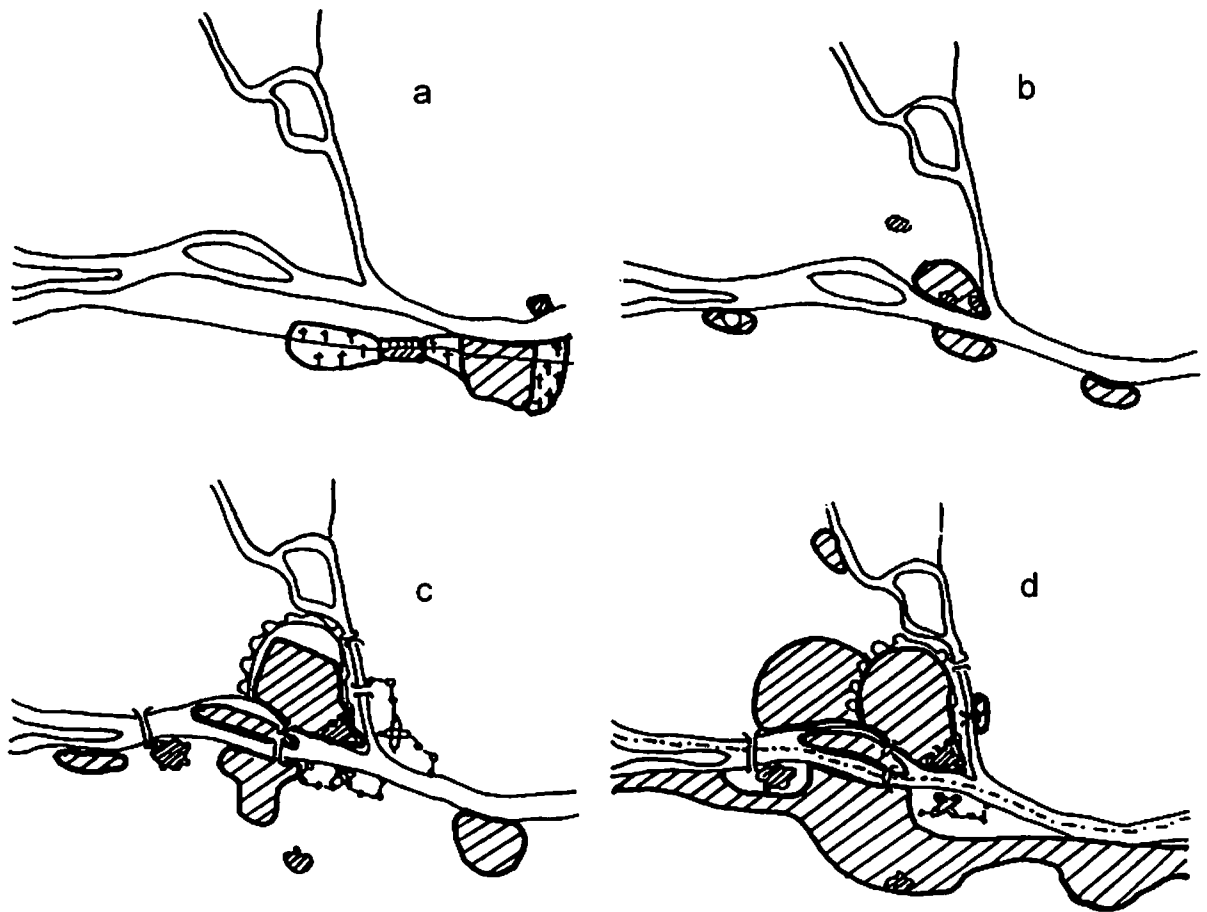


Fig. 1. Development of Komárom (based on figures of Kecskés (1984, pp. 8–9)). a = 1–4. century, b = 10. century–middle 16. century, c = middle 18. century–1896, d = 1977–1984

tribution by the help of hierarchical agglomerative classification. Built-up areas and other factors (e.g. climatic factors) are also intended to be considered (Molnár 1999).

The study area

Komárom is situated on the Little Hungarian Plain (Kisalföld), at the junction of Duna (Danube) and Vág-Duna at 50–100 m above sea level (Fig. 2). Its climate is semiarid, moderately warm, moderately dry continental with relatively mild winters. Mean annual temperature is 9.5 °C, mean yearly rainfall is 530–540 mm. Winds of western and northwestern prevailing direction are strongest here on the Little Hungarian Plain within Hungary.

The development of the settlement Komárom was analysed by Buno-vác (1988), Csikány and Horváth (1998) and Kecskés (1973, 1984, 1985) (Fig. 1). The first signs of a human population at this area dates back to 3500–2500 B. C. A fortress was built on the northern bank of the Danube by the conquering Hungarians recognising the advantageous position of the place during the tenth century. In the seventeenth century the increasing trade (and traffic) through the crossing point on the Danube resulted in small settlements also on the southern bank of the Danube: Rév, Szőny, Koppánmonostor. The smaller settlements formed a united city several decades ago.

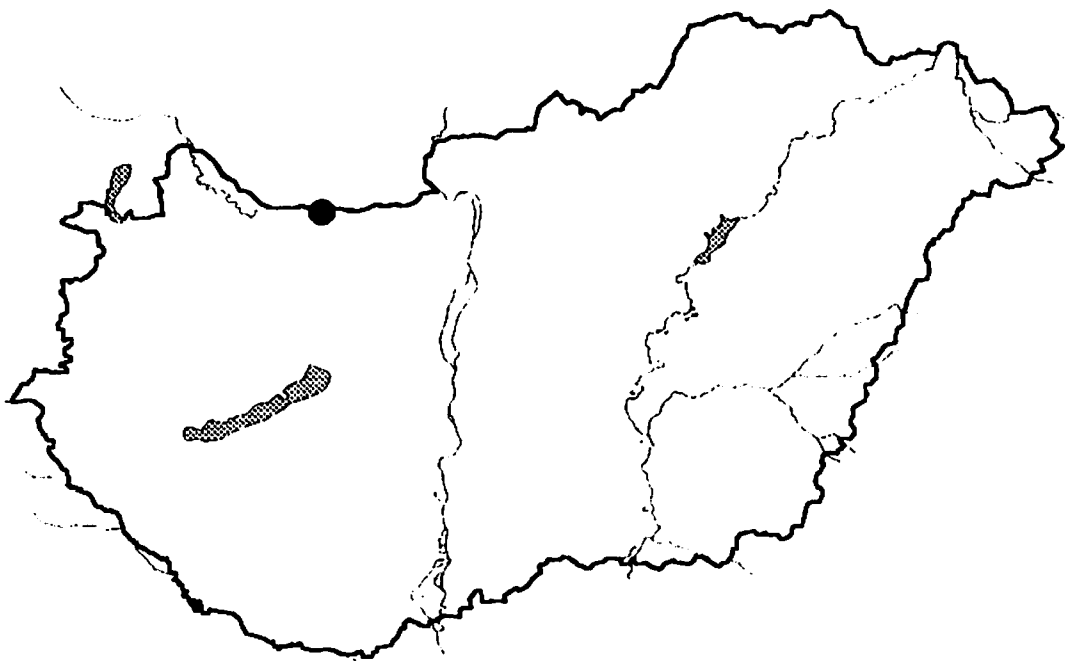


Fig. 2. Location of the study area in Hungary

Komárom is a small city. The area of the highly built-up central part of Komárom is 1491 ha, the surrounding fields (mainly agricultural areas) cover 5526 ha extending 13 km along the Danube. The number of inhabitants in Komárom is ca 20,000.

The air pollution (dust, SO_2 , NO_2 , etc.) originates from anthropogenic sources, from the relatively heavy traffic (along the former main route between Budapest and Vienna), industrial and agricultural activities, and heating. The situation has been improved in the last decade due to decreasing industrial activity and advantageous changes in heating systems (gas heating project). Air pollution parameters are measured at 5 points of the city (dust at 5 points, sulphur dioxide and nitrogen dioxide at 3 points – Fig. 3). Dust pollution dominates over the year reaching or slightly exceeding the value of public health limits, other pollutants remain under these limits.

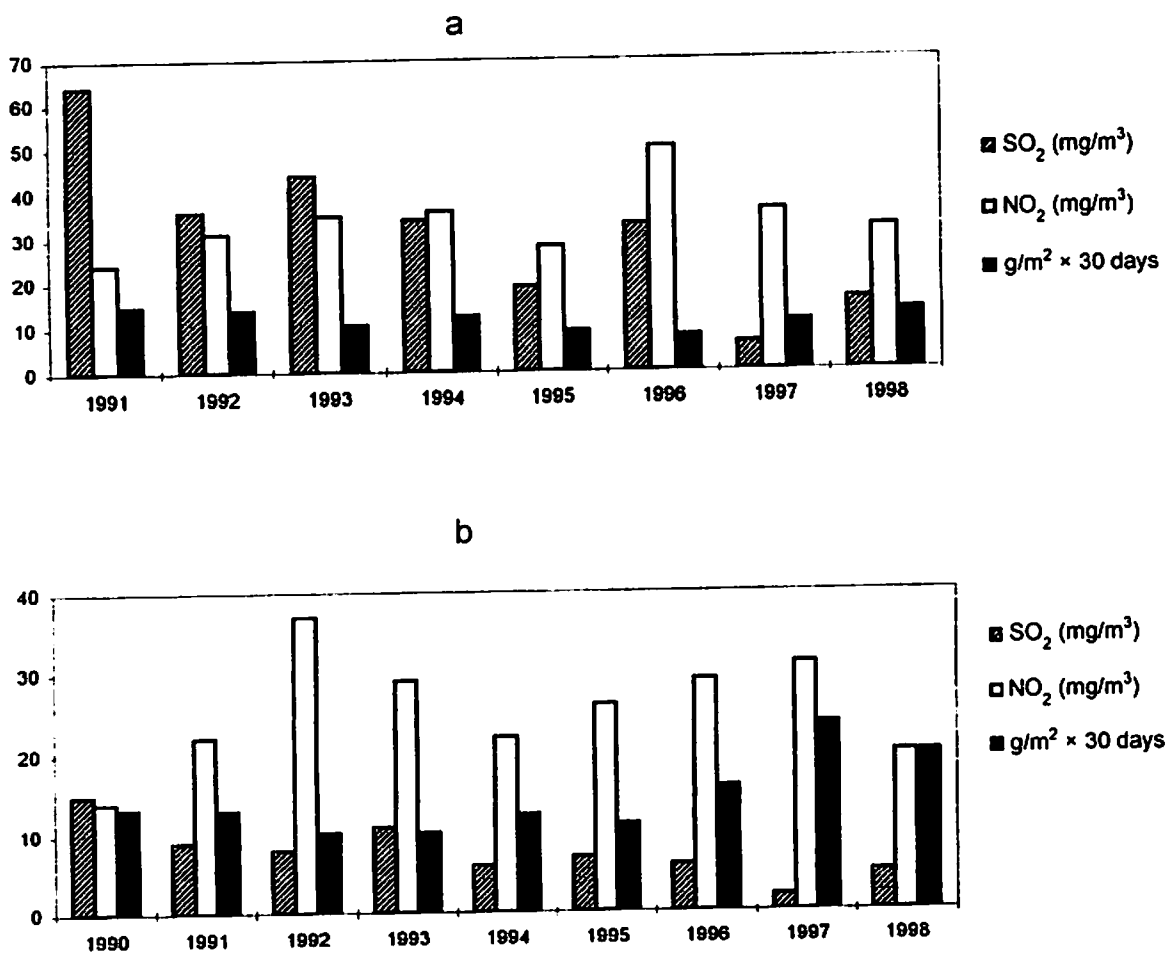


Fig. 3. Main measured parameters over the year in Komárom. a = 6 months with public heating ("winter" half year), b = 6 months without heating ("summer" half year)

MATERIAL AND METHODS

Lichen samples were collected at 84 sites (Fig. 4) between October 1997 and April 1999:

1. Almásfüzitő-felső lakótelep (ltp. – housing estate)
2. Szőny-Molaj (ltp. - housing estate)
3. Szőny-Molaj, Stadion út (road)
4. Szőny-Molaj, Duna-part (bank of Danube)
5. Szőny, Bokréta utca – Szabadság utca kereszteződés (junction of streets)
6. Szőny, Vasútállomás (railway station)
7. Szőny, Magtár épületének falai (outer wall of the building)
8. Szőny, Selye János Kórház parkja (park)
9. Szőny, Kossuth Lajos utca, artézi kút talapzata (concrete structure)
10. Szőny, Kossuth L. u. – Tatai út kereszteződés (junction of streets)
11. Szőny, Tatai út (Komárom végét jelző táblánál) (at the city border)
12. Szőny, Tatai út – Mocsai út kereszteződés (Huszár-dűlő) (junction of streets)
13. Szőny, Virág utca vége (street)
14. Szőny, Virág utca – Ifjúság utca kereszteződés (junction of streets)
15. Szőny, Vasút utcától északra (north from the street)
16. Szőny, Korpáskúti-dűlő (field)
17. Szőny, Túróhát (field)
18. Komárom, Csősz-hegy (field)
19. Komárom, Térffy Gyula utca, park (park)
20. Komárom, Igmándi-erőd falai (outer walls of the building)
21. Komárom, Rüdiger I.-tó partja (lake side)
22. Komárom, Tópart ltp. parkja (park)
23. Komárom, Igmándi úti vadgesztenye-fasor (avenue)
24. Komárom, Arany János utca (street)
25. Komárom, Babits Mihály utca (street)
26. Komárom, Szamos utca 4. (street)
27. Komárom, Szabadság tér (square)
28. Komárom, Petőfi Sándor Általános Iskola udvara (playground)
29. Komárom, Csillag-erőd falai (outer walls of the building)
30. Komárom, Új Csillag ltp. (housing estate)
31. Komárom, Csillag ltp. (housing estate)
32. Komárom, Mártírok útja (Gyermekvárosnál) (road)
33. Komárom, Bem József utca – Táncsics Mihály utca kereszteződés (junction of streets)
34. Komárom, Bem J. utca – Czuczor Gergely utca kereszteződés (junction of streets)
35. Komárom, Táncsics Mihály utca (street)
36. Komárom, Jókai Mór liget (grove)
37. Komárom, Jókai Mór Gimnázium Sport utcai sarka (street)
38. Komárom, Sport utca (street)
39. Komárom, Czibor Zoltán Sporttelep (sports ground)
40. Komárom, Szélső utca (street)
41. Komárom, Rákóczi Ferenc rakpart (quayside)
42. Komárom, Gyár utca (street)
43. Komárom, Autóbusz-pályaudvar (bus-station)

44. Komárom, Szent István tér (square)
45. Komárom, Kelemen László utca – József Attila utca kereszteződés (junction of streets)
46. Komárom, Klapka György utca – Temető utca kereszteződés (junctions of streets)
47. Komárom, Duna Áruház parkolója (parking place)
48. Komárom, Csokonai V. M. utca, ltp. (housing estate)
49. Komárom, Csokonai V. M. utca, Vita Sütőipari Vállalat betonkerítése (concrete fence)
50. Komárom, Sportpálya (sports ground)
51. Komárom, Temető parkolója (parking place)
52. Komárom, Temető (cemetery)
53. Komárom, Báthori István utca (street)
54. Komárom, Báthori I. utca – Marek József utca kereszteződés (junction of streets)
55. Komárom, Marek József utca (street)
56. Komárom, Báthori I. utca – Igmándi út kereszteződés (junction of streets)
57. Komárom, Beöthy Zsolt utca (street)
58. Komárom, Jókai Mór tér (square)
59. Komárom, Frigyes laktanya (barrack)
60. Komárom, Gujon Richárd utca (street)
61. Komárom, Zrínyi Miklós utca – Bocskai István utca kereszteződés (junction of streets)
62. Komárom, Mátyás király utca (street)
63. Komáromtól 0.5 km-re délre, a 13-as számú főút mellett közvetlenül (half km south of Komárom, near road 13)
64. Komáromtól 1 km-re délre, a 13-as számú főút mellett közvetlenül (1 km south of Komárom, near road 13)
65. Komáromtól 1 km-re délre, a 13-as számú főúttól kb. 300 méterre
66. Komárom, Alsó-hosszú-dűlő (field)
67. Komárom, Monostori-erőd (fortress)
68. Koppánymonostor, Pálffy Miklós utca (street)
69. Koppánymonostor, Duna-part (Monostor panziónál) (bank of Danube)
70. Koppánymonostor, Duna-part (Szent Pál-sziget) (bank of Danube)
71. Koppánymonostor, Horgász köz (lane)
72. Koppánymonostor, Radnóti Miklós utca (street)
73. Herkályi- (Ácsi) erdő (forest)
74. Komárom, MÁV ltp. (housing estate)
75. Komárom, Korona utca (street)
76. Komárom, Szent László utca eleje (street)
77. Komárom, Klapka György út (road)
78. Komárom, Tóth Lőrinc utca (street)
79. Nagy- és Kisherkály közötti nyárerdő (forest)
80. Nagyherkály
81. Bartusekpuszta
82. Csém
83. Komárom, városközpont (Igmándi út / Mártírok útja / Klapka György út kereszteződése) (the centre of the city)
84. Komárom, Erdélyi utca (street)

Altogether 630 specimens (mainly corticolous and fewer saxicolous) were collected. A few terricolous specimens originate from wall crevices of buildings and fortresses only.

Identified specimens are deposited in the Lichen Herbarium of the Hungarian Natural History Museum (BP). For identification the following literature sources were used: Purvis et al. (1992), Verseghy (1994), Wirth (1995a, b) and Degelius (1954) for *Collema* species.

A list of species was compiled, the distributions of species were mapped. Zones were established on the basis of the number of species, their distribution, comparing to the level of built-up areas and known air pollution data. Lichen data were analysed by multivariate classification methods (for further details see Csontos et al. 2000).

RESULTS

List (and characterisation) of species

The following 50 taxa were found on the 84 collecting sites:

Amandinea punctata (Hoffm.) Coppins et Scheideg., *Aspicilia contorta* (Hoffm.) Krempelh., *A. moenium* (Vainio) G. Thor et Timdal, *Bacidina arnoldiana* agg., *Bacidina* cf. *egenula* (Nyl.) Vězda, *Caloplaca citrina* (Hoffm.) Th. Fr., *C.* cf. *crenulatella* (Nyl.) Oliv., *C. decipiens* (Arnold) Blomb. et Forss., *C. dolomiticola* s. l., *C. saxicola* (Hoffm.) Nordin, *C. teicholyta* (Ach.) Steiner, *Candelariella aurella* (Hoffm.) Zahlbr., *C. medians* (Nyl.) A. L. Sm., *C. xanthostigma* (Ach.) Lettau, *Cladonia* spp., *Collema crispum* (Hudson) Weber ex Wigg., *Endocarpon pusillum* Hedwig, *Evernia prunastri* (L.) Ach., *Hypogymnia physodes* (L.) Nyl., *Lecania erysibe* agg., *Lecanora albescens* (Hoffm.) Branth et Rostrup, *L.* cf. *chlarotera* Nyl., *L. campestris* (Schaerer) Hue, *L. conizaeoides* Nyl. ex Crombie, *L. dispersa* (Pers.) Sommerf., *L. hagenii* (Ach.) Ach., *L. muralis* (Schreber) Rabenh., *L. saligna* (Schrader) Zahlbr., *Lecidella elaeochroma* (Ach.) Choisy, *L. stigmatea* (Ach.) Hertel et Leuck., *Lepraria incana* (L.) Ach., *Leptogium plicatile* (Ach.) Leighton, *Parmelia sulcata* Taylor, *Phaeophyscia nigricans* (Flörke) Moberg, *P. orbicularis* (Necker) Moberg, *Physcia adscendens* (Fr.) Oliv., *P. caesia* (Hoffm.) Fűrnr., *P. dimidiata* (Arnold) Nyl., *P. stellaris* (L.) Nyl., *P. tenella* (Scop.) DC., *P. wainioi* Räsänen, *Pleurosticta acetabulum* (Necker) Elix et Lumbsch, *Sarcogyne regularis* Körber, *Scoliciosporum chlorococcum* (Graewe ex Stenh.) Vězda, *Staurothele frustulenta* Vainio, *Strangospora pinicola* (Massal.) Körber, *Verrucaria muralis* Ach., *V. nigrescens* Pers., *Xanthoria elegans* (Link) Th. Fr., *X. parietina* (L.) Th. Fr.

Locality numbers and substrates are presented in Table 1.

Forty-seven species (see the above list, except *Caloplaca decipiens*, *Evernia prunastri*, *Physcia tenella*) are new to the investigated area (cf. Introduction). *Bacidina* cf. *egenula* is new also to Hungary, however this record needs further investigation in the field.

The collected species (corticolous indicated in boldface) varies in frequency of their occurrence (characterised by the number of collecting sites), listed in the sequence of decreasing frequency:

Lecanora hagenii	39	<i>Lecania erysibe</i> agg.	3
Amandinea punctata	35	Lecanora conizaeoides	3
<i>Lecanora dispersa</i>	29	<i>Physcia caesia</i>	3
Phaeophyscia orbicularis	25	<i>Candelariella medians</i>	2
<i>Candelariella aurella</i>	24	<i>Cladonia</i> spp.	2
Physcia adscendens	24	<i>Endocarpon pusillum</i>	2
Physcia tenella	23	Hypogymnia physodes	2
Xanthoria parietina	16	Lepraria incana	2
<i>Lecanora muralis</i>	13	<i>Leptogium plicatile</i>	2
<i>Caloplaca</i> cf. <i>crenulatella</i>	11	<i>Physcia dimidiata</i>	2
<i>Lecanora albescens</i>	11	<i>Xanthoria elegans</i>	2
Parmelia sulcata	11	<i>Aspicilia moenium</i>	1
<i>Caloplaca citrina</i>	10	<i>Bacidina</i> cf. <i>egenula</i>	1
Lecanora saligna	10	<i>Caloplaca dolomiticola</i> s. l.	1
<i>Sarcogyne regularis</i>	9	<i>Caloplaca teicholyta</i>	1
<i>Verrucaria nigrescens</i>	9	<i>Collema crispum</i>	1
<i>Phaeophyscia nigricans</i>	8	Evernia prunastri	1
Physcia stellaris	6	Lecanora cf. <i>chlarotera</i>	1
<i>Verrucaria muralis</i>	6	<i>Lecanora campestris</i>	1
Candelariella xanthostigma	5	Lecidella elaeochroma	1
Scoliciosporum chlorococcum	5	<i>Lecidella stigmatea</i>	1
<i>Caloplaca saxicola</i>	4	<i>Physcia wainioi</i>	1
Strangospora pinicola	4	Pleurosticta acetabulum	1
<i>Aspicilia contorta</i>	3	<i>Staurothele frustulenta</i>	1
<i>Caloplaca decipiens</i>	3	<i>Bacidina arnoldiana</i> agg.	1

Obligately corticolous species in this study

Lecanora hagenii	39	Scoliciosporum chlorococcum	5
Amandinea punctata	35	Strangospora pinicola	4
Physcia adscendens	24	Lecanora conizaeoides	3
Physcia tenella	23	Hypogymnia physodes	2
Xanthoria parietina	16	Lepraria incana	2
Parmelia sulcata	11	Evernia prunastri	1
Lecanora saligna	10	Lecanora cf. <i>chlarotera</i>	1
Physcia stellaris	6	Lecidella elaeochroma	1
Candelariella xanthostigma	5	Pleurosticta acetabulum	1

The most frequent species, known from the literature as nitro-frequent (e.g. *Lecanora hagenii*, *Amandinea punctata*, *Phaeophyscia orbicularis*, *Xanthoria parietina*), are widely distributed in the studied area. The typical toxin-tolerant species were found only at a few sites, e.g. *Scoliciosporum chlorococcum* (5), *Lecanora conizaeoides* (3).

Statistical analysis

Lichen floristical data and their distribution data in Komárom were analysed by hierarchical agglomerative classification methods. For results and a detailed discussion see Csontos et al. (2000).

Method MINGFC was most helpful for establishing and confirming lichen distribution zones. The localities of highly built-up areas and those of with more vegetation were possible to distinguish similarly to the results of mapping of species.

Lichen map of Komárom

A zone map of lichen distribution in Komárom and its surroundings (Fig. 4) was created on the basis of lichen floristical data, their mathematical analysis, investigating the distribution of built-up area and pollution data. According to our results the investigated area consists of two struggle zones and some patches of normal lichen vegetation. No lichen desert was detected.

The centre of Komárom with continuous built-up area with relatively high pollution (CO, Pb) due to increased traffic is the inner struggle zone (struggle zone I). Epiphytic lichen cover is not higher than 5%, dominating species is *Lecanora hagenii*. Foliose lichens if any (e.g. *Phaeophyscia orbicularis*, *Physcia adscendens*, *P. tenella*, *Xanthoria parietina*), present with small (1–2 cm²) thalli.

Surrounding areas with lower degree of built-up area and pollution is the outer struggle zone (struggle zone II). Epiphytic lichen cover (ca 30–40%) and size of foliose lichen thalli (5–50 cm²) are close to normal. Thalli of *Xanthoria parietina*, occurring in both zones, are sterile and about 1 cm in diameter in zone I, and richly fertile with the size of 20–50 cm² in zone II.

Normal zone was recognised at only two localities (Ácsi-erdő, Csém). These areas are not very rich in species, however some rare species occurred exclusively at one or both places (e.g. *Hypogymnia physodes*, *Lecanora*

Table 1

The occurrence of the lichen species at the collecting sites (ct: corticolous, r, ru: saxicolous, t, te: terricolous)

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.		
<i>Amandinea punctata</i>	ct	ct	ct	ct						ct	ct	ct	ct		ct	ct			ct	ct		ct	ct							ct		
<i>Aspicilia contorta</i>																														ru		
<i>Aspicilia moenium</i>																																
<i>Bacidina arnoldiana</i> agg.																																
<i>Bacidina</i> cf. <i>egenula</i>																					ru			ru								
<i>Caloplaca citrina</i>			ru																		ru			ru								
<i>Caloplaca</i> cf. <i>crematella</i>			ru																					ru								
<i>Caloplaca decipiens</i>																								ru								
<i>Caloplaca dolomiticola</i> s. l.																					ru						ru					
<i>Caloplaca saxicola</i>																																
<i>Caloplaca teicholyta</i>																																
<i>Candelariella aurella</i>			ru						ru												ru	ru		ru								
<i>Candelariella medians</i>									ru															ru								
<i>Candelariella xanthostigma</i>	ct																ct															
<i>Cladonia</i> spp.																																
<i>Collema crispum</i>																																
<i>Endocarpon pusillum</i>									ru																							
<i>Evernia prunastri</i>																																
<i>Hypogymnia physodes</i>	ct																															
<i>Lecania erysibe</i> agg.									ru												ru							ru				
<i>Lecanora albescens</i>									ru												ru			ru								
<i>Lecanora</i> cf. <i>chlarotera</i>																																
<i>Lecanora campestris</i>																																
<i>Lecanora conizaeoides</i>																																
<i>Lecanora dispersa</i>			ru						ru	ru											ru	ru	ct	ru	ru							
<i>Lecanora hagenii</i>	ct	ct			ct	ct				ru																						
<i>Lecanora muralis</i>			ru																		ru	ct										
<i>Lecanora saligna</i>	ct								ct							ct							ct	ct							ct	
<i>Lecidella elaeochroma</i>																																
<i>Lecidella stigmatea</i>																																
<i>Lepraria incana</i>																ct																
<i>Leptogium plicatile</i>									r,t																							
<i>Parmelia sulcata</i>	ct	ct										ct				ct																
<i>Phaeophyscia nigricans</i>									ru																							
<i>Phaeophyscia orbicularis</i>	ct	r,c	ct	ct									ct																			ct
<i>Physcia adscendens</i>	ct	ct	ct							ct		ct																				ct
<i>Physcia caesia</i>			ru																													
<i>Physcia dimidiata</i>																																

Table 1 (cont.)

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.					
<i>Physcia stellaris</i>		ct															ct																		
<i>Physcia tenella</i>	ct	ct	ct	ct								ct					ct	ct									ct			ct					
<i>Physcia wainioi</i>							ru																												
<i>Pleurosticta acetabulum</i>																																			
<i>Sarcogyne regularis</i>																				ru	ru			ru							ru				
<i>Scoliciosporum chlorococcum</i>		ct																			ct		ct												
<i>Staurothele frustulenta</i>																																			
<i>Strangospora pinicola</i>																			ct													ru			
<i>Verrucaria muralis</i>																				ru												ru			
<i>Verrucaria nigrescens</i>									ru											ru	ru			ru											
<i>Xanthoria elegans</i>																																			
<i>Xanthoria parietina</i>	ct	ct		ct								ct				ct																			
	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.	59.	60.					
<i>Amandinea punctata</i>		ct				ct		ct	ct											ct				ct		ct					ct				
<i>Aspicilia contorta</i>														ru																					
<i>Aspicilia moenium</i>																																			
<i>Bacidina arnoldiana</i> agg.																																			
<i>Bacidina</i> cf. <i>egenula</i>																									ru										
<i>Caloplaca citrina</i>						ru						ru									ru				ru							ru			
<i>Caloplaca</i> cf. <i>crenulatella</i>						ru		ru			ru				ru		ru					ru											ru		
<i>Caloplaca decipiens</i>																										ru									
<i>Caloplaca dolomiticola</i> s. l.																																			
<i>Caloplaca saxicola</i>																																			
<i>Caloplaca teicholyta</i>																																			
<i>Candelariella aurella</i>					ru	ru		ru	ru		ru	ru	ru		ru		ru	ru	ru		ru	ru					ru		ru	ru	ru				
<i>Candelariella medians</i>																																			
<i>Candelariella xanthostigma</i>																					ct														
<i>Cladonia</i> spp.																																			
<i>Collema crispum</i>																																			
<i>Endocarpon pusillum</i>																																			
<i>Evernia prunastri</i>																																			
<i>Hypogymnia physodes</i>																																			
<i>Lecania erysibe</i> agg.																																			
<i>Lecanora albescens</i>					ru	ru						ru													ru							ru	ru		
<i>Lecanora</i> cf. <i>chlarotera</i>																																			
<i>Lecanora campestris</i>																																			
<i>Lecanora conizaeoides</i>						ct																													
<i>Lecanora dispersa</i>					ru	ru		ru	ru		ru	ru			ru	ru	ru	ru	ru		ru	ru	ru		ru		ru		ru		ru		ru		
<i>Lecanora hagenii</i>	ct	ct	ct	ct		ct	ct	ct	ct	ct	ct	ct		ct							ct				ct		ct		ct		ct		ct		

Table 1 (cont.)

	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.	59.	60.					
<i>Lecanora muralis</i>					ru	ct								ru					ru											ct					
<i>Lecanora saligna</i>							ct		ct																										
<i>Lecidella elaeochroma</i>																																			
<i>Lecidella stigmatea</i>																																			
<i>Lepraria incana</i>																																			
<i>Leptogium plicatile</i>																																			
<i>Parmelia sulcata</i>										ct																				ct					
<i>Phaeophyscia nigricans</i>																															ru				
<i>Phaeophyscia orbicularis</i>						ru			ct	ct				ru						ru			ru	ct		ct									
<i>Physcia adscendens</i>		ct					ct													ct															
<i>Physcia caesia</i>						ru																													
<i>Physcia dimidiata</i>																																			
<i>Physcia stellaris</i>																																			
<i>Physcia tenella</i>		ct								ct																					ct				
<i>Physcia wainioi</i>																																			
<i>Pleurosticta acetabulum</i>																																			
<i>Sarcogyne regularis</i>									ru									ru	ru												ru				
<i>Scoliciosporum chlorococcum</i>							ct																												
<i>Staurothele frustulenta</i>																																			
<i>Strangospora pinicola</i>							ct			ct																									
<i>Verrucaria muralis</i>																																ru			
<i>Verrucaria nigrescens</i>						ru			ru					ru												ru					ru				
<i>Xanthoria elegans</i>																																			
<i>Xanthoria parietina</i>							ct							ct																		ct			
	61.	62.	63.	64.	65.	66.	67.	68.	69.	70.	71.	72.	73.	74.	75.	76.	77.	78.	79.	80.	81.	82.	83.	84.	85.	86.	87.	88.	89.	90.					
<i>Amandinea punctata</i>			ct	ct	ct	ct														ct	ct	ct	ct												
<i>Aspicilia contorta</i>																																			
<i>Aspicilia moenium</i>																																			
<i>Bacidina arnoldiana</i> agg.																																			
<i>Bacidina</i> cf. <i>egenula</i>																																			
<i>Caloplaca citrina</i>		ru																																	
<i>Caloplaca</i> cf. <i>crenulatella</i>																																			
<i>Caloplaca decipiens</i>																																			
<i>Caloplaca dolomiticola</i> s. l.																																			
<i>Caloplaca saxicola</i>																																			
<i>Caloplaca teicholyta</i>																																			
<i>Candelariella aurella</i>																																			
<i>Candelariella medians</i>																																			
<i>Candelariella xanthostigma</i>																																			

Table 1 (cont.)

	61.	62.	63.	64.	65.	66.	67.	68.	69.	70.	71.	72.	73.	74.	75.	76.	77.	78.	79.	80.	81.	82.	83.	84.	85.	86.	87.	88.	89.	90.
<i>Cladonia</i> spp.																														
<i>Collema crispum</i>																														
<i>Endocarpon pusillum</i>																							ct							
<i>Evernia prunastri</i>													ct																	
<i>Hypogymnia physodes</i>																														
<i>Lecania erysibe</i> agg.																														
<i>Lecanora albescens</i>							ru																	ru						
<i>Lecanora cf. chlorotera</i>																							ct							
<i>Lecanora campestris</i>																														
<i>Lecanora conizaeoides</i>																ct														
<i>Lecanora dispersa</i>	ru	ru					ru	ru									ru										ru			
<i>Lecanora hagenii</i>			ct	ct	ct		ct	ct					ct	ct			ct	ct			ct	ct								
<i>Lecanora muralis</i>							ru		ru													ct								
<i>Lecanora saligna</i>												ct																		
<i>Lecidella elaeochroma</i>																														
<i>Lecidella stigmatea</i>																														
<i>Lepraria incana</i>												ct																		
<i>Leptogium plicatile</i>																														
<i>Parmelia sulcata</i>					ct																ct									
<i>Phaeophyscia nigricans</i>			ct					ru		ct												ct								
<i>Phaeophyscia orbicularis</i>			ct	ct	ct			ru		ct			ct				ru				ct	ct	ct	ct						
<i>Physcia adscendens</i>			ct	ct			ct	ct		ct	ct		ct				ct	ct			ct	ct	ct	ct						
<i>Physcia caesia</i>																														
<i>Physcia dimidiata</i>																														
<i>Physcia stellaris</i>										ct											ct									
<i>Physcia tenella</i>			ct	ct	ct	ct	ct	ct			ct		ct								ct	ct	ct	ct						
<i>Physcia wainioi</i>																														
<i>Pleurosticta acetabulum</i>																														
<i>Sarcogyne regularis</i>							ru																					ru		
<i>Scoliciosporum chlorococcum</i>										ct		ct																		
<i>Staurothele frustulenta</i>																														
<i>Strangospora pinicola</i>													ct					ct												
<i>Verrucaria muralis</i>								ru																			ru			
<i>Verrucaria nigrescens</i>																										ru	ru			
<i>Xanthoria elegans</i>								ru	ru																					
<i>Xanthoria parietina</i>			ct	ct	ct			ct		ct											ct		ct	ct						

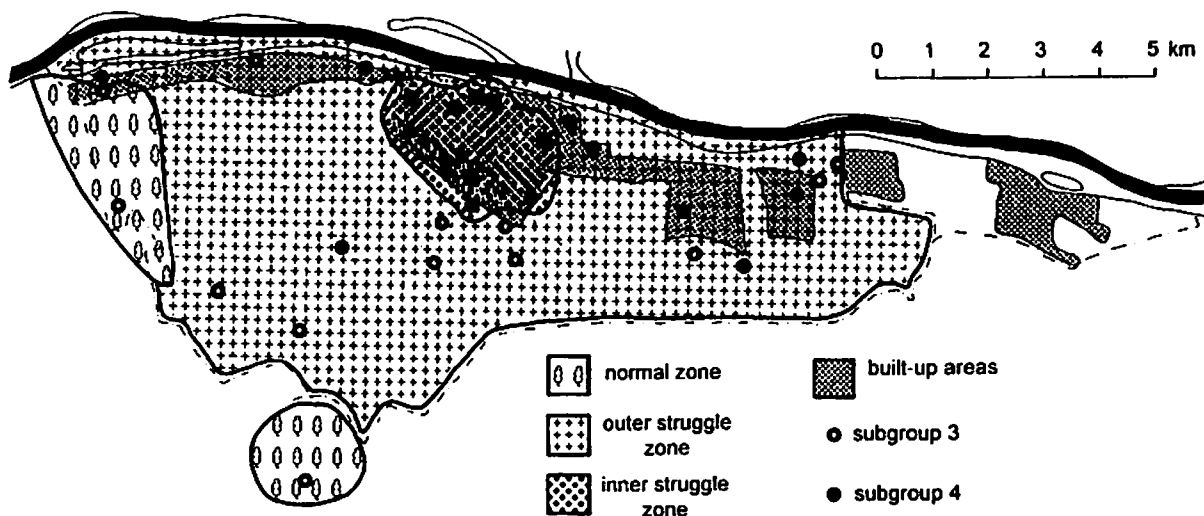


Fig. 4. The lichen map of Komárom with the reallocated epiphytic subgroups obtained by the global optimization method (Csontos et al. 2000)

cf. *chlarotera*, *Lecidella elaeochroma*, *Lepraria incana*, *Pleurosticta acetabulum*). *Evernia prunastri*, the only fruticose species, was found at Csém.

Improvement in environmental conditions due to the activity of the local authorities of public health is possible to be detected by reinvestigation of the lichen flora in the future (compared to the recent lichen map). Changes in lichen cover, extinction or recolonisation of various species can be expected. Colonisation of species is also possible from the normal zone or struggle zone II to the struggle zone I.

*

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