

THE LICHEN-FORMING AND LICHENICOLOUS FUNGI OF THE SOROKSÁR BOTANICAL GARDEN (SZENT ISTVÁN UNIVERSITY, BUDAPEST, HUNGARY)

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Abstract: A total of 78 lichen-forming and 5 lichenicolous fungi were recognised in the Soroksár Botanical Garden (Budapest, Hungary). *Psorotichia frustulenta* is new to Hungary. A nitrofrequency lichen community is represented by the most frequent, common species. Some rare, interesting species, e.g. *Flavoparmelia soredians*, *Piccolia ochrochlora* were also found. The legally protected *Cladonia magyarica* was discovered in sandy grassland habitat of a sand dune.

Key words: anthropogenic, eutrophicated, floristic novelty, lichens, protected species

INTRODUCTION

Gardens in general (e.g. botanical gardens, arboreta, castle gardens, public parks, gardens of cemeteries or sanatoria) created artificially by various purposes do not represent natural biotopes. However, as continuous green areas they supply habitats – e.g. as possible green corridors – for various plants and animals, also for lichens.

Special attention of lichenologists was devoted to the study of these habitats and also several lichenological studies were published from botanical gardens worldwide (e.g., ALMBORN 1943, APTROOT and HONEGGER 2006, ARVIDSSON and LINDSTRÖM 1980, MALYSHEVA and SIMACHEV 1994, MALYSHEVA and SVJAZEVA 1995, SCHULTZ 1996, SIPMAN and APTROOT 2007), as well as in Hungary (GALLÉ 1966, 1967, 1970, KISS and SEAWARD 1985, KOREN 1874, 1883, SOLYMOSSI 1976, VERSEGHY 1968). There are also a large number of specimens kept in herbaria hidden, unpublished.

Checklists of these treatments carry a number of common features, such as common, frequent species, which are expected also from the lichen flora of the Soroksár Botanical Garden. Although the colonisation of the species depends on several environmental conditions, an even richer lichen flora could develop among undisturbed circumstances.

The Soroksár Botanical Garden is situated in the microregion “Pesti hordalékkúp-síkság” (named also as “Öreg-Homok”) at the Pest alluvial plain of the Danube lowlands. Phytogeographically it belongs to the floristical area Praematricum of the floristical district Eupannonicum.

Due to the urbanisation, increasing of built-up areas, and intense landscape usage the natural vegetation remained here and there, in small patches only. At the foundation (in 1963) the Soroksár Botanical Garden of 60 hectares was covered mostly by the plantations of the Budapest State Forestry: spruce, poplar, wild pear, acacia, black walnut, silverberry, ash, and oak. Forest plantations started in 1952, remnants of these still exist in the garden. Remnants of vineyards and orchards of former owners (individual farmers) represent smaller areas. Therefore, the mean age of the Soroksár Botanical Garden is rather young, without larger, several-hundred-year-old trees.

The entire area of the Garden is of medium elevation (alt. 110–120 m) proportioned lowland, its surface is covered by loose sediments of sand and pebbles of 5–15 m layer. It has characteristic soil types produced on Danube sediments: wind-blown sand, humus-rich sand, loess sand, meadow soils, bog meadow soils, brown earth produced on sand, raw alluvial soil at a smaller area.

The climate of this area is moderately warm and dry (annual precipitation ca 550–580 mm), arid conditions are rather frequent. The typical chemical character of the waters is dominantly of CaMgHCO_3 type.

The area of the botanical garden has been registered as a nature conservation area of the capital since 1977. It represents an “island” in the neighbouring cultivated landscape since it is surrounded by agricultural fields of 1–2 km thick zone. The closest extended forest area is the Halmi-erdő.

In 2013 the Botanical Department of the Szent István University (former Corvinus University of Budapest) and the Hungarian Biodiversity Research Society initiated an inventory study and documentation of the cryptogamic organisms living in the Soroksár Botanical Garden, so lichenological results carried out in the framework of this agreement are presented below.

MATERIAL AND METHODS

Field work was carried out in 24.08.2013, 09.06.2013, and 07.04.2015. Voucher specimens are deposited in the lichen collection of the Hungarian Natural History Museum (BP).

SMITH *et al.* (2009) and WIRTH *et al.* (2013) were used for identifications of the species. Morphological-anatomical investigations were carried out by standard methods using Olympus SZX-9 and BX-50, Nikon Eclipse/NiU (DIC) dissecting and research microscopes. Micrographs were prepared by Olympus

E450 camera (with Quick Photo Camera 2.3 software) and Nikon DS-Fi1c camera (with NIS-Elements BR software) according to the above microscope types. Standard spot tests and HPTLC analysis for chemical substances were applied according to ARUP *et al.* (1993) and ORANGE *et al.* (2010).

Nomenclature of the names follows mostly the name concept of the IndexFungorum (CABI 2016), the MycoBank (ROBERT *et al.* 2016), and WIRTH *et al.* (2013). Collecting sites are presented on the map of the botanical garden (Fig. 1).

RESULTS AND DISCUSSION

List of localities

- Loc. 1 = Soroksár Botanical Garden, near the entrance, right side of the road. Lat.: 47° 24' 01.1" N; Long.: 19° 09' 08.3" E; Alt.: 105 m a.s.l. Leg.: Lőkös, L., 24.08.2013 (GPS 831).
- Loc. 2 = Soroksár Botanical Garden (nr. 25), "Black locust plantation", behind the reception building. Lat.: 47° 23' 59.6" N; Long.: 19° 09' 15.0" E; Alt.: 112 m a.s.l. Leg.: Lőkös, L., 24.08.2013 (GPS 832).
- Loc. 3 = Soroksár Botanical Garden, sand dune, on sandy soil. Lat.: 47° 23' 55.1" N; Long.: 19° 09' 17.3" E; Alt.: 119 m a.s.l. Leg.: Lőkös, L., 24.08.2013 (GPS 833).
- Loc. 4 = Soroksár Botanical Garden, S of the sand dune, small park. Lat.: 47° 23' 53.5" N; Long.: 19° 09' 19.2" E; Alt.: 120 m a.s.l. Leg.: Lőkös, L., 24.08.2013 (GPS 834).
- Loc. 5 = Soroksár Botanical Garden, southern part, clearing near a remnant orchard. Lat.: 47° 23' 51.2" N; Long.: 19° 09' 30.2" E; Alt.: 106 m a.s.l. Leg.: Lőkös, L., 24.08.2013 (GPS 835).
- Loc. 6 = Soroksár Botanical Garden, southern part, old remnant orchard. Lat.: 47° 23' 50.6" N; Long.: 19° 09' 34.1" E; Alt.: 106 m a.s.l. Leg.: Lőkös, L., 24.08.2013 (GPS 836).
- Loc. 7 = Soroksár Botanical Garden (nr. 12), "Wild fruit species". Lat.: 47° 23' 52.8" N; Long.: 19° 09' 41.7" E; Alt.: 115 m a.s.l. Leg.: Lőkös, L., 24.08.2013 (GPS 837).
- Loc. 8 = Soroksár Botanical Garden (nr. 15), near "Plants of the Hungarian mountains", rocky garden. Lat.: 47° 23' 55.8" N; Long.: 19° 09' 31.2" E; Alt.: 109 m a.s.l. Leg.: Lőkös, L., 24.08.2013 (GPS 838).
- Loc. 9 = Soroksár Botanical Garden (nr. 05), "Plants of Eastern, Central and Southern Europe", southern part, along the path near "Wetlands" (nr. 09). Lat.: 47° 23' 56.1" N; Long.: 19° 09' 25.8" E; Alt.: 133 m a.s.l. Leg.: Lőkös, L., 24.08.2013 (GPS 839).
- Loc. 10 = Near the entrance, but outside of the Soroksár Botanical Garden. Lat.: 47° 23' 56.7" N; Long.: 19° 08' 59.9" E; Alt.: 136 m a.s.l. Leg.: Lőkös, L., 24.08.2013 (GPS 840).
- Loc. 11 = Soroksár Botanical Garden (nr. 01), "Plants of North America". Lat.: 47° 24' 07.0" N; Long.: 19° 09' 11.2" E; Alt.: 125 m a.s.l. Leg.: Lőkös, L., 06.09.2013 (GPS 841).
- Loc. 12 = Soroksár Botanical Garden (nr. 01), "Plants of North America". Lat.: 47° 24' 06.3" N; Long.: 19° 09' 17.0" E; Alt.: 110 m a.s.l. Leg.: Lőkös, L., 06.09.2013 (GPS 842).
- Loc. 13 = Soroksár Botanical Garden (nr. 01), "Plants of North America". Lat.: 47° 24' 08.5" N; Long.: 19° 09' 14.6" E; Alt.: 107 m a.s.l. Leg.: Lőkös, L., 06.09.2013 (GPS 843).
- Loc. 14 = Soroksár Botanical Garden (nr. 23), "Taxonomic collections". Lat.: 47° 24' 11.8" N; Long.: 19° 09' 11.3" E; Alt.: 126 m a.s.l. Leg.: Lőkös, L., 06.09.2013 (GPS 844).
- Loc. 15 = Soroksár Botanical Garden (nr. 17), "Pedunculate oak woodland of the Great Hungarian Plain". Lat.: 47° 24' 14.8" N; Long.: 19° 09' 13.7" E; Alt.: 114 m a.s.l. Leg.: Lőkös, L., 06.09.2013 (GPS 845).

- Loc. 16 = Soroksár Botanical Garden (nr. 16), northern part, "Calcareous shrub woodland". Lat.: 47° 24' 20.6" N; Long.: 19° 09' 09.5" E; Alt.: 118 m a.s.l. Leg.: Lökös, L., 06.09.2013 (GPS 846).
- Loc. 17 = Soroksár Botanical Garden (nr. 16), northwestern part, "Calcareous shrub woodland". Lat.: 47° 24' 16.2" N; Long.: 19° 08' 59.2" E; Alt.: 131 m a.s.l. Leg.: Lökös, L., 06.09.2013 (GPS 847).
- Loc. 18 = Soroksár Botanical Garden (nr. 01), "Plants of North America". Lat.: 47° 24' 05.5" N; Long.: 19° 09' 16.1" E; Alt.: 127 m a.s.l. Leg.: Lökös, L., 06.09.2013 (GPS 848).
- Loc. 19 = Soroksár Botanical Garden, near entrance, left side of the road. Lat.: 47° 24' 0.87" N; Long.: 19° 09' 7.64" E; Alt.: 112 m a.s.l. Leg.: Lökös, L., Varga, N., 07.04.2015 (GPS 001).
- Loc. 20 = Soroksár Botanical Garden, near the reception building. Lat.: 47° 24' 2.12" N; Long.: 19° 09' 15.62" E; Alt.: 114 m a.s.l. Leg.: Lökös, L., Varga, N., 07.04.2015 (GPS 002).
- Loc. 21 = Soroksár Botanical Garden (nr. 02), "Plants of East Asia". Lat.: 47° 24' 4.28" N; Long.: 19° 09' 18.35" E; Alt.: 117 m a.s.l. Leg.: Lökös, L., Varga, N., 07.04.2015 (GPS 003).
- Loc. 22 = Soroksár Botanical Garden (nr. 03), "Plants of Central Asia and Asia Minor". Lat.: 47° 24' 1.21" N; Long.: 19° 09' 20.59" E; Alt.: 116 m a.s.l. Leg.: Lökös, L., Varga, N., 07.04.2015 (GPS 004).
- Loc. 23 = Soroksár Botanical Garden (nr. 15), "Plants of the Hungarian mountains", rocky garden. Lat.: 47° 23' 58.69" N; Long.: 19° 09' 31.11" E; Alt.: 113 m a.s.l. Leg.: Lökös, L., Varga, N., 07.04.2015 (GPS 005).
- Loc. 24 = Soroksár Botanical Garden (nr. 15), "Plants of the Hungarian mountains", rocky garden. Lat.: 47° 23' 57.09" N; Long.: 19° 09' 30.32" E; Alt.: 116 m a.s.l. Leg.: Lökös, L., Varga, N., 07.04.2015 (GPS 006).
- Loc. 25 = Soroksár Botanical Garden (nr. 20), "Birch woodland". Lat.: 47° 23' 58.82" N; Long.: 19° 09' 37.62" E; Alt.: 115 m a.s.l. Leg.: Lökös, L., Varga, N., 07.04.2015 (GPS 007).
- Loc. 26 = Soroksár Botanical Garden (nr. 15), near "Plants of the Hungarian mountains", rocky garden. Lat.: 47° 23' 56.67" N; Long.: 19° 09' 32.05" E; Alt.: 115 m a.s.l. Leg.: Lökös, L., Varga, N., 07.04.2015 (GPS 008).
- Loc. 27 = Soroksár Botanical Garden, near entrance, right side of the road. Lat.: 47° 24' 1.07" N; Long.: 19° 09' 8.41" E; Alt.: 112 m a.s.l. Leg.: Varga, N., 07.04.2015 (GPS 409).
- Loc. 28 = Soroksár Botanical Garden, near the reception building. Lat.: 47° 24' 1.77" N; Long.: 19° 09' 15.88" E; Alt.: 114 m a.s.l. Leg.: Varga, N., 07.04.2015 (GPS 410).
- Loc. 29 = Soroksár Botanical Garden (nr. 02), "Plants of East Asia". Lat.: 47° 24' 3.49" N; Long.: 19° 09' 16.34" E; Alt.: 116 m a.s.l. Leg.: Varga, N., 07.04.2015 (GPS 411).
- Loc. 30 = Soroksár Botanical Garden (nr. 02), "Plants of East Asia". Lat.: 47° 24' 2.72" N; Long.: 19° 09' 20.32" E; Alt.: 116 m a.s.l. Leg.: Varga, N., 07.04.2015 (GPS 412).
- Loc. 31 = Soroksár Botanical Garden (nr. 04), "Plants of the Caucasus". Lat.: 47° 24' 0.59" N; Long.: 19° 09' 22.56" E; Alt.: 116 m a.s.l. Leg.: Varga, N., 07.04.2015 (GPS 413).
- Loc. 32 = Soroksár Botanical Garden (nr. 15), "Plants of the Hungarian mountains", rocky garden. Lat.: 47° 23' 56.97" N; Long.: 19° 09' 30.45" E; Alt.: 116 m a.s.l. Leg.: Varga, N., 07.04.2015 (GPS 414).
- Loc. 33 = Soroksár Botanical Garden (nr. 15), "Plants of the Hungarian mountains", rocky garden. Lat.: 47° 23' 58.70" N; Long.: 19° 09' 30.80" E; Alt.: 114 m a.s.l. Leg.: Varga, N., 07.04.2015 (GPS 415).
- Loc. 34 = Soroksár Botanical Garden (nr. 20), "Birch woodland". Lat.: 47° 23' 59.17" N; Long.: 19° 09' 36.39" E; Alt.: 114 m a.s.l. Leg.: Varga, N., 07.04.2015 (GPS 416).
- Loc. 35 = Soroksár Botanical Garden (nr. 15), near "Plants of the Hungarian mountains", rocky garden. Lat.: 47° 23' 56.76" N; Long.: 19° 09' 32.47" E; Alt.: 116 m a.s.l. Leg.: Varga, N., 07.04.2015 (GPS 417).

Loc. 36 = Soroksár Botanical Garden (nr. 15), near “Plants of the Hungarian mountains”, rocky garden. Lat.: 47° 23' 55.39" N; Long.: 19° 09' 31.45" E; Alt.: 116 m a.s.l. Leg.: Varga, N., 07.04.2015 (GPS 418).

Loc. 37 = At the bus stop, outside of the Soroksár Botanical Garden. Lat.: 47° 23' 54.95" N; Long.: 19° 08' 57.54" E; Alt.: 111 m a.s.l. Leg.: Varga, N., 07.04.2015 (GPS 419).



Fig. 1. Map of the Soroksár Botanical Garden with the collecting localities. (Habitat numbers are bold, italic and underlined: ***01*** = Plants of North America; ***02*** = Plants of East Asia; ***03*** = Plants of Central Asia and Asia Minor; ***04*** = Plants of the Caucasus; ***05*** = Plants of Eastern, Central and Southern Europe; ***09*** = Wetlands; ***12*** = Wild fruit species; ***15*** = Plants of the Hungarian mountains; ***16*** = Calcareous shrub woodland; ***17*** = Pedunculate oak woodland of the Great Hungarian Plain; ***20*** = Birch woodland; ***23*** = Taxonomic collections; ***25*** = Black locust plantation).

Enumeration

Names of species are followed by their locality number(s) and short notes on habitat preference or other circumstances. Microfungi are indicated by an asterisk (*). Abbreviation “calc” refers to calcareous rock, and “sil” for siliceous rock substrate.

Acarospora fuscata (Nyl.) Th. Fr. – Loc. 24 (sil) – It is a character species in natural lichen associations on siliceous rocky habitats. Its small, brown, areolate thalli were found on boulders in the rocky garden.

Acarospora nitrophila H. Magn. – Loc. 24 (sil) – Nitrogen-rich, sun-exposed rocks are favoured by this species, differing from the related *A. fuscata* by its whitish pruinose thallus.

Amandinea punctata (Hoffm.) Coppins et Scheid. – Loc. 2 (*Rosa*, *Salix*), Loc. 4 (*Juniperus*), Loc. 6 (*Prunus*), Loc. 7 (*Pinus nigra*), Loc. 12 (*Pinus nigra*), Loc. 15 (*Quercus*), Loc. 19 (*Pinus sylvestris*), Loc. 20 (*Syringa*), Loc. 23 (*Pinus nigra*), Loc. 24 (sil) – It is an inconspicuous, but frequent, mostly corticolous species colonising on a number of substrates – here found on 8 tree species (see above in brackets). It is extremely toxitolerant.

Anaptychia ciliaris (L.) A. Massal. – Loc. 6 (*Prunus*) – It is found seldom on the bark of fruit trees in the botanical garden, since it is mostly epiphytic. Its foliose-fruticose thallus consists of elongated, flattened, marginally ciliate, tomentose lobes often forming a small shrub.

Aspicilia hoffmannii (Ach.) Flagey – Loc. 26 (calc) – It often grows in anthropogenic habitats, on dust-covered rocks. Its greyish white areolate thalli are found on calcareous rock.

Aspicilia moenium (Vain.) G. Thor et Timdal – Loc. 19 – Its whitish-greyish thalline squamules with marginal black soralia are scattered on the substrate. It was recognised about 25 years ago in Hungary, now having several localities. In the botanical garden it grows on calcareous rock.

**Athelia arachnoidea* (Berk.) Jülich – Loc. 2 (*Robinia pseudacacia*: *Phaeophyscia orbicularis*, *Physcia adscendens*, *Xanthoria parietina*), Loc. 6 (*Cerasus*, *Prunus*: *Candelariella reflexa*, *Melanelixia* sp., *Physcia adscendens*), Loc. 10 (*Tilia*: *Phaeophyscia orbicularis*, *Physcia adscendens*), Loc. 17 (*Robinia pseudoacacia*: *Physcia adscendens*, *Phaeophyscia orbicularis*), Loc. 33 (*Acer* sp.: *Physcia adscendens*) – Easily recognisable by the white rings on barks mostly after frosty and rainy periods. Its asexual brownish-creamy sclerotia can be seen frequently on the host thallus covered by white mycelia of the fungi. It is widespread throughout the country in most habitats. In the botanical garden it occurs in small white patches on thalli of various host lichens.

Bacidina arnoldiana (Körb.) V. Wirth et Vězda – Loc. 11 (calc) – Its thalli with tiny brownish black apothecia cover the substrate with a farinose green layer. It grows on shaded calcareous rock at the “North American plants” area of the garden.

Bacidina egenula (Nyl.) Vězda – Locs 4, 15, and 19 (calc) – It is found on calcareous rocks and the concrete base of the fence. Its thalli are very similar to its related species *B. arnoldiana*, but the two species can be differentiated by anatomical features of their apothecia.

Caloplaca flavocitrina (Nyl.) H. Olivier – Locs 4 and 19 (calc) – Its thallus is lemon yellow, farinose. It is found on the concrete base of the fence around the garden and also on other concrete rocks.

Caloplaca holocarpa (Hoffm.) A. E. Wade – Loc. 15 (calc) – Saxicolous species, its thalli are endolithic, inconspicuous, only the tiny bright orange apothecia are seen on the surface.

Caloplaca obscurella (J. Lahm) Th. Fr. – Loc. 2 (*Robinia*) – Recently spreading corticolous species. Its thalli appear with green crater-like soralia.

Caloplaca pyracea (Ach.) Th. Fr. – Loc. 2 (*Robinia*), Loc. 4 (*Populus tremula*, *Quercus*), Loc. 6 (*Fraxinus*), Loc. 15 (*Populus alba*) – It is frequent on eutrophicated bark in the whole garden. The bright reddish orange apothecia make it a very attractive species.

Candelaria concolor (Dicks.) Arnold – Loc. 2 (*Robinia*, *Salix*) – This not too frequent species occurs on bark.

Candelariella aurella (Hoffm.) Zahlbr. – Locs 4 and 15 (*Populus alba*), Locs 20 and 24 – Well distributed in the garden on calcareous rocks, on concrete, as well as on bark and lignum.

Candelariella reflexa (Nyl.) Lettau – Loc. 2 (*Robinia*, *Salix*), Loc. 6 (*Cerasus*), Loc. 14 (*Quercus*), Loc. 23 (*Pinus nigra*), Loc. 24 (bark), Loc. 26 (*Prunus*) – It is frequent, especially on eutrophicated bark, tree trunk and twigs. Its lemon yellow, farinose, often sterile thalli form larger patches, or vertical stripes on the substrate.

Candelariella vitellina (Hoffm.) Müll. Arg. – Loc. 26 (sil) – It grows mostly on rocks, it was found on the concrete base of an electric pole. The egg yolk-yellow, orange apothecia often totally cover the areolate-squamulose thalli of the same colour.

Catillaria nigroclavata (Nyl.) J. Steiner – Loc. 2 (*Robinia*, *Salix*), Loc. 4 (*Crataegus*, *Euonymus europaeus*, *Quercus*), Loc. 6 (*Fraxinus*), Loc. 15 (*Buddleia*), Loc. 20 (*Cornus*, *Syringa*), Loc. 21 (*Quercus*) – It is a nitro-frequent species, often colonising eutrophicated bark of shrubs and trees (9 species), both on trunk and twigs.

Cladonia chlorophaea (Sommerf.) Spreng. – Locs 2 and 11 – A fruticose, predominantly terricolous species. Its brown apothecia develop at the edge of the small funnel shaped podetia. Frequent in Hungary, also in the botanical garden on sandy soil.

Cladonia coniocraea (Flörke) Spreng. – Loc. 11 (*Rhus hirta*) – One of the most frequent *Cladonia* species in Hungary. It is a fruticose, mostly epiphytic species with pointed, farinose sorediose podetia.

Cladonia fimbriata (L.) Fr. – Locs 8 and 11 – This fruticose species is frequently found both on bark and soil. Its narrow funnel shaped podetia are farinose everywhere.

Cladonia magyarica Gyeln. – Loc. 3 – It is a legally protected species. It forms funnel shaped podetia richly covered by squamules. It is a typical representative of the lowland sand steppe vegetation, but also grow in dolomitic rocky grasslands. It was found on sandy soil in the sand dune (“Csont-hegy”) of the botanical garden.

Cladonia pyxidata (L.) Hoffm. – Locs 3 and 8 – Similar to the protected *C. magyarica*, but differs by its chemical characters. It was found on sandy soil and among bryophytes in the rocky garden.

Cladonia rangiformis Hoffm. – Loc. 24 – It is a widespread terricolous, fruticose species. Its richly branched thalli cover large continuous areas. It is not rare in the botanical garden (especially in the rocky garden).

Cladonia rei Schaer. – Locs 2, 8, 11, 24 and 26 – Its thallus is similar to *C. coniocraea*, but its branches are longer and entirely farinose. The other similar species (*C. subulata*) differs by its chemical content. It was found in several places as a pioneer species.

Coenogonium pineti (Ach.) Lücking et Lumbsch (= *Dimerella pineti*) – Loc. 23 (*Pinus nigra*), Loc. 25 (*Betula pendula*) – Crustose, corticolous species with tiny, pale apothecia. It often grows near the tree base, preferring relatively humid places. It is spreading in the whole country.

Evernia prunastri (L.) Ach. – Loc. 2 (*Robinia*), Loc. 6 (*Cerasus*, *Malus*, *Prunus*), Loc. 26 (*Prunus*) – This fruticose species with yellow-green thalli were found on various fruit trees.

Flavoparmelia caperata (L.) Hale – Loc. 2 (*Salix*) – It is characteristic in well-lit deciduous forests, much more rare among anthropogenic conditions. It is found only near the botanical garden in the forest Halmi-erdő.

Flavoparmelia soredians (Nyl.) Hale – Loc. 2 (*Robinia*) – This is a recently spreading species in Hungary, its second specimen was found in the botanical garden (FARKAS *et al.* 2016). Similarly to the other Hungarian specimen, its thallus is small, looks like young or underdeveloped.

Hyperphyscia adglutinata (Flörke) H. Mayrhofer et Poelt – Loc. 2 (*Robinia*), Loc. 4 (*Quercus*), Loc. 7 (*Sambucus nigra*), Loc. 23 (*Fraxinus*) – It is also a spreading species, but due to its small size, it becomes visible if covers a relatively big area. It was found in many places in the garden.

Hypogymnia physodes (L.) Nyl. – Loc. 6 (*Prunus*), Loc. 23 (*Pinus nigra*) – This is among the most frequent corticolous, foliose species in Hungary. Its lead grey lobe-tips usually have characteristic labriform soralia. It is found only at two places in the botanical garden.

Hypogymnia tubulosa (Schaer.) Hav. – Loc. 6 (*Cerasus*, *Prunus*), Loc. 23 (*Pinus nigra*) – Usually this species is more rare than the related species *H. physodes*. Its soralia are different: capitate. It is also rare in the botanical garden.

**Illosporopsis christiansenii* (B. L. Brady et D. Hawksw.) D. Hawksw. – Loc. 19 (*Quercus rubra*: *Physcia adscendens*) – Forming soft, bright pink sporodochia of coiled conidia on the host thallus. Known from Hungary from the 1980s, it was considered as a widespread parasite in more region of Europe, but found in a few sites from the country, it was discovered near the entrance.

Lecania cyrtella (Ach.) Th. Fr. – Loc. 4 (*Populus tremula*), Loc. 6 (*Fraxinus*), Loc. 20 (*Cornus*, *Platycladus orientalis*) – It is a corticolous, nitrofrequency, pioneer, crustose lichen. It is easy to discover, since its reddish brown apothecia are rather tiny. It is relatively frequent among anthropogenic conditions.

Lecania naegelii (Hepp) Diederich et Van den Boom – Loc. 4 (*Crataegus*, *Euonymus europaeus*, *Quercus*), Loc. 6 (*Fraxinus*) – It is similar to its related species *L. cyrtella*, but its apothecia are dark grey and ascospores are four-celled (while they are two-celled at *L. cyrtella*). It is relatively frequent in the garden, recognised on four phorophyte species.

Lecanora albescens (Hoffm.) Branth et Rostr. – Loc. 20 (concrete) – It grows in nitrogen-rich habitats, on calcareous rocks. Brown apothecia with white margin are on its white, areolate, conspicuous thalli.

Lecanora carpinea (L.) Vain. – Loc. 2 (*Rosa*) – It prefers usually forest habitats, it seldom occurs among urban circumstances. The surface of the tiny apothecia is covered with white pruina visible also by hand lens.

Lecanora conizaeoides Cromb. – Loc. 7 (*Pinus nigra*), Loc. 17 (*Gleditsia triacanthos*) – It is one of the well-known indicator species of acidic air pollution. It is not frequent in the botanical garden, found only at two places.

Lecanora dispersa (Pers.) Röhl. – Loc. 11 (calc), Loc. 24 (calc) – It is a saxicolous, pioneer crustose species. Its thallus is inconspicuous, only the dispersed brown apothecia with white margin are well visible.

Lecanora hagenii (Ach.) Ach. – Loc. 4 (*Populus tremula*), Loc. 15 (*Populus alba*), Loc. 20 (*Cornus*) – This species is frequent among anthropogenic, urban circumstances, toxitolerant, corticolous.

Lecanora muralis (Schreb.) Rabenh. – Loc. 4 (lignum), Loc. 26 (sil) – In the botanical garden it was found on disturbed anthropogenic substrates, on rocks and wooden frame around flowerbeds.

Lecanora polytropa (Ehrh.) Rabenh. – Loc. 26 (sil) – Saxicolous, crustose species, its apothecia are ochraceous yellow-brown with yellowish margin. It is distributed throughout the country on siliceous rocks, it was also found on siliceous boulders in the rocky garden.

Lecanora saligna (Schrad.) Zahlbr. – Loc. 4 (lignum), Loc. 6 (*Prunus*) – It is a crustose species frequently occurring on decaying wood. Its thallus is inconspicuous, apothecia are brown, yellowish brown or brownish red with pale yellow margin.

Lepraria elobata Tønsberg – Loc. 18 (*Platycladus orientalis*) – Its bluish green sorediate thalli cover smaller or larger patches on tree bark. It is possible to differentiate from its related species, *L. incana* and *L. lobificans*, only by chemical investigations.

Lepraria incana (L.) Ach. – Loc. 14 (*Quercus cerris*), Loc. 22 (*Pyrus*) – Its soredia are very similar to those of *L. elobata*. This species and also *L. lobificans* can be differentiated only by chemical investigations.

Lepraria lobificans Nyl. – Loc. 16 (*Pyrus*), Loc. 22 (*Populus*) – Similarly to the other two *Lepraria* species, it appears as a bluish green layer on the tree bark. Though its soredia are somewhat bigger and more fluffy, chemical investigation is necessary to differentiate the species.

**Lichenocodium erodens* M. S. Christ. et D. Hawksw. – Loc. 23 (*Pinus nigra*: *Hypogymnia physodes*) – This species appears as pale, black-emarginated patches on the host lichen, immersed, black pycnidia could be seen under the microscope. Found only at one place and one host species.

**Marchandiomyces aurantiacus* (Lasch) Diederich et Etayo – Loc. 19 (*Quercus rubra*: *Physcia adscendens*) – This lichenicolous, parasitic species is regarded as common everywhere; but in the botanical garden only some underdeveloped specimens were found at one locality.

Massjukiella polycarpa (Hoffm.) S. Y. Kondr., Fedorenko, S. Stenroos, Kärnefelt, Elix, J.-S. Hur et A. Thell (= *Xanthoria polycarpa*) – Loc. 28 (*Malus*, *Platycladus orientalis*) – It is a tiny, orange, fruticose, epiphytic species. Its underdeveloped thalli with a few apothecia were discovered in the garden in two places.

Melanelixia subaurifera (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. et Lumbsch (= *Melanelia subaurifera*, *Parmelia subaurifera*) – Loc. 4 (*Juniperus*), Loc. 6 (*Malus*), Loc. 14 (*Quercus*), Loc. 15 (*Pinus nigra*), Loc. 20 (*Syringa*), Loc. 23 (*Pinus nigra*), Loc. 26 (*Prunus*) – The dark green, olive, greenish brown, epiphytic, foliose thalli are adpressed to the substrate. It is relatively frequent in the garden.

Melanohalea exasperatula (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. et Lumbsch (= *Melanelia exasperatula*, *Parmelia exasperatula*) – Loc. 6 (*Cerasus*) – It has also olive, greenish brown, epiphytic, foliose thalli, but with elongated, flattened isidia.

Micarea misella (Nyl.) Hedl. – Loc. 13 (lignum) – It is a rare, crustose species, found on decaying pine trunk in the “North American plants” area of the garden.

Parmelia sulcata Taylor – Loc. 2 (*Robinia*, *Salix*), Loc. 4 (*Juniperus*), Loc. 6 (*Cerasus*, *Malus*) – This relatively large foliose lichen has bluish gray thalli with whitish pattern (lines), which later becomes farinose sorediose. It tolerates nitrogen pollution. It is a frequent corticolous species occurring also in the botanical garden.

Parmelina tiliacea (Hoffm.) Hale (= *Parmelia tiliacea*) – Loc. 2 (*Robinia*), Loc. 6 (*Malus*) – As a woodland species it is more frequent in natural forests than among urban circumstances. It was found only at two localities in the botanical garden.

Peltigera didactyla (With.) J. R. Laundon – Locs 8, 11 and 26 – It was found in a few places in the botanical garden, on pioneer surfaces near the rocky garden, on bare soil.

Peltigera rufescens (Weiss) Humb. – Loc. 8 – It is a large, terricolous, foliose, conspicuous species found among bryophytes in the rocky garden.

Phaeophyscia nigricans (Flörke) Moberg – Loc. 1 (*Acer acuminatilobum*), Loc. 2 (*Robinia*), Loc. 4 (*Quercus*), Loc. 14 (*Sambucus nigra*), Loc. 20 (*Cornus*), Loc. 21 (*Quercus*) – Its tiny, dark brown, olive brown thalli are not well seen. It is becoming rather frequent on eutrophicated bark among urban circumstances.

Phaeophyscia orbicularis (Neck.) Moberg – Loc. 1 (*Acer acuminatilobum*), Loc. 2 (*Robinia*, *Salix*), Loc. 4 (*Quercus*), Loc. 11 (calc), Loc. 14 (*Sambucus nigra*), Loc. 15 (*Populus alba*), Loc. 19 (concrete), Loc. 20 (*Cornus*, *Platycladus orientalis*), Loc. 21 (*Quercus*) – It is the most frequent species of the botanical garden. It is nitrofrequency, and was found on 9 phorophyte species, also on eutrophicated, bird-manured rock surfaces.

Phlyctis argena (Ach.) Flot. – Loc. 6 (*Cerasus*, *Prunus*), Loc. 17 (*Robinia pseudoacacia*) – In mountain forests its large, whitish greyish thalli develop on smooth tree bark. It is rare among urban circumstances, just like in the botanical garden.

Physcia adscendens (Fr.) H. Olivier – Loc. 1 (*Acer acuminatilobum*), Loc. 2 (*Robinia*, *Salix*), Loc. 4 (*Quercus*), Loc. 6 (*Malus*, *Prunus*), Loc. 14 (*Quercus*), Loc. 15 (*Populus alba*), Loc. 19 (*Quercus rubra*), Loc. 20 (*Platycladus orientalis*), Loc. 21 (*Quercus*), Loc. 26 (*Prunus*) – It is one of the most frequent species of the botanical garden. It is nitrofrequency and was found on 9 phorophyte species.

Physcia aipolia (Humb.) Fűrnr. – Loc. 2 (*Salix*) – It is a rare *Physcia* species. Its grey thalli are very similar to its related species *P. stellaris*, which differs in chemical characters.

Physcia dimidiata (Arnold) Nyl. – Loc. 2 (*Robinia*) – It is a foliose species, growing both on bark and rocks. Its thalli are white pruinose with farinose marginal soralia along the lobes.

Physcia stellaris (L.) Nyl. – Loc. 2 (*Salix*), Loc. 6 (*Malus*), Loc. 21 (*Quercus*) – It is a corticolous, foliose species. Its name refers to its radially arranged elongated lobes. Its thalli are very similar to its related species *P. aipolia*, which differs in chemical characters.

Physcia tenella (Scop.) DC. – Loc. 6 (*Cerasus*, *Prunus*) – Its well-developed, corticolous, pale grey thalli are marginally ciliate similarly to *P. adscendens*, but it differs in having labriform soralia.

Physciella chloantha (Ach.) Essl. (= *Phaeophyscia luganensis*) – Loc. 2 (*Robinia*), Loc. 4 (*Quercus*) – It is a rare, corticolous, foliose species, having labriform soralia on its lobes. Its lower surface is pale.

Physconia grisea (Lam.) Poelt – Loc. 2 (*Cerasus*, *Robinia*) – This corticolous, nitrorequent, foliose species often occurs in highly eutrophicated habitats. Its thalli are covered by pruina, have labriform soralia and simple rhizines. It is not frequent in the botanical garden.

Physconia perisidiosa (Erichsen) Moberg – Loc. 2 (*Salix*) – It is typically found in forests, rarely occurs among anthropogenic conditions. It is an easily recognisable species having bluish-brownish grey thalli with imbricately arranged lobes and marginal soralia. Only one underdeveloped thallus was found in the botanical garden.

Piccolia ochrophora (Nyl.) Hafellner – Loc. 7 (*Sambucus nigra*), Loc. 14 (*Sambucus nigra*) – It is a spreading species occurring on eutrophicated tree bark. In the botanical garden it grows on its preferred substrate, on the bark of black elder.

Pleurosticta acetabulum (Neck.) Elix et Lumbsch (= *Parmelia acetabulum*) – Loc. 9 (*Cercis siliquastrum*) – It is a large foliose lichen. Its thalli are olive or greyish green, often with bluish pruina, or bright olive green if wet. It produces large apothecia. It is found more often on solitary trees at forest edges, tolerating dust-pollution relatively well.

Pseudevernia furfuracea (L.) Zopf – Loc. 6 (*Cerasus*, *Prunus*), Loc. 23 (*Pinus nigra*) – It is found mainly on the bark of forest trees, on pine and fruticose species among unpolluted air conditions. Not well developed specimens with small, foliose-lichen-like thalli found among urban conditions, also in larger parks and orchards.

Pseudosagedia chlorotica (Ach.) Hafellner et Kalb – Loc. 24 (sil) – It is a hardly visible, tiny, crustose, corticolous species. It was found on siliceous rocks in the rocky garden.

Psorotichia frustulosa Anzi – Loc. 20 (concrete) – This is the first record of the species from Hungary! It occurs in xerothermic habitats also among anthropogenic conditions, probably it is not a rare species. It was found on concrete in the garden.

Punctelia subrudecta (Nyl.) Krog (= *Parmelia subrudecta*) – Loc. 17 (*Pyrus*, *Robinia pseudacacia*) – It is more frequent in forests on the well-lit bark of solitary trees, but it is becoming frequent also in anthropogenic places.

Ramalina farinacea (L.) Ach. – Loc. 6 (*Prunus*) – It is a fruticose species, living on forest trees, but was found also in anthropogenic habitats.

Rinodina pyrina (Ach.) Arnold – Loc. 2 (*Robinia*, *Rosa*), Loc. 4 (*Quercus*), Loc. 6 (*Fraxinus*), Loc. 15 (*Buddleia*) – It is a corticolous, nitrorequent, crustose species. Its thalli are hardly visible, densely covered by black apothecia with paler margin. It is frequent on eutrophicated bark together with *Caloplaca pyracea*, *Phaeophyscia orbicularis*, *Physcia adscendens*, and *Xanthoria parietina*.

Sarcogyne regularis Körb. – Loc. 4 (concrete), Loc. 19 (concrete), Loc. 20 (concrete) – It is a crustose, saxicolous, pioneer species. Its thalli are inconspicuous, the black apothecia are often bluish pruinose. It prefers calcareous rocks in natural habitats, but it colonises concrete fence footings in the botanical garden.

Scoliciosporum chlorococcum (Stenh.) Vězda – Loc. 6 (*Prunus*) – Rather inconspicuous, but frequent epiphytic species. A well-known indicator species of the acidic air pollution. Found only once in the botanical garden.

Scoliciosporum umbrinum (Ach.) Arnold – Locs 24 and 26 – It was found on siliceous rock and also on bark in the garden. Curved ascospores differentiate it from its related species *S. chlorococcum*.

Trapeliopsis flexuosa (Fr.) Coppins et P. James – Loc. 4 (*Juniperus*) – It is a crustose species with mostly sterile, green, farinose thalli covering decaying wooden surfaces. It was found only once among thalli of *Melanelixia subaurifera*.

Usnea sp. – Loc. 6 (*Cerasus*) – These species prefer natural forests of clean air. Some species (e.g. *U. hirta*) can tolerate anthropogenic conditions better. Only young, underdeveloped thalli of 3–4 cm were found, insufficient for species identification.

Verrucaria nigrescens Pers. – Loc. 11 (calc), Loc. 15 (calc) – It is a crustose, saxicolous species with brown thalli, which is widely distributed in Hungary in natural and anthropogenic (mainly eutrophicated) habitats. It was also found in the garden on calcareous rock and concrete.

Xanthoria parietina (L.) Beltr. – Loc. 2 (*Robinia*), Loc. 4 (*Populus tremula*, *Quercus*), Loc. 6 (*Malus*), Loc. 15 (*Buddleia*, *Populus alba*), Loc. 19 (*Quercus rubra*), Loc. 20 (*Berberis*, *Broussonetia*, *Cornus*, *Platycladus orientalis*). – It is a corticolous, nitrorequent, conspicuous species, which is very frequent in the garden, occurring on almost all phorophyte species (11).

**Xanthoriicola physciae* (Kalchbr.) D. Hawksw. – Loc. 20 (*Berberis*: *Xanthoria parietina*), Loc. 28 (*Malus*, *Platycladus orientalis*: *Xanthoria parietina*). – Known only from one host, *X. parietina* on which forms dark brown patches mainly on apothecia. Producing globose, brown, minutely echinulate conidia. This parasitic fungi is distributed all over in the country, but it is not very frequent in the garden.

DISCUSSION

Prior to this study no lichen records have been published from the Soroksár Botanical Garden. During our investigation 83 species were identified from the garden. Eight of them are terricolous, 18 saxicolous (6 on siliceous rock, 12 on calcareous rock), 4 lignicolous, and 48 epiphytic, corticolous lichen species, furthermore 5 species of lichenicolous fungi were detected. Epiphytic species were collected from altogether 30 host tree species (phorophytes). Most of the species occurred on *Robinia pseudacacia*, an introduced (not native) species in Hungary. It represents almost 25% of the lichen flora of the garden. Considerable number of species was found on oak (18), on plum (12), willow (12), and cherry (10).

On the other hand *Xanthoria parietina*, *Amandinea punctata*, *Catillaria nigroclavata*, *Physcia adscendens*, *Phaeophyscia orbicularis*, *Parmelia sulcata*, *Rinodina pyrrena*, and *Caloplaca pyracea*, predominantly nitrofrequency and common species were found on the highest number of phorophyte species. More than half of the species (40) belong to the crustose, 26 (33%) to the foliose, and 12 (15%) to the fruticose growth forms. Physcias are represented by 11, Parmelias by 10, Lecanoras by 7, and Cladonias by 6 species.

A legally protected species, *Cladonia magyarica* was discovered in one locality of the sand dune.

Open, bare, for a long time undisturbed soil surfaces supporting rich terricolous lichen flora are practically absent in the botanical garden due to the necessary horticultural activities. However, several terricolous species occur in the (artificial) sand dune area, or in the marginal parts of the rocky garden and roadsides among bryophytes or grasses, especially conspicuous macrolichens, i.e. *Cladonia chlorophaea*, *C. fimbriata*, *C. magyarica*, *C. pyxidata*, *P. rufescens*. Pioneer species adapting to the regularly disturbed soil surfaces (e.g. *Cladonia rei*, *Peltigera didactyla*.) are also present.

Although natural rocks are missing from the botanical garden, saxicolous lichen species abundantly colonise artificial rocks, like concrete fence, concrete pillar, tiles, rock walls, pavements, ditch, and also big boulders of the rocky gardens transferred here from quarries. These rocks can be calcareous of basic character with calciphilous lichen species (e.g. *Bacidina arnoldiana*, *B. egenula*, *Caloplaca flavocitrina*, *Candelariella aurella*, *Lecanora dispersa*, *Sarcogyne regularis*, *Verrucaria nigrescens*); or siliceous of acidic character with acidophilous lichen species (e.g. *Acarospora fuscata*, *Candelariella vitellina*, *Lecanora polytropia*, *Pseudosagedia chlotica*, *Scoliciosporum umbrinum*). Nitrofrequency species (e.g. *Caloplaca flavocitrina*, *Lecanora muralis*, *Phaeophyscia orbicularis*, *Verrucaria nigrescens*, *Xanthoria parietina*) might occur on both kinds of rocks enriched in nutrients.

Epiphytic lichen species predominant (60%) in the botanical garden occur mostly on trees with nutrient rich bark (e.g. ash, elder, poplar, walnut, willow), i.e. the nitrofrequency *Phaeophyscia orbicularis*, *Physcia adscendens*, and *Xanthoria parietina*. Lichen species toxitolerant to acidic air pollution are less frequent, e.g. *Hypogymnia physodes*, *Lecanora conizaeoides*, and *Scoliciosporum chlorococcum*. Woodland species generally preferring natural habitats are also present, but with smaller, not well-developed, sporadic thalli, e.g. *Evernia prunastri*, *Flavoparmelia caperata*, *Parmelina tiliacea*, *Phlyctis argena*, *Pseudevernia furfuracea*, *Punctelia subrudecta*, and *Usnea* sp. Some rare (but probably spreading) epiphytic species are represented by *Candelaria concolor*, *Flavoparmelia soledians*, *Hyperphyscia adglutinata*, *Piccolia ochrophora*.

Comparing to natural habitats, lignicolous species are not abundant and less frequent in the botanical garden due to the lack of decaying wooden logs. However, they also colonise artificial wooden surfaces, like wooden bench, table, or fence, e.g. *Candelariella aurella*, *Lecanora saligna*, *Micarea misella*, *Trapeliopsis flexuosa*.

Lichenicolous fungi, parasitic or saprotrophic on lichens, were also detected in the Soroksár Botanical Garden, e.g. *Athelia arachnoidea*, *Illosporopsis christianseanii*, *Lichenocodium erodens*, *Marchandiomyces aurantiacus*, *Xanthoriicola physciae*. This special group of fungi of various appearance, nutrition, and systematic position usually needs microscopical techniques for identifications. They are rather inconspicuous in nature, those species, which cause conspicuous lesions, discolorations or warts on the thallus of the host lichen species could be found easier.

* * *

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Összefoglaló: A Soroksári Botanikus Kertben összesen 78 zuzmófaj és 5 zuzmóparazita mikrogombafaj előfordulását mutattuk ki. Legnagyobb fajszámmal és gyakorisággal a nitrogéntűrő (nitrofrekvens) fajokból álló zuzmóegyüttesek dominálnak. Néhány ritkább és érdekes faj is előfordult, pl. *Flavoparmelia soledians*, *Piccolia ochrochlora*. A törvényesen védett fajok közül a *Cladonia magyará-t* a homokbucka gyeptársulásában fedeztük fel. A *Psorotichia frustulenta* új florisztikai adatot jelent Magyarországra nézve.

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