

cryptogamie

Mycologie

2023 • 44 • 5

Analysis of lichen secondary metabolites
and morphometrics in the *Cladonia chlorophaea*
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- Biological Abstracts
- Current Contents
- Science Citation Index
- Publications bibliographiques du CNRS (Pascal)

Cryptogamie, Mycologie est distribué en version électronique par / *Cryptogamie, Mycologie is distributed electronically by:*

- BioOne® (<http://www.bioone.org/loi/crym>)

Cryptogamie, Mycologie est une revue en flux continu publiée par les Publications scientifiques du Muséum, Paris
Cryptogamie, Mycologie is a fast track journal published by the Museum Science Press, Paris

Les Publications scientifiques du Muséum publient aussi / *The Museum Science Press also publishes: Adansonia, Geodiversitas, Zoosystema, Anthropozoologica, European Journal of Taxonomy, Naturae, Comptes Rendus Palevol, Cryptogamie sous-sections Algologie, Bryologie.*

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diff.pub@mnhn.fr / <http://sciencepress.mnhn.fr>

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ISSN (imprimé / print) : 0181-1584 / ISSN (électronique / electronic) : 1776-100

Analysis of lichen secondary metabolites and morphometrics in the *Cladonia chlorophaea* species group (Cladoniaceae, lichenized Ascomycota) in Hungary

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Submitted on 13 March 2023 | Accepted 11 on May 2023 | Published on 14 June 2023

Farkas E., Lőkös L. & Veres K. 2023. — Analysis of lichen secondary metabolites and morphometrics in the *Cladonia chlorophaea* species group (Cladoniaceae, lichenized Ascomycota) in Hungary. *Cryptogamie, Mycologie* 44 (5): 61-82. <https://doi.org/10.5252/cryptogamie-mycologie2023v44a5>. <http://cryptogamie.com/mycologie/44/5>

ABSTRACT

The genus *Cladonia* P.Browne is one of the richest genera in species among lichenized fungi, consisting of about 500 species based on both morphological and chemical diversity. Thalli of the *Cladonia chlorophaea* species group with horizontal primary thalline lobes and sorediate, cup-, funnel-, goblet- or wineglass-shaped podetia contain twelve different lichen secondary metabolites (atranorin, congrayanic, cryptochlorophaeic, 4-O-methyl-cryptochlorophaeic, fumarprotocetraric, grayanic, 4-O-demethyl-grayanic, homosekikaic, merochlorophaeic, norrangiformic, quaesitic, rangiformic and thamnolic acids) in various combinations. Six taxa are currently distinguished at species level based mainly on these substances. The 281 specimens kept in herbaria as *Cladonia chlorophaea* s.l. collected in Hungary were analysed by high performance thin-layer chromatography (HPTLC). The chemical revision allowed to separate *C. asabinae* J.W.Thomson, *C. cryptochlorophaea* Asahina, *C. grayi* G.Merr. ex Sandst., *C. merochlorophaea* Asahina and *C. novochlorophaea* (Sipman) Brodo & Ahti from *C. chlorophaea* s.str. Three species – *C. asabinae*, *C. grayi* and *C. novochlorophaea* – represent new distribution records to Hungary. The morphological characters differentiating these species according to the literature data were less obvious. Therefore, a detailed morphometric study of 227 podetia – considering the size of podetia, cup, stalk, soredia and squamules – was carried out on selected specimens. Although *Cladonia asabinae* and *C. cryptochlorophaea* were usually smaller than the robust *C. chlorophaea* (Flörke ex Sommerf.) Spreng. or *C. merochlorophaea*, the chemical characteristics supplied more stable results than morphological metrics.

KEY WORDS

Cladoniaceae,
lichen-forming fungus,
lichen secondary
metabolites,
chemotaxonomy,
geographical distribution,
high performance thin-
layer chromatography,
morphometric analysis.

RÉSUMÉ

Analyse des métabolites secondaires et de la morphométrie des lichens du groupe d'espèces Cladonia chlorophaea (Cladoniaceae, Ascomycota lichénisé) en Hongrie.

Le genre *Cladonia* P.Browne est l'un des genres les plus riches en espèces de champignons lichénisés, composé d'environ 500 espèces sur la base de la diversité morphologique et chimique. Les thalles du groupe d'espèces *Cladonia chlorophaea* avec leurs lobes thallin primaires horizontaux et leurs podetia sorédiés en forme d'entonnoir contiennent douze métabolites secondaires différents (atranorin, acide congrayanique, acide cryptochlorophaeïque, acide 4-O-méthyl-cryptochlorophaeïque, acide fumarprotocetrarique, acide grayanique, acide 4-O-déméthyl-grayaniques, acide homosekikaïque, acide mérochlorophaeïque, acide norrangiformique, acide quaesitique, acide rangiformique et acide thamnolique) dans diverses combinaisons. Six espèces sont actuellement reconnues principalement sur la base de ces substances. Les 281 spécimens conservés dans des herbiers sous le nom de *Cladonia chlorophaea s.l.* collectés en Hongrie ont été analysés par chromatographie sur couche mince à haute performance (HPTLC). Cette analyse a permis de séparer *C. asahinae* J.W.Thomson, *C. cryptochlorophaea* Asahina, *C. grayi* G.Merr. ex Sandst., *C. merochlorophaea* Asahina et *C. novochlorophaea* (Sipman) Brodo & Ahti de *C. chlorophaea s.str.* en accord avec les résultats des études précédentes portant sur les variations chimiques. Trois espèces – *C. asahinae*, *C. grayi* et *C. novochlorophaea* – représentent de nouveaux relevés de distribution en Hongrie. Les caractères morphologiques différenciant ces espèces étaient moins clairs d'après les données de la littérature. C'est pourquoi une étude morphométrique détaillée des données de 227 podetia – tenant compte de la taille des podetia, de la cupule, de la tige, des sorédiés et des squamules – a été réalisée sur des spécimens sélectionnés. Bien que *Cladonia asahinae* et *C. cryptochlorophaea* soient généralement plus petits que les robustes *C. chlorophaea* (Flörke ex Sommerf.) Spreng. ou *C. merochlorophaea*, les caractéristiques chimiques ont fourni des résultats plus stables que les mesures morphologiques lors de la révision du groupe.

MOTS CLÉS

Cladoniaceae, champignons formant des lichens, métabolites secondaires des lichens, chimiotaxonomie, distribution géographique, chromatographie en couche mince haute performance, analyse morphométrique.

INTRODUCTION

Cladonia P.Browne (Cladoniaceae, lichenised Ascomycota) is one of the most diverse genera of the lichen-forming fungi with c. 500 species (Ahti 1961, 2000; Jaklitsch *et al.* 2016). In spite of the extended studies dealing with this genus, including also recent molecular phylogenetic studies (DePriest 1994, 1995; Timsina *et al.* 2014; Stenroos *et al.* 2018), some details on their taxa – and especially the correlation between the secondary chemistry and morphology – are insufficiently known (Wirth 1980; Smith *et al.* 2009; Wirth *et al.* 2013; Roux *et al.* 2017) and little studied in several countries. Such a knowledge gap concerns the species of *Cladonia chlorophaea* (Flörke ex Sommerf.) Spreng. group rich in lichen secondary metabolites (LSMs) and especially its taxa occurring in Hungary (Verseghy 1994). Several national and regional studies have been prepared on the group (e.g. Holien & Tønberg 1985; Kowalewska *et al.* 2008; Tsurykau & Golubkov 2015; Matwiejuk 2017). Furthermore, Osyczka (2013) has performed a morphometric study – including quantitative and qualitative parameters – comparing six species (*C. asahinae* J.W.Thomson, *C. chlorophaea s.str.*, *C. cryptochlorophaea* Asahina, *C. grayi* G.Merr. ex Sandst., *C. merochlorophaea* Asahina, *C. novochlorophaea* (Sipman) Brodo & Ahti) of the *C. chlorophaea* group with other scyphose *Cladonia* species (*C. fimbriata* (L.) Fr., *C. humilis* (With.) J.R.Laundon). The cluster analysis separated *C. fimbriata*, but did not separate species of the *C. chlorophaea* group and recognised morphological similarity of *C. conista* A.Evans and *C. humilis*.

The correspondence analysis of the binary-coded qualitative characters resulted in four groups of species: *C. asahinae*, *C. chlorophaea*, *C. fimbriata* and *C. humilis*.

Standardised chromatographic studies (TLC: Culberson & Kristinsson 1970; Culberson 1972, 1974; HPTLC: Arup *et al.* 1993) were used to investigate the LSMs. The distribution patterns of LSMs characterising taxa have been widely used in lichen taxonomy and systematics (Culberson 1969, 1970, 1986a, 1986b; Hawksworth 1976; Carlin 1987; Schmitt & Lumbsch 2004; Nelsen & Gargas 2008; Leavitt *et al.* 2011) since they represent cryptic chemical diversity additional to morphological-anatomical biodiversity (Crespo & Lumbsch 2010). The presence/absence and composition of LSMs have been considered at various levels of taxa from chemosyndromes, chemical races – via species – to families (Hawksworth 1976; Nourish & Oliver 1976; Randle *et al.* 2009; Osyczka & Skubała 2011; Lendemer 2012). HPTLC was also applied in addition to morphological investigations during identifications and revisions of Hungarian herbarium material (Farkas *et al.* 1998, 2021).

Our aim was to revise the Hungarian specimens of the *Cladonia chlorophaea* group kept in Hungarian herbaria under various names, mostly *C. chlorophaea*, its forms (*Cladonia chlorophaea* f. *costata* (Flörke) Sandst., *Cladonia chlorophaea* f. *hyalinella* Flörke, *Cladonia chlorophaea* f. *mesotheta* (Wallr.) Anders, *Cladonia chlorophaea* f. *pachyballina* Vain., *Cladonia chlorophaea* f. *prolifera* Anders, *Cladonia chlorophaea* f. *pterygota* (Flörke) Motyka), *C. cryptochlorophaea* and *C. merochlorophaea* (Verseghy 1994). Furthermore, to investigate the LSMs and the morphological characters available to recognise these species.

MATERIAL AND METHODS

THE RESEARCH OBJECT

Altogether 281 specimens of the herbaria BP and VBI (abbreviations according to Thiers 2023) were revised by HPTLC and analysis of macromorphological characters (colour, shape and rough size of podetia, the presence of soredia and squamules). Micromorphological parameters (the size of podetia and their various parts, cup, stalk, soredia and squamules; the angle between cup and stalk) were measured and statistically analysed. Altogether 213 specimens were found to belong to the group *C. chlorophaea* s.l. from Hungary (Appendix 1), 196 specimens in the lichen collection BP (Budapest), and 17 from the lichen herbarium VBI (Vácrátót). The remainder appeared to belong to other species.

GEOGRAPHY AND CLIMATE IN HUNGARY

Hungary has a varied relief ranging from c. 70 m (lowland) to c. 1000 m (lower montane regions) with a varied geomorphological origin – mostly marine, fluvial, and aeolian sediment of various ages and in smaller areas volcanic rocks covering the formations of older geographical periods. Six main geomorphological districts are distinguished: the Alföld (the Great Hungarian Plain), the Kisalföld (the Little Hungarian Plain), the Alpokalja (the Foot of the Alps), the Transdanubian Hills, the Transdanubian Range, and the North Hungarian Range (as a part of the Northwestern Carpathians) (Gábris *et al.* 2018; Kocsis 2018). The natural Pannonian vegetation consists of various deciduous forests in mountainous regions and montane rocky and lowland sandy grasslands with special microclimatic conditions allowing lichen colonization on various soil and rock surfaces (Molnár *et al.* 2018). The macroclimate is predominantly continental with oceanic and Mediterranean influence, with recent changes due to global climatic tendencies (Thomas *et al.* 2004; Thuiller *et al.* 2005; UNFCCC 2013; Bihari *et al.* 2018).

CHEMICALS

All chemicals were of analytical or higher grade. HPLC acetone (VWR) was applied to extract LSMs from intact lichen samples for chromatographic analysis. Toluene (CARLO ERBA), acetic acid (LACH-NER), dioxane (REANAL, Sigma Aldrich), cyclo-hexane (LACH-NER), methyl-tert-butyl ether (Fisher Scientific, United Kingdom), formic acid (LACH-NER), and sulphuric acid (CARLO ERBA) were obtained from Reanal for HPTLC investigations.

HPTLC METHOD

HPTLC analysis was carried out according to the standard methods for analysing lichen samples described by Arup *et al.* (1993) and Molnár & Farkas (2011). A CAMAG horizontal chamber of 10 cm × 10 cm, a CAMAG TLC Plate Heater III, and 10 cm × 10 cm HPTLC plates (Merck, Kieselgel 60 F254) were used. Approximately 3–5 mm × 3–5 mm air-dried podetium fragments (a part of a single podetium/sample) were soaked in 0.2 ml acetone for c. 30 minutes in order to extract the lichen substances. Sampling was carried out by

one of the authors, most often by K. V. Pretreated (50°C for five minutes, CAMAG TLC Plate Heater III, then cooled to room temperature), 10 cm × 10 cm thin-layer chromatographic plates (Merck, Kieselgel 60 F254) were used. 8 µl acetone extracts (1 µl at each time) were applied to each position (5 mm apart) on the plate. The solvent systems A (toluene – dioxane – acetic acid, 45 : 15 : 2 v/v/v), B (cyclo-hexane – methyl-tert-butyl ether – formic acid, 6.5 : 5 : 1 v/v/v) and most often solvent system C (toluene – acetic acid, 20:3 v/v) were applied. *Pleurosticta acetabulum* (Neck.) Elix & Lumbsch (norstictic acid) and *Leucodermia boryi* (Fée) Kalb (atranorin, zeorin) were used as controls. Plates were investigated under UV 254 nm and UV 366 nm after development, then fatty acids and water-repellent substances were studied, while sprayed with water, finally it was followed by spraying with 10% sulphuric acid and heating at 110°C for 5–10 minutes, then spots were observed at daylight and under UV light (366 nm).

MORPHOLOGICAL INVESTIGATIONS

The morphology and anatomy were studied by using a NIKON Eclipse/NiU (DIC, epifluorescence) compound microscope (Nikon Corporation, Tokyo, Japan), as well as an Olympus SZX7 stereomicroscope (Olympus Corporation, Tokyo, Japan). Micrographs were prepared by a Canon EOS 1300D (Canon Inc., Tokyo, Japan) camera (with Quick Photo Camera 3.2 software, Olympus Corporation, Tokyo, Japan) and Nikon DS-Fi1c camera (with NIS-Elements BR software, Nikon Corporation, Tokyo, Japan) with the above-mentioned microscopes. For the morphometric analysis the size of 227 podetia, cup, stalk, soredia and squamules were measured on selected specimens after revision based on LSMs and macromorphological investigations. The measured characters are illustrated in Figure 1.

STATISTICAL ANALYSIS

The statistical analysis was carried out on 227 podetia belonging to six species and 50 specimens. The chemical and morphometric data were handled separately. The statistical difference between the species in the morphological characteristics was analysed by a one-way Analysis of Variance (ANOVA) followed by a Tukey HSD test in R environment (software version 3.6.3, R Core Team 2020). The normality of data distribution was checked visually by a Q-Q plot (quantiles of the residuals were plotted against the quantiles of the normal distribution with a 45° degree reference line) and by Shapiro-Wilk normality test. The homogeneity of variances was tested by Levene's test. A level of $p < 0.05$ was considered for a significant difference. Two conditional inference trees were prepared: one for chemical and one for morphological characteristics. Before creating the trees, two correlation matrices were prepared to exclude the strongly correlating variables during the data processing with the Hmisc package (Harrell 2022) with 'rcorr' function using Spearman rank correlation. The trees were prepared in the partykit package (Hothorn & Zeileis 2015) by 'ctree' function (Hothorn *et al.* 2006) in R.

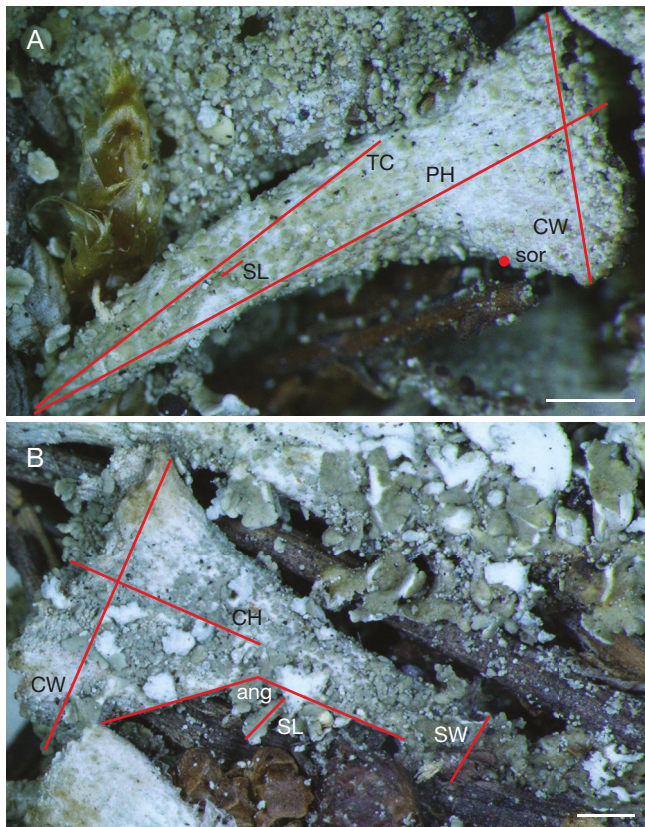


Fig. 1. — Indication of measurements for morphometric analysis: **A**, podetium of *Cladonia novochlorophaea* (Sipman) Brodo & Ahti (BP[BP 9314]); **B**, podetium of *C. merochlorophaea* Asahina (BP[BP 32926]). Abbreviations: **ang**, angle between cup and stalk; **CH**, cup height; **CW**, cup width; **PH**, podetium height; **SL**, length of squamules; **sor**, diameter of soredium; **SW**, stalk width; **TC**, corticated part of podetium. Scale bars: 1 mm.

DISTRIBUTION MAPS

Distribution maps were constructed by the computer program for geographical information system QGIS 3.28 Firenze (Qgis 2022), applying an adaptation of the Central European grid system (Niklfeld 1971; Borhidi 1984). The symbols (dots) illustrated represent units of *c.* 5 km × 6 km areas. Maps presenting distribution before and after revision were compared.

ABBREVIATIONS

ang	angle between cup and stalk;
CH	cup height;
CW	cup width;
HPTLC	high performance thin layer chromatography;
LSM	lichen secondary metabolite;
PH	podetium height;
PHCW	the ratio of podetium height to cup width;
SL	mean length of squamules;
sor	mean diameter of soredium;
SW	stalk width;
TC	corticated part of podetium;
TCPH	the ratio of the corticated part of the podetium to the height of the whole podetium;
TLC	thin layer chromatography.

RESULTS AND DISCUSSION

HPTLC ANALYSIS

The LSM content and composition were established for all 213 *Cladonia chlorophaea s.l.* specimens (Fig. 2).

The *Cladonia chlorophaea s.l.* specimens usually contained the LSMs described in the main literature sources (Culberson & Kristinsson 1969; Sipman 1973; Thomson 1976; Culberson *et al.* 1977; Holien & Tønberg 1985; Culberson 1986a; Ahti *et al.* 2013), however, in some cases unusual LSMs were also found. It resulted in a certain diversity within the species. The following lichen secondary metabolites were found during the HPTLC analysis of the present investigation: atranorin, congrayanic, cryptochlorophaeic, 4-O-methyl-cryptochlorophaeic, fumarprotocetraric, grayanic, 4-O-demethyl-grayanic, homosekikaic, merochlorophaeic, norrangiformic, quaesitic, rangiformic and thamnolic acids.

The specimens of *C. asahinae* (6) contain fumarprotocetraric acid and rangiformic acid. The presence of the additional norrangiformic acid was found only in one specimen (BP[BP 87625]).

The specimens of *C. chlorophaea* (159) are usually characterised by the single appearance of fumarprotocetraric acid (probably sometimes with protocetraric acid not analysed separately).

The specimens of *C. cryptochlorophaea* (18) have a variable chemical composition. Normally fumarprotocetraric and cryptochlorophaeic acids were found, however, occasionally some other LSMs cooccurred with these LSMs: 4-O-methyl-cryptochlorophaeic acid, thamnolic acid, quaesitic acid (BP[BP 48938]), also with additional rangiformic acid and norrangiformic acid (BP[BP 51940]).

The specimens of *C. grayi* (6) contained normally fumarprotocetraric and grayanic acids, sometimes with additional 4-O-demethyl-grayanic acid. The appearance of additional cryptochlorophaeic acid was also found (BP[BP 32924]), where probably *C. cryptochlorophaea* occurred together with *C. grayi*.

The specimens of *C. merochlorophaea* (21) contained usually fumarprotocetraric and merochlorophaeic acids, often with 4-O-methyl-cryptochlorophaeic acid. In one specimen (BP[BP 65213]) merochlorophaeic acid was missing, but 4-O-methyl-cryptochlorophaeic acid was present together with fumarprotocetraric acid and congrayanic acid (BP[BP 65176]) appeared with the two main substances. Thus this species had a considerable diversity of LSMs.

The specimens of *C. novochlorophaea* (3) contained fumarprotocetraric and homosekikaic acids.

One specimen (BP[BP 52885]) contained a combination of LSMs characteristic for two species (fumarprotocetraric, cryptochlorophaeic, 4-O-methyl-cryptochlorophaeic and merochlorophaeic acids), therefore we concluded that probably thalli of *C. cryptochlorophaea* and *C. merochlorophaea* were found together.

A great number of further specimens (68) had to be excluded from the *Cladonia chlorophaea* group based on their different LSM composition and/or morphological characteristics. These mistakenly identified species turned out to be *C. conista*,

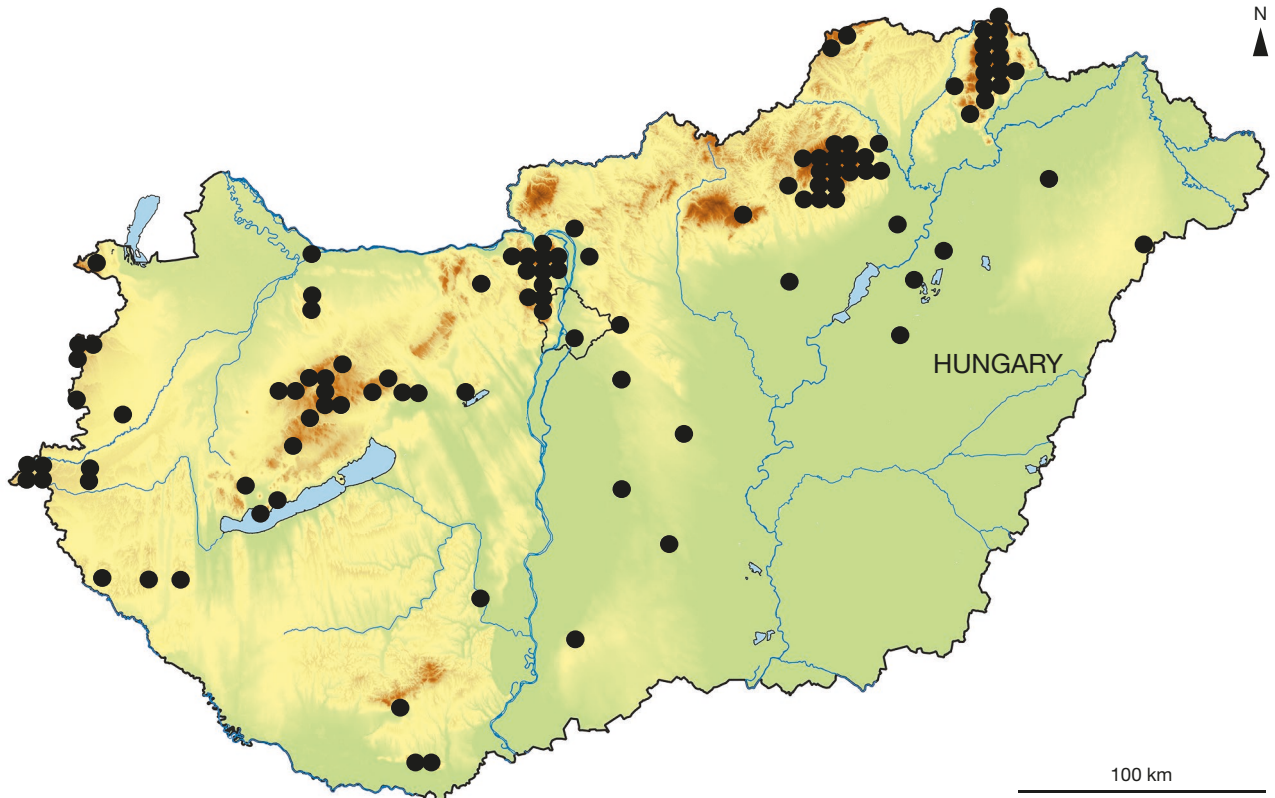


Fig. 2. — Distribution of *Cladonia chlorophaea* s.l. species in Hungary before revision.

C. fimbriata, *C. magyarica* Vain., *C. pocillum* (Ach.) O.J.Rich., *C. pyxidata* (L.) Hoffm. and various usnic acid and zeorin containing species, that usually carry red apothecia, but our specimens contained only sterile podetia.

The chromatographic analysis was followed by a statistical analysis based on LSMs. Then the specimens selected from the revised ones were measured for the morphometric analysis.

STATISTICAL ANALYSIS BASED ON LICHEN SECONDARY METABOLITES

We carried out a statistical analysis for LSMs only that occurred in more than one species. We found significant strong correlation ($r > 0.9$) between the occurrence of 4-O-methyl-cryptochlorophaeic acid and grayanic acid. Therefore, the 4-O-methyl-cryptochlorophaeic acid was excluded from the further analysis.

A conditional inference tree (Fig. 3) was created that presents the chemical characteristics of the investigated species with two splits and three terminal nodes. The first split cuts the tree into two sides based on the presence of cryptochlorophaeic acid (cch), with the presence on the right side and the absence on the left side. Specimens containing cryptochlorophaeic acid and thamnolic acid were mainly *Cladonia cryptochlorophaea* (around 85%) and several *C. merochlorophaea* specimens (around 15%) also occurred on this node. The second split was based on the presence of rangiformic acid. Specimens containing rangiformic acid were mainly *C. asahinae* (c. 75%), and some *C. merochlorophaea* speci-

mens (c. 25%) also contained the metabolite. Rangiformic acid was always missing in the specimens of *C. chlorophaea*, *C. grayi*, *C. novochlorophaea*. Specimens containing thamnolic acid were mainly *Cladonia cryptochlorophaea* (c. 85%) and several *C. merochlorophaea* specimens (c. 15%) also occurred on this node.

STATISTICAL ANALYSIS BASED ON MORPHOLOGICAL MEASUREMENTS

According to the results of the ANOVA, several characteristics caused dissimilarities between the species (Table 1). *Cladonia chlorophaea* (mean 10.35 mm) and *C. merochlorophaea* (mean 8.94 mm) had significantly taller podetia than *C. asahinae* (mean 5.00 mm), *C. cryptochlorophaea* (mean 6.53 mm) and *C. grayi* (mean 6.88 mm) (Tables 1; 2; Fig. 4).

C. novochlorophaea (mean 3.71 mm), *C. chlorophaea* (mean 3.03 mm) and *C. merochlorophaea* (mean 2.51 mm) showed significantly higher cup than *C. cryptochlorophaea* (mean 1.92 mm) and *C. asahinae* (mean 1.3 mm) (Tables 1; 2; Fig. 5). *C. asahinae* had the shortest cup among the investigated species.

C. asahinae (mean 1.75 mm) showed a significantly thinner cup compared to *C. cryptochlorophaea* (mean 3.32 mm), *C. chlorophaea* (mean 3.95 mm) and *C. merochlorophaea* (mean 3.89 mm) (Tables 1; 2; Fig. 6).

Cladonia asahinae (mean 0.53 mm) had a significantly narrower podetium stalk than *C. chlorophaea* (mean 1.01 mm) and *C. merochlorophaea* (mean 1.13 mm) (Tables 1; 2; Fig. 7).

TABLE 1. — Species pairs differing in morphometric characteristics. Abbreviations: **asa**, *C. asahinae*; **chlo**, *C. chlorophaea*; **cry**, *C. cryptochlorophaea*; **gra**, *C. grayi*; **mero**, *C. merochlorophaea*; **novo**, *C. novochlorophaea*; **ang**, the angle between cup and stalk; **CH**, height of cup; **CW**, width of cup; **PH**, height of podetium; **PHCW**, the ratio of podetium height to cup width; **SL**, mean length of squamule on podetia (n=3 / podetium); **sor**, mean diameter of soredium (n=10 / podetium); **SW**, width of stalk; **TCPH**, the ratio of the corticated part of the podetium to the height of the whole podetium.

Species pairs	Variables								
	ang	CH	CW	PH	PHCW	SL	sor	SW	TCPH
asah-chlo	ns	p<0.001	p<0.001	p<0.001	0.002	ns	p<0.001	p<0.001	ns
asah-cry	ns	ns	0.006	ns	p<0.001	ns	ns	ns	ns
asah-gra	ns	ns	ns	ns	p<0.001	ns	ns	ns	ns
asah-mero	ns	0.027	p<0.001	p<0.001	p<0.001	ns	p<0.001	p<0.001	ns
asah-novo	ns	0.002	ns	ns	0.046	ns	ns	ns	ns
gra-chlo	ns	ns	ns	0.021	ns	ns	ns	ns	ns
gra-cry	ns	ns	ns	ns	ns	ns	ns	ns	ns
gra-mero	ns	ns	ns	ns	ns	ns	0.019	0.054	ns
gra-novo	ns	ns	ns	ns	ns	ns	ns	ns	ns
mero-chlo	ns	ns	ns	ns	ns	0.006	ns	ns	ns
mero-cry	ns	ns	ns	0.011	ns	ns	0.012	0.001	ns
mero-novo	ns	ns	ns	ns	ns	0.004	ns	0.007	ns
chlo-cry	ns	0.005	ns	p<0.001	ns	ns	ns	ns	ns
chlo-novo	ns	ns	ns	0.053	ns	ns	ns	ns	ns
novo-cry	ns	0.018	ns	ns	ns	ns	ns	ns	0.043

TABLE 2. — The mean values of morphological parameters in the different investigated species. Abbreviations: **asa**, *C. asahinae*; **chlo**, *C. chlorophaea*; **cry**, *C. cryptochlorophaea*; **gra**, *C. grayi*; **mero**, *C. merochlorophaea*; **novo**, *C. novochlorophaea*; **ang**, the angle between cup and stalk; **CH**, height of cup; **CW**, width of cup; **PH**, height of podetium; **SL**, mean length of squamule on podetia (n=3 / podetium); **sor**, mean diameter of soredium (n=10 / podetium); **SW**, width of stalk.

Species	Variables						
	PH (mm)	CH (mm)	CW (mm)	SW (mm)	sor (µm)	ang (°)	SL (mm)
asah	5.00	1.30	1.75	0.53	29	149	0.20
chlo	10.35	3.03	3.95	1.01	62	152	0.74
cry	6.53	1.92	3.32	0.80	48	149	0.74
gra	6.88	2.39	3.24	0.78	42	149	0.31
mero	8.94	2.51	3.89	1.13	65	154	0.75
novo	6.49	3.71	2.47	0.58	43	156	0.16

TABLE 3. — Correlation matrix between the morphological parameters. Abbreviations: **ang**, the angle between cup and stalk; **CH**, height of cup; **CW**, width of cup; **PH**, height of podetium; **PHCW**, the ratio of podetium height to cup width; **SL**, mean length of squamule on podetia (n=3 / podetium); **sor**, mean diameter of soredium (n=10 / podetium); **SW**, width of stalk; **TCPH**, the ratio of the corticated part of the podetium to the height of the whole podetium (n=227).

	PH	CH	CW	SW	sor	ang	PHCW	SL	TCPH
PH	–	0.78	0.76	0.75	0.80	0.05	0.24	0.20	0.15
CH	0.78	–	0.78	0.76	0.75	0.10	-0.11	0.11	0.14
CW	0.76	0.78	–	0.85	0.77	-0.09	-0.37	0.07	0.05
SW	0.75	0.76	0.85	–	0.77	0.02	-0.19	0.12	0.07
sor	0.80	0.75	0.77	0.77	–	0.10	-0.01	0.08	0.16
ang	0.05	0.10	-0.09	0.02	0.10	–	0.20	0.07	0.05
PHCW	0.24	-0.11	-0.37	-0.19	-0.01	0.20	–	0.18	0.13
SL	0.20	0.11	0.07	0.12	0.08	0.07	0.18	–	0.10
TCPH	0.15	0.14	0.05	0.07	0.16	0.05	0.13	0.10	–

Cladonia asahinae (mean 29 µm) had significantly smaller soredia than *C. chlorophaea* (mean 62 µm) and *C. merochlorophaea* (mean 65 µm) (Tables 1; 2; Fig. 8).

The angle between the cup and stalk (113-179°) did not show any significant difference between the species (Table 1). The length of squamules on podetia (0.11-2.1 mm) and the part of the corticated area on podetium did not show any differences between the species (Table 1).

Before creating the conditional inference trees, a correlation matrix (Table 3) was prepared to exclude the correlating variables during the data process.

We found significant strong correlations (Spearman correlation coefficient, $r > 0.6$) between the podetium height, cup height, cup width, stalk width and soredium diameter, respectively.

The conditional inference tree (Fig. 9) showed the basic morphological characteristics of the investigated species with five splits and six terminal nodes. The first split cut the tree into two sides based on the mean podetium height (PH) with lower than 5 mm on the left side and higher than 5 mm on the right side.

The first split on the left side was based on the cup width (CW), forming two branches: with a narrower or wider than

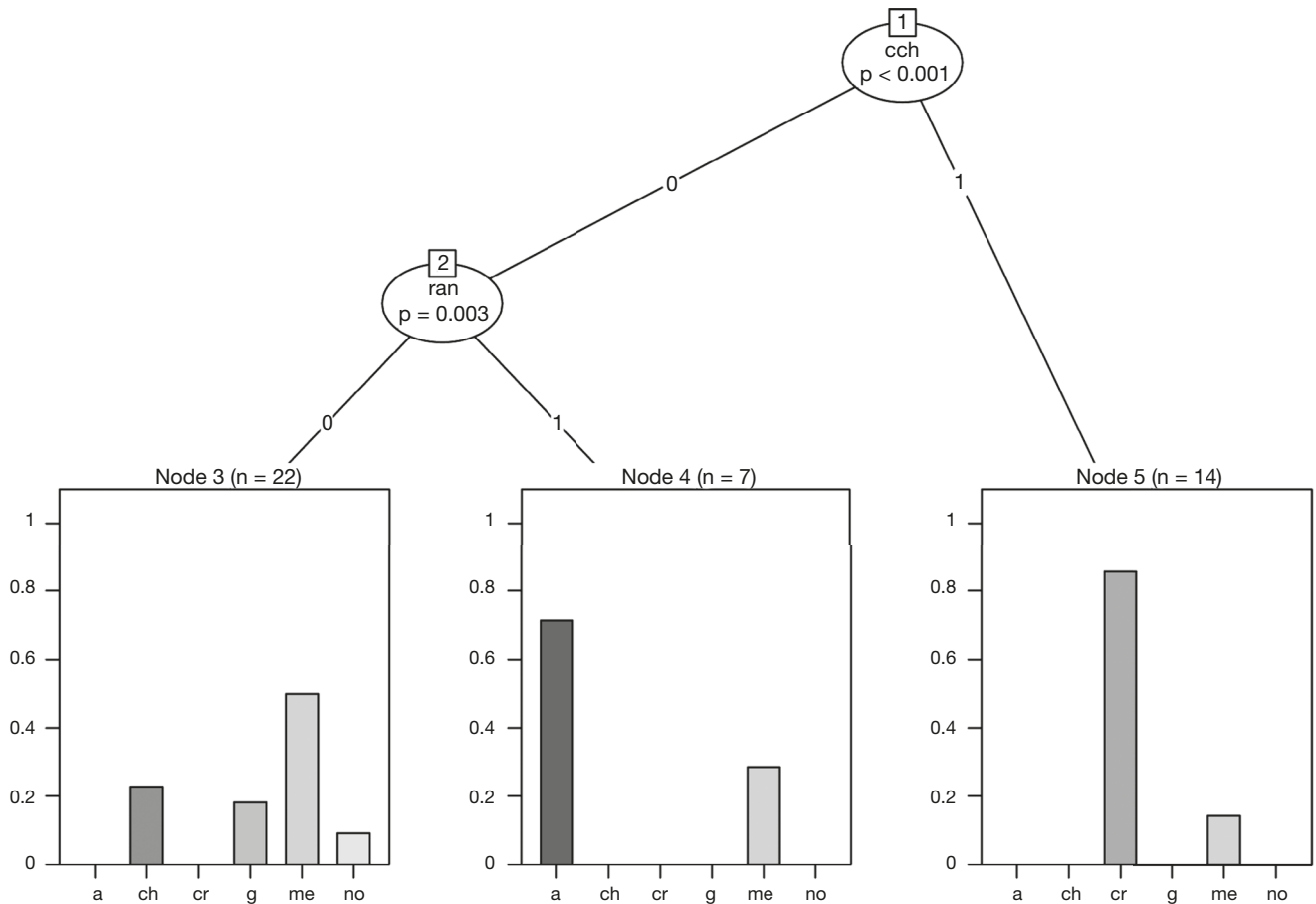


FIG. 3. — Conditional inference tree presenting the presence of the three most abundant lichen secondary metabolites occurring in more than one species of the *C. chlorophaea* species group. A level of $p < 0.05$ was considered for a significant difference. Abbreviations: **cch**, cryptochlorophaeic acid; **ran**, rangiformic acid; **tha**, thamnolic acid; **a**, *C. asahinae*; **ch**, *C. chlorophaea*; **cr**, *C. cryptochlorophaea*; **g**, *C. grayi*; **me**, *C. merochlorophaea*; **no**, *C. novochlorophaea*. Boxes represent the highest probability of a species occurrence on the tree node.

1.2 mm cup on the podetium. The specimens in the group wider than 1.2 mm cup mainly (more than 40%) belonged to *C. cryptochlorophaea*. Going further, the second split divided the groups into two terminal nodes along podetium stalk width (SW). The specimens which were characterised by a thinner podetium stalk (0.3 mm) proved to be mainly *C. asahinae* (more than 60%), and some *C. novochlorophaea* (around 30%) and *C. grayi* (around 5%) specimens also occurred in this terminal node.

The first split on the right side of the tree was based on cup height (CH). Specimens with higher than 5.6 mm cups were mainly *C. novochlorophaea* (around 40%) and *C. chlorophaea* (around 50%). The second split on the right side of the tree was based on podetium stalk width (SW). Specimens with wider than 1 mm stalk were mainly *C. merochlorophaea* (almost 60%) or *C. cryptochlorophaea* (20%). More than half of the specimens with wider than 1 mm podetium stalks were mainly *C. chlorophaea*.

Though, similarly to the results of Osyczka (2013), the best separated taxon was *C. asahinae* among the *C. chlorophaea* s.l. species, our analyses could present differences also between the other five species and the differences based on LSM composition have been confirmed by morphometric studies.

Furthermore, the species had characteristic differences also in their geographical distribution within the country as it is summarised below.

STUDIED SPECIES

Cladonia asahinae J.W.Thomson
(Fig. 10)

NOTES

The Hungarian specimens contain rangiformic and norrangiformic acids. Though Thomson (1976) indicated the presence of fumarprotocetraric acid and protolichesterinic acid in the original description of the species, according to the chemical revision of Hennings (1983) the type specimen contains rangiformic and norrangiformic acids and not protolichesterinic acid, just as in the specimens investigated from Hungary.

The shape of the rather thin podetia is similar to that of *Cladonia fimbriata* having thin and short cups. According to various literature sources (Thomson 1976; Holien & Tønberg 1985; Ahti *et al.* 2013) *C. asahinae* is less farinose than that species, since towards the not melanotic base corticated granules appear, furthermore the small squamules at the base of podetia

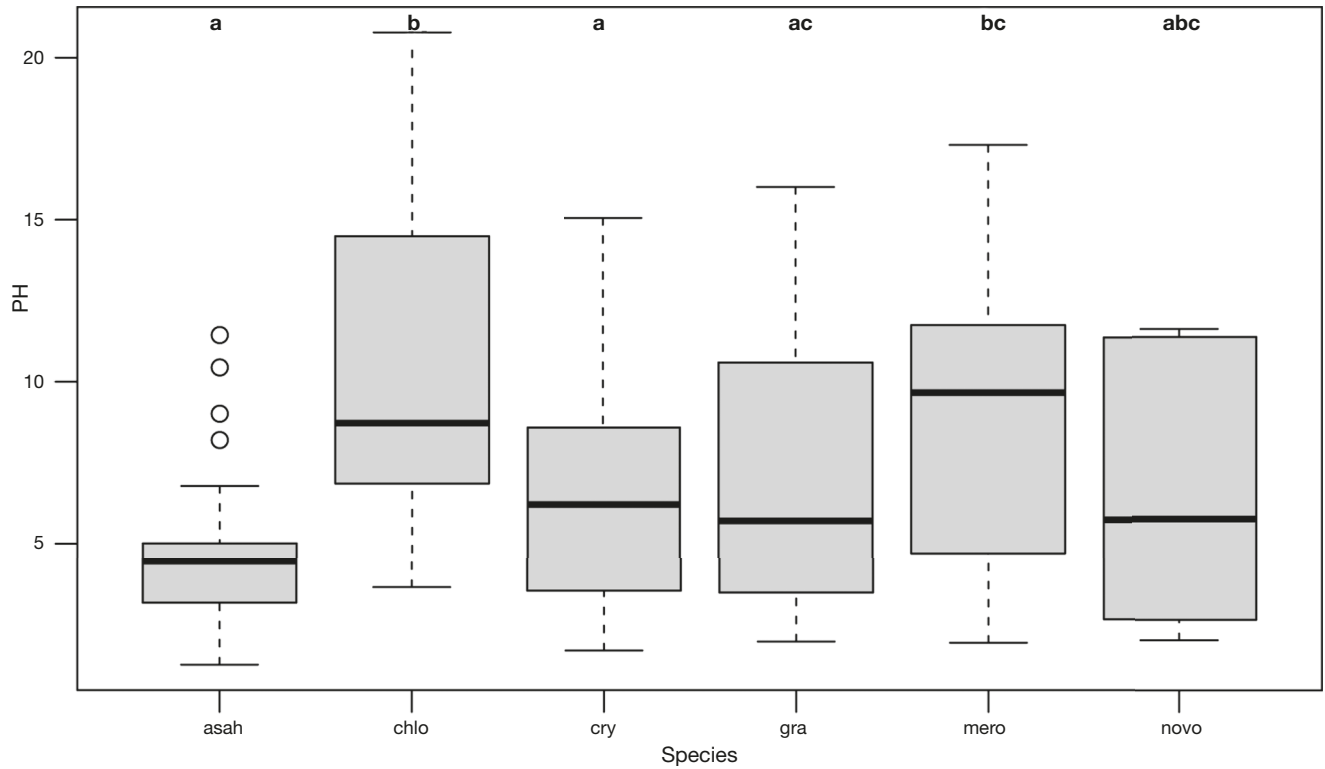


FIG. 4. — Height of podetia (mm) of the different species. Abbreviations: **asa**, *C. asahinae* (n=22); **chlo**, *C. chlorophaea* (n=55); **cry**, *C. cryptoclorophaea* (n=53); **gra**, *C. grayi* (n=17); **mero**, *C. merochlorophaea* (n=70); **novo**, *C. novochlorophaea* (n=10). The lines represent the minimum and maximum values, the box represents the 25% and 75% of the data, the thick line represents the median. Means with the same letter are not significantly different at 95% confidence.

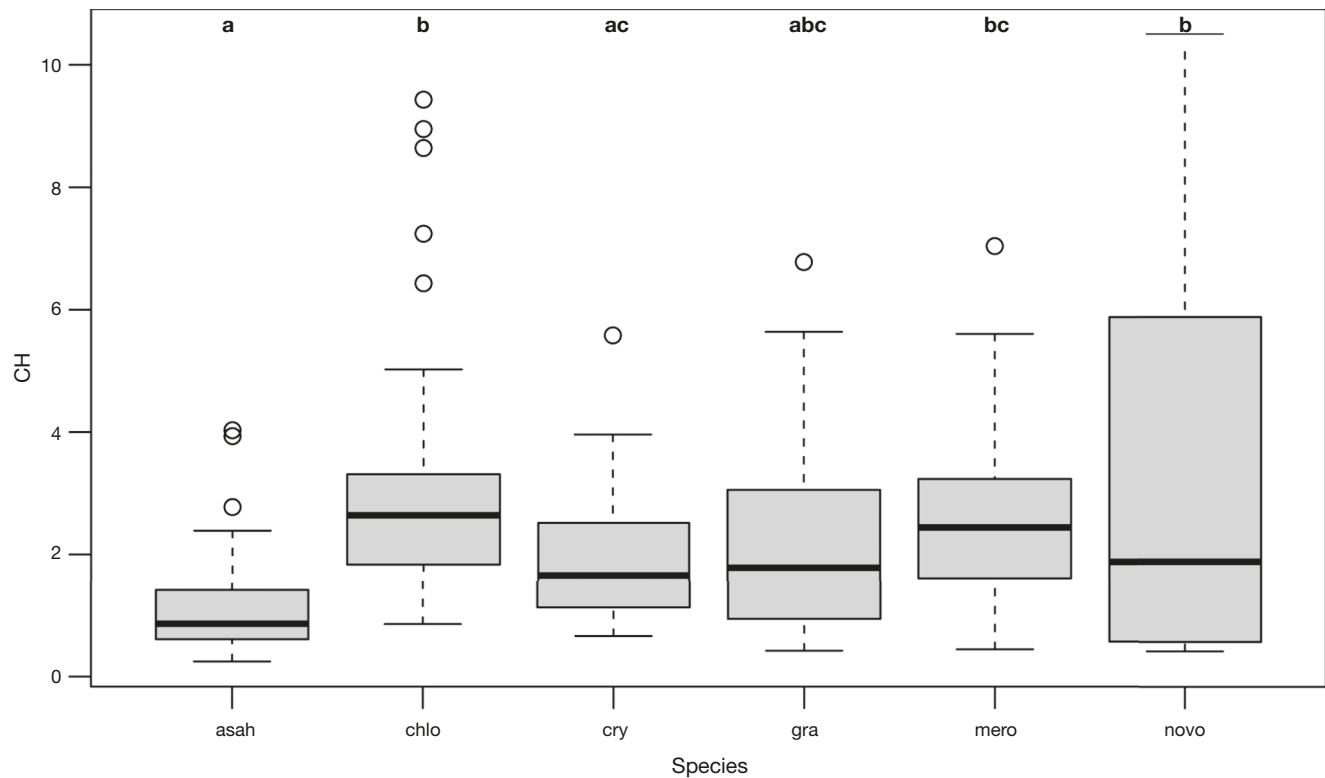


FIG. 5. — Height of cup (mm) in different species. Abbreviations: **asa**, *C. asahinae* (n=22); **chlo**, *C. chlorophaea* (n=55); **cry**, *C. cryptoclorophaea* (n=53); **gra**, *C. grayi* (n=17); **mero**, *C. merochlorophaea* (n=70); **novo**, *C. novochlorophaea* (n=10). The lines represent the minimum and maximum values, the box represents the 25% and 75% of the data, the thick line represents the median. Means with the same letter are not significantly different at 95% confidence.

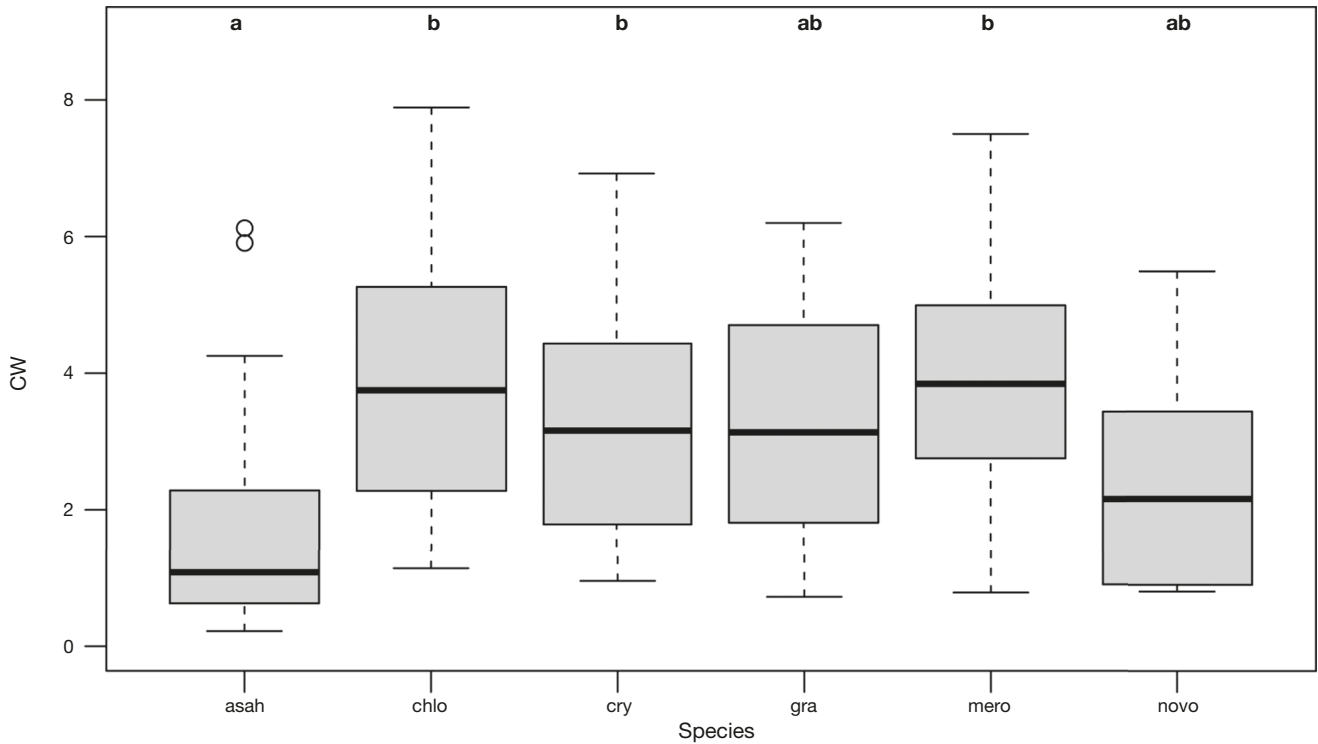


FIG. 6. — Width of cup (mm) in different species. Abbreviations: **asa**, *C. asahinae* (n=22); **chlo**, *C. chlorophaea* (n=55); **cry**, *C. cryptochlorophaea* (n=53); **gra**, *C. grayi* (n=17); **mero**, *C. merochlorophaea* (n=70); **novo**, *C. novochlorophaea* (n=10). The lines represent the minimum and maximum values, the box represents the 25% and 75% of the data, the thick line represents the median. Means with the same letter are not significantly different at 95% confidence.

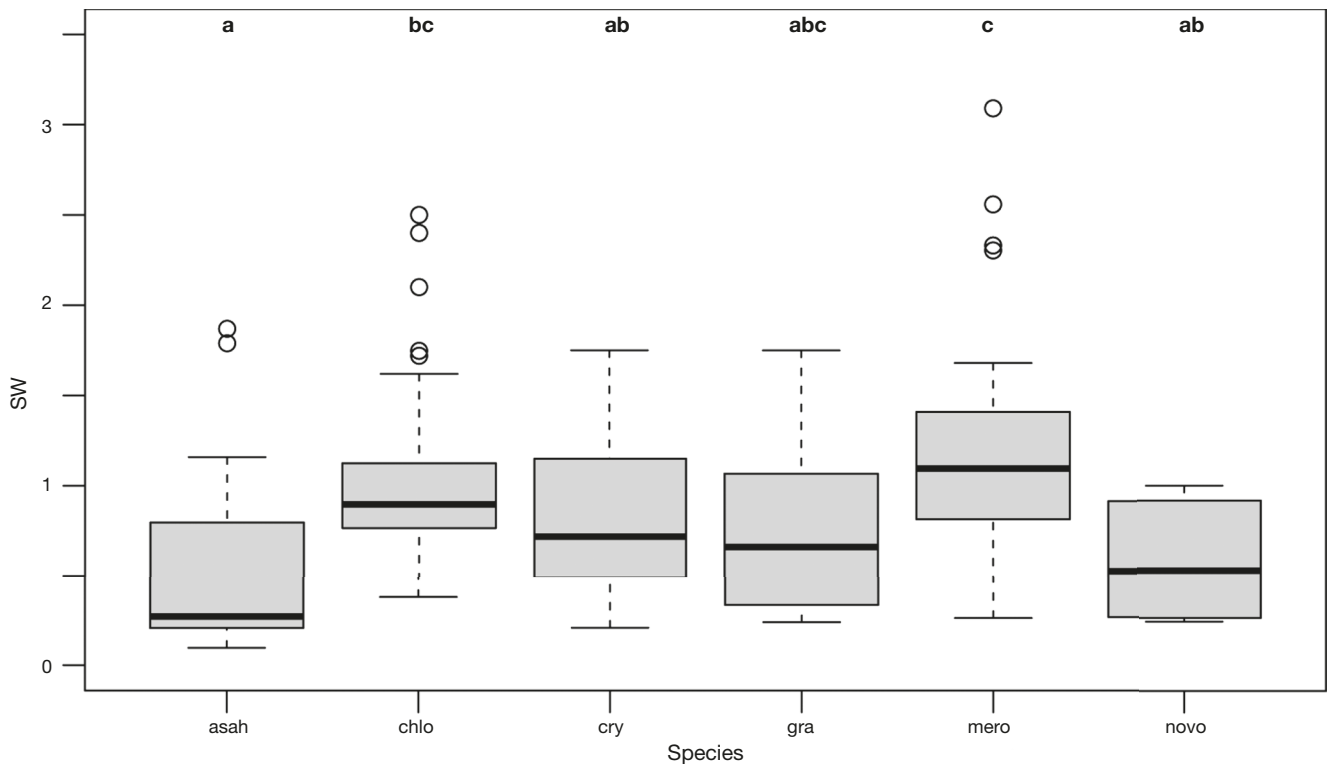


FIG. 7. — Width of podetium stalk (mm) in different species. Abbreviations: **asa**, *C. asahinae* (n=22); **chlo**, *C. chlorophaea* (n=55); **cry**, *C. cryptochlorophaea* (n=53); **gra**, *C. grayi* (n=17); **mero**, *C. merochlorophaea* (n=70); **novo**, *C. novochlorophaea* (n=10). The lines represent the minimum and maximum values, the box represents the 25% and 75% of the data, the thick line represents the median. Means with the same letter are not significantly different at 95% confidence.

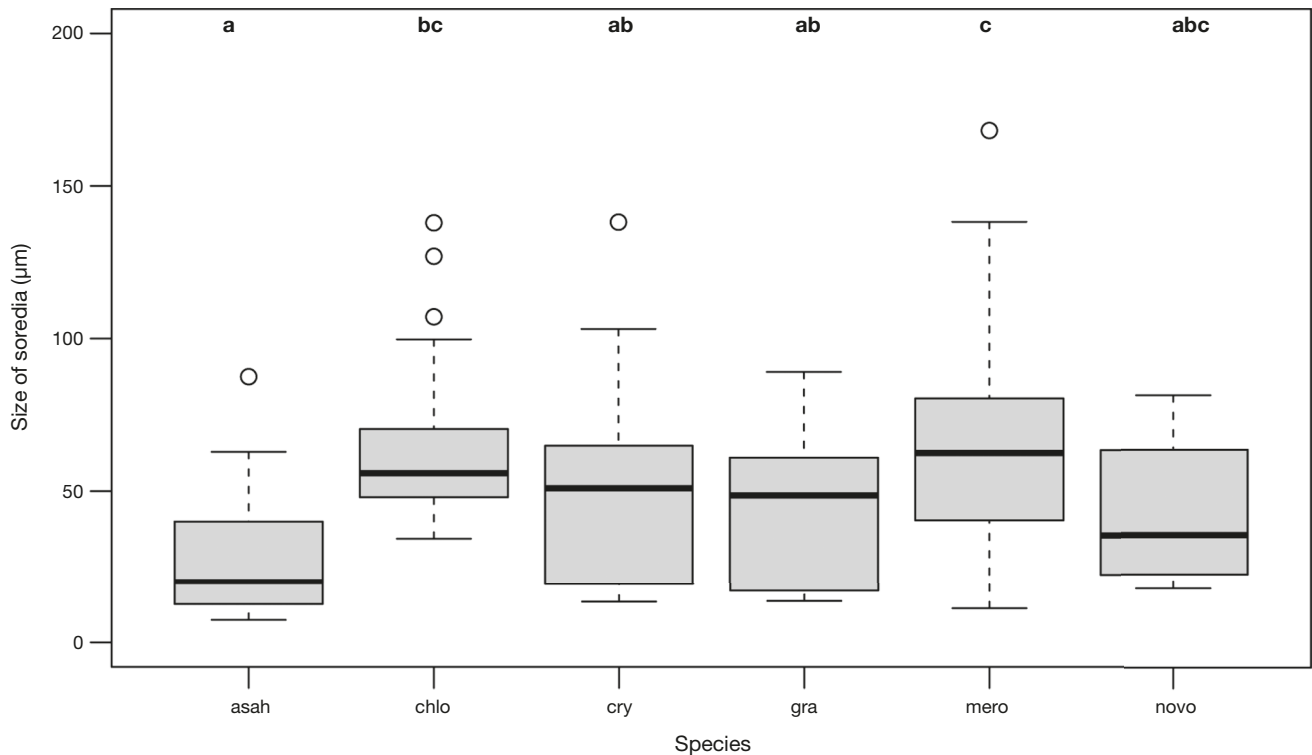


Fig. 8. — The mean diameter of soredia (μm) measured on podetia ($n=10$). Abbreviations: **asa**, *C. asahinae* ($n=22$); **chlo**, *C. chlorophaea* ($n=55$); **cry**, *C. cryptochlorophaea* ($n=53$); **gra**, *C. grayi* ($n=17$); **mero**, *C. merochlorophaea* ($n=70$); **novo**, *C. novochlorophaea* ($n=10$). The lines represent the minimum and maximum values, the box represents the 25% and 75% of the data, the thick line represents the median. Means with the same letter are not significantly different at 95% confidence.

are regarded as important characters for *C. asahinae*. Its color is yellowish to slaty gray. While this species was found to be the smallest in the height of podetia (1.2–11.4 mm) and width (0.2–6.1 mm) and height (0.2–4 mm) of cups, and it had the thinnest stalk (0.1–1.9 mm), also the diameter of the soredia (7–88 μm) is among the smaller ones of the investigated species, the size of squamules (0.11–0.38 mm) was not significantly smaller than those of other species in Hungary. Differences were found from all species in a great number of characters (Table 1).

C. asahinae was seldom collected in Hungary and it represents a new distribution record to the country. It grows on both calcareous and siliceous soil, also among bryophytes in various hilly regions between 135 and 800 m a.s.l. in the Bakony, the Pilis and the Bükk Mts and in the Hegyalja. These are relatively humid regions within Hungary, and thus its distribution agrees well with the habitat preferences described by Holien & Tønberg (1985).

Cladonia chlorophaea (Flörke ex Sommerf.) Spreng.
(Fig. 11)

NOTES

It contains fumarprotocetraric acid (itself or with related compound protocetraric acid – not analysed separately).

Their colour is pale greenish brown, the margin of the scyphi is dentate and becoming broken and denuded with age, the base

of the podetia is not melanotic (Ahti *et al.* 2013). The soredia are granulose and thus measured as relatively larger (34–138 μm) than in other species in Hungary. It has relatively tall (3.6–20.8 mm) and broad (1.1–7.9 mm) scyphi with short stalk. Differences were found from *C. asahinae* in several characters (CH, CW, PH, PHCW, sor, SW), from *C. cryptochlorophaea* in height of cup and podetium, from *C. grayi* in the height of podetium, from *C. merochlorophaea* in the length of squamules and from *C. novochlorophaea* in the height of the podetium (Table 1).

It is the most frequent and most widely spread species in Hungary among the *C. chlorophaea* s.l. species. *C. chlorophaea* is found on calcareous soil, in deciduous and coniferous forests, at the basis of various tree species (e.g. *Alnus glutinosa* (L.) Gaertn., *Betula pendula* Roth, *Fagus sylvatica* L., *Quercus* spp., *Robinia pseudoacacia* L.), sometimes on stumps on lignum or thatched roof and almost equally frequent in the Hungarian Great Plain (70–200 m a.s.l.) and in hilly regions (up to c. 1000 m a.s.l.) in Hungary. However, specimens from hilly regions were mostly recognised as other *C. chlorophaea* s.l. species during our revision.

Cladonia cryptochlorophaea Asahina
(Fig. 12)

NOTES

The Hungarian specimens contain fumarprotocetraric, cryptochlorophaeic, quesitic (?), norrangiformic and thamnolic acids.

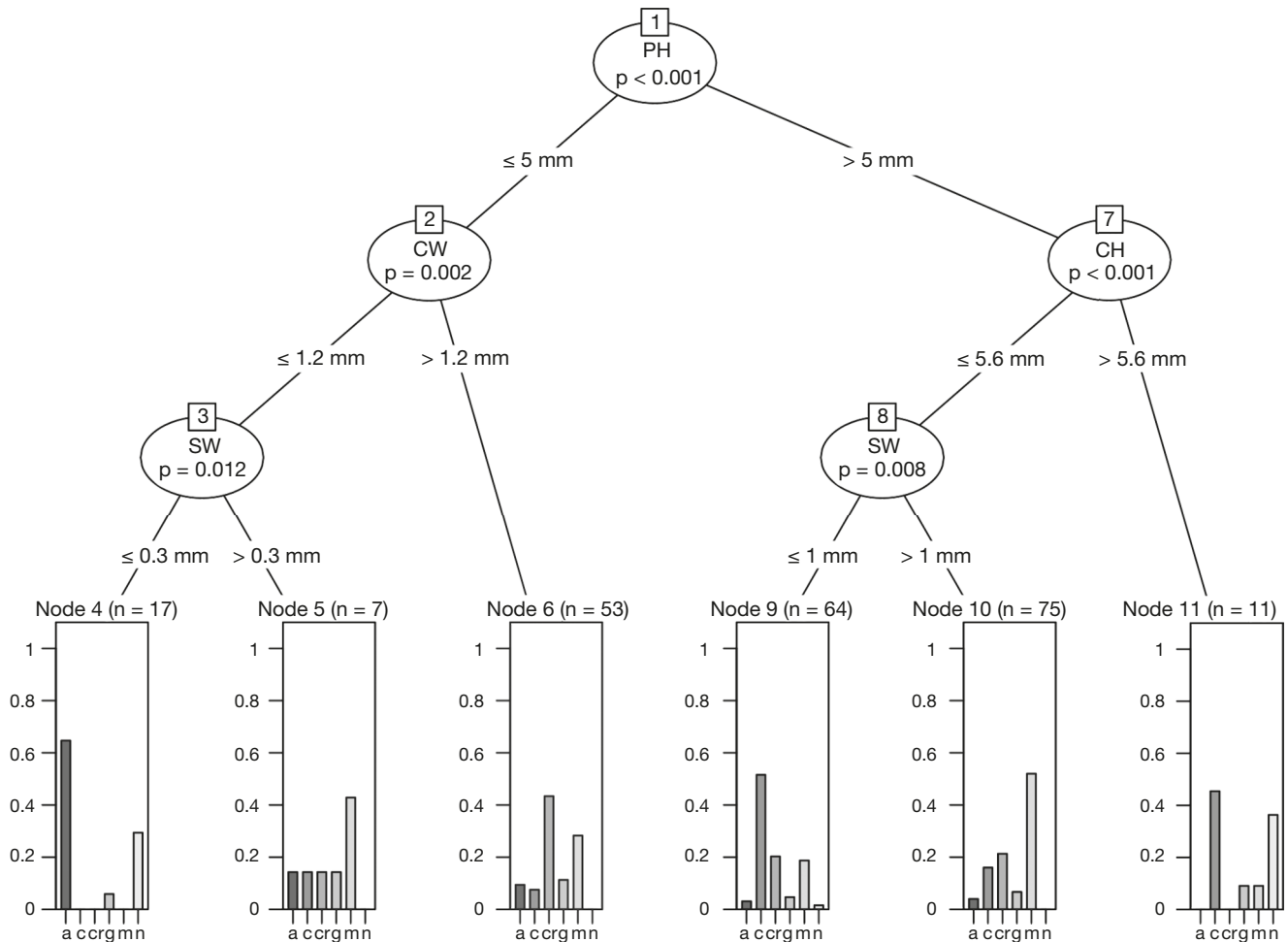


FIG. 9. — Conditional inference tree presenting the five most important morphological variables separating species: **CH**, height of cup; **CW**, width of cup; **PH**, height of podetium; **SW**, width of podetium stalk. The order of the species at the end of the nodes is as follows: **a**, *C. asahinae*; **c**, *C. chlorophaea*; **cr**, *C. cryptochlorophaea*; **g**, *C. grayi*; **m**, *C. merochlorophaea*; **n**, *C. novochlorophaea*. Boxes represent the highest probability of a species occurrence on the tree node. A level of $p < 0.05$ was considered for a significant difference.

Their colour is dark greenish grey, weakly black melanotic at base. The scyphi are hardly dentate at margin, the basis of the stalk is usually blackening (Stenroos *et al.* 2011, 2016; Ahti *et al.* 2013). The podetia are medium tall (1.7–15.1 mm) with relatively wide (1–6.9 mm) and short (0.7–5.6 mm) cup. The soredia are granulate, their diameter is medium to large (13–138 μm).

C. cryptochlorophaea differs from *C. asahinae* in the width of cup and podetium height related to cup width, from *C. chlorophaea* in the height of the cup and podetium height, from *C. merochlorophaea* in podetium height, size of soredia and width of stalk and from *C. novochlorophaea* in the height of the cup and the ratio of the corticated part of the podetium to the height of the whole podetium. None of the measured characters were significantly different between *C. cryptochlorophaea* and *C. grayi* (Table 1).

It is a rare species, collected on calcareous and siliceous soil, in deciduous, more often in coniferous forest, at the edge of the forests or along paths between 200 and 650 m a.s.l. in the Őrség, the Vendvidék, the Little Hungarian Plain, the Bakony, the Bükk and the Zemplén Mts, more or less covering the country's hilly regions.

Cladonia grayi G.Merr. ex Sandst. (Fig. 13)

NOTES

The Hungarian specimens contain fumarprotocetraric, grayanic and 4-O-demethyl-grayanic acids.

Their colour is rather grayish, from greenish to pale gray, at base weakly melanotic (Stenroos *et al.* 2011, 2016; Ahti *et al.* 2013). Podetia are medium tall (1.9–16 mm) with relatively wide (0.7–6.2 mm) and high (0.4–6.8 mm) cup. *C. grayi* differs from *C. asahinae* in the ratio of podetium height to cup width, from *C. chlorophaea* in podetium height, from *C. merochlorophaea* in size of soredia and width of stalk. None of the measured characters were significantly different between *C. cryptochlorophaea*, *C. novochlorophaea* and *C. grayi* (Table 1).

The species is extremely rare in Hungary and it represents a new distribution record to the country, collected on acidic soil mostly, more often in coniferous forests, but occasionally on *Quercus* spp., between 200–300 m a.s.l. in the Vendvidék, W-Hungary only. Matwiejuk (2017) reported its frequency

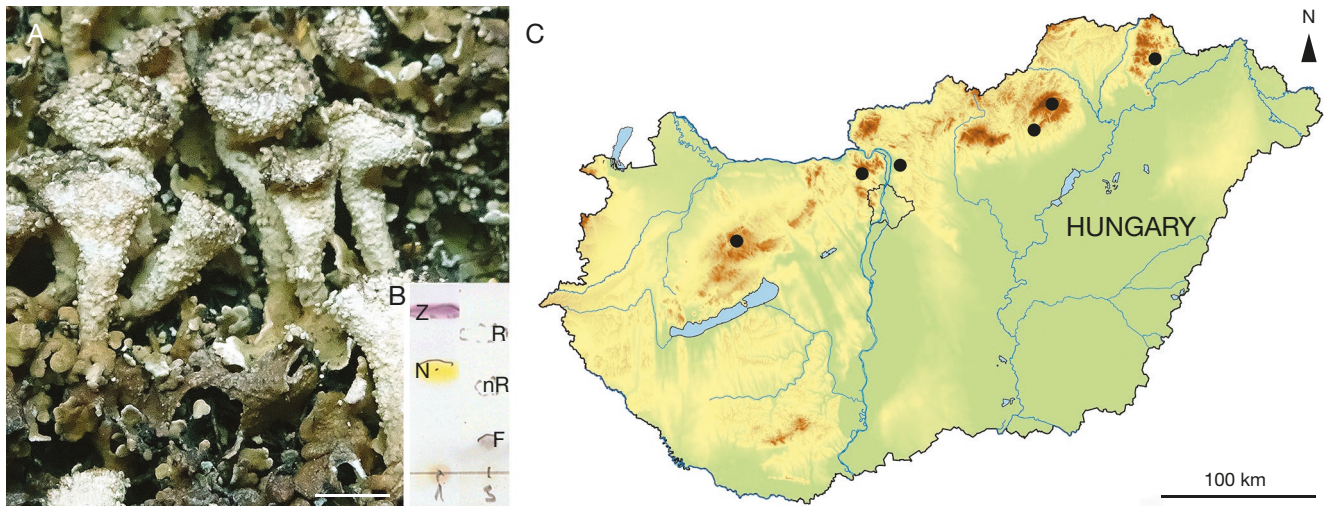


FIG. 10. — *Cladonia asahinae* J.W.Thomson: **A**, habit (BP[BP 9421]); **B**, spots of lichen secondary metabolites on chromatographic plates; **C**, distribution in Hungary. Abbreviations: **R**, rangiformic acid; **nR**, norrangiformic acid; **F**, fumarprotocetraric acid; **Z**, zeorin; **N**, norstictic acid. Scale bar: A, 2 mm.

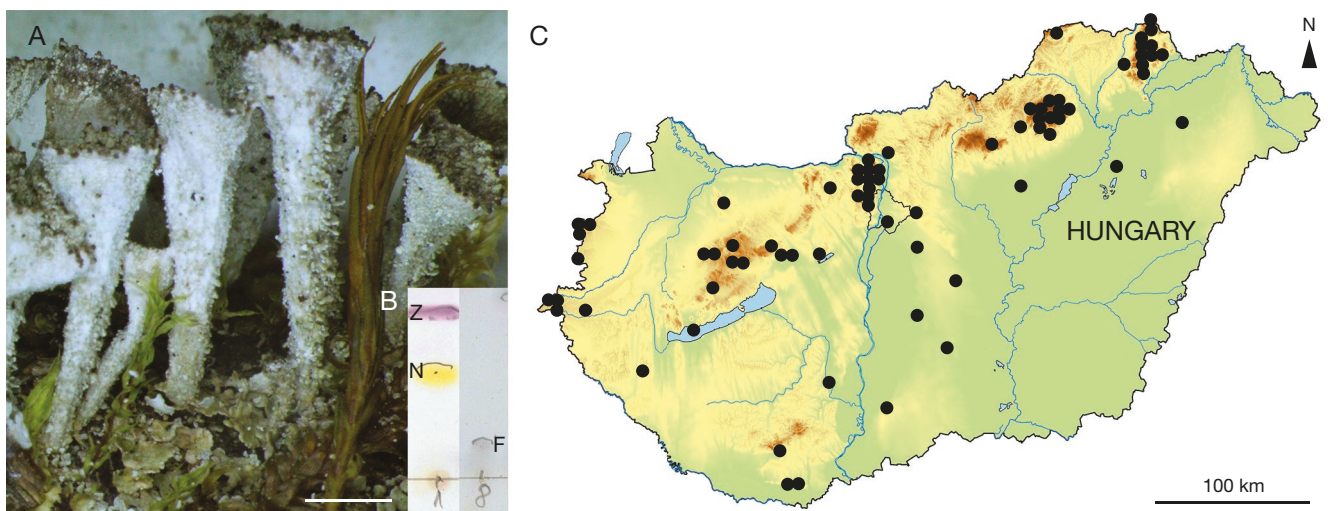


FIG. 11. — *Cladonia chlorophaea* (Flörke ex Sommerf.) Spreng.: **A**, habit (BP[BP 49014]); **B**, spots of lichen secondary metabolites on chromatographic plates; **C**, distribution in Hungary. Abbreviations: **F**, fumarprotocetraric acid; **Z**, zeorin; **N**, norstictic acid. Scale bar: A, 2 mm.

from pine forests. The localities in W-Hungary are also rich in pine forests.

Cladonia merochlorophaea Asahina
(Fig. 14)

NOTES

The Hungarian specimens contain fumarprotocetraric, cryptochlorophaeic, congrayanic, 4-O-methyl-cryptochlorophaeic, 4-O-demethyl-grayanic, rangiformic and merochlorophaeic acids and they belong to the chemically most diverse species of the group.

The podetia are darker brown or gray, strongly melanotic at base (Stenroos *et al.* 2011, 2016; Ahti *et al.* 2013). Soredia are relatively larger (11-168 µm) than at other species. It is characterised by relatively tall (1.9-17.3 mm) and broad

(0.8-7.5 mm) scyphi with wide (0.3-3.1 mm) stalk. *C. merochlorophaea* differs from *C. asahinae* in a number of characters (CH, CW, PH, PHCW, sor, SW), from *C. chlorophaea* and *C. novochlorophaea* in the mean length of squamules on podetia, from *C. grayi* in size of soredia and width of stalk, from *C. novochlorophaea* it also differs in stalk width and in the length of squamules. (Table 1).

It is collected more often on acidic, but also on calcareous soil, mossy soil, in coniferous forest, sometimes in oak or mixed forest, between 200 and 760 m a.s.l. in hilly regions in Hungary, in the Soproni-hegység, Őrség, the Vendvidék, the Balaton Uplands, the Bükk and the Zemplén Mts, similarly to *C. cryptochlorophaea*. Holien & Tønsberg (1985), Kowalewska *et al.* (2008) and Matwiejuk (2017) reported its frequency from pine forests. Localities of *C. merochlorophaea* in Hungary are more rich in pine forests than other regions within the country.

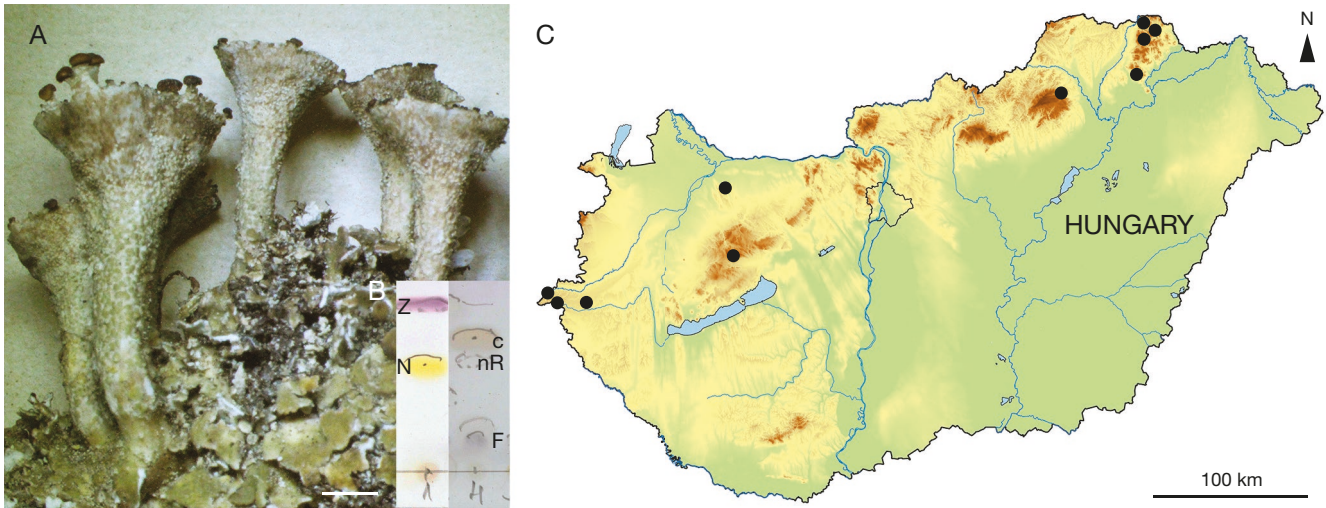


FIG. 12. — *Cladonia cryptochlorophaea* Asahina: **A**, habit (BP[BP 48938]); **B**, spots of lichen secondary metabolites on chromatographic plates; **C**, distribution in Hungary. Abbreviations: **c**, cryptochlorophaeic acid; **nR**, norrangiformic acid; **F**, fumarprotocetraric acid; **Z**, zeorin; **N**, norstictic acid. Scale bar: **A**, 2 mm.

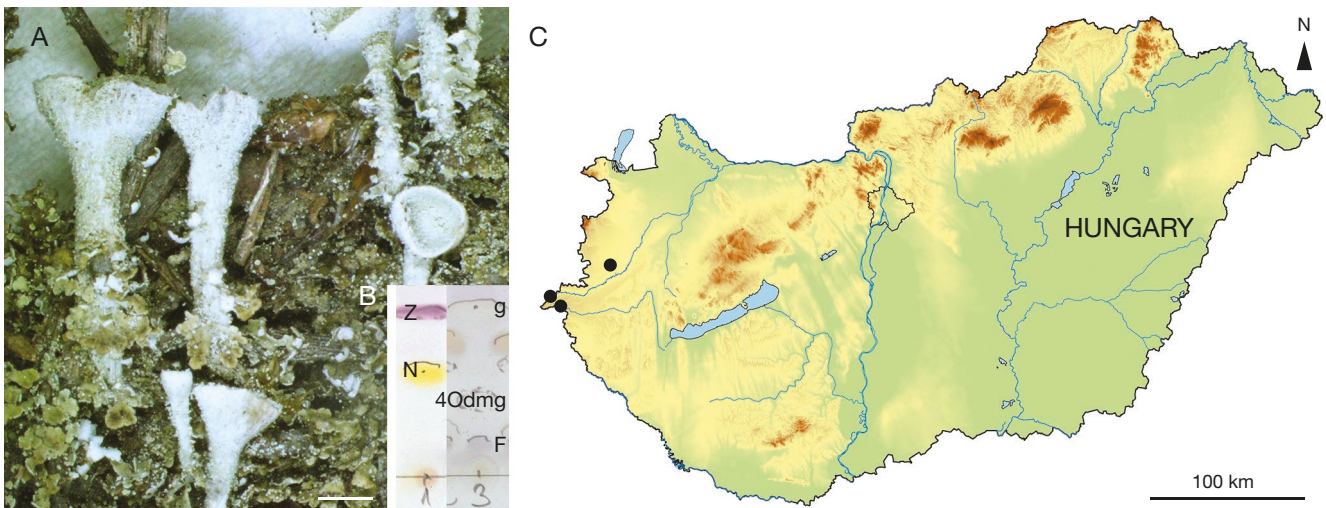


FIG. 13. — *Cladonia grayi* G.Merr. ex Sandst.: **A**, habit (BP[BP 52041]); **B**, spots of lichen secondary metabolites on chromatographic plates; **C**, distribution in Hungary. Abbreviations: **g**, grayanic acid; **4Odmg**, 4-O-demethylgrayanic acid; **F**, fumarprotocetraric acid; **Z**, zeorin; **N**, norstictic acid. Scale bar: **A**, 2 mm.

Cladonia novochlorophaea (Sipman) Brodo & Ahti
(Fig. 15)

NOTES

The Hungarian specimens contain fumarprotocetraric and homosekikaic acids.

Their colour is dark to blackish brown, darker at base (Stenroos *et al.* 2011, 2016; Ahti *et al.* 2013). They have medium sized podetia (2–11.6 mm high) and stalk (0.24–1 mm wide) with tall (0.4–10.5 mm) cup and medium diameter (18–81 µm) of granulose soredia. *C. novochlorophaea* differs from *C. asahinae* in cup height and podetium height related to cup width, from *C. chlorophaea* in podetium height, from *C. cryptochlorophaea* in cup height and in the ratio of the corticated part of the podetium to the height of the whole podetium and from *C. merochlorophaea* in stalk width and in the length of squamules.

None of the measured characters were significantly different between *C. novochlorophaea* and *C. grayi* (Table 1).

C. novochlorophaea is a very rare species in Hungary and it represents a new distribution record to the country, collected on acidic soil between 250 and 450 m a.s.l. in the Bakony Mts, the Balaton Uplands and the Visegrádi Mts, lignicolous, while in NE Poland it was found on soil, wood and bark of *Picea abies* (L.) H.Karst. in open habitats and forests (Matwiejuk 2017).

CONCLUSIONS

The combined study of lichen secondary metabolites and measurable microscopic morphological characters in a LSM rich species group offers a useful tool for taxonomic revision

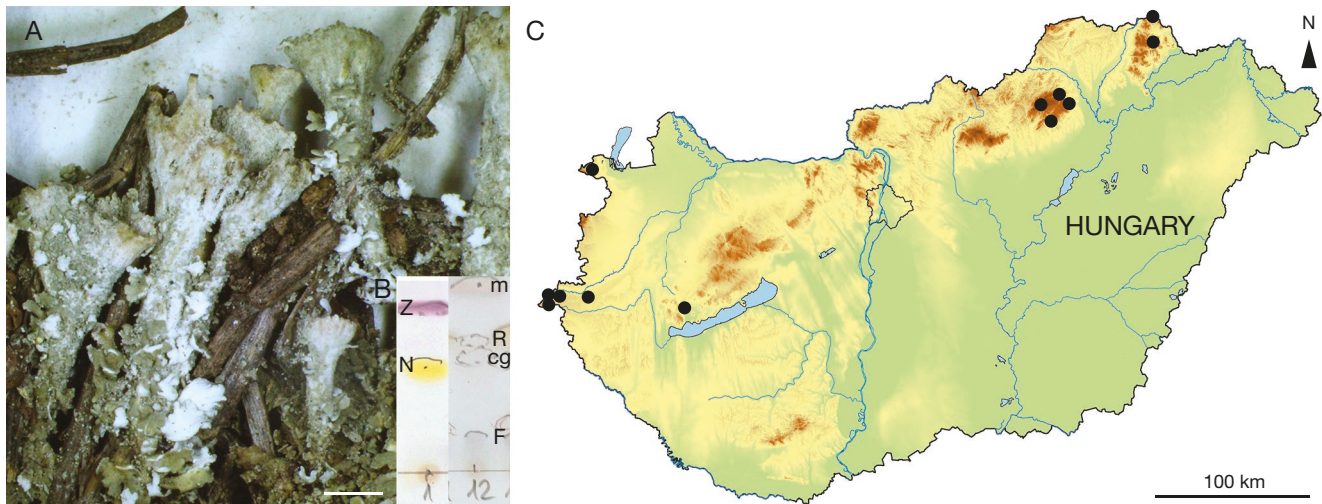


FIG. 14. — *Cladonia merochlorophaea* Asahina: **A**, habit (BP[BP 32926]); **B**, spots of lichen secondary metabolites on chromatographic plates; **C**, distribution in Hungary. Abbreviations: **m**, merochlorophaeic acid; **R**, rangifurmic acid; **cg**, congranagic acid; **F**, fumarprotocetraric acid; **Z**, zeorin; **N**, norstictic acid. Scale bar: A, 2 mm.

of so far insufficiently known taxa and for analysing the biodiversity of an area of varied habitats from geographic and climatic points of view. Since the statistical analysis mostly, but not exclusively confirmed our preliminary, unpublished measurements at a coarser scale, the measurements of the selected parameters in microscopic scale and larger number obviously led to a more precise and advisable direction for analysing taxa of similar scyphose habit. Furthermore, a new perspective on genes and metabolic paths of lichen secondary metabolite production (Singh *et al.* 2021a, 2021b; Singh 2023) opens further possibilities for phylogenetic studies also within the *Cladonia chlorophaea* group for revealing or confirming species boundaries, where additional data gained by other methods – like the results presented above – will have an important role.

Acknowledgements

The authors are grateful to Dr Katalin Molnár (Komárom) for reading the manuscript. We highly appreciate comments of the anonymous reviewers. The French abstract was kindly translated by Emma Sicre. The work was supported by the project NKFI K 124341 financed by the National Research Development and Innovation Fund of Hungary.

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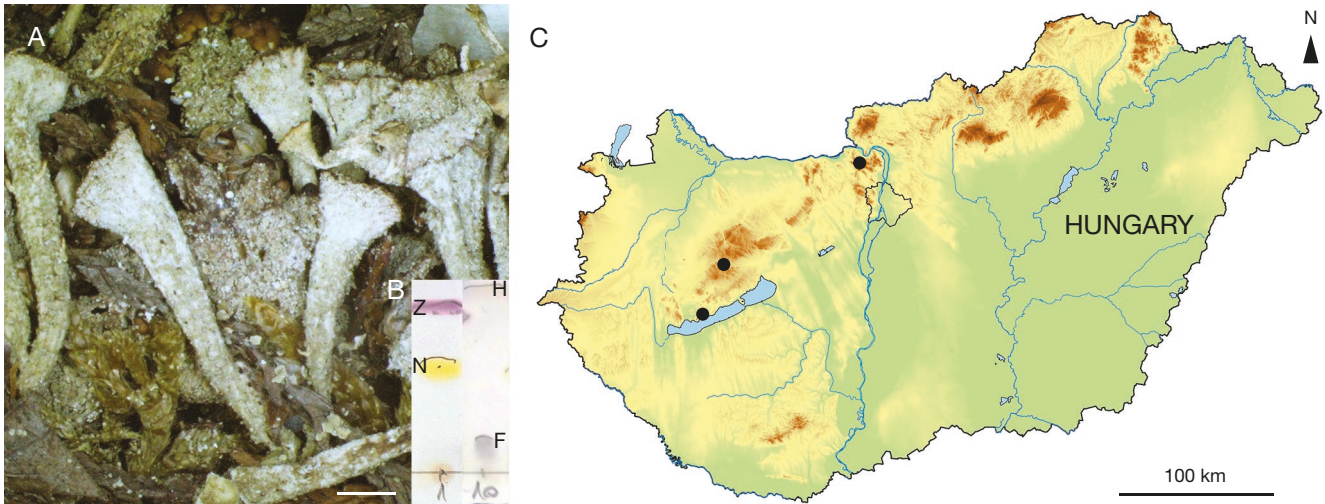


Fig. 15. — *Cladonia novochlorophaea* (Sipman) Brodo & Ahti: **A**, habit (BP[BP 9314]); **B**, spots of lichen secondary metabolites on chromatographic plates; **C**, distribution in Hungary. Abbreviations: **H**, homosekaiic acid; **F**, fumarprotocetraric acid; **Z**, zeorin; **N**, norstictic acid. Scale bar: A, 2 mm.

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Submitted on 13 March 2023;
 accepted on 11 May 2023;
 published on 14 June 2023.

APPENDIX

APPENDIX 1. — Herbarium records of the investigated 213 *Cladonia chlorophaea* s.l. specimens from BP (Budapest) and VBI (Vácrátót).

Name	Year	CES code	Locality	Herb. ID
<i>Cladonia asahinae</i>	1948	7989.1	Montium Bükk: Ómassa, in regione Kismező. Substr.: saxa calcarea musc.; alt. 800 m.	BP 65174
<i>Cladonia asahinae</i>	1950	7694.4	Hegyalja: Erdőhorváti: Gát oldal. Substr.: saxa silicea musc.; alt. 180 m.	BP 65206
<i>Cladonia asahinae</i>	1925	8772.2	Prope pagum Porva, in cacumine montis "Kőrös hegy", ad rupem calcaream umbrosam supra muscos.	BP 74831
<i>Cladonia asahinae</i>	1880	8088.3	Eger.	BP 9421
<i>Cladonia asahinae</i>	1985	8379.1	Pilis. Mts "Pilis-hegység" on the SW side of the Mt. "Pilis" W of Pilisszentkereszt; alt. 700 m (8522/M).	VBI 347
<i>Cladonia asahinae</i>	1952	8281.3	Hungary. Pest. Vácrátót. Ass. Festucetum vaginatae danubiale.	VBI 5843
<i>Cladonia chlorophaea</i>	1915	8380.1	Agyagos földön árnyékban füves, mohás helyen a "Kőhegy" bokros oldalán Pomáz mellett; alt. 330 m.	BP 10319
<i>Cladonia chlorophaea</i>	1903	8479.4	Budapest.	BP 10335
<i>Cladonia chlorophaea</i>	1940	9577.2	Mezőföld. Szedres, terricola.	BP 10338
<i>Cladonia chlorophaea</i>	1925	8186.1	Mátra: mohás törmelékes földön a "Disznókő" alatt Óhuta közelében; alt. 500 m.	BP 10340
<i>Cladonia chlorophaea</i>	1916	8279.2	In valle "Apátkúti völgy" prope Visegrád.	BP 32929
<i>Cladonia chlorophaea</i>	1918	8479.4	In valle Zugliget ad Budapestinum.	BP 32930
<i>Cladonia chlorophaea</i>	1917	8279.2	In declivibus inter Zebegény et Nagy-Maros.	BP 32931
<i>Cladonia chlorophaea</i>	1916	8380.1	In monte Kőhegy, prope Pomáz.	BP 32932
<i>Cladonia chlorophaea</i>	1916	8580.4	Ad terram arenaceam in insula "Csepelsziget" prope Csepel; alt. c. 120 m.	BP 39709
<i>Cladonia chlorophaea</i>	1916	8380.1	Ad corticem Quercus in silva "Kis Kartalja" prope Pomáz; alt. c. 200 m.	BP 39738
<i>Cladonia chlorophaea</i>	1931	7594.4	Kishuta.	BP 39739
<i>Cladonia chlorophaea</i>	1926	8479.2	Prope Máriaremete, Remetehegy. Solo: dolomitica; alt. 426 m.	BP 39746
<i>Cladonia chlorophaea</i>	1916	8096.1	Ad tectum domi in vineas "Ószőlő" prope Nyiregyháza; alt. c. 110 m.	BP 40109
<i>Cladonia chlorophaea</i>	1918	8280.3	ad saxam in silvis "Dugacka livoda" supra Pilisszentlászló; alt. c. 400 m.	BP 40115
<i>Cladonia chlorophaea</i>	1953	9975.1	Mt. Mecsek. In Quercetis declivium montis Misina supra opp. Pécs.	BP 48690
<i>Cladonia chlorophaea</i>	1963	9063.4	Apátistvánfalvától kb. 6 km-re északra, fenyő erdőben.	BP 48782
<i>Cladonia chlorophaea</i>	1962	7694.1	Zemplén hg.: Hajagos oldala Erdőhorváti felett.	BP 48813
<i>Cladonia chlorophaea</i>	1963	9063.4	Apátistvánfalvától északra lévő láp környékén, fenyvesben.	BP 49014
<i>Cladonia chlorophaea</i>	1963	7694.1	Zemplén hg.: Középhuta, az erdőszellett szembeni szikla alatt az erdőben, út mentén.	BP 49117
<i>Cladonia chlorophaea</i>	1955	9165.1	Szócei határban.	BP 49133
<i>Cladonia chlorophaea</i>	1959	7594.1	Zemplén hg.: Amadé vár és Potácsház közötti úton.	BP 49178
<i>Cladonia chlorophaea</i>	1955	7494.4	Zemplén hg.: Füzéri vár.	BP 49296
<i>Cladonia chlorophaea</i>	1963	9063.3	Szakonyfalutól délre, hegyoldalban, árnyékban; alt. c. 250-300 m.	BP 49350
<i>Cladonia chlorophaea</i>	1955	7594.3	Sátorhegység: Köves patak völgyében.	BP 49387
<i>Cladonia chlorophaea</i>	1960	7794.1	Zempléni hegység: Nagy Sasvölgy Erdőbénye mellett.	BP 49389
<i>Cladonia chlorophaea</i>	1959	7694.2	Zemplén hegység: Vadas tető gerinc, Ujhuta mellett.	BP 49425
<i>Cladonia chlorophaea</i>	1963	9063.3	Vas m.: Grajka völgytől nyugatra lévő hegytetőn; alt. c. 300 m.	BP 49496
<i>Cladonia chlorophaea</i>	1965	7594.1	Zemplén hg.: Telkibánya, Nagykirály hegy oldalán, fiatal fenyvesben és az út mentén, földön; alt. c. 200-250 m.	BP 49530
<i>Cladonia chlorophaea</i>	1965	7494.4	Zemplén hg.: Füzéri vár, ad saxa andesitica; alt. c. 450-500 m pr. Füzéri.	BP 51879
<i>Cladonia chlorophaea</i>	1965	8186.1	Mátra: Kékestető és Saskő közötti úton; alt. c. 900-1000 m.	BP 51989
<i>Cladonia chlorophaea</i>	1964	8971.4	Őcs: Őcsi nagy tó melletti andezit köveken.	BP 52370
<i>Cladonia chlorophaea</i>	1966	9063.3	Vend vidék: Kétvölgy és Szakonyfalu között, a Szakonyfalvi patak mentén, hegyoldalban, fenyvesben; alt. 200 m.	BP 52809
<i>Cladonia chlorophaea</i>	1964	9163.2	Vend vidék: Apátistvánfalvától K-re az úttörő tábor feletti erdei fenyő fenyvesben.	BP 52969
<i>Cladonia chlorophaea</i>	1964	8665.1	Kőszegi hg.: Kőszeg, Hétforrástól kb. 1-3 km-re, út mentén Kőszeg felé.	BP 52995
<i>Cladonia chlorophaea</i>	1964	8664.4	Kőszegi hg.: Bozsok Kalaposkőtől ny.-ra lévő Ény.-i fekvésű, kb. 80 m hosszú pala vonulaton; alt. c. 600 m.	BP 52996
<i>Cladonia chlorophaea</i>	1964	8664.4	Kőszegi hg.: Kalaposkőtől ny.-ra lévő Ény.-i fekvésű kb. 80 m hosszú pala vonulaton; alt. 600 m.	BP 53017
<i>Cladonia chlorophaea</i>	1964	8665.1	Kőszegi hg.: Királyvölgy felett száraz földön, Kőszeg mellett.	BP 53018
<i>Cladonia chlorophaea</i>	1935	7988.4	Bükk: Zsérc, in m. Kavicsostető, Törökut, substr.: terra muscosa; alt. 540 m.	BP 65171
<i>Cladonia chlorophaea</i>	1938	7988.1	Montium Bükk: Bélapátfalva, in cac. m. Örkő, substr.: saxa calcarea musc.; alt. 870 m.	BP 65194
<i>Cladonia chlorophaea</i>	1960	7693.3	Boldogkőváralja: in m. Tóhegy, substr.: saxa and. musc.; alt. 350 m.	BP 65215

Appendix 1. — Continuation.

Name	Year	CES code	Locality	Herb. ID
<i>Cladonia chlorophaea</i>	1912	8379.4	Pilisborosjenő: sub rad. m. Nagykevély, substr.: terra humosa; alt. 350 m.	BP 65218
<i>Cladonia chlorophaea</i>	1912	7990.1	Bükk: M.-Diósgyőr, in jugo m. Bányabükk, substr.: terra muscosa; alt. 400 m.	BP 65219
<i>Cladonia chlorophaea</i>	1927	7889.4	Bükk: Ómassa, sub rad. montis Kovácskő, substr.: terra muscosa; alt. 420 m.	BP 65222
<i>Cladonia chlorophaea</i>	1930	8088.2	Bükk: Felsőtárkány, juxta Isaák menház, substr.: trunc. Querc. musc.; alt. 520 m.	BP 65224
<i>Cladonia chlorophaea</i>	1934	7889.3	Bükk: Ómassa, in jugo montis Magoskő, substr.: terra muscosa; alt. 620 m.	BP 65228
<i>Cladonia chlorophaea</i>	1935	7989.4	Bükk: Kisgyőr, inter Bogárástető et Előgalya, substr.: terra muscosa; alt. 500 m.	BP 65230
<i>Cladonia chlorophaea</i>	1927	7990.1	Bükk: M.-Diósgyőr, in cac. montis Veresbérc, substr.: terra graminosa; alt. 420 m.	BP 65285
<i>Cladonia chlorophaea</i>	1941	8472.3	Comit. Győr. In silva Écsi erdő, ad terram.	BP 72803
<i>Cladonia chlorophaea</i>	1968	8873.1	Mt. Bakony: in cacumine m. Papod tető pr. Hárskút, in pratis montis ad saxa calc.; alt. 646 m.	BP 74942
<i>Cladonia chlorophaea</i>	1968	8873.1	Mt. Bakony: in cacumine m. Papod tető pr. Hárskút, in pratis ad saxa calc.; alt. 646 m.	BP 74944
<i>Cladonia chlorophaea</i>	1968	8873.1	Mt. Bakony: in cacumine m. Papod tető pr. Hárskút, in pratis montis ad saxa calc.; alt. 646 m.	BP 74946
<i>Cladonia chlorophaea</i>	1968	7694.3	Mt. Zemplén: in jugo m. Körösbérc pr. Baskó, ad saxa and., ad terram; alt. c. 560 m.	BP 74989
<i>Cladonia chlorophaea</i>	1968	7694.3	Mt. Zemplén: in jugo m. Körösbérc pr. Baskó, ad cort.; alt. c. 560 m.	BP 74993
<i>Cladonia chlorophaea</i>	1968	7694.1	Mt. Zemplén: Baskó: in decl. or. m. Bogolyka hegy, in sylvis ad saxa and.; alt. c. 550 m.	BP 75042
<i>Cladonia chlorophaea</i>	1968	7694.1	Mt. Zemplén: Baskó: sub cac. m. Bogolyka hegy, in rupibus and.; alt. c. 600 m.	BP 75064
<i>Cladonia chlorophaea</i>	1968	7694.3	Mt. Zemplén: supra Baskó: in decl. bor. occ. m. Köröshegy, in pratis siccis ad saxa and.; alt. c. 300-400 m.	BP 75116
<i>Cladonia chlorophaea</i>	1968	8771.3	Mt. Bakony: Döbrönte, m. "Várhegy", ad saxa arenaceis, exp.: N.; alt. c. 250 m.	BP 75374
<i>Cladonia chlorophaea</i>	1968	8771.4	Mt. Bakony, pr. Bakonyjákó, ad vias, ad saxa calc., exp.: N.; alt. c. 250 m.	BP 75401
<i>Cladonia chlorophaea</i>	1969	8872.2	Mt. Bakony: Hárskút, in jugo m. Kőrísgyőrhegy, supra cava, in saxis apricis; alt. c. 350 m.	BP 75511
<i>Cladonia chlorophaea</i>	1915	8479.2	Budapest, pr. pag. Máriaremete, in decl. m. Hosszúerdő, supra muscos in rup. calc.; alt. c. 260 m.	BP 75552
<i>Cladonia chlorophaea</i>	1970	0176.1	Mt. Villányi hg.: in jugo m. Harsány h. pr. Nagyarsány, ad terram; alt. 350-440 m.	BP 75752
<i>Cladonia chlorophaea</i>	1968	8380.1	Pomázi Kőhegy sziklái alatt, dombtetőn Stipetum szélén, Festucetumban; alt. c. 260 m.	BP 75945
<i>Cladonia chlorophaea</i>	1968	8380.1	Pomázi Kőhegy sziklái alatt, dombtetőn Stipetum szélén; alt. c. 260 m.	BP 75946
<i>Cladonia chlorophaea</i>	1972	8774.2	Mt. Bakony: cca Várpalota, pr. Királyszállás ad versus Burok völgy, ad saxa cacl. musci; alt. c. 400 m.	BP 76914
<i>Cladonia chlorophaea</i>	1884	8479.4	Buda Állatkerthegegy földön mohgyepen.	BP 80118
<i>Cladonia chlorophaea</i>	1884	8479.4	János hegy.	BP 80125
<i>Cladonia chlorophaea</i>	1904	8582.1	Pécel, Lötér. supra muscos in silvis.	BP 80174
<i>Cladonia chlorophaea</i>	1905	8279.3	In silvis ad montem "Dobogókő" (com. Pest) supra terram.	BP 80416
<i>Cladonia chlorophaea</i>	1846	8479.4	4. Budai Lindenberg hegyen.	BP 80422
<i>Cladonia chlorophaea</i>	1976	8292.4	Hortobágy: Ujszentmargita, legeltetett Festucetumban.	BP 87161
<i>Cladonia chlorophaea</i>	1981	7989.3	BNP: Pázsagi vadászház felett nyugati hegyoldalon, árnyas mészkő sziklán; alt. 560 m.	BP 87560
<i>Cladonia chlorophaea</i>	1981	7989.3	BNP: Pázsagi vadászház mellett, a sárga jelzéses út mentén, öreg bükkös erdő szélén, földön; alt. 550 m.	BP 87564
<i>Cladonia chlorophaea</i>	1956	9975.1	Mtes. Mecsek. In silvaticis ad Dömörkapu pr. opp. Pécs. Solum calc.; alt. c. 350 m.	BP 88147
<i>Cladonia chlorophaea</i>	1936	8775.3	In declivibus occident. valle Hidegvölgy prope Inota.	BP 88148
<i>Cladonia chlorophaea</i>	1998	8377.4	Bajna (Komárom-Esztergom megye): Kablász-hegy, S of Epöl, on soil.	BP 90333
<i>Cladonia chlorophaea</i>	1994	0175.2	Villányi-hegység. Siklós, Máriagyűd: southern slope of Tenkes, on rocky soil.	BP 90611
<i>Cladonia chlorophaea</i>	1916	8280.3	In monte "Duboka bara" prope Izbég; alt. c. 350 m.	BP 9302
<i>Cladonia chlorophaea</i>	1915	8479.2	Mohborította Megalodus-mészkősziklán az "Ördögárok" völgyében; alt. c. 270 m. Mária Remete mel.	BP 9303
<i>Cladonia chlorophaea</i>	1911	7889.3	Mohán. Bükkhegység. Szentléleki zárdarom tájáról.	BP 9304
<i>Cladonia chlorophaea</i>	1954	9468.3	Ad margines silvarum pr. pag. Nagybakónak; alt. c. 200 m.	BP 9305
<i>Cladonia chlorophaea</i>	1912	8479.2	Hosszúerdő, Mária-Remete mel., moha között mészkősziklán; alt. c. 350 m.	BP 9307
<i>Cladonia chlorophaea</i>	1912	8089.3	Régi szalmás háztetőn Cserépváralja.	BP 9308
<i>Cladonia chlorophaea</i>	1912	8479.1	Nagykopaszhegy, Nagykovácsi mel., Megalodus mészkőtuskón moha között; alt. c. 300 m.	BP 9311
<i>Cladonia chlorophaea</i>	1911	8279.2	Nagygyarosi hegyek.	BP 9313
<i>Cladonia chlorophaea</i>	1916	8279.2	In valle "Malomkert" prope Visegrád; alt. c. 120-180 m.	BP 9316
<i>Cladonia chlorophaea</i>	1920	8280.3	In rupibus trachyticis montis Asztal supra vallem Stara voda ad oppid. Szt. Endre.	BP 9318
<i>Cladonia chlorophaea</i>	1912	8479.4	Feketefej, Budapest mel., moha között mészkősziklán; alt. c. 300 m.	BP 9443
<i>Cladonia chlorophaea</i>	1924	8775.4	Sárrét: ad terram declivibus meridionalibus montis Iszkahegy supra pagum Csór; alt. c. 260 m., solo andesitica.	BP 9449
<i>Cladonia chlorophaea</i>	1965	8186.1	Comit. Heves, Matricum, in cacumine montis "Kékes", ad truncum Fagi silvaticae.	BP 94853

Appendix 1. — Continuation.

Name	Year	CES code	Locality	Herb. ID
<i>Cladonia chlorophaea</i>	2007	8984.1	Pest County, Kiskunság National Park, Nagykőrös, on sand.	VBI 5170
<i>Cladonia chlorophaea</i>	1985	8279.3	Pilis. Mts “Visegrádi-hegység” in valley “Rámszakadék”, S of Dömös; alt. 350 m.	VBI 276
<i>Cladonia chlorophaea</i>	1984	8279.4	Pilis. Mts “Visegrádi-hegység” Mt. “Keserűs-hegy” on the rocks under the summit “Prédikálószték” S of Dömös; alt. 630 m.	VBI 272
<i>Cladonia chlorophaea</i>	1984	8279.4	Pilis. Mts “Visegrádi-hegység” on a small rock of the Mt. “Üstök-hegy” S of Dömös; alt. 400 m.	VBI 271
<i>Cladonia chlorophaea</i>	1984	8379.1	Pilis. Mts “Pilis-hegység”, Mt. “Vaskapu-hegy” at rocks of “Vaskapu”, NW of Pilisszentkereszt; alt. 550 m.	VBI 269
<i>Cladonia chlorophaea</i>	1984	8379.2	Pilis. Mts “Pilis-hegység”, Mt. “Hosszú-hegy” near “Hosszú-hegyi-zsomboly” NW of Csobánka; alt. 470 m.	VBI 2554
<i>Cladonia chlorophaea</i>	1985	8279.3	Pilis. Mts “Visegrádi-hegység”, on the rocks “Thirring-sziklák” NW of the peak “Dobogó-kő”; alt. 600 m a.s.l.	VBI 344
<i>Cladonia chlorophaea</i>	1983	8279.4	Pilis. Mts “Visegrádi-hegység”. Mt. “Keserűs-hegy” at cottage “Hubertus kunyhó”, SSE of Dömös; alt. 600 m (8340/D, 8340/N).	VBI 6049
<i>Cladonia chlorophaea</i>	1983	8087.2	County Heves. At the surroundings of the peat-bog near Egerbakta (8372/B).	VBI
<i>Cladonia chlorophaea</i>	1984	8280.3	Pilis. Mts “Visegrádi-hegység” on the E side of the Mt. “Urak asztala” – “Urasztaloldal” W of Tahi; alt. 450 m (8443/A, F).	VBI 335
<i>Cladonia chlorophaea</i>	1985	8279.3	Pilis. Mts “Pilis-hegység” in the valley “Vaskapu-völgy” NW of Pilisszentkereszt; alt. 500 m (8516/B).	VBI
<i>Cladonia chlorophaea</i>	1982	8782.1	County Pest. Junipero-Populetum at Csévharaszt; alt. 150 m (8202/H).	VBI
<i>Cladonia chlorophaea</i>	1938	7989.2	Bükk: Ujhuta, circa fontem Hollóskút, substr.: trunc. putr. Abietis; alt. 550 m.	BP 65195
<i>Cladonia chlorophaea</i>	1937	7489.4	Derenk: in decl. montis Szádvár, substr.: saxa calcarea musc; alt. 440 m.	BP 65175
<i>Cladonia chlorophaea</i>	1956	7695.1	Sárospatak: in decl. m. Királyhegy, substr.: terra. Alt. 210 m.	BP 64011
<i>Cladonia chlorophaea</i>	1937	7989.2	Montium Bükk: sub rad m. Hollós hegyek pr. pag. Ujhuta, substr.: cort. Laricis. Alt. 511 m.	BP 64214
<i>Cladonia chlorophaea</i>	1930	8088.2	Bükk: Felsőtárkány, juxta Isaák menház, substr.: trunc. Querc. musc; alt. 520 m.	BP 65224
<i>Cladonia chlorophaea</i>	2020	8777.3	Velencei-hegység Leg.: Veres, K.	VBI
<i>Cladonia chlorophaea</i> f. <i>carpophora</i>	1965	7594.4	Zemplén hg.: Kemence völgyben Kókapu környékén; alt. 250 m.	BP 90951
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1916	8280.3	Ad terram in silva “Duboka bara” prope Izbég; alt. c. 350 m.	BP 39733
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1922	8279.3	Ad terram in monte “Dobogókő” pr. Dömös; alt. c. 600 m.	BP 39741
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1916	8380.1	In monte “Messelja hegy” prope Pomáz; alt. c. 300 m.	BP 39744
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1960	7694.2	Zemplén hegység: Simonostető szikláin.	BP 48789
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1959	7694.2	Zemplén hg.: Középhutától délre Élesbérc szikláin.	BP 48797
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1959	7594.3	Zemplén hegység: Hemzsőkő szikláin, Telkibányától délre.	BP 49076
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1959	7594.1	Zemplén hg.: Amadé vár és Potácsház közötti uton.	BP 49102
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1956	7594.3	Zemplén hegység: Pengőkő szikla.	BP 49393
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1959	7694.2	Zemplén hegység: Vadaskert, Ujhuta mellett.	BP 49422
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1940	9270.2	Balatonicum. Ovár pr. Szigliget, muscicola ad rup. vulcanic.tof.	BP 51217
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1941	7988.2	Bükk: Ómassa, in monte Lyukasgerinc, substr.: trunc. musc.; alt. 860 m.	BP 65185
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1911	8279.2	Visegrád: circa ruinis Salamon torony, substr.: saxa and.musc.; alt. 200 m.	BP 65187
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1939	7989.2	Montium Bükk: Lillafüred: in decl. m. Jávör h., substr.: terra argillacea. Alt. 520 m.	BP 65202
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1968	7694.1	Mt. Zemplén: Baskó: in decl. or. m. Bogolyka hegy, in sylvis ad saxa and.; alt. c. 550 m.	BP 75043
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1968	8772.2	Mt. Bakony: pr. Bakonybél, in collibus, in pratis montanis, ad saxa calc., exp.: N.; alt. 500 m.	BP 75366

Appendix 1. — Continuation.

Name	Year	CES code	Locality	Herb. ID
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1979	9383.2	Kiskunsági Nemzeti Park: Bugac, ősbörökásban, homokon.	BP 85740
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1977	9182.1	Duna Tisza köze: Fülöpháza, Solt felé vezető út mentén a homokbuckákon.	BP 85763
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1977	9182.1	KNP: Fülöpháza, Poetum annuae társulásban, egyéves moha színuziumban.	BP 87523
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1913	8387.4	Homokos földön a posta úti Tölgyesben, Heves határában; alt. 110 m.	BP 9396
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1872	8479.4	Budapest, Hárshegy.	BP 9402
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1965	8186.1	Comit. Heves, Matricum, in summo montium "Kékestető", ad cort. Fagi silvaticae.	BP 95748
<i>Cladonia chlorophaea</i> f. <i>costata</i>	1965	7594.1	Zemplén hg.: Telkibánya, Nagykirály hegy oldalán, fiatal fenyvesben és az út mentén, földön; alt. c. 200-250 m.	BP 51860
<i>Cladonia chlorophaea</i> f. <i>epistelís</i>	1961	7494.2	Zemplén hegység: Nagy Milic.	BP 49490
<i>Cladonia chlorophaea</i> f. <i>epistelís</i>	1953	7889.3	Bükk: Ómassa, Jávorkút: Bolhás rét. Substr.: trunc.Fagi musc.; alt. 630 m.	BP 65182
<i>Cladonia chlorophaea</i> f. <i>epistelís</i>	1958	7889.3	Bükk: Ómassa, in valle Tekenős. Substr.: terra argill.muscosa; alt. 560 m.	BP 65183
<i>Cladonia chlorophaea</i> f. <i>hyalinella</i>	1965	8186.1	Comit. Heves, Matricum, in summo montium "Kékestető", ad cort. Fagi silvaticae.	BP 95749
<i>Cladonia chlorophaea</i> f. <i>mesothetum</i>	1960	7694.2	Zemplén hegység: Simonostető szikláján.	BP 49382
<i>Cladonia chlorophaea</i> f. <i>mesothetum</i>	1960	7794.1	Zempléni hegység: Nagy Sasvölgy Erdőbénye mellett.	BP 49391
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1962	7694.1	Zemplén hg.: Középhuta, az erdészettel szembeni szikla alatt az erdőben, út mentén.	BP 49018
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1959	7594.1	Zemplén hegység: Amadé vár és Potácsház közötti uton.	BP 49139
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1955	7494.4	Zemplén hegység: Füzéri vár.	BP 49298
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1963	8864.2	Pornóapátitól délre, c. 3 km-re, gyertyán elegyes erdei fenyvesben.	BP 49355
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1960	7694.2	Zemplén hegység: Simonostető szikláján.	BP 49421
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1965	7594.1	Zemplén hg.: Telkibánya, Nagykirály hegy oldalán, fiatal fenyvesben és az út mentén, földön; alt. c. 200-250 m.	BP 51857
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1964	8664.2	Kőszegi hg.: Kőszeg, Hét forrás és Keresztkút közötti út mentén.	BP 53034
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1935	7989.3	Bükk: Zsérc, Pajzak: Derecske rét. Substr.: terra muscosa; alt. 450 m.	BP 65178
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1921	7989.2	Montium Bükk: Diósgyőr. in jugo m. Bányahegy. Substr.: terra arg. muscosa; alt. 400 m.	BP 65180
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1912	8089.3	Bükk: Tard, in valle Mélyvölgy. Substr.: terra muscosa; alt. 200 m.	BP 65188
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1937	7889.3	Bükk: Mályinka, in decl. montis Czakókő. Substr.: terra arg. muscosa; alt. 580 m.	BP 65191
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1931	7988.2	Montium Bükk: Szilvásvár, Bánkút. Substr.: trunc. putr. musc.; alt. 860 m.	BP 65198
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1938	7988.2	Montium Bükk: Ómassa, in pratum Nagymező. Substr.: saxa calc. muscosa; alt. 880 m.	BP 65200
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1968	7694.3	Mt. Zemplén: in jugo m. Körösbérc pr. Baskó, ad cort.; alt. c. 560 m.	BP 74991
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1968	7694.3	Mt. Zemplén: supra Baskó: in decl. bor.occ. m. Köröshegy, in pratis siccis ad saxa and.; alt. c. 300-400 m.	BP 75120
<i>Cladonia chlorophaea</i> f. <i>prolifera</i>	1962	7494.2	Zemplén hg.: Kőves hegy árnyas szikláján, Füzértől ény.-ra; alt. c. 500 m északi oldalon.	BP 75142
<i>Cladonia chlorophaea</i> f. <i>pseudotrachyna</i>	1916	8380.1	In monte "Messelja hegy" prope Pomáz; alt. c. 300 m.	BP 39808

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Name	Year	CES code	Locality	Herb. ID
<i>Cladonia chlorophaea</i> f. <i>pterygora</i>	1915	0176.1	Mészkösziklát takaró mohán a "Harsányhegy" sziklás gerincén Nagyharsány mel.; alt. c. 400 m.	BP 9470
<i>Cladonia chlorophaea</i> f. <i>pterygota</i>	1916	8180.4	Ad terram in monte "Nagyszál" prope Vác; alt. c. 400-500 m.	BP 39811
<i>Cladonia chlorophaea</i> f. <i>pterygota</i>	1918	8280.3	Ad saxam muscosam in silvis "Dugacka livoda" prope Pilisszentlászló; alt. c. 400 m.	BP 39812
<i>Cladonia chlorophaea</i> f. <i>pterygota</i>	1955	7594.4	Zemplén hg.: Kőkapuval szembeni sziklán.	BP 48951
<i>Cladonia chlorophaea</i> f. <i>pterygota</i>	1912	9680.4	Nádudvar mel., Homokbuckán. Hildpuszta közelében; alt. c. 110 m.	BP 9469
<i>Cladonia chlorophaea</i> f. <i>pterygota</i>	1912	8089.3	Régi szalmás háztetőn Cserépváralja (Borsod m.).	BP 9472
<i>Cladonia cryptochlorophaea</i>	1954	9063.3	Vendvidék, Betuleto-Callunetum pr. pg. Szakonyfalu, supra vall. riv. Cselin.	BP 32924
<i>Cladonia cryptochlorophaea</i>	1954	9165.1	Praenoricum: Órség, Betuleto-Callunetum in colle Kovácsszer, supra pg. Szőce.	BP 32925
<i>Cladonia cryptochlorophaea</i>	1955	7594.2	Zemplén hg.: Dedó völgy.	BP 48938
<i>Cladonia cryptochlorophaea</i>	1963	9063.3	Szakonyfalvi pataktól keletre, hegyoldalon, Szakonyfalu alatt.	BP 49243
<i>Cladonia cryptochlorophaea</i>	1961	7494.3	Zemplén hg.: Kishegytől északra, a Szurokhegy felé vivő uttól jobbra lévő hegy gerincén, sziklákon.	BP 49467
<i>Cladonia cryptochlorophaea</i>	1963	9063.3	Vas m.: Grajka völgytől nyugatra lévő hegytetőn; alt. c. 300 m.	BP 49481
<i>Cladonia cryptochlorophaea</i>	1965	7594.3	Zemplén hg.: Istvánkút; Mlaka réttől az Ördög völgy felé, utmentén, elhalt fűvön; alt. 450 m.	BP 51937
<i>Cladonia cryptochlorophaea</i>	1965	7594.3	Zemplén hg.: Istvánkút; Mlaka réttől az Ördög völgy felé, út mentén.	BP 51939
<i>Cladonia cryptochlorophaea</i>	1965	7594.3	Zemplén hg.: Istvánkút; Mlaka réttől az Ördög völgy felé, út mentén; alt. c. 450 m.	BP 51940
<i>Cladonia cryptochlorophaea</i>	1965	7594.3	Zemplén hg.: Istvánkút; Mlaka réttől az Ördög völgy felé, út mentén; alt. c. 450 m.	BP 51941
<i>Cladonia cryptochlorophaea</i>	1965	7594.3	Zemplén hg.: Istvánkút; Mlaka réttől az Ördög völgy felé, út mentén.	BP 51946
<i>Cladonia cryptochlorophaea</i>	1965	9063.3	Vend vidék: Szakonyfalu, Szakonyfalvi patak völgye mentén, földön, erdő tisztáson vagy út mentén.	BP 52047
<i>Cladonia cryptochlorophaea</i>	1966	9163.2	Vend vidék: Apátistvánfalva kb. 3 km-re, tölgy-fenyő elegyes erdő szélén, földön.	BP 52751
<i>Cladonia cryptochlorophaea</i>	1964	9163.1	Vend vidék: Kétvölgy községeitől északra völgyárok szélén, napos, de nyirkos mohos helyen; alt. c. 300 m.	BP 52885
<i>Cladonia cryptochlorophaea</i>	1937	7889.4	Bükk: M.-Diósgyőr, in valle Forrásvölgy, substr.: terra arg.musc; alt. 280 m.	BP 65236
<i>Cladonia cryptochlorophaea</i>	1951	7793.4	Com. Zemplén. Mád: in declivibus montis Dióshegy, substr.: terra argillosa; alt. 400 m.	BP 65290
<i>Cladonia cryptochlorophaea</i>	1913	8472.1	Comit. Győr, Nagycsicshegy, in silva.	BP 72792
<i>Cladonia cryptochlorophaea</i>	1969	8872.2	Mt. Bakony: Hárskút, in decl. bor.-or. m. Borzás hegy, in pratis montanis, ad saxa dol., in apricis; alt. c. 450 m.	BP 75481
<i>Cladonia grayi</i>	1889	8866.3	S.-Tótfalu.	BP
<i>Cladonia grayi</i>	1910	8191.3	Humuszon erdőben. Mezőcsát.	BP 10353
<i>Cladonia grayi</i>	1954	9063.3	Vendvidék, Betuleto-Callunetum pr. pg. Szakonyfalu, supra vall. riv. Cselin.	BP 32924
<i>Cladonia grayi</i>	1965	9063.3	Vend vidék: Szakonyfalu, Szakonyfalvi patak völgye mentén, földön, erdő tisztáson vagy út mentén.	BP 52041
<i>Cladonia grayi</i>	1966	9063.3	Vend vidék: Kétvölgy és Szakonyfalu között, a Szakonyfalvi patak mentén, hegyoldalon, fenyvesben; alt. c. 200 m.	BP 52780
<i>Cladonia grayi</i>	1964	9163.2	Vend vidék: Apátistvánfalva és Orfalu között fenyőkkel kevert tölgyesben.	BP 52941
<i>Cladonia merochlorophaea</i>	1954	9065.3	Praenoricum: Órség. Dicrano-Pinetum callunetosum in silv. Csonkás-e., ad. Sólíktó, supra pg. Szőce.	BP 32926
<i>Cladonia merochlorophaea</i>	1961	7594.4	Zemplén hg.: Kerekő észak és keleti oldalán Rostallótól dk.-re.	BP 48886
<i>Cladonia merochlorophaea</i>	1957	7594.4	Zemplén hg.: Laczkó hegy déli oldalában, Kemencepataki erdészet közelében.	BP 49153
<i>Cladonia merochlorophaea</i>	1963	9063.3	Szakonyfalutól délre csarabos erdei fenyvesben; alt. c. 300 m.	BP 49561
<i>Cladonia merochlorophaea</i>	1953	9170.1	In Callunetis collium glareosarum ad stat. ferroviariae Uzsa.	BP 51194
<i>Cladonia merochlorophaea</i>	1965	9063.3	Vend vidék: Szakonyfalu, Szakonyfalvi patak völgye mentén, földön, erdő tisztáson vagy út mentén.	BP 52044
<i>Cladonia merochlorophaea</i>	1965	9063.3	Vend vidék: Szakonyfalu, Szakonyfalvi patak völgye mentén, földön, erdő tisztáson vagy út mentén.	BP 52048
<i>Cladonia merochlorophaea</i>	1966	9063.4	Vend vidék: Farkasfa elágazástól kb. 1 km-re tölgy elegyes fenyvesben földön.	BP 52693
<i>Cladonia merochlorophaea</i>	1966	9063.4	Vend vidék: Farkasfa elágazástól kb. 1 km-re tölgy elegyes fenyvesben földön.	BP 52696
<i>Cladonia merochlorophaea</i>	1966	9063.4	Vend vidék: Farkasfa elágazástól kb. 1 km-re tölgy elegyes fenyvesben, földön.	BP 52700
<i>Cladonia merochlorophaea</i>	1966	9063.3	Vendvidék: Kétvölgy és Szakonyfalu között, a Szakonyfalvi patak mentén, hegyoldalon, fenyvesben; alt. c. 200 m.	BP 52778

Appendix 1. – Continuation.

Name	Year	CES code	Locality	Herb. ID
<i>Cladonia merochlorophaea</i>	1966	9063.3	Vend vidék: Kétvölgy és Szakonyfalu Között, a Szakonyfalvi patak mentén, hegyoldalban, fenyvesben; alt. c. 200 m.	BP 52783
<i>Cladonia merochlorophaea</i>	1964	9163.1	Vend vidék: Kétvölgy községtől északra, völgyárok szélén, napos, de nyirkos mohos helyen; alt. c. 300 m.	BP 52871
<i>Cladonia merochlorophaea</i>	1964	9163.1	Vend vidék: Kétvölgy községtől északra völgyárok szélén, napos, de nyirkos mohos helyen; alt. c. 300 m.	BP 52885
<i>Cladonia merochlorophaea</i>	1964	9163.1	Vend vidék: Kétvölgy községtől lévő völgyben és fenyvesben.	BP 52977
<i>Cladonia merochlorophaea</i>	1942	8089.1	Montium Bükk: Cserépfalu, sub rad. m. Odorvár, substr.: terra muscosa; alt. 300 m.	BP 64165
<i>Cladonia merochlorophaea</i>	1927	7889.4	Bükk: Lillafüred, in decl. m. Szent Istvánhegy, substr.: saxa porf. musc.; alt. 400 m.	BP 65176
<i>Cladonia merochlorophaea</i>	1923	7990.1	Montium Bükk: Diósgyőr. in decl. m. Várhegy, substr.: terra muscosa; alt. 300 m.	BP 65201
<i>Cladonia merochlorophaea</i>	1954	7988.2	Bükk: Ómassa, Nagymező: reservatio, substr.: saxa calcarea musc.; alt. 760 m.	BP 65213
<i>Cladonia merochlorophaea</i>	1960	7494.2	Hollóháza: circa László tanya, substr.: terra muscosa; alt. 650 m.	BP 65216
<i>Cladonia merochlorophaea</i>	1983	8365.1	County Győr-Sopron. Mts Soproni-hegység, "Lővérek", Sopron, Récényi út, at the quarry.	VBI 375
<i>Cladonia novochlorophaea</i>	1964	8872.3	Mt. Bakony: in decl. montis pr. Szentgál, ad terram.	BP 69400
<i>Cladonia novochlorophaea</i>	1913	9171.3	Kisörsihegyen Calluna közt.	BP 9314
<i>Cladonia novochlorophaea</i>	1984	8279.3	Pilis. Mts "Visegrádi-hegység" W of the Mt. "Kakas-hegy" near the road NW of Pilisszentkereszt at the spring "Kinizsi-forrás"; alt. 450 m.	VBI 343