

**AGRESTIA ZEROVII (MEGASPORACEAE,
LICHEN-FORMING ASCOMYCETES), A NEW SPECIES
FROM SOUTHEASTERN EUROPE
PROVED BY ALTERNATIVE PHYLOGENETIC ANALYSIS**

Sergii Y. KONDRATYUK^{1*}, Alla B. GROMAKOVA², Alexander Y. KHODOSOVTSSEV³, Jung A. KIM⁴, Anna S. KONDRATIUK^{4,5} and Jae-Seoun HUR⁴

¹M. H. Kholodny Institute of Botany, Tereshchenkivska str. 2, 01004 Kyiv-1, Ukraine; *ksya_net@ukr.net

²V. N. Karazin Kharkiv National University, Svobody Sq. 4, 61022 Kharkiv, Ukraine

³Kherson State University, 40 rokiv Zhovtnia str. 27, 73000 Kherson, Ukraine

⁴Korean Lichen Research Institute, Suncheon National University, Sunchon 540-742, Republic of Korea

⁵Institute of Biology' Scientific Educational Centre, Taras Shevchenko National University of Kyiv, Volodymyrska str. 64/13, 01601 Kyiv, Ukraine

Kondratyuk, S. Y., Gromakova, A. B., Khodosovtsev, A. Y., Kim, J. A., Kondratiuk, A. S. & Hur, J.-S. (2015): *Agrestia zerovii* (Megasperaceae, lichen-forming Ascomycetes), a new species from southeastern Europe proved by alternative phylogenetic analysis. – *Studia bot. hung.* 46(2): 69–94.

Abstract: *Agrestia zerovii* is described, illustrated, and compared here with closely related taxa. It is a member of the *A. hispida* complex of the steppe zone of Ukraine, southeastern Europe, and differs from *A. hispida* s. str. in having much thicker main thalline lobes, in forming thick “horizontal crust”, and in the lack of black tips of secondary branchlets. The position of the newly described *A. zerovii* in the alternative combined phylogenetic tree of the Megasperaceae with all members for which reliable data on the nrITS, nrLSU, and mtSSU sequences are hitherto available is discussed. Four new robust branches and their taxonomic diversity are discussed, i.e.: the *Agrestia*, the *Chlorangium*, the *Sphaerothallia* s. str., and the “*Circinaria*” *lacunosa* clades being in separate position from the *Circinaria* s. str. clade (additionally to five genera of the Megasperaceae, i.e. *Aspicilia*, *Circinaria*, *Lobothallia*, *Megaspore* and *Sagedia* accepted by previous authors). The genera *Agrestia*, *Chlorangium*, and *Sphaerothallia*, proposed to be resurrected, and a number of aspicilioid lichens the status of which are in need of revision are discussed. Five new combinations for the species of the genus *Chlorangium* (*C. alpicola*, *C. aschabadense*, *C. asperum*, *C. gyrosum*, and *C. sphaerothallinum*) are proposed.

Key words: *Agrestia*, alternative combined phylogenetic analysis, *Chlorangium*, ITS and LSU nrDNA, 12S SSU mtDNA, sequences

INTRODUCTION

The most comprehensive treatment of the vagrant members of the genus *Aspicilia* to date was published by OXNER (1971), with some additional information by ANDREEVA (1987) and SOHRABI *et al.* (2013a) (in the latter treated as members of the genus *Circinaria*). Vagrant *Aspicilia* species are mainly known

from arid regions in Eurasia and North Africa. They are often collectively referred to as “manna lichens” (cf. the biblical Book of Exodus 16; see DONKIN 1980, 1981). Some of the vagrant species were included in identification keys by SZATALA (1957) and POELT (1969). Nomenclatural problems involved in this group were recently discussed by SOHRABI and AHTI (2010), who also summarised the history of the group and listed the most important publications.

After NORDIN *et al.* (2010) and OWE-LARSSON *et al.* (2011) two “manna lichens”, viz. *Circinaria emiliae* (Tomin) A. Nordin, S. Savič et Tibell and *C. hispida* (Mereschk.) A. Nordin, S. Savič et Tibell were segregated from the genus *Aspicilia* into the genus *Circinaria* for the first time. These authors recently revised the phylogeny of the Megasporaceae using a combined data set of nrLSU and mtSSU, and accepted the division of the Megasporaceae into the following five genera, i.e.: *Aspicilia* A. Massal., *Circinaria* Link, *Lobothallia* (Clauzade et Cl. Roux) Hafellner, *Megaspora* (Clauzade et Cl. Roux) Hafellner et V. Wirth, and *Sagedia* Ach. Taxonomy and molecular phylogeny of the “manna lichens” have considerably developed in the last years (SOHRABI *et al.* 2011b, 2013a).

Status of *Circinaria hispida* s. str. was outlined by SOHRABI *et al.* (2011b, 2013a) using the same combined data set of nrLSU and mtSSU, and separate nrITS analysis. From the data of these authors *Circinaria hispida* s. str., a vagrant morphotype sensu MERESCHKOWSKY (1911), is characterised by subfruticose, tiny, bushy, more or less *Cladonia*-like thallus with narrow cylindrical branches, with black apices at the tip of the branchlets, and scattered whitish pseudocyphellae along the branches. It grows initially on soil and later becomes vagrant. Therefore, it is classified as erratic. *Circinaria hispida* s. str. has never been reported in fertile condition in Eurasia. So far, its fertile specimens have been reported from North America (BRODO 1976, SOHRABI *et al.* 2011b, THOMSON 1961). In the nrITS analysis, *C. hispida* is grouped with a few Eurasian saxicolous specimens that are fertile. Therefore, the saxicolous specimens with crustose morphotype were accepted as *C. hispida* s. l. in contrast to the vagrant morphotypes as *C. hispida* s. str. (SOHRABI *et al.* 2013a). We follow similar terminology in this paper, too.

Ukrainian specimens previously recorded as *Agrestia hispida* (see OXNER 2010, KONDRATYUK *et al.* 2014c) were found to be different from *A. hispida* s. str. based on molecular and morphological data, i.e.: different in having distinctly swollen basal portions of the lobes (main lobes), often forming “horizontal crust”, as well as in the lack of black tips of the branchlets. Furthermore, Ukrainian specimens were shown to be different when applying phylogenetic analysis based on nuclear and mitochondrial DNA sequences (KONDRATYUK *et al.* 2014c, and see below).

The aim of this paper is to provide legal description of a new taxon named here as *Agrestia zerovii* as well as to discuss its position in the phylogenetic tree

of the Megasporaceae based on ITS1/ITS2 nrDNA, LSU nrDNA and 12S SSU mtDNA sequences. *Chlorangium asperum*, which was assumed to be an appropriate name for the species described below as *Agrestia zerovii* at the beginning of this study, was included into the phylogenetic analysis, too. Status of the genera *Agrestia*, *Chlorangium*, *Sphaerothallia*, and the “*Circinaria*” *lacunosa* group are briefly discussed below.

MATERIAL AND METHODS

Material was collected during several field trips to Kharkiv oblast, Ukraine in 2012 and 2013, while the locality of the new species (as *Agrestia hispida*) has been known since the 1940s (OXNER 2010).

Extracting DNA, sequencing and phylogenetic analysis (alignment with Clustal and manual steps, and MP, ME and ML phylogenetic methods) were done as described in our previous papers (KONDRATYUK *et al.* 2013, 2014a, c, 2015).

List of specimens included in the phylogenetic analysis along with their GenBank accession numbers are provided in Table 1 (a few specimens were not included in the final phylogenetic tree, Fig. 1).

The alternative combined phylogenetic analysis based on nrITS, nrLSU and mtSSU data sets, similarly as it was done in the Teloschistaceae (see KONDRATYUK *et al.* 2013, 2014a, b, 2015) was used within this study.

RESULTS

It should be emphasised that a topology of the phylogenetic tree of the Megasporaceae obtained in the results of our analysis is different from the trees of previous authors. Four more robust clades, i.e. the *Agrestia*, the *Chlorangium*, the *Sphaerothallia*, and the “*Circinaria*” *lacunosa* group were resulted additionally to the five genera accepted by NORDIN *et al.* (2010), OWE-LARSSON *et al.* (2011) and SOHRABI *et al.* (2013a) within the Megasporaceae. The genera *Agrestia* J. W. Thomson, *Chlorangium* Link, and *Sphaerothallia* Nees ex Eversm., are resurrected within this study (see below).

Separate analyses

The ITS analysis included 74 sequences of 38 species and a total of 633 positions of which 441 were informative. The LSU analysis included 57 sequences representing 31 species and a total of 787 positions of which 206 were informative, whereas the 12S mtSSU analysis included 71 sequences of 33 species and a total of 826 positions of which 354 were informative.

Table 1. Material used in this study. Vouchers, their geographical origin, and herbaria where vouchers are deposited are also listed. GenBank accession numbers of the newly obtained sequences are in boldface.

Taxon name	Country, voucher, reference	ITS	LSU	12S SSU mtDNA
<i>Agrestia hispida</i> s. l.	USA, SOHRABI <i>et al.</i> (2011a)	HQ171234		
<i>Agrestia hispida</i> s. str.	Iran, SOHRABI <i>et al.</i> (2011b)	HQ389197		
<i>Agrestia hispida</i> s. str.	USA, SOHRABI <i>et al.</i> (2011b)	HQ389198		
<i>Agrestia hispida</i> s. str.	Iran, Golestan, Sohrabi 15099 (hb. M. Sohrabi), SOHRABI <i>et al.</i> (2011a)	HQ171233		
<i>Agrestia hispida</i> s. str.	Iran, Golestan, Sohrabi 15099 (hb. M. Sohrabi), SOHRABI <i>et al.</i> (2013a)		JQ797503	JQ797488
<i>Agrestia hispida</i> s. str.	Russia, Kalmyk, SOHRABI <i>et al.</i> (2011a)	HQ171235		
<i>Agrestia hispida</i> s. str.	Turkey, Candan 11 (ANES), NORDIN <i>et al.</i> (2010)		HM060760	HM060722
<i>Agrestia hispida</i> s. str.	Turkey, Candan 11 (ANES), OWE-LARSSON <i>et al.</i> (2011), SOHRABI <i>et al.</i> (2013a as <i>Circinaria hispida</i> s. str.)	HQ406806		
<i>Agrestia hispida</i> s. str.	Spain, Lumbsch, 2.06.2003 (F), SCHMITT <i>et al.</i> (2006)		DQ780305	DQ780273
<i>Agrestia zerovii</i>	SK A12, Ukraine, Kharkiv oblast, Dvorychansky district, "Korobchyno" zakaznik, 19.06.2013, M. Kryvokhyzhaya (KW-L), this paper	KT456205	KT456208	
<i>Agrestia zerovii</i>	SK A12, Ukraine, Kharkiv oblast, Dvorychansky district, "Korobchyno" zakaznik, 19.06.2013, M. Kryvokhyzhaya (KW-L), KONDRATYUK <i>et al.</i> (2014c as <i>Circinaria hispida</i>)			KP059052
<i>Agrestia zerovii</i>	SK A15, Ukraine, Kharkiv oblast, Dvorychansky district, "Korobchyno" zakaznik, 19.06.2013, M. Kryvokhyzhaya 2 (KW-L), this paper	KT456206	KT456209	
<i>Agrestia zerovii</i>	SK A15, Ukraine, Kharkiv oblast, Dvorychansky district, "Korobchyno" zakaznik, 19.06.2013, M. Kryvokhyzhaya 2 (KW-L), KONDRATYUK <i>et al.</i> (2014c as <i>Circinaria hispida</i>)			KP059053

Table 1. (cont.).

Taxon name	Country, voucher, reference	ITS	LSU	12S SSU mtDNA
<i>Aspicilia caesiocinerea</i>	AFTOL-ID 653, MIADEŁ-KOWSKA <i>et al.</i> (2006)			DQ986892
<i>Aspicilia caesiocinerea</i>	Sweden, NORDIN <i>et al.</i> (2007)	EU057897		
<i>Aspicilia caesiocinerea</i>	UK: Wales, Orange 17594 (NMW) (unpubl.)	FJ532372		
<i>Aspicilia cinerea</i>	AFTOL-ID 647, SCHMULL <i>et al.</i> (2011)	HQ650637		
<i>Aspicilia cinerea</i>	AFTOL-ID 647, MIADEŁ-KOWSKA <i>et al.</i> (2006)		DQ986779	DQ986890
<i>Aspicilia cinerea</i>	Sweden, Dalarna, Hermansson 13275 (UPS), NORDIN <i>et al.</i> (2007)	EU057899	HM060733	HM060695
<i>Aspicilia cinerea</i>	France, Roux 25015 (MARSSJ), Roux <i>et al.</i> (2011)	JF710311		
<i>Aspicilia epiglypta</i>	Sweden, Nordin 6303 (UPS), NORDIN <i>et al.</i> (2007)	EU057907		
<i>Aspicilia epiglypta</i>	Sweden, Nordin 6303 (UPS), NORDIN <i>et al.</i> (2010)		HM060756	HM060718
<i>Aspicilia laevata</i>	Sweden, Tibell 23659 (UPS), NORDIN <i>et al.</i> (2007)	EU057910		
<i>Aspicilia laevata</i>	Sweden, Tibell 23659 (UPS), NORDIN <i>et al.</i> (2010)		HM060730	HM060692
<i>Circinaria affinis</i>	Russia: Astrakhan Region, Kulakov 1408B (M), SOHRABI <i>et al.</i> (2011 <i>b</i>)	HQ389196		
<i>Circinaria affinis</i>	Russia: Astrakhan Region, Kulakov 1408B (M), SOHRABI <i>et al.</i> (2013 <i>a</i>)		JQ797502	JQ797492
<i>Circinaria calcarea</i>	Sweden, Öland, Nordin 5888 (UPS), NORDIN <i>et al.</i> (2007)	EU057898		
<i>Circinaria calcarea</i>	Sweden, Öland, Nordin 5888 (UPS), NORDIN <i>et al.</i> (2010)		HM060743	HM060705
<i>Circinaria calcarea</i>	Sweden, OWE-LARSSON <i>et al.</i> (2011)	HQ406804		
<i>Circinaria calcarea</i>	Sweden, Wedin 6500 (UPS), WEDIN <i>et al.</i> (2005)			AY853310
<i>Circinaria calcarea</i>	Austria(?), Wilfling (GZU), IVANOVA and HAFELLNER (2002)	AF332109		
<i>Circinaria calcarea</i>	AFTOL-ID 1358, MIADEŁ-KOWSKA <i>et al.</i> (2006)			DQ986876

Table 1. (cont.).

Taxon name	Country, voucher, reference	ITS	LSU	12S SSU mtDNA
<i>Circinaria cerebroides</i>	Kyrgyzstan, Innerer Tian-Shan, Ringel 5138(H), SOHRABI <i>et al.</i> (2013a)	JQ797534	JQ797506	JQ797484
<i>Circinaria contorta</i>	Austria (GZU), IVANOVA and HAFELLNER (2002)	AF332108		
<i>Circinaria desertorum</i>	USA, NORDIN <i>et al.</i> (2007)	EU057905		
<i>Circinaria desertorum</i>	Russia, OWE-LARSSON <i>et al.</i> (2011)	HQ406802		
<i>Circinaria desertorum</i>	Russia, NORDIN <i>et al.</i> (2010)			HM060689
<i>Circinaria digitata</i>	Kyrgyzstan, SOHRABI <i>et al.</i> (2011a)	HQ171230		
<i>Circinaria digitata</i>	Kyrgyzstan, SOHRABI <i>et al.</i> (2011a)	HQ171236		
<i>Circinaria elmorei</i>	RUSSIA, Owe-Larsson 9814 (UPS), NORDIN <i>et al.</i> (2010)	HQ406802	HM060727	HM060689
<i>Circinaria cf. elmorei</i>	Ukraine: Crimea, SOHRABI <i>et al.</i> (2013a)	JQ797551		
<i>Circinaria cf. elmorei</i>	Iran, SOHRABI <i>et al.</i> (2013a)	JQ797542		
<i>Circinaria cf. elmorei</i>	Iran, SOHRABI <i>et al.</i> (2013a)	JQ797526		
<i>Circinaria cf. elmorei</i>	Iran, SOHRABI <i>et al.</i> (2013a)	JQ797558		
<i>Circinaria emiliae</i>	Kazakhstan, Atyrau, Kulakov 3702 (UPS), SOHRABI <i>et al.</i> (2013a)	JQ797512		
<i>Circinaria emiliae</i>	Kazakhstan, Atyrau, Kulakov 3702 (UPS), NORDIN <i>et al.</i> (2010)		HM060728	HM060690
<i>Circinaria emiliae</i>	Kazakhstan, Atyrau, Kulakov 3702B (UPS), SOHRABI <i>et al.</i> (2013a)	JQ797513		
<i>Circinaria emiliae</i>	Kazakhstan, Atyrau, Kulakov 3798 (UPS), NORDIN <i>et al.</i> (2010)		HM060729	HM060691
<i>Circinaria fruticulosa</i>	Ukraine: Crimea, SOHRABI <i>et al.</i> (2013a)	JQ797555		
<i>Circinaria fruticulosa</i>	Turkey, SOHRABI <i>et al.</i> (2013a)	JQ797535		
<i>Circinaria fruticulosa</i>	Kazakhstan, Tarbagatai, Lange 5186 (H), SOHRABI <i>et al.</i> (2013b)	HQ171228	JQ797505	JQ797486
<i>Circinaria gibbosa</i>	Sweden, Uppland, Nordin 5878 (UPS), NORDIN <i>et al.</i> (2007)	EU057908		
<i>Circinaria gibbosa</i>	Sweden, Uppland, Nordin 5878 (UPS), NORDIN <i>et al.</i> (2010)		HM060740	HM060702

Table 1. (cont.).

Taxon name	Country, voucher, reference	ITS	LSU	12S SSU mtDNA
<i>Circinaria jussuffii</i>	Morocco, SOHRABI <i>et al.</i> (2013a)	JQ797521		
<i>Circinaria jussuffii</i>	Algeria, Esnault 2033 (GZU), SOHRABI <i>et al.</i> (2013a)	JQ797518	JQ797495	JQ797489
<i>Circinaria lacunosa</i>	Kazakhstan, SOHRABI <i>et al.</i> (2013a)	JQ797520		
<i>Circinaria lacunosa</i>	China, Xinjiang, Abbas 940003 (H), SOHRABI <i>et al.</i> (2013a)	JQ797517	JQ797494	JQ797490
<i>Circinaria leproscens</i>	Sweden, Uppland, Nordin 5906 (UPS), NORDIN <i>et al.</i> (2007)	EU057911		
<i>Circinaria leproscens</i>	Sweden, Uppland, Nordin 5906 (UPS), NORDIN <i>et al.</i> (2010)		HM060749	HM060711
<i>Circinaria rogeri</i>	USA, SOHRABI <i>et al.</i> (2011a)	HQ171231		
<i>Circinaria rogeri</i>	USA, SOHRABI <i>et al.</i> (2011a)	HQ171232		
<i>Circinaria rostamii</i>	Iran, East Azerbaijan, Sohrabi 10212 (IRAN), SOHRABI <i>et al.</i> (2013a)	JQ797538	JQ797507	JQ797491
<i>Chlorangium alpicola</i>	Kyrgyzstan, SOHRABI <i>et al.</i> (2013a)	JQ797556		
<i>Chlorangium alpicola</i>	Kyrgyzstan, SOHRABI <i>et al.</i> (2013a)	JQ797552		
<i>Chlorangium alpicola</i>	Kyrgyzstan, SOHRABI <i>et al.</i> (2013a)	JQ797524		
<i>Chlorangium alpicola</i>	Kyrgyzstan, Ringel 5241, SOHRABI <i>et al.</i> (2013a)	JQ797554		
<i>Chlorangium aschabadense</i>	Turkmenistan, SOHRABI <i>et al.</i> (2013a)	JQ797519		
<i>Chlorangium aschabadense</i>	Turkmenistan, SOHRABI <i>et al.</i> (2010a)	GU289916		
<i>Chlorangium cf. asperum</i>	Russia, Astrakhan region, SOHRABI <i>et al.</i> (2013a)	JQ797531		
<i>Chlorangium gyrosum</i>	Spain, SOHRABI <i>et al.</i> (unpubl.)	JX306734		
<i>Chlorangium gyrosum</i>	Iran, SOHRABI <i>et al.</i> (2013a)	NR_120106		
<i>Chlorangium gyrosum</i>	Iran, East Azerbaijan, Sohrabi 10085 (hb. M. Sohrabi), SOHRABI <i>et al.</i> (2013a)	JQ797540	JQ797504	
<i>Chlorangium gyrosum</i>	Iran, SOHRABI <i>et al.</i> (2013a)	JQ797539		
<i>Chlorangium gyrosum</i>	Spain, SOHRABI <i>et al.</i> (2013a)	JQ797557		
<i>Chlorangium gyrosum</i>	Iran, East Azerbaijan, Sohrabi 10401A (hb. M. Sohrabi), SOHRABI <i>et al.</i> (2013a)	JQ797528		JQ797487

Table 1. (cont.).

Taxon name	Country, voucher, reference	ITS	LSU	12S SSU mtDNA
<i>Chlorangium sphaerotherallinum</i>	Iran, Semnan, Sohrabi 9369 (hb. M. Sohrabi), SOHRABI et al. (2013a)	JQ797545	JQ797508	JQ797476
<i>Chlorangium sphaerotherallinum</i>	Iran, SOHRABI et al. (2013a)	JQ797537		
<i>Chlorangium sphaerotherallinum</i>	Iran, SOHRABI et al. (2013a)	JQ797536		
<i>Chlorangium sphaerotherallinum</i>	Iran, SOHRABI et al. (2013a)	JQ797543		
<i>Chlorangium sphaerotherallinum</i>	Armenia, SOHRABI et al. (2013a)	JQ797525		
<i>Lobothallia alphoplaca</i>	USA, Leavitt 447 (BRY), SOHRABI et al. (2013b)	JX306737		
<i>Lobothallia alphoplaca</i>	USA, SOHRABI et al. (2013b)	JX306738		
<i>Lobothallia alphoplaca</i>	USA, SOHRABI et al. (2013b)	JX306739		
<i>Lobothallia alphoplaca</i>	China, SDNU 20117646, KOU et al. (2013)	JX476025		
<i>Lobothallia alphoplaca</i>	SK A20, Ukraine, Donetsk oblast, "Kamjani Mogyly" zapovidnyk, near the stream, 131 m alt, 13.05.2011, Nadeina et al. [ex KW-L 68283], this paper	KT456207	KT456210	KT456211
<i>Lobothallia melanaspis</i>	Norway, VALADBEIGI et al. (2011)	JF825524		
<i>Lobothallia melanaspis</i>	Sweden, Jämtland, Nordin 6622 (UPS), NORDIN et al. (2011)	HQ259272		
<i>Lobothallia melanaspis</i>	Sweden, Jämtland, Nordin 6622 (UPS), NORDIN et al. (2010)		HM060726	HM060688
<i>Lobothallia radiosa</i>	Sweden, ROUX et al. (2011)	JF703124		
<i>Lobothallia radiosa</i>	Switzerland, Schmitt et al. (2006)		DQ780306	DQ780274
<i>Lobothallia recedens</i>	Sweden, Dalarna, Nordin 6582 (UPS), NORDIN et al. (2010)		HM060762	HM060724
<i>Megaspora verrucosa</i>	Austria, 1996, Trinkaus (GZU), IVANOVA and HAFELLNER (2002)	AF332121		
<i>Megaspora verrucosa</i>	Austria(?), Hafellner 48544 & Ivanova (GZU), IVANOVA and HAFELLNER (2002)	AF332122		
<i>Megaspora verrucosa</i>	USA, SOHRABI et al. (2013b)	KC667053		
<i>Megaspora verrucosa</i>	Sweden, Jämtland, Nordin 6495 (UPS), NORDIN et al. (2010)		HM060725	HM060687

Table 1. (cont.).

Taxon name	Country, voucher, reference	ITS	LSU	12S SSU mtDNA
<i>Megaspora verrucosa</i>	Iran, East Azerbaijan, Sipman 55434 (B), SOHRABI <i>et al.</i> (2013a)		JQ797498	JQ797483
<i>Megaspora verrucosa</i>	Turkey, Prov. Çorum, Kinalioglu 1679 (B), SOHRABI <i>et al.</i> (2013a)		JQ797497	JQ797482
<i>Oxneria alfredi</i>	FNM 152, Russia, FEDORENKO <i>et al.</i> (2009)	EU681344		EU680932
<i>Oxneria huculica</i>	FNM 199, Russia, FEDORENKO <i>et al.</i> (2009)	EU681346		EU680931
<i>Oxneria huculica</i>	USA, Søchting 9566, C ARUP <i>et al.</i> (2013)		KC179279	
<i>Oxneria ulophyllodes</i>	FNM 198, FEDORENKO <i>et al.</i> (2009)	EU681342		EU680930
<i>Oxneria ulophyllodes</i>	USA: Wetmore 80270, LD ARUP <i>et al.</i> (2013)		KC179283	
<i>Sagedia mastrucata</i>	Sweden, Lycksele Lappmark, Nordin 5481 (UPS), NORDIN <i>et al.</i> (2007)	EU057914		
<i>Sagedia mastrucata</i>	Sweden, Lycksele Lappmark, Nordin 5481 (UPS), NORDIN <i>et al.</i> (2010)		HM060737	HM060699
<i>Sagedia mastrucata</i>	Norway, Troms, Nordin 5708 (UPS), NORDIN <i>et al.</i> (2007)	EU057913		
<i>Sagedia mastrucata</i>	Norway, Troms, Nordin 5708 (UPS), NORDIN <i>et al.</i> (2010)		HM060736	HM060698
<i>Sagedia simoënsis</i>	Norway, Troms, Owe-Larsson 9000 (UPS), NORDIN <i>et al.</i> (2010)		HM060739	HM060701
<i>Sagedia zonata</i>	Sweden, Nordin 6006 (UPS), NORDIN <i>et al.</i> (2007)	EU057952		
<i>Sagedia zonata</i>	Sweden, Nordin 5949 (UPS), NORDIN <i>et al.</i> (2007)	EU057953		
<i>Sagedia zonata</i>	Norway, Troms, Owe-Larsson 8942 (UPS), NORDIN <i>et al.</i> (2010)		HM060738	HM060700
<i>Sphaerothallia esculenta</i>	Russia, Astrakhan region, SOHRABI <i>et al.</i> (2013a)	JQ797511		
<i>Sphaerothallia esculenta</i>	Russia, Astrakhan Region, Owe-Larsson 9796 (UPS), SOHRABI <i>et al.</i> (2013a)		JQ797493	JQ797485

The new species *Agrestia zerovii*, forms as a strongly supported clade in all separate analyses with the highest level of bootstrap support.

However, based on ITS analysis *Agrestia zerovii* forms a robust monophyletic clade within the *Agrestia* clade together with specimens of *Agrestia hispida* s. str. with GenBank accession numbers HQ389197 and HQ389198 (data not shown). The specimen of *Chlorangium asperum* (Mereschk.) S. Y. Kondr., A. B. Gromakova et Khodos. is a member of the *Chlorangium* clade with *C. jussuffii* (Link) Link, *C. sphaerothallinum* (J. Steiner) S. Y. Kondr., A. B. Gromakova et Khodos., *C. aschabadense* (J. Steiner) S. Y. Kondr., A. B. Gromakova et Khodos., and *C. alpicola* (Elenkin) S. Y. Kondr., A. B. Gromakova et Khodos.

Based on LSU analysis *Agrestia zerovii* forms as robust monophyletic branch a weakly supported clade with specimens of *Agrestia hispida* s. str. with GenBank accession numbers DQ780305 and HM060760 (data not shown). Unfortunately, LSU data are still missing for *Chlorangium asperum*.

According to the mtSSU analysis all specimens of *Agrestia zerovii*, *Agrestia hispida* s. str., and *Agrestia hispida* s. l., as well as specimen of *Chlorangium asperum* are rather different and they do not form a separate clade (data not shown).

Combined analysis

The alternative combined analysis based on nuclear ITS, LSU and 12S mtSSU data sets included 67 specimens of 29 species and a total of 2,084 positions of which 1,050 were informative.

The combined phylogenetic analysis based on ITS and LSU nrDNA, as well as 12S SSU mtDNA sequences strongly supports the proposal that the new species *Agrestia zerovii* is a member of the genus *Agrestia* (Fig. 1). *Agrestia zerovii* appears as a sister group to the other *Agrestia hispida* s. str. and *Agrestia hispida* s. l. specimens based on data so far available in GenBank. The genus *Agrestia* together with the genera *Sphaerothallia* Nees ex Eversm., *Chlorangium* Link, as well as the “*Circinaria*” *lacunosa* group form a weakly supported clade (Fig. 1). The specimen of *Chlorangium asperum* similarly to the nrITS analysis is a member of the *Chlorangium* clade.

DISCUSSION

Our data on the number of generic clades/branches within the Megasporaceae are, however, in conflict with NORDIN *et al.* (2010), OWE-LARSSON *et al.* (2011), and SOHRABI *et al.* (2013a), who accepted the division of the Megasporaceae into the following five genera, i.e. *Aspicilia*, *Circinaria*, *Lobothallia*, *Megasporea*, and *Sagedia* using a combined data set of nrLSU and mtSSU.

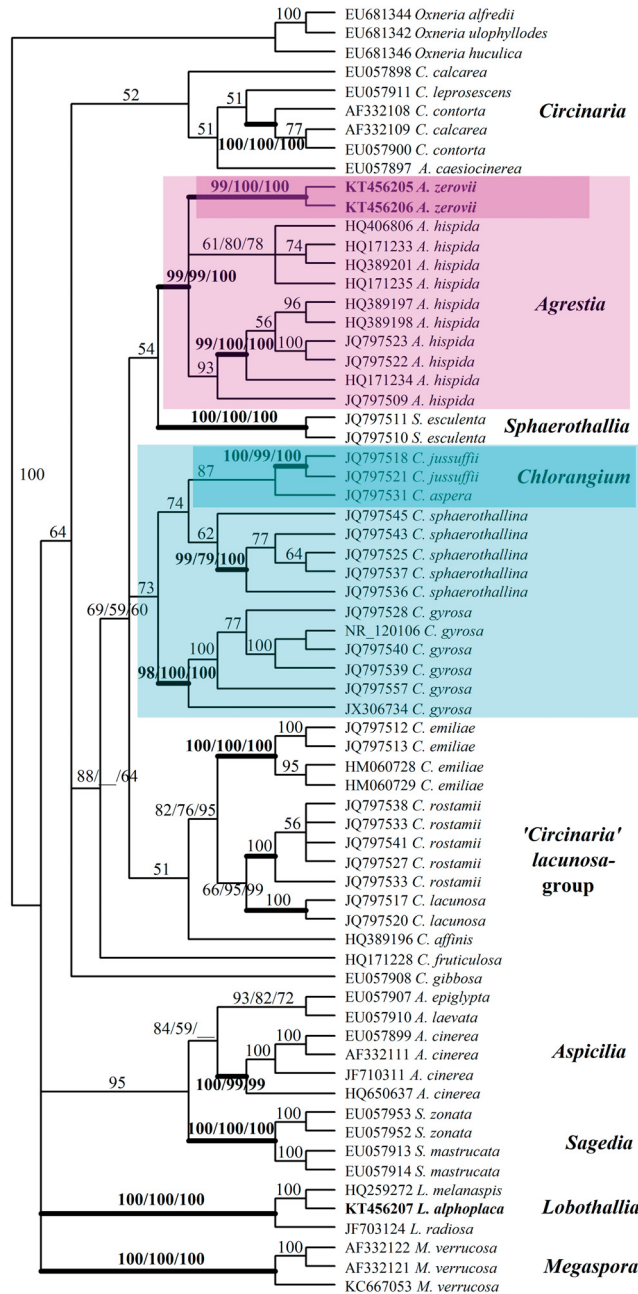


Fig. 1. The combined phylogenetic tree of the Megasporaceae based on nrITS, nrLSU and mtSSU data set (data of MP, ME and ML methods are shown if branches have had support in all the cases, otherwise only data of MP analysis are given).

The *Circinaria* s. str. branch

The genus *Circinaria* Link resurrected by NORDIN *et al.* (2010) and OWELARSSON *et al.* (2011) has very low support according to our alternative combined phylogenetic analysis based on the nrITS, nrLSU and mtSSU data sets, and probably can be accepted for a very narrow species group, i.e.: *C. contorta* group s. str., including only *C. contorta* (Hoffm.) A. Nordin, S. Savić et Tibell, *C. leproscens* (Sandst.) A. Nordin, S. Savić et Tibell, *C. caesiocinerea* (Nyl. ex Malbr.) A. Nordin, S. Savić et Tibell, and *C. calcarea* (L.) A. Nordin, S. Savić et Tibell (Fig. 1). It should be mentioned that molecular data of one voucher specimen is still missing for *C. contorta*, the type species of this genus. NORDIN *et al.* (2010) and SOHRABI *et al.* (2013a) provided nrITS sequences on one side and nrLSU and mtSSU sequences on another side from different voucher specimens. However, the rather weak support of the *Circinaria* s. str. branch in the phylogenetic tree of the Megasporaceae (Fig. 1) illustrates that *C. contorta* is still a complex taxon or the identification of some voucher specimens was incorrect.

The *Sphaerothallia* s. l. clade

The other species group included by previous authors into the genus *Circinaria* s. l. and forming separate group from the *Circinaria* s. str. clade, hereafter the *Sphaerothallia* s. l. clade, which, however, has very weak support (Fig. 1). The *Sphaerothallia* s. l. clade includes four robust branches, i.e.: the *Agrestia*, the *Chlorangium*, the *Sphaerothallia* s. str. and the “*Circinaria*” *lacunosa* group.

The *Agrestia* branch

Our data on the *Agrestia hispida* group are, however, in conflict with SOHRABI *et al.* (2013a), who proposed that this complex belongs to the genus *Sphaerothallia* (as *S. hispida* (Mereschk.) Follmann et A. Crespo). All specimens of *Agrestia hispida* s. str., as well as *Agrestia hispida* s. l. form a separate robust monophyletic branch, which is sister to the *Sphaerothallia* and the *Chlorangium* branches, as well as to the “*Circinaria*” *lacunosa* group within the *Sphaerothallia* s. l. clade.

For this reason *Agrestia* J. W. Thomson (THOMSON 1961) might be assumed to be an appropriate generic name for this monophyletic clade if the type species, *Agrestia cyphellata* J. W. Thomson, a terricolous lichen from Canada and the USA, belongs to this clade. The status of this species needs urgent verification by molecular data.

After SOHRABI *et al.* (2013a) “*Circinaria*” *elmorei* (E. D. Rudolph) Owe-Larss., “*Circinaria*” sp. 3, “*Circinaria*” *rogeri* (Sohrabi) Sohrabi, and “*Circinaria*” *digitata* (Sohrabi et Litterski) Sohrabi are closely related to the *Agrestia hispida* complex based on the nrITS data set. However “*Circinaria*” *elmorei* was not in-

cluded in our combined data (see below), and “*Circinaria*” *rogeri* and “*Circinaria*” *digitata* for which data on nrLSU and mtSSU are still missing in GenBank were also excluded from our combined analysis. “*Circinaria*” *elmorei* was not included in our combined phylogenetic analysis since there are contradictive data on this species in GenBank. According to nrITS “*Circinaria*” *elmorei* is positioned in several branches, while data on nrLSU and mtSSU sequences originate from only one voucher which is not the type of this species. Unidentified and undescribed taxa are also excluded from our analysis.

The *Sphaerothallia* branch

The genus *Sphaerothallia* is assumed by SOHRABI *et al.* (2013a) to be a probably appropriate generic name for the rather large group of spherothalloid lichens (sensu SOHRABI *et al.* 2013a). However, our data indicate that the genus can be used for a very narrow group including so far only the type species *S. esculenta* (Pall.) Reichardt, which has the highest level of support as a separate branch in the phylogenetic tree of the family (Fig. 1). According to SOHRABI *et al.* (2013a) the *Sphaerothallia* s. str. clade includes also “*Circinaria*” *elmorei* s. l. using nrITS data set. However, “*Circinaria*” *elmorei* as it is emphasised above was not included in our combined phylogenetic analysis.

Our analysis demonstrates that another “*Circinaria*” species, “*Circinaria*” *emiliae* does not belong to the *Sphaerothallia* s. str. branch in contrast to the data by SOHRABI *et al.* (2013a) (Fig. 1).

Furthermore “*Circinaria*” sp. 2 according to SOHRABI *et al.* (2013a) is also closely related to this branch. However, unidentified and undescribed taxa are excluded from our analysis.

The *Chlorangium* branch

The *Chlorangium* clade includes the type species *C. jussuffii* (Link) Link, as well as *C. alpicola*, *C. aschabadense*, and *C. asperum*. The status of *Chlorangium gyrosum* (Sohrabi, Sipman, V. John et V. J. Rico) S. Y. Kondr., A. B. Gromakova et Khodos. and *C. sphaerothallinum* (J. Steiner) S. Y. Kondr., A. B. Gromakova et Khodos. in this branch is the most questionable since this clade has rather weak support. These species may belong to separate monophyletic clades.

Based on nrITS data set (both by SOHRABI *et al.* (2013a) and by our nrITS analysis) *Chlorangium alpicola* belongs to the *Chlorangium* clade, however, it was not included in the combined analysis since nrLSU and mtSSU data are still missing for this taxon. Based on nrITS data set “*Circinaria*” *fruticulosa* (Eversm.) Sohrabi is in sister position to *Chlorangium gyrosum* with very weak level of support (SOHRABI *et al.* 2013a). However, “*Circinaria*” *fruticulosa* was excluded from

our analysis because its mtSSU sequence data are very different from all other members of the Megasporaceae. The data on mtSSU of “*Circinaria*” *fruticulosa* need to be confirmed by further voucher specimens.

The “*Circinaria*” *lacunosa* group branch

The “*Circinaria*” *lacunosa* group includes “*C.*” *lacunosa* (Mereschk.) Sohrabi, “*C.*” *rostamii* Sohrabi, and “*C.*” *emiliae* (Tomlin) A. Nordin, S. Savić et Tibell. The branch shows the highest level of support for all the species each sampled from four to five voucher specimens. According to the nrITS data set published by SOHRABI *et al.* (2013a), this group includes also “*Circinaria*” *affinis* (Eversm.) Sohrabi. However, based on our data “*C.*” *affinis*, for which there is only one voucher sequence with ITS and LSU nrDNA and 12S SSU mtDNA available in GenBank, falls out of the whole *Sphaerothallia* s. l. clade.

After SOHRABI *et al.* (2013a) this branch includes also “*Circinaria*” *cerebroides* (Mereschk.) Sohrabi based on nrITS data set. However, this species was excluded from our combined analysis because its nrLSU and mtSSU data are incomplete and very different from other taxa included in our combined matrix.

Our data support the data of previous authors (SOHRABI *et al.* 2013a) that the *Aspicilia* *epiglypta* group (including *A. epiglypta* (Norrl. ex Nyl.) Hue, *A. indissimilis* (H. Magn.) Räsänen, and *A. laevata* (Ach.) Arnold) has very low support together with *Aspicilia* s. str. (i.e. *Aspicilia cinerea* group). So the status of the *Aspicilia epiglypta* group requires further investigations.

Thus, four more robust monophyletic branches, i.e. the *Agrestia*, the *Chlorangium*, the *Sphaerothallia*, and the “*Circinaria*” *lacunosa* group branches within the *Sphaerothallia* s. l. clade, having very weak support and located in separate place from the *Circinaria* s. str. clade, are shown additionally to five genera accepted by NORDIN *et al.* (2010), OWE-LARSSON *et al.* (2011) and SOHRABI *et al.* (2013a) within the Megasporaceae (*Aspicilia*, *Circinaria*, *Lobothallia*, *Megaspora* and *Sagedia*).

Consequently, the genera *Agrestia* J. W. Thomson, *Chlorangium* Link, and *Sphaerothallia* Nees ex Eversm. are resurrected within this study.

Taxon description

Agrestia zerovii S. Y. Kondr., A. B. Gromakova et Khodos., *spec. nova*
(Figs 2–4)

Mycobank no.: MB 813878.

Similar to Agrestia hispida s. str., but differs in having well-developed, horizontally orientated, very thick thalline lobes often forming distinct crust of the central portion of thallus, in the lack of blackish tips of the erect secondary branchlets, as well as deviates in the nrDNA ITS region.

Type: Ukraine, Kharkiv oblast (= region), Dvorichansky district, in the vicinity of Dvorichana settlement, Korobchyno protected territory (= zakaznik), 49° 50' 00.5" N, 37° 40' 27.7" E, the upper part of the slope, to W from the road, below of plantation, leg. Gromakova, A. B., s.n., 27.05.2012, (holotype: KW-L 70479); the same locality (isotypes: KW-L 70480, KHER, CWU).

Thallus subfruticose, erratic (sensu BÜDEL and WESSELS (1986), i.e. the facultatively unattached lichen), 2–3(–4) cm in diam./across and 1.5–3(–4)[–8] mm thick; bushy, more or less *Cladonia*-like thallus with abundant erect secondary branchlets or mainly “horizontal crusts” of densely compressed main lobes and scarce erect secondary branchlets, grey to greenish-grey if freshly collected especially in wet conditions; consisting of two morphologically different types of thalline lobes, i.e. the main lobes very thick, (1.5–)2–3(–3.5) mm wide and to 7–10(–14) mm long, massive, mainly horizontally orientated, often somewhat compressed or deformed, infrequently regularly cylindrical, often densely pressed to each other and form thick “horizontal crust” of (3–)7–10(–12) mm across with numerous erect secondary lobules.

Secondary lobules (1–)3–6(–8) mm long, ranging from very thin (0.2–0.3 mm diam.) to rather thick (0.5–)0.7–1.2(–1.5) mm diam.) at the basis and gradually becoming thinner towards the tips, mainly erect, usually regularly cylindrical, concolorous along the whole length (not blackish towards the tips); sometimes secondary lobules branched and secondary branchlets 1–2 mm long and *ca* 0.5 mm in diam. at the basis and becoming thinner towards the tips present; pseudocyphellae regularly rounded up to 0.2–0.3 mm in diam., white, sometimes quite distinct. Apothecia unknown. Conidia not seen.

Chemistry: All spot-tests (K, C, KC, CK, P) negative both in the cortex and medulla.

Ecology: The species grows together with *Collema tenax* (Sw.) Ach. var. *tenax*, *C. tenax* var. *ceranoides* (Borrer) Degel., *C. crispum* (Huds.) Weber ex F. H. Wigg., *Endocarpon pusillum* Hedw., *Megaspora verrucosa* (Ach.) Arcadia et A. Nordin, *Thrombium epigaeum* (Pers.) Wallr. on lime rich soil in arid steppe or steppe-like habitats. Vagrant forms accumulate in wind-deposited drifts.

The following plants accompanying *Agrestia zerovii* were registered: *Androsace koso-poljanskii* Ovcz., *Artemisia hololeuca* M. Bieb. ex Besser, *Asperula tephrocarpa* Czern. ex M. Pop. et Chrshan., *Astragalus albicaulis* DC., *Hedysarum grandiflorum* Pall., *Hyssopus cretaceus* Dubjan., *Linaria cretacea* Fisch. ex Spreng., *Linum ucranicum* (Griseb. ex Planch.) Czern., *Pimpinella titanophila* Woronow, *Polygala cretacea* Kotov, *Thymus calcareus* Klokov et Des.-Shost. (see also GROMAKOVA 2013).

Two different morphotypes were observed in the field conditions of the type locality. Bushy, more or less *Cladonia*-like thallus with abundant, erect secondary branchlets are easily observable in the open areas, while mainly “horizontal crusts”

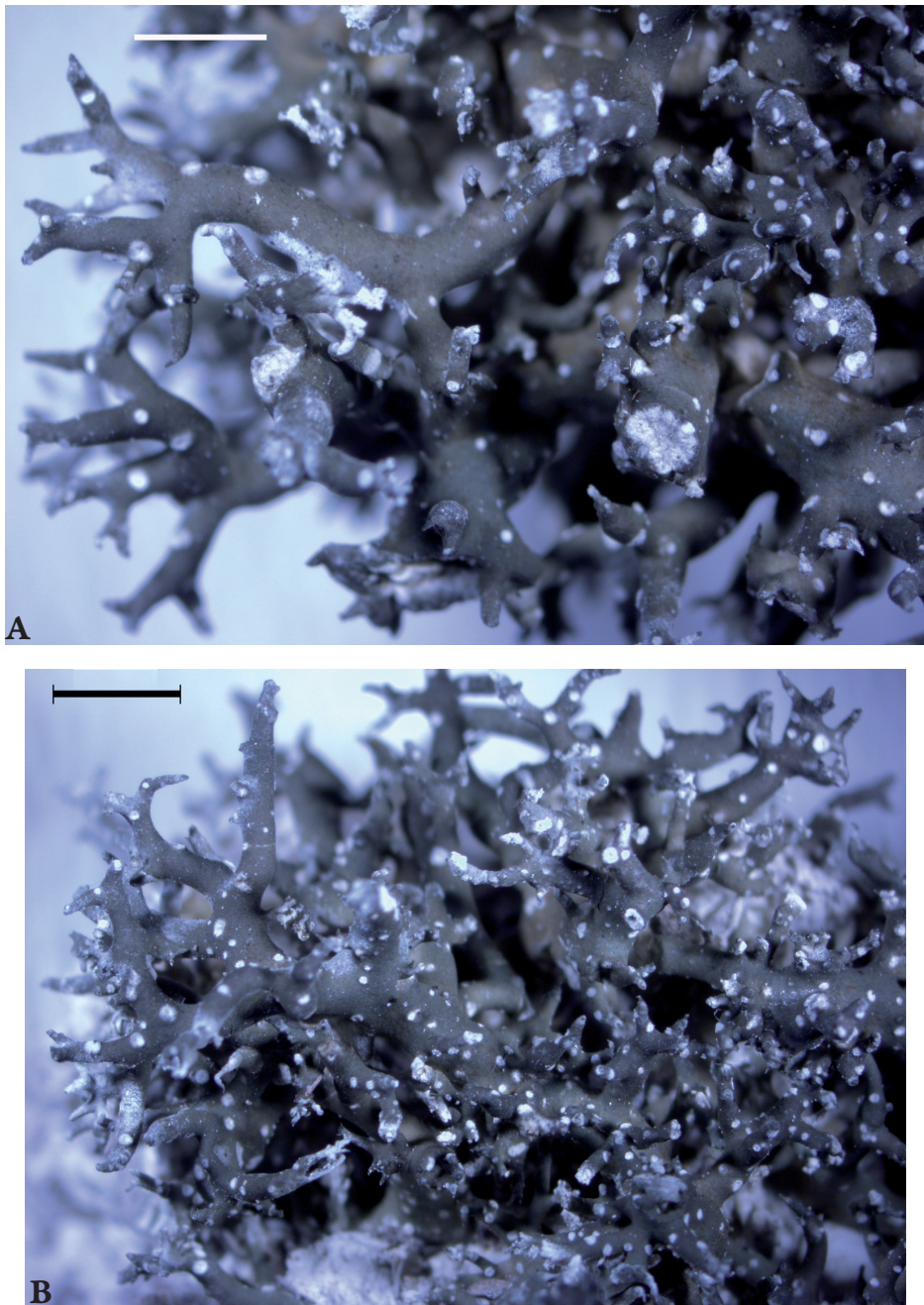


Fig. 2. *Agrestia zerovii* (holotype), general habit. Scale: A = 2 mm, B = 3 mm.

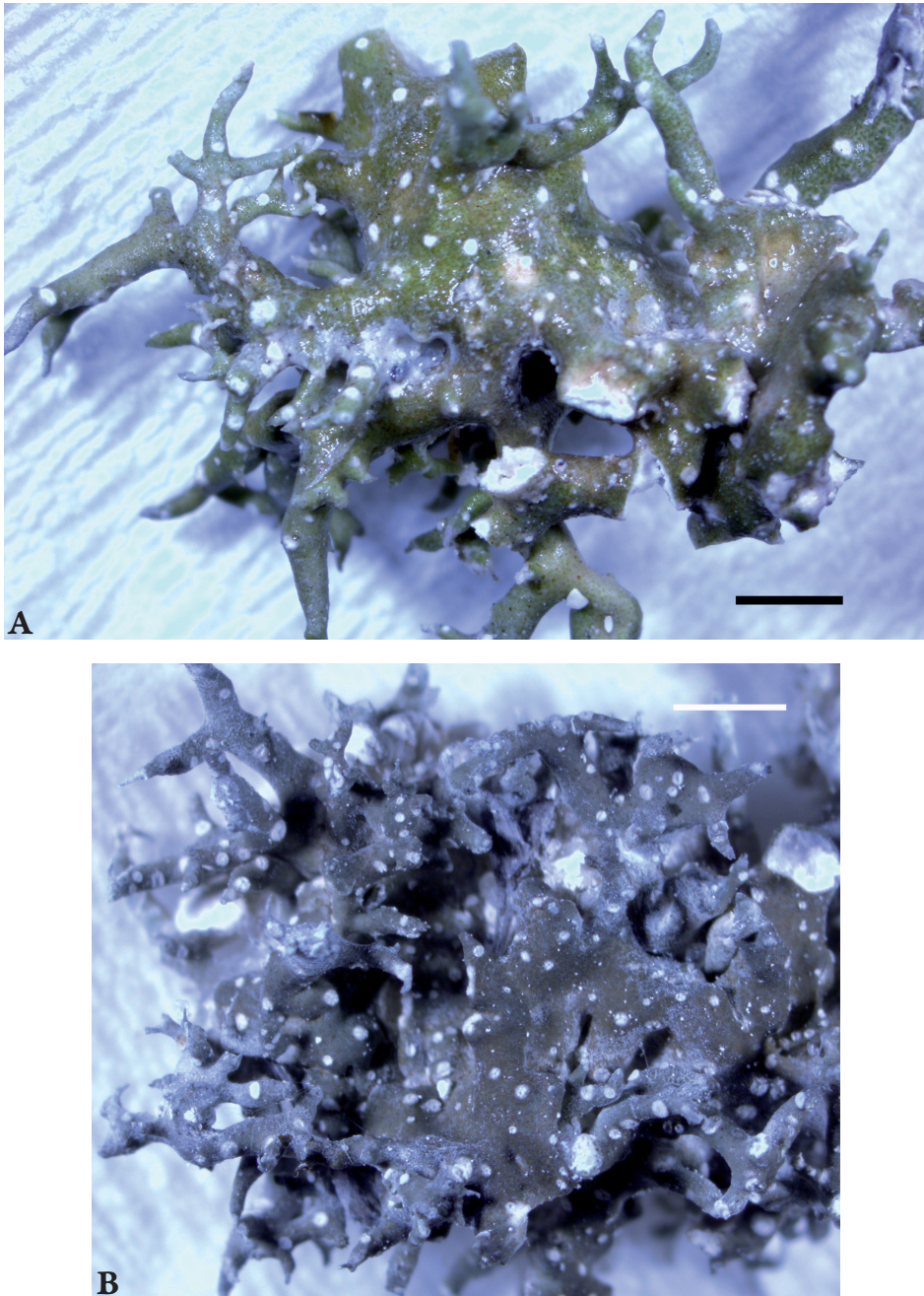


Fig. 3. *Agrestia zerovii* (holotype), enlarged “horizontal crust” of two different thalli, A = after wetting, B = in dry conditions. Scale: A and B = 2 mm.

of densely compressed main lobes and scarce erect secondary branchlets were observed under the crown layer of the endemic shrub species, *Thymus calcareus*.

Etymology: It is named after Dmytro K. Zerov (1895–1971) (Kyiv, Ukraine, KW-B) in honour of the 120th anniversary of his birthday. He was a well-known Ukrainian bryologist, palaeobotanist, and specialist of the phylogeny of non-vascular (= lower) plants, and the founder of the Kyiv bryological and Ukrainian palaeobotanical scientific schools.

Distribution: In contrast to *Agrestia hispida*, which is a widely distributed steppe element in temperate and subtropical, semi-arid regions of the Northern Hemisphere from Italy to the Russian part of the Caspian Sea coast, the Tian-Shan Mts in Kyrgyzstan and Iran (ANDREEVA 1987, KULAKOV 2002, 2003, HAFELLNER *et al.* 2004, SEAWARD *et al.* 2008) and North America (OWE-LARSSON *et al.* 2007), *A. zerovii* is so far known only from the type locality, where it was observed in the 1940s.

It is important to emphasise that *Agrestia zerovii* was first recorded/collected from locus classicus by a known Ukrainian bryologist, Dr Anna F. Bachurina, one of the students of Dmytro K. Zerov. The Ukrainian localities of *Agrestia hispida* recorded by MERESCHKOWSKY (1911), OXNER (2010) and other colleagues require revision since some of them may belong to *A. zerovii* too.

Taxonomic notes: Though *Agrestia zerovii* is more or less similar to *A. hispida* s. str. it differs in having much thinner (1.3–3(–4) mm thick vs. 5–20 mm tall?) thalline tufts, two morphologically different types of thalline lobes, well-developed, horizontally orientated, much thicker (2–3(–3.5) mm diam. vs. (0.3–)0.5–1.5(–2) mm diam.) main lobes, often distinct “horizontal portion” or flattened crust of thallus consisting of interwoven/or to each other pressed flattened main lobes of (3–)7–10(–12) mm across, in the lack of blackish tips of the erect secondary branchlets. Finally, it has different sequence of the nrDNA ITS region.

Agrestia zerovii is positioned in a branch separate from the specimens of *Agrestia hispida* s. str. in the combined phylogenetic analysis based on ITS and LSU nrDNA and 12S SSU mtDNA sequences (Fig. 1).

The two morphotypes observed in the type locality and described above seem to differ only in the development level of the erect secondary branchlets. So, bushy, more or less *Cladonia*-like thallus with abundant erect secondary branchlets, which are common in the open areas has both types of thalline lobes, much thicker, mainly horizontally orientated main lobes and erect secondary branchlets. However, the first (main lobes) are usually not seen through the dense cover of the erect secondary branchlets or owing to the dust particles covering this portion of the thallus. The second morphotype, i.e. mainly “horizontal crusts” of densely compressed main lobes, which are more common under the crown layer

of the endemic shrub species *Thymus calcareus*, differs in having only scarce erect portions and the “horizontal crust” of this lichen is better observable. However, it should be mentioned that the “horizontal crust” is well developed in both cases, but it is poorly observable, especially in the first case.

Specimens of *Agrestia zerovii* were sterile (no apothecia were observed), similarly to all Eurasian specimens of *A. hispida* s. str. (cf. SOHRABI *et al.* 2013a).

Unfortunately, SOHRABI *et al.* (2013a) did not mention the length of the main lobes and secondary branchlets of *Agrestia hispida*, probably they did not think that these characters are important for taxonomy of this species group. However, differences between *A. zerovii* and *A. hispida* s. str. prove that details on lobe morphology are important. In our opinion the descriptions of *A. hispida* s. str., and of the crustose *A. hispida* s. l. should be completed with data on the length of main lobes and secondary branchlets.

Agrestia hispida was illustrated in the Red data book of Ukraine (DIDUKH 2009) by photos of North American material, because it was fertile. It is necessary to emphasise based on the morphological differences between *A. zerovii* and *A. hispida*, that the Ukrainian material is quite different from the North American one. Differences of *A. zerovii* and *A. hispida* are also observable by comparison of the illustrations of *A. hispida* published in the Red data book of Ukraine (DIDUKH 2009) and illustrations of *A. zerovii* provided here. To our opinion *Agrestia zerovii* should be included in the next edition of the Red data book of Ukraine.

Colour photos of the Eurasian and American representatives of *Agrestia hispida* based on SOHRABI *et al.* (2011b) presented on the Myco-Lich website (www.myc-lich.com) and edited by SOHRABI *et al.* (2010) were also consulted within this revision, too.

Other specimens examined: Ukraine: Kharkiv oblast, Dvorichansky district, in the vicinity of Dvorichana settlement, Korobchyno zakaznik, 49° 50' 00.5" N, 37° 40' 27.7" E, the upper part of the slope, below the plantation, 2 m W of the road, leg. M. Kryvokhyzhaya, 19.06.2013 (paratype: KW-L 70658); the same locality, (paratype: KW-L 70659); the same locality, S exposure of the slope, in the middle part of the slope, W of the road, leg. M. Kryvokhyzhaya, 19.06.2013 (paratype: KW-L 70660); the same locality, S exposure of the slope, in the middle part of the slope, to W of the road, near the *Thymus calcareus* shrub, leg. M. Kryvokhyzhaya, 19.06.2013 (paratype: KW-L 70661); the same locality, S exposure of the slope, in the middle part of the slope, to W of the road, just close to the *Thymus calcareus* shrub, leg. M. Kryvokhyzhaya, 19.06.2013 (paratype: KW-L 70662).

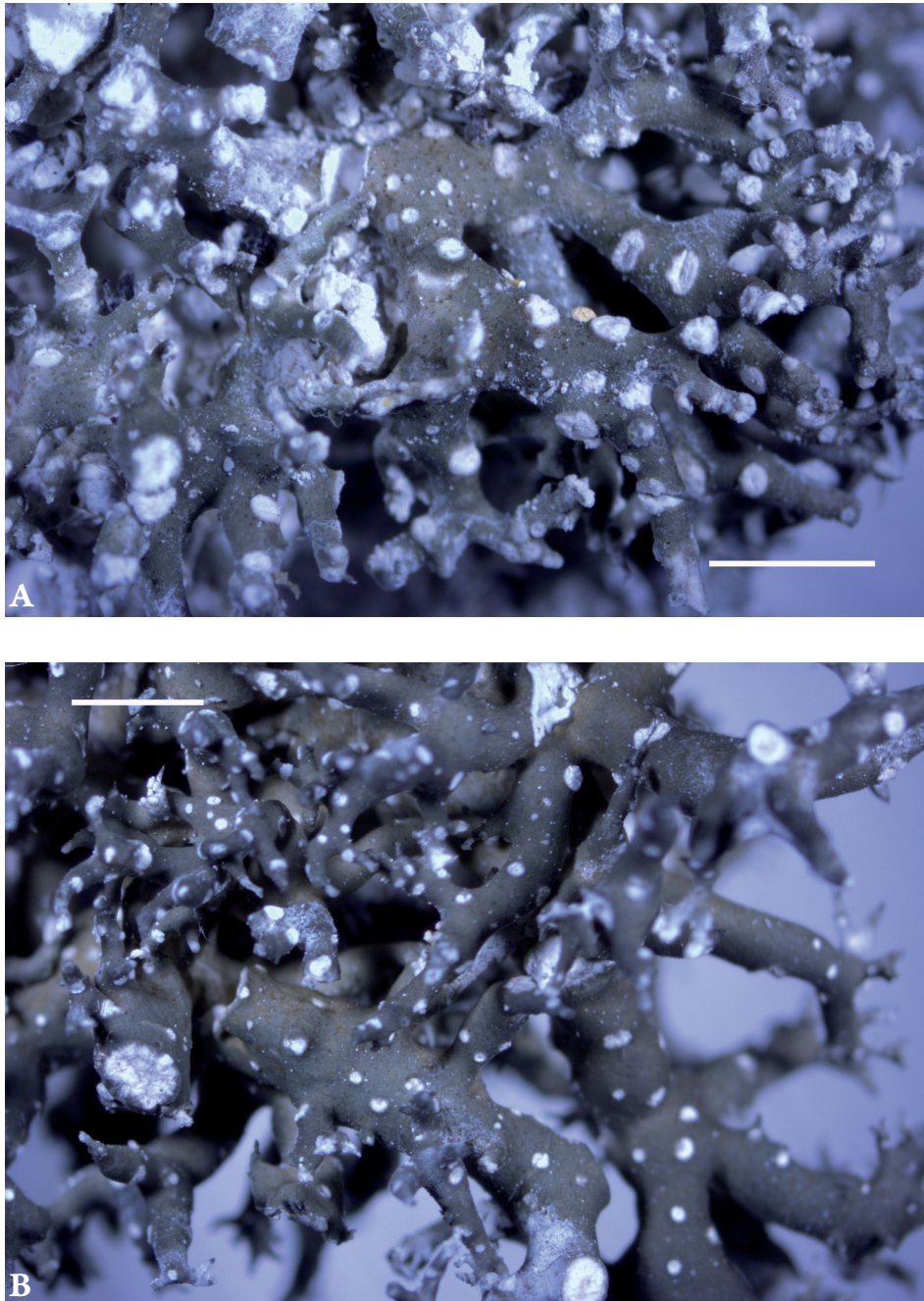


Fig. 4. *Agrestia zerovii* (holotype), enlarged main thalline lobes. Scale: A and B = 2 mm.



Fig. 5. General view of the type locality of *Agrestia zerovii*.

New combinations

Chlorangium alpicola (Elenkin) S. Y. Kondr., A. B. Gromakova et Khodos., *comb. nova* [Mycobank no.: MB 813879]. – Basionym: *Aspicilia alpicola* Elenkin, Fl. Lishaynikov Sredney Rossii [Lichenes Florae Rossiae Mediae] 2: 222 (1907). ≡ *Circinaria alpicola* (Elenkin) Sohrabi in Sohrabi *et al.*, Mycol Progr. 12: 244 (2013). – Type: Kyrgyzstan. “Ad terram argillosam in regione alpina montium Tian-Shan (Kaschgariae: Werchnij Syrt 12,000 ft. ped)”, 1889, Roborowsky in Elenkin, Lich. Fl. Ross. No. 24d (lectotype: H; isolectotype: LE (L2008), designated by SOHRABI and AHTI (2010)). = *Aspicilia alpinodesertorum* f. *esculenta-alpina* Elenkin in Izv. Imp. S.-Peterburgsk. Bot. Sada 1: 36 (1901) (16 July), as “*esculenta alpina*” or “*esculenta (alpina)*”. = *Aspicilia alpinodesertorum* f. *fruticulosofoliacea* Elenkin in Izv. Imp. S.-Peterburgsk. Bot. Sada 1: 27, 36, 39, tab. 2, rows IX–X, figs 1–7 (1901), as “*fruticulosofoliacea*”. = *Aspicilia fruticulosofoliacea* (Elenkin) Sohrabi in Taxon 59: 627 (2010).

Chlorangium aschabadense (J. Steiner) S. Y. Kondr., A. B. Gromakova et Khodos., *comb. nova* [Mycobank no.: MB 813881]. – Basionym: *Lecanora esculenta* subsp. *aschabadensis* J. Steiner in Ann. Mycol. 8: 227 (1910). ≡ *Aspicilia aschabadensis* (J. Steiner) Mereschk., Trudi naturh. Ver. ksl. Univ. Kasan 43: 34 (1911). ≡ *Circinaria aschabadensis* (J. Steiner) Sohrabi in Sohrabi *et al.*, Mycol Progress 12: 249 (2013). – Type: Turkmenistan. “Regio trans-caspica: Aschabad [Ashgabat] ad fines Persiae”, sine dato, Sintenisin Zahlbruckner, Lich. Rarior. Exs. No. 32 (error “39”) (lectotype: W; isolectotypes: LE, PC, designated by SOHRABI and AHTI (2010)).

Chlorangium asperum (Mereschk.) S. Y. Kondr., A. B. Gromakova et Khodos., *comb. nova* [Mycobank no.: MB 813882]. – Basionym: *Aspicilia desertorum* var. *aspera* Mereschk. in Trudy Obshch. Estestvoisp. Imp. Kazansk. Univ. 43(5): 13 (1911). ≡ *Lecanora aspera* (Mereschk.) Tomin, Prir. Sel'sk. Khoz. Zasushl.-Pustyn. Obl. SSSR. 1/2: 4 (1927), nom. illeg., non. *L. aspera* Stizenb. (1890). ≡ *Aspicilia aspera* (Mereschk.) Tomin, in Kopaczewskaja *et al.*, Handbook of the lichens of the USSR 1: 198 (1971). ≡ *Circinaria aspera* (Mereschk.) Sohrabi et Şenkard, in Sohrabi *et al.*, Mycol Progr. 12: 265 (2013). – Type: Azerbaijan. “In rupibus calcareis e gub. Baku in Caucaso”, 1893, Lipsky in Elenkin: Lich. Fl. Ross. No. 24b (lectotype: LE (L 2017); isolectotypes: H (L 2016, L 2018), designated by SOHRABI *et al.* 2013a).

Chlorangium gyrosum (Sohrabi, Sipman, V. John et V. J. Rico) S. Y. Kondr., A. B. Gromakova et Khodos., *comb. nova* [Mycobank no.: MB 813885]. – Basionym: *Circinaria gyrosa* Sohrabi, Sipman, V. John et V. J. Rico, in Sohrabi *et al.*, Mycol Progr. 12: 255 (2013). – Type: Iran, East Azerbaijan, Marand district, 32 km N of Marand towards Jolfa, 38° 40.58' N, 45° 39.44' E, 1,440 m, leg. M. Sohrabi 10085, H. Sipman, U. Söchting, M. R. Asef, 2 Nov. 2007 (holotype: IRAN 14444; isotypes: B, H).

Chlorangium sphaerothallinum (J. Steiner) S. Y. Kondr., A. B. Gromakova et Khodos., *comb. nova* [MycoBank no.: MB 813887]. – Basionym: *Aspicilia calcarea* var. *sphaerothallina* J. Steiner, Ann. Naturhist. Hofmus. 20: 379 (1907). ≡ *Aspicilia sphaerothallina* (J. Steiner) Szatala, Annln K. K. naturh. Hofmus. Wien 50: 527 (1940) [1939]. ≡ *Circinaria sphaerothallina* (J. Steiner) Sohrabi, in Sohrabi *et al.*, Mycol Progr. 12: 266 (2013). – As mentioned by SOHRABI *et al.* (2013a) additional study is required before a lectotype specimen can be designated for this species.

CONCLUSIONS

Ukrainian as well as the whole Eurasian material of *Agrestia hispida* is in urgent need of revision to clarify the distribution of both *A. zerovii* and *A. hispida*. The inclusion of the type specimen of the genus *Agrestia* (i.e. *A. cyphellata*) and of further specimens of *A. zerovii* and *A. hispida* in the phylogenetic analysis is also very desirable.

The revision of the small species groups discussed above (i.e. *Aspicilia epiglypta*, *Chlorangium sphaerothallinum*, “*Circinaria*” *fruticulosa*, etc.) will clarify their relation to the genera *Agrestia*, *Chlorangium*, *Sphaerothallina* within the family Megasporaceae.

* * *

Acknowledgements – We are thankful to Maryna Kryvokhyzhaya (Kharkiv, Ukraine) for providing additional collection of *A. zerovii*, to Dr Anna Guttová (Bratislava, Slovakia) for the possibility to make illustrations of the new species, to Prof. Teuvo Ahti (Helsinki, Finland), Dr László Lőkös (Budapest, Hungary) and Dr Arne Thell (Lund, Sweden), as well as Natalie van de Wiele and Dr Shaun Pennycook (Auckland, New Zealand) for valuable comments to this manuscript.

Összefoglaló: Az *Agrestia zerovii* S. Y. Kondr., A. B. Gromakova et Khodos. új zuzmófaj az ukrán sztyeppzóna meszes talajain elterjedt, vándorló életmódot folytató *Agrestia hispida* fajkomplexből került leírásra. Az *A. hispida*-tól abban különbözik, hogy jóval vastagabb elsődleges telepi karéjokkal rendelkezik, melyek egy vastag vízszintes kérget alkotnak, továbbá a másodlagos ágacskák csúcsa nem fekete. A kombinált filogenetikai analízis (riboszomális DNS ITS, LSU, mitokondriális DNS SSU) a Megasporaceae család azon fajainak bevonásával történt, amelyekhez megbízható szekvenciaadatok álltak rendelkezésre. A kladogramon a *Circinaria* s. str. 5 klasszikus nemzetséget (*Aspicilia*, *Circinaria*, *Lobothallia*, *Megaspora* és *Sagedia*) tömörítő kládtól elkülönülten négy új, markáns klád vált el, az *Agrestia*, a *Chlorangium*, a *Sphaerothallia* s. str. és a “*Circinaria*” *lacunosa* komplex (a gyengén támogatott *Sphaerothallia* s. l. fajcsoport). Taxonómiai diverzitásuk részletes tárgyalása mellett az *Agrestia* J. W. Thomson, a *Chlorangium* Link és a *Sphaerothallia* Nees ex Eversm. nemzetségek újraértelmezése, visszaállítása, valamint több más aspicilioid zuzmófaj taxonómiai státusának rendezése javasolt további revíziós kutatásokat követően. Az analízis eredményeként 5 új kombinációt hajtottunk végre a *Chlorangium* Link nemzetségben (*C. alpicola*, *C. aschabadense*, *C. asperum*, *C. gyrosum*, *C. sphaerothallinum*).

REFERENCES

- ANDREEVA, E. I. (1987): *Flora sporovykh rasteniy Kazakhstana. Vol. 11, Lichenes, 3, Lecanorales, Physciales.* – Nauka, Nauka Kazakhskoy SSR, Alma Ata (Almaty), 296 pp. (in Russian).
- ARUP, U., SØCHTING, U. and FRÖDÉN, P. (2013): A new taxonomy of the family Teloschistaceae. – *Nordic J. Bot.* **31**: 16–83. <http://dx.doi.org/10.1111/j.1756-1051.2013.00062.x>
- BRODO, I. M. (1976): Lichenes canadenses exsiccati, Fasc. II. – *Bryologist* **79**: 385–405. <http://dx.doi.org/10.2307/3241935>
- BÜDEL, B. and WESSELS, D. C. J. (1986): *Parmelia hueana* Gyeln., a vagrant lichen from the Namib Desert, SWA Namibia. I. Anatomical and reproductive adaptations. – *Dinteria* **18**: 3–15.
- DIDUKH, Ya. P. (ed.) (2009): *Red data book of Ukraine. Vegetable kingdom.* – Globalconsalting Press, Kiev, 912 pp.
- DONKIN, R. A. (1980): Manna: an historical geography. – *Biogeographica* **17**: 1–161. <http://dx.doi.org/10.1007/978-94-017-6117-8>
- DONKIN, R. A. (1981): The “manna lichen” *Lecanora esculenta*. – *Anthropos* **76**: 562–576.
- FEDORENKO, N. M., STENROOS, S., THELL, A., KÄRNEFELT, I. and KONDRATYUK, S. Y. (2009): A phylogenetic analysis of xanthoroid lichens (Teloschistaceae, Ascomycota) based on ITS and mtSSU sequences. – *Bibl. Lichenol.* **100**: 49–84.
- GROMAKOVA, A. B. (2013): New and rare species of lichens for the Left Bank part of Ukraine from cretaceous outcrops. – *Ukr. Bot. J.* **70**(5): 664–668. (in Ukrainian).
- HAFELLNER, J., NIMIS, P. L. and TRETJACH, M. (2004): New records of *Aspicilia hispida* from Italy and Greece. – *Herzogia* **17**: 95–102.
- IVANOVA, N. V. and HAFELLNER, J. (2002): Searching for the correct placement of *Megaspora* by use of ITS1, 5.8S and ITS2 rDNA sequence data. – *Bibl. Lichenol.* **82**: 123–140.
- KONDRATYUK, S., JEONG, M.-H., YU, N.-H., KÄRNEFELT, I., THELL, A., ELIX, J. A., KIM, J., KONDRATYUK, A. S. and HUR, J.-S. (2013): Four new genera of teloschistoid lichens (Teloschistaceae, Ascomycota) based on molecular phylogeny. – *Acta Bot. Hung.* **55**(3–4): 251–274. <http://dx.doi.org/10.1556/ABot.55.2013.3–4.8>
- KONDRATYUK, S. Y., JEONG, M.-H., YU, N.-N., KÄRNEFELT, I., THELL, A., ELIX, J. A., KIM, J., KONDRATIUK, A. S. and HUR, J.-S. (2014a): A revised taxonomy for the subfamily Caloplacoideae (Teloschistaceae, Ascomycota) based on molecular phylogeny. – *Acta Bot. Hung.* **56**(1–2): 93–123. <http://dx.doi.org/10.1556/ABot.56.2014.1–2.10>
- KONDRATYUK, S. Y., KÄRNEFELT, I., THELL, A., ELIX, J. A., KIM, J., JEONG, M.-H., YU, N.-H., KONDRATIUK, A. S. and HUR, J.-S. (2014b): A revised taxonomy of the subfamily Xanthorioideae (Teloschistaceae, Ascomycota) based on molecular phylogeny. – *Acta Bot. Hung.* **56**(1–2): 141–178. <http://dx.doi.org/10.1556/ABot.56.2014.1–2.12>
- KONDRATYUK, S. Y., JEONG, M.-H., GALANINA, I. A., YAKOVCHENKO, L. S., YATSYNA, A. P. and HUR, J.-S. (2014c): Molecular phylogeny of placodioid lichen-forming fungi reveal a new genus, *Sedelnikovaea*. – *Mycotaxon* **129**(2): 269–282. <http://dx.doi.org/10.5248/129.269>
- KONDRATYUK, S. Y., KÄRNEFELT, I., THELL, A., ELIX, J. A., KIM, J., KONDRATIUK, A. S. and HUR, J.-S. (2015): *Tassiloa*, a new genus in the Teloschistaceae (lichenized ascomycetes). – *Graphis Scripta* **27**(1–2): 22–26.
- KOU, X.-R., LI, S.-X., REN, Q. (2013): Three new species and one new record of *Lobothallia* from China. – *Mycotaxon* **123**: 241–249. <http://dx.doi.org/10.5248/123.241>
- KULAKOV, V. G. (2002): *Foliose and fruticulose lichens of the Lower Volga Region.* – Regional'nyy centr o izucheniyu i sokhraneniyu bioraznoobraziya, Volgograd, 125 pp. (in Russian)
- KULAKOV, V. G. (2003): Foliose and fruticulose lichens of Baskunchak Lake vicinity. – *Bot. Zhurn.* **88**: 96–104. (in Russian)

- MERESCHKOWSKY, C. (1911): Excursion liche'ologique dans les steppes Kirghises (Mont Bogdo). – *Trudy Obsc. Estestvoisp. Imp. Kazansk. Univ.* **43**: 1–42.
- MIADLIKOWSKA, J., KAUFF, F., HOFSTETTER, V., FRAKER, E., GRUBE, M., HAFELLNER, J., REEB, V., HODKINSON, B. P., KUKWA, M., LÜCKING, R., HESTMARK, G., OTALORA, M. G., RAUHUT, A., BÜDEL, B., SCHEIDEGGER, C., TIMDAL, E., STENROOS, S., BRODO, I., PERLMUTTER, G. B., ERTZ, D., DIEDERICH, P., LENDEMER, J. C., MAY, P., SCHOCH, C. L., ARNOLD, A. E., GUEIDAN, C., TRIPP, E., YAHR, R., ROBERTSON, C. and LUTZONI, F. (2006): New insights into classification and evolution of the Lecanoromycetes (Pezizomycotina, Ascomycota) from phylogenetic analyses of three ribosomal RNA- and two protein-coding genes. – *Mycologia* **98**(6): 1088–1103. <http://dx.doi.org/10.3852/mycologia.98.6.1088>
- NORDIN, A., OWE-LARSSON, B. and TIBELL, L. (2011): Two new *Aspicilia* species from Fennoscandia and Russia. – *Lichenologist* **43**(1): 27–37. <http://dx.doi.org/10.1017/S0024282910000629>
- NORDIN, A., SAVIČ, S. and TIBELL, L. (2010): Phylogeny and taxonomy of *Aspicilia* and *Megasporaceae*. – *Mycologia* **102**: 1339–1349. <http://dx.doi.org/10.3852/09-266>
- NORDIN, A., TIBELL, L. and OWE-LARSSON, B. (2007): A preliminary phylogeny of *Aspicilia* in relation to morphological and secondary product variation. – *Bibl. Lichenol.* **96**: 247–266.
- OWE-LARSSON, B., NORDIN, A. and TIBELL, L. (2007): *Aspicilia*. – In: NASH, T. H., GRIES, C. and BUNGARTZ, F. (eds): Lichen flora of the Greater Sonoran Desert Region. 3. Lichens Unlimited, Arizona State University, Tempe, Arizona, pp. 61–108.
- OWE-LARSSON, B., NORDIN, A., TIBELL, L. and SOHRABI, M. (2011): *Circinaria arida* spec. nova and the *Aspicilia* desertorum complex. – *Bibl. Lichenol.* **106**: 235–246.
- OXNER, A. N. (1971): *Aspicilia Massal.* – In: KOPACZEVSKAJA, E. F., MAKAREVICZ, M. F., OXNER, A. N. and RASSADINA, K. A. (eds): Handbook of the lichens of the USSR. Vol. 1. Nauka, Leningrad, pp. 146–217. (in Russian)
- OXNER, A. M. (2010): *Flora of the Lichens of Ukraine, in two volumes*. Vol. 2(3). – Nauk. dumka, Kyiv, 663 pp.
- POELT, J. (1969): *Bestimmungsschlüssel europäischer Flechten*. – J. Cramer, Lehre, 757 pp.
- ROUX, C., NORDIN, A., TIBELL, L. and SOHRABI, M. (2011): Some poorly known or new *Aspicilia* species from Pyrenees-Orientales (France). – *Bull. Soc. Linn. Provence* **14**: 177–227.
- SCHMITT, I., YAMAMOTO, Y. and LUMBSCH, T. (2006): Phylogeny of Pertusariales (Ascomycotina): Resurrection of Ochrolechiaceae and new circumscription of Megasporaceae. – *J. Hattori Bot. Lab.* **100**: 753–764.
- SCHMULL, M., MIADLIKOWSKA, J., PELZER, M., STOCKER-WÖRGÖTTER, E., HOFSTETTER, V., FRAKER, E., HODKINSON, B. P., REEB, V., KUKWA, M., LUMBSCH, H. T., KAUFF, F. and LUTZONI, F. (2011): Phylogenetic affiliations of members of the heterogeneous lichen-forming fungi of the genus *Lecidea* sensu Zahlbruckner (Lecanoromycetes, Ascomycota). – *Mycologia* **103**(5): 983–1003. <http://dx.doi.org/10.3852/10-234>
- SEAWARD, M. R. D., SIPMAN, H. J. M. and SOHRABI, M. (2008): A revised checklist of lichenized, lichenicolous and allied fungi for Iran. – *Sauteria* **15**: 459–520.
- SOHRABI, M. and AHTI, T. (2010): Nomenclatural synopsis of the Old World's 'manna' lichens of the genus *Aspicilia* (Megasporaceae). – *Taxon* **59**: 628–636. <http://dx.doi.org/10.2307/25677623>
- SOHRABI, M., AHTI, T. and LITTEKSKI, B. (2011a): *Aspicilia digitata* sp. nov., a new vagrant lichen from Kyrgyzstan. – *Lichenologist* **43**: 39–46. <http://dx.doi.org/10.1017/S0024282910000538>
- SOHRABI, M., MYLLYS, M. and STENROOS, S. (2010): Successful DNA sequencing of a 75 year-old herbarium specimen *Aspicilia aschabadensis* (J. Steiner) Mereschk. – *Lichenologist* **42**: 626–628. <http://dx.doi.org/10.1017/S0024282910000344>

- SOHRABI, M., STENROOS, S., HÖGNABBA, F., NORDIN, A. and OWE-LARSSON, B. (2011*b*): *Aspicilia rogeri* sp. nov., (Megasperaceae) and other allied vagrant species in North America. – *Bryologist* **114**: 178–189. <http://dx.doi.org/10.1639/0007-2745-114.1.178>
- SOHRABI, M., LEAVITT, S. D., RICO, V. J., HALICI, M. G., SHRESTHA, G. and STENROOS, S. (2013*b*): *Teuvoa*, a new lichen-forming fungal genus in Megasperaceae (Ascomycota: Pertusariales), including *Teuvoa junipericola* sp. nov. – *Lichenologist* **45**: 347–360. <http://dx.doi.org/10.1017/S0024282913000108>
- SOHRABI, M., STENROOS, S., MYLLYS, L., SØCHTING, U., AHTI, T. and HYVÖNEN, J. (2013*a*): Phylogeny and taxonomy of the ‘manna lichens’. – *Mycol. Progr.* **12**: 231–269. <http://dx.doi.org/10.1007/s11557-012-0830-1>
- SZATALA, Ö. (1957): Prodrömus einer Flechtenflora des Irans. – *Annl. hist.-nat. Mus. natn. Hung., ser. nov.* **8**: 101–154.
- THOMSON, J. W. (1961): *Agrestia cyphellata*, a new genus and species of lichen in the Usneaceae. – *Bryologist* **63**(4): 246–250.
- VALADBEIGI, T., NORDIN, A. and TIBELL, L. (2011): *Megaspora rimisorediata* (Pertusariales, Megasperaceae), a new sorediate species from Iran and its affinities with *Aspicilia* sensu lato. – *Lichenologist* **43**(4): 285–291. <http://dx.doi.org/10.1017/S0024282911000211>
- WEDIN, M., WIKLUND, E., CREWE, A., DORING, H., EKMAN, S., NYBERG, A., SCHMITT, I. and LUMBSCH, H. T. (2005): Phylogenetic relationships of Lecanoromycetes (Ascomycota) as revealed by analyses of mtSSU and nLSU rDNA sequence data. – *Mycol. Res.* **109** (2): 159–172. <http://dx.doi.org/10.1017/S0953756204002102>

(submitted: 04.06.2015, accepted 04.11.2015)