

**NEW MEMBERS OF THE MEGASPORACEAE  
(PERTUSARIALES, LICHEN-FORMING ASCOMYCOTA):  
MEGASPOIRA IRANICA SPEC. NOVA  
AND OXNERIARIA GEN. NOVA**

M. HAJI MONIRI<sup>1</sup>, A. B. GROMAKOVA<sup>2</sup>, L. LÖKÖS<sup>3</sup> and S. Y. KONDRATYUK<sup>\*4, 5</sup>

<sup>1</sup>Department of Biology, Faculty of Sciences, Mashhad Branch, Islamic Azad University  
Rahnamaie str., Postal Code: 917 56 87 119 Mashhad, Iran; E-mail: m.h.moniri@mshdiau.ac.ir

<sup>2</sup>V. N. Karazin Kharkiv National University  
Svobody Sq. 4, 61022 Kharkiv, Ukraine; E-mail: alla.gromakova@karazin.ua

<sup>3</sup>Department of Botany, Hungarian Natural History Museum  
H-1431 Budapest, Pf. 137, Hungary; E-mail: lokos.laszlo@nhmus.hu

<sup>4</sup>M. H. Kholodny Institute of Botany, Tereshchenkivska str. 2, 01004 Kyiv-1, Ukraine  
\*E-mail: ksya\_net@ukr.net

<sup>5</sup>Korean Lichen Research Institute, Suncheon National University  
Suncheon 540-742, Republic of Korea

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The new species *Megaspora iranica* M. Haji Moniri et S. Y. Kondr. is described from NE Iran, illustrated and compared with closely related taxa. It is similar to the recently described *M. rimisorediata*, which is known from Eurasia (from SE Europe and Middle Asia (Armenia) to Central Asia, i.e. Iran and China), but differing in having larger thallus, smaller soredia, thicker cortical layer of thallus, thicker hymenium, narrower ascospores and thinner ascospore wall. *Megaspora rimisorediata* is for the first time recorded from Europe (eastern Ukraine, Kharkiv oblast). Additional data to its diagnosis is given based on extensive collections from Eurasia. The new genus *Oxneriaria* S. Y. Kondr. et L. Lökös (for the former *Aspicilia mashiginensis* group) found to be a member of the *Sagedia* clade and positioning in distant position from the *Aspicilia* / *Circinaria* clade after three gene phylogeny based on nrITS, 28S nrLSU and 12S mtSSU sequences. The members of the genus *Oxneriaria* mainly distributed in cold polar and high altitude localities of Eurasia and the northern hemisphere. Nine new combinations, i.e.: *Oxneriaria dendroplaca* (basionym: *Lecanora dendroplaca* H. Magn.), *Oxneriaria haeyrenii* (basionym: *Lecanora haeyrenii* H. Magn.), *Oxneriaria mashiginensis* (basionym: *Lecanora mashiginensis* Zahlbr.), *Oxneriaria nikrapensis* (basionym: *Aspicilia nikrapensis* Darb.), *Oxneriaria permutata* (basionym: *Lecanora permutata* Zahlbr.), *Oxneriaria rivulicola* (basionym: *Lecanora rivulicola* H. Magn.), *Oxneriaria supertegens* (basionym: *Aspicilia supertegens* Arnold), *Oxneriaria verruculosa* (basionym: *Aspicilia verruculosa* Kremp.), and *Oxneriaria virginea* (basionym: *Aspicilia virginea* Hue) are proposed.

Key words: *Aspicilia*, Iran, Kharkiv oblast, Megasporaceae, new species, *Oxneriaria*, Razavi Khorasan Province, three gene phylogeny, Ukraine

## INTRODUCTION

According to the current Outline of Ascomycota (Lumbsch and Huhndorf 2010) the Megasporaceae Lumbsch, Feige et K. Schmitz includes three genera, i.e.: *Aspicilia* A. Massal., *Lobothallia* (Clauzade et Cl. Roux) Hafellner and *Megaspora* (Clauzade et Cl. Roux) Hafellner et V. Wirth. Since 2013 one new genus *Teuvoa* Sohrabi et S. D. Leav. has been described (Sohrabi *et al.* 2013a), and four more genera (*Agrestia* J. W. Thomson, *Chlorangium* Link, *Circinaria* Link, and *Sphaerothallia* Nees ex Eversm.) were resurrected (Sohrabi *et al.* 2013b, Kondratyuk *et al.* 2015).

The genus *Megaspora* (Clauzade et Cl. Roux) Hafellner et V. Wirth, the type genus of the Megasporaceae Lumbsch, Feige et K. Schmitz, seems to be one the best studied genera of this family from molecular point of view in contrast to other genera of the Megasporaceae, i.e. *Aspicilia* and *Circinaria*, where only small part of species diversity of the genera mentioned, are studied from molecular point of view or genera *Agrestia*, *Chlorangium*, and *Teuvoa* Sohrabi et S. D. Leav. (Kondratyuk *et al.* 2015), for which only the first data are hitherto available.

The recently described *Megaspora rimisorediata* Valadbeigi et A. Nordin, characterised by a pale ochraceous to bluish grey, cracked and sorediate, very rarely fertile thallus, is found to be rather commonly distributed in Iran (Valadbeigi *et al.* 2011). This species was also recently recorded from Armenia and China based on several collections (Gasparyan and Sipman 2013, Kondratyuk *et al.* 2016a) and here for the first time recorded from Europe.

During the taxonomic revision of sorediate *Megaspora* specimens from Asia and Europe a new taxon, described below as *Megaspora iranica*, was found.

One of the aims of this paper is to describe the new species, as well as to provide new European localities and new data on *Megaspora rimisorediata* based on extensive collections from Eurasia.

During combined phylogenetic analysis based on nrITS, 28S nrLSU and 12S mtSSU sequences the former *Aspicilia mashiginensis* group, mainly distributed in cold polar and high altitude localities of Eurasia and the northern hemisphere, found to be positioned in the *Sagedia* clade and in distant position from the *Aspicilia* / *Circinaria* clade. In all phylogenetic trees of the Megasporaceae the *Aspicilia mashiginensis* group was in somewhat distant position from *Aspicilia* s. str., i.e. *Aspicilia cinerea* branch (Nordin *et al.* 2007, 2010, Kondratyuk *et al.* 2016b). The new set of molecular data accumulated during last decade confirms that the former *Aspicilia mashiginensis* group (or the clade II sensu Nordin with colleagues (Nordin *et al.* 2007); or the *Aspicilia dendroplaca* – *A. supertegens* group sensu Nordin with colleagues (Nordin *et al.*

2010) (see also Sohrabi *et al.* 2013b, Kondratyuk *et al.* 2016b, and this paper)) is positioned in the same robust monophyletic branch as the genera *Aspicilia* s. str. and *Sagedia*.

The new genus *Oxneriaria* for the former *Aspicilia mashiginensis* group is proposed in this paper, too.

## MATERIAL AND METHODS

Our study and revisions are based on numerous specimens from the private herbarium of Haji Moniri (Iran), on collections deposited in BP, CWU, KW-L, KoLRI and TARI, as well as on some specimens from another herbaria included in a comparative study (see also Kondratyuk *et al.* 2016b).

Procedures of extracting, sequencing, and phylogenetic analysis are described in our previous papers (Kondratyuk *et al.* 2013, 2014a, b, c, 2015, 2016b). Specimens included in the phylogenetic analysis based on ITS nrDNA sequences as well as in the combined phylogenetic analysis based on ITS nrDNA, nrLSU and mtSSU sequences are listed with GenBank accession numbers in the Appendix.

## RESULTS

### *Megaspora iranica* M. Haji Moniri et S. Y. Kondr., *spec. nova* (Figs 1–2)

Mycobank nr.: MB 822415.

*It is similar to M. rimisorediata, but differs in having larger thallus, smaller soredia, thicker cortical layer of thallus, thicker hymenium, narrower ascospores and thinner ascospore walls.*

Type: Iran: Razavi Khorasan Province, 15 km route of Dargaz to Quchan, Nokhandan, Tagan village, on bark of *Morus alba* L. Lat.: 37° 31' N; Long.: 59° 10' E; Alt.: 900 m a.s.l. Coll.: Haji Moniri, M. [sine num.], 13.12.2013 (holotype: TARI; isotypes: KW-L, voucher for DNA SK D67, and BP, voucher for DNA SK D69).

Thallus to 5–10 cm across, or may form larger aggregations, crustose, whitish grey to light grey, with distinctly cracked upper surface, where cracks similarly to *Megaspora rimisorediata* often forming a dense net over the thallus, and usually darker, well contrasting with soredia. Thalline areoles to 10–25 mm long and 0.3–0.8 mm wide, often elongated portion perpendicularly elongated to twigs; cracks 0.2–0.4(–0.5) mm wide. Thallus in section to 0.2–0.3 mm thick; cortical layer of thallus very varying in thickness, from 10–25 µm thick,

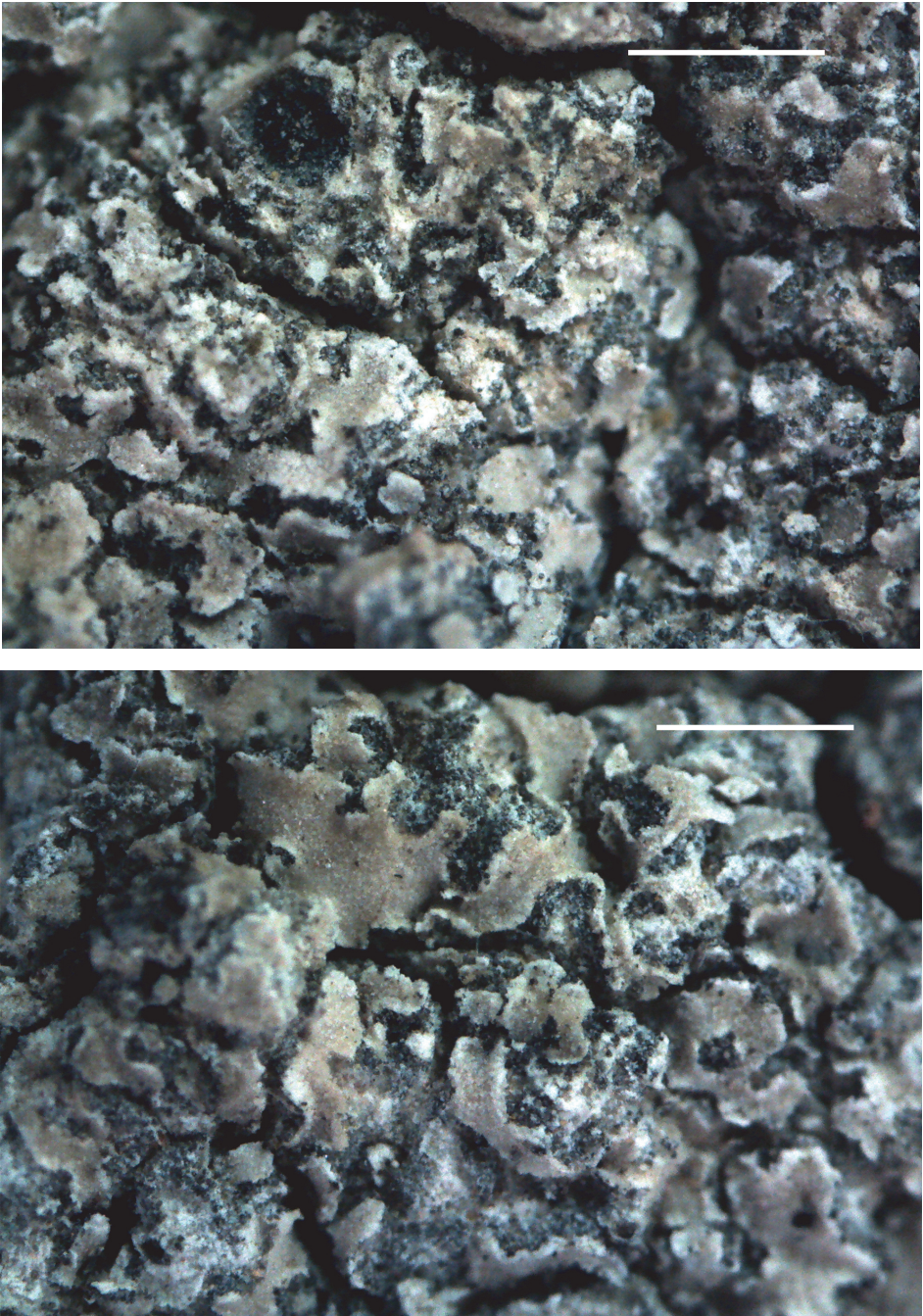


Fig. 1. *Megaspora iranica* (KW-L, isotype), general habit. Scale 1 mm (photo: S. Kondratyuk)

with epinecral layer to 10  $\mu\text{m}$  thick to (37.5–)50–75(–100)[–175]  $\mu\text{m}$  thick, with upper portion to 25–30(–75)  $\mu\text{m}$  thick with numerous amount of crystals, palisade paraplectenchymatous, cell lumina rounded, 10–15  $\mu\text{m}$  diam./across (almost as *Massjukiella* type of cortical layer in the member of the Teloschistaceae, see Fedorenko *et al.* 2012); algal layer 50–100  $\mu\text{m}$  thick, more or less continuous, algal cells 20–25  $\mu\text{m}$  diam., medulla 100–200  $\mu\text{m}$  thick, more or less greyish owing to crystals; cracks/soralia to 0.2–0.4(–0.5) mm wide. Soredia (30–)37.5–50  $\mu\text{m}$  diam., with somewhat greyish outer layer owing to the numerous crystals.

Apothecia 0.8–1.3 mm diam., 0.35–0.4 mm thick in section, zeorine; true exciple (70–)90–110(–120)  $\mu\text{m}$  thick in the uppermost lateral portion, with 20–30  $\mu\text{m}$  thick uppermost blackish-greenish layer, uneven surface and groups/aggregations of dust particles (crystals), with 20–25  $\mu\text{m}$  thick necrotic layer; to 30–45(–70)  $\mu\text{m}$  thick in lower lateral portions, hyaline, both of “textura intricata”, and to 20–35  $\mu\text{m}$  thick in basal portion, paraplectenchymatous with cell lumina to 4  $\mu\text{m}$  diam./across; hymenium to 250  $\mu\text{m}$  high, with oil droplets to 7–10  $\mu\text{m}$  diam./across or with irregular oil aggregations; epihymenium to 60–70  $\mu\text{m}$  thick dull greenish brown, epipsamma to 15–20  $\mu\text{m}$  thick; paraphy-

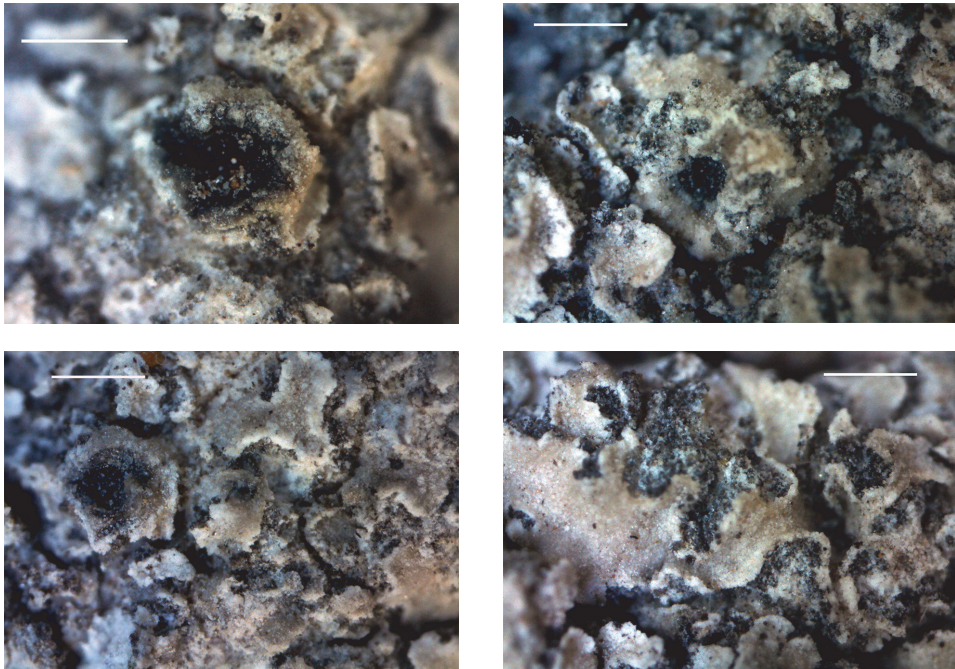


Fig. 2. *Megaspora iranica* (KW-L, isotype), enlarged portions with apothecia and with soralia. Scale 0.5 mm (photo: S. Kondratyuk)

ses to 2.5–3(–5)  $\mu\text{m}$  diam.; subhymenium to 70–100  $\mu\text{m}$  thick; asci 4–8-spored, *ca* 190  $\times$  40  $\mu\text{m}$ ; ascospores ovoid to widely ellipsoid, with oil droplets of 16  $\mu\text{m}$  diam., (25–)32–37(–40)  $\times$  (16–)17–21(–23)  $\mu\text{m}$ , at overmature becoming compressed or distorted and slightly greenish or greyish, ascospore wall to 1–1.5  $\mu\text{m}$  thick.

Chemistry: Section of apothecium K+ brown, intensifying green or olive, N+ greenish (brownish olive portions becoming intense green).

Ecology: On bark of deciduous trees (*Morus alba* and *Acer monspessulanum*).

Distribution: So far known from scattered localities in NE Iran, central Asia.

Etymology: Species epithet refers to the country of type locality, i.e.: Iran, Central Asia.

Taxonomic notes: *Megaspora iranica* is similar to *M. rimisorediata*, known from scattered localities in Eurasia (Armenia, China, Iran and Ukraine), but differs in having larger thallus (5–10 cm vs. to 4 cm across), in having smaller soredia ((30–)37.5–50  $\mu\text{m}$  diam. vs. 50–70  $\mu\text{m}$  diam./across), in having thicker cortical layer of thallus (50–75(–100)  $\mu\text{m}$  vs. 30  $\mu\text{m}$  thick), in having larger cells in cortical layer (cell lumina to 10–15  $\mu\text{m}$  vs. *ca* 5–9  $\mu\text{m}$  diam./across), in having thicker hymenium (to 250  $\mu\text{m}$  vs. to 150  $\mu\text{m}$  high), and in having distinctly narrower ascospores (32–37  $\times$  (16–)17–21(–23) vs. 35.3–38.8–42.2  $\times$  (21.5–)22.9–24.9–26.9(–28.3)  $\mu\text{m}$  after Valadbeigi *et al.* (2011), and (30–)35–48(–53)[–70]  $\times$  (16–)21–32(–35)  $\mu\text{m}$  from our data see below), as well as in having narrower ascospore walls.

Note: Our measurements of fertile specimens from China, Iran (see Kondratyuk *et al.* 2016a) and Ukraine show that other characters (thallus, cortical layer, hymenium, etc.) of *Megaspora rimisorediata* have wider range of variation than it was mentioned in original description (Valadbeigi *et al.* 2011) (see also below), but width of ascospores and thickness of ascospore wall are more or less stable characters.

*Megaspora iranica* is also similar to *M. cretacea* Gasparayan, Zakeri *et al.* Aptroot recently described from bark of *Juniperus* from Armenia (Zakeri *et al.* 2016), but differs in having larger not lobate thallus (5–10 cm vs. to 5 cm across), in having smaller soredia ((30–)37.5–50  $\mu\text{m}$  diam. vs. *ca* 0.1 mm diam.), in having thicker hymenium (to 250  $\mu\text{m}$  vs. *ca* 150  $\mu\text{m}$  high), in having 4–8-spored asci (vs. only 4-spored), and in having longer ascospores (32–37  $\times$  (16–)17–21(–23) vs. 27–31  $\times$  18–21  $\mu\text{m}$ ), as well as in different substrate (bark of deciduous trees vs. bark of *Juniperus*).

Voucher specimens SK D67 and SK D69 were included into molecular phylogenetic study, and according to their ITS sequences these specimens belong to the *Megaspora* branch of the phylogenetic tree of the Megasporaceae, where *M. iranica* together with *M. cretacea* form sister, but separate from both *M. rimisorediata* and *M. verrucosa* subbranch (Fig. 3).

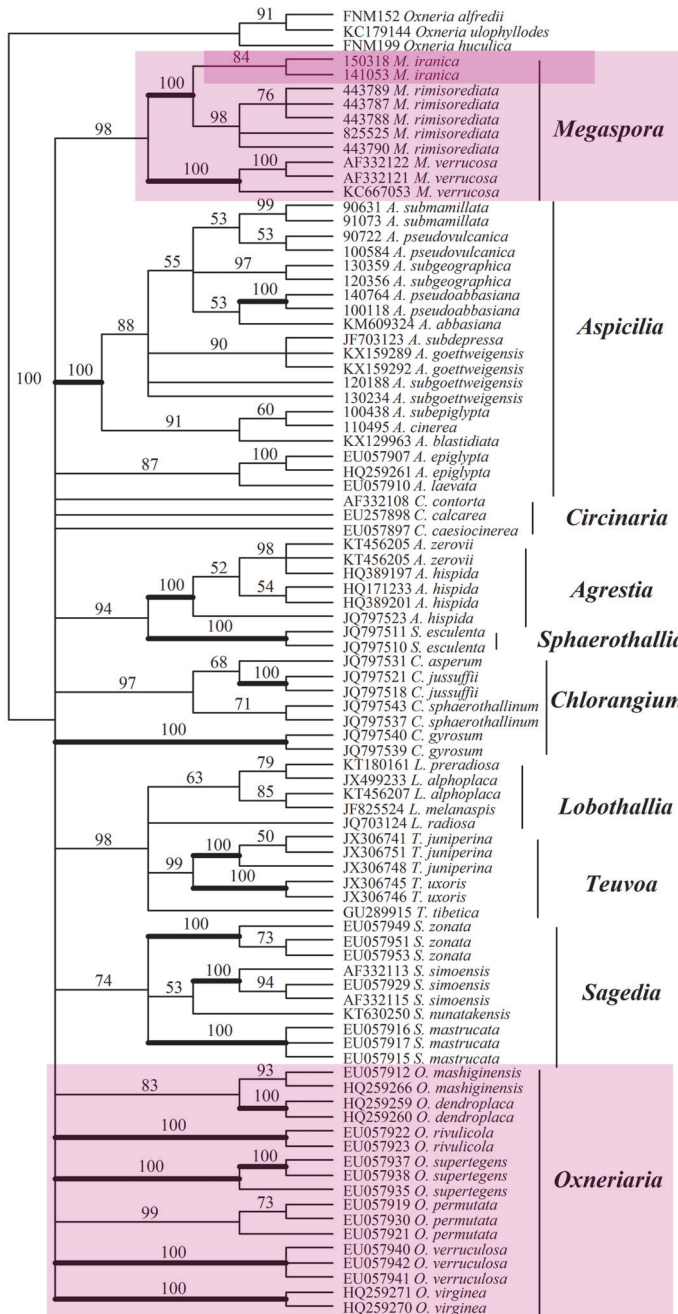


Fig. 3. Phylogenetic tree of the members of the Megasperaceae based on ITS nrDNA sequences

Other specimens examined: Iran: Razavi Khorasan Province, 34 km SW of Dargaz, Cherlagh Valley, on bark of *Acer monspessulanum* L. Lat.: 37° 28' N; Long.: 58° 50' E; Alt.: 1,070 m a.s.l. Coll.: Haji Moniri, M. and Alizadeh, Z. [sine num.], 28.08.2013 (herb. Haji Moniri); Razavi Khorasan Province, 25 km SW of Mashhad, Jaghargh, on bark of *Morus alba* L. (coordinates not mentioned). Alt.: 1,200 m a.s.l. Coll.: Haji Morini, M. (2465), 15.09.2010 (herb. Haji Moniri).

***Megaspora rimisorediata*** Valadbeigi et A. Nordin  
(Figs 4–6)

As far from our study data on some characters of *Megaspora rimisorediata* are rather wider than those of original description of Valadbeigi *et al.* (2011), we provide description of this taxon based on our revision of Iranian, Chinese and Ukrainian specimens.

Thallus to 3–5 cm across (but sometimes thalli to 10–12 cm across were observed). Thalline areoles to 10–25 mm long and 0.3–0.8 mm wide, often elongated portion perpendicularly elongated to twigs; cracks 0.2–0.4(–0.5) mm wide. Thallus in section to 0.35–0.5(–0.8) mm thick or sometimes more; cortical layer to 50–100  $\mu\text{m}$  thick, developed in places, cell lumina to 12.5–15(–20)  $\mu\text{m}$  long/across, leptodermatous paraplectenchymatous, and additionally with 50  $\mu\text{m}$  thick layer of crystals. Soralia somewhat elongated to 40–50  $\mu\text{m}$  wide and 60–80  $\mu\text{m}$  long or (40–)50–80  $\mu\text{m}$  across. Soredia (30–)37–50(–60)  $\mu\text{m}$  diam. if regularly rounded, or somewhat elongate, consoredia/conblastidia type, to 50–75(–87)  $\mu\text{m}$  long or 60–75  $\times$  45  $\mu\text{m}$ , i.e.: consisting of 2 or more soredia/blastidia; sometimes very rare to almost absent or almost indistinct because of greyish-brownish to whitish- or transparent greyish colour, concolorous (in Iranian specimens, while Ukrainian material was with darker soredia).

Apothecia to 0.8–1 mm diam. and to 0.45–0.5 mm in section, somewhat seem to be smaller because being immersed into thallus (disc below of level of thallus); lecanorine with highly uplifted to 0.3 mm wide thalline margin, often cracked and soredious; disc to 0.3 mm diam., deeply concave; in section lecanorine or zeorine, thalline exciple to 100  $\mu\text{m}$  thick, cortical layer to (20–)30–40  $\mu\text{m}$  thick, outer layer brownish or completely covered by crystals, paraplectenchymatous, cell lumina to 7–10  $\mu\text{m}$  across; algal cells to 12–18  $\mu\text{m}$  diam.; true exciple to 50–80(–90)  $\mu\text{m}$  thick in the uppermost lateral portion with brownish-greenish outermost layer, to 50  $\mu\text{m}$  thick in the lower lateral portion and to 15–20  $\mu\text{m}$  thick in basal portion; hymenium to 180–230(–250)  $\mu\text{m}$  high with oil droplets to 8–9  $\mu\text{m}$  diam.; uppermost cells of paraphyses to 7  $\mu\text{m}$  diam., with brown greenish or greenish-greyish to greenish-blackish uppermost portion; subhymenium to 50–60  $\mu\text{m}$  thick, with oil droplets to 5–6



(–7)  $\mu\text{m}$  diam.; asci 6(?)–8-spored, (140–)160–170  $\times$  32–45  $\mu\text{m}$ , with very thick wall to 10  $\mu\text{m}$  thick; ascospores regularly ovoid (one end slightly narrower) to widely ovoid or ellipsoid, (29–)35–48(–53)[–70]  $\times$  (16–)21–32(–35)  $\mu\text{m}$  (more of 70 measurements), ascospore wall to (1–)2–3  $\mu\text{m}$  thick.

Note: Our data differs from original description in having much wide variation of thalline cracks, height of hymenium, length of ascospores, and colour of soredia.

Ecology: In Ukrainian localities listed below *Megaspora rimisorediata* was found on bark of *Artemisia salsoloides* Willd., where it was often associated with *M. verrucosa* (Ach.) Hafellner et V. Wirth, a species, which also was recorded from soil and plant debris. Among terricolous lichens *Enchylium tenax* (Sw.) Gray, furthermore *Megaspora verrucosa* (Ach.) Hafellner et V. Wirth, *Scytinium schraderi* (Ach.) Otálora, P. M. Jørg. et Wedin, *Endocarpon pusillum* Hedw., *Catapyrenium squamulosum* (Ach.) Breuss and *Involucropyrenium* sp. were also recorded in localities mentioned.

In the first Ukrainian locality cited below (with alt.: 126 m a.s.l., Fig. 7) *Megaspora rimisorediata* was collected on rather steep slope (to 60°) of the chalk outcrops. Soil is represented by fine crushed stone with thick chalk crust. Total plant cover is about 20%, with *Artemisia salsoloides* and *Hyssopus cretaceus* Dubjan., as dominant taxa, as well as associated plants *Androsace kosopoljanskii* Ovcz., *Asperula cynanchica* L., *Cephalaria uralensis* (Murray) Roem. et Schult.,

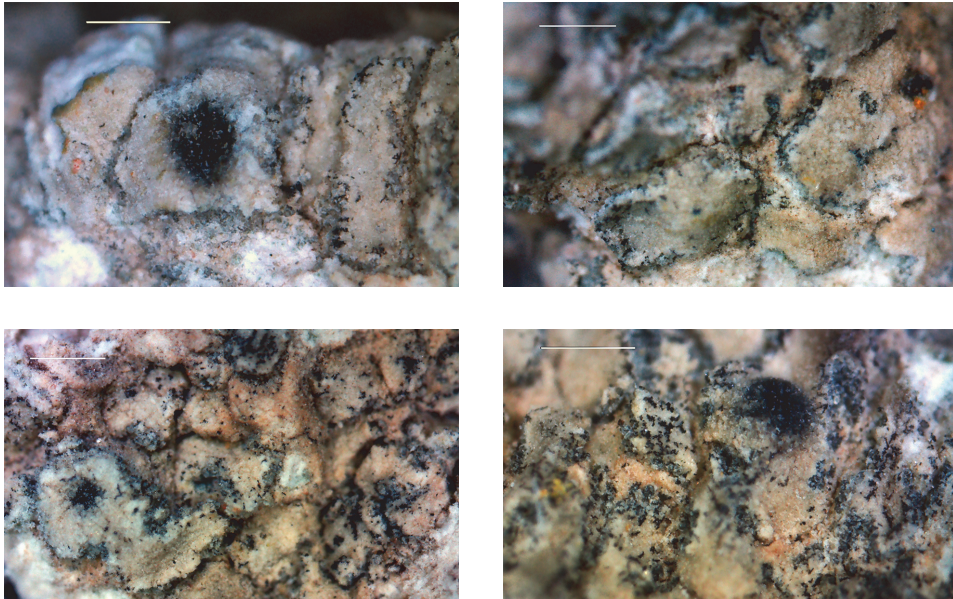


Fig. 4. *Megaspora rimisorediata* (Iran, Haji Moniri M. and Alizadeh Z., KW-L), enlarged portions with apothecia and soralia. Scale 0.5 mm (photo: S. Kondratyuk)

*Gypsophila oligosperma* A. Krasnova, *Pimpinella titanophila* Woronow, *Schive-reckia mutabilis* (M. Alexeenko) M. Alexeenko, *Scutellaria cretica* Juz., *Scrophularia cretacea* Fisch. ex Spreng., *Silene supina* M. Bieb., *S. cretacea* Fisch. ex Spreng., and *Thymus calcareus* Klokov et Des.-Shost.

In the second Ukrainian locality cited below (with alt.: 100 m a.s.l., Fig. 8) *Megaspora rimisorediata* was collected on gentle slope (about 30°) of the chalk outcrops, where total plant cover was also about 15–20%, with *Artemisia salsoloides* and *Thymus calcareus*, as dominant taxa. Rarely, as associated taxa the following plants were recorded: *Asperula cynanchica*, *Bupleurum falcatum* L., *Hyssopus cretaceus*, *Linaria cretacea* Fisch. ex Spreng., *Linum hirsutum* L., *Odontites luteus* (L.) Clairv., *Pimpinella titanophila*, *Scrophularia cretacea*, *Teucrium polium* L., *Vincetoxicum hirundinaria* Medik.

Distribution: So far this species is known from scattered localities in Eurasia, from SE Europe (Ukraine) to Asia (Armenia, China, Iran). Some more similar specimens from Kazakhstan (Khodosovtsev, pers. comm.) are still waiting for taxonomic revision).



Fig. 5. *Megaspora rimisorediata* on bark of *Artemisia salsoloides* Willd. in field conditions (photo: A. Gromakova)

Taxonomic notes: In comparison with original description thallus of *Megaspora rimisorediata* after our observation can be to 10–12 cm across (vs. up to 4 cm diam.), cortical layer of thallus may vary to 50–100  $\mu\text{m}$  thick (vs. ca 30  $\mu\text{m}$  thick), with cell lumina to 12.5–15(–20)  $\mu\text{m}$  long / across (vs. cells ca 5–9  $\mu\text{m}$  diam.), soredia can be from rounded to 37–50(–60)  $\mu\text{m}$  diam., and elongate (of consoredia type) to 50–75(–85)  $\mu\text{m}$  long or 60–75  $\times$  45  $\mu\text{m}$  (vs. soredia 50–70  $\mu\text{m}$  diam.), and soredia varying from greyish-brownish to whitish- or transparent greyish colour (vs. soredia blue-green). According to our data hymenium is also higher (180–230(–250)  $\mu\text{m}$  vs. to 150  $\mu\text{m}$  high), and range of ascospore measurements is wider, too ((29–)35–48(–53)  $\times$  (16–)21–32(–35)  $\mu\text{m}$  (n = 70) vs. (33–)35–42(–45)  $\times$  (21.5–)23–27(–28.3)  $\mu\text{m}$  (n = 20)).

Thus *Megaspora rimisorediata* is characterised by much wider range of variation of measurements of thallus, anatomical elements of thallus, colour of soredia and may still include several taxa. The further revision of this complex based on extensive collections from other Eurasian regions including molecular phylogeny data is very desirable.

Within our study it is for the first time shown that the *Megaspora verrucosa* complex includes two or three separate (may be cryptic) species distinctly differing in their ITS sequences.

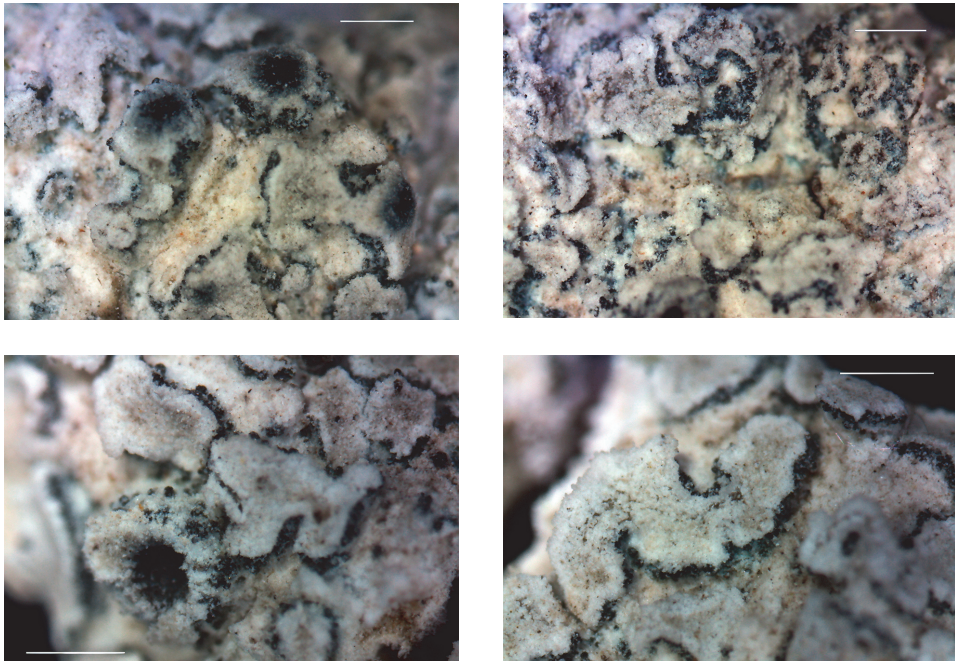


Fig. 6. *Megaspora rimisorediata* (Ukraine, Gromakova, A. B., 28.05.2012, KW-L), enlarged portions with apothecia and soralia. Scale 0.5 mm (photo: S. Kondratyuk)



Fig. 7. General view of the first Ukrainian locality of *Megaspora rimisorediata* in steppes with chalk outcrops (with alt.: 126 m a.s.l.) (photo: A. Gromakova)



Fig. 8. General view of the second Ukrainian locality of *Megaspora rimisorediata* in steppes with chalk outcrops (with alt.: 100 m a.s.l.) (photo: A. Gromakova)

Special revision of molecular data on the genus *Megaspora* (Megasporeaceae) shows that data submitted by Zhao (unpublished, in 2017) as '*Megaspora* sp.' [GenBank numbers KU535654-KU535656] belong to still unidentified *Aspicilia* (or *Circinaria*) species.

Other specimens of *Megaspora rimisorediata* examined: Iran: Razavi Khorasan Province, 15 km route of Dargaz to Quchan, Nokhandan, on bark of *Morus nigra* L. Lat.: 37° 30' N; Long.: 58° 59' E; Alt.: 610 m a.s.l. Coll.: Haji Moniri, M. and Alizadeh, Z. [sine num.], 28.08.2013 (herb. Haji Moniri, KW-L). – Ukraine: Kharkiv oblast, Dvorichansky district, in the vicinity of Dvorichna settlement, Kreidyany protected territory (= zakaznyk), on bark of *Artemisia salsoloides* Willd., growing on chalk outcrops. Lat.: 49° 49' 39.5" N; Long.: 37° 40' 33.8" E; Alt.: ca 126 m a.s.l. Coll.: Gromakova, A. B. [sine num.], 28.05.2012 (CWU, KW-L, see Fig. 7); the same locality, on bark of *A. salsoloides*. Lat.: 49° 49' 19.9" N; Long.: 37° 40' 31.7" E; Alt.: ca 100 m a.s.l. Coll.: Gromakova, A. B. [sine num.], 18.09.2016 (CWU, see Fig. 8).

*Oxneriaria* S. Y. Kondr. et L. Lőkös, *gen. nova*

Mycobank nr.: MB 822416.

*Similar to the genus Aspicilia, but differs in having mostly radiating thallus with wrinkled or lobate peripheral zone, in having mainly smaller ascospores, in having substictic acid, and in having mainly polar and highly alpine distribution as well as in positioning in separate branch of the phylogenetic tree of the Megasporeaceae.*

Type species: *Oxneriaria mashiginensis* (Zahlbr.) S. Y. Kondr. et L. Lőkös.

Thallus crustose, from evenly areolate throughout to mostly more or less radiating wrinkled especially in peripheral zone or radiating lobate, sometimes distinctly zoned; areoles sometimes aggregated in branch-like or tree-like formations especially in peripheral part, with soredia or isidia or without. Hypothallus dark to black, rarely white or absent. Cortical layer and algal zone more or less well developed, attached to the substrate by hyphae of medulla.

Apothecia aspicilioid or lecanorine, immersed at first, later sometimes sessile, usually numerous especially in the centre of thallus; disc mostly concave or plane, sometimes with pruina; true exciple mostly weakly developed; paraphyses simple or scarcely branched, more or less constricted at septa; asci 8-spored, rarely (1–)2–6-spored; ascospores simple, hyaline, mostly ellipsoid to almost spherical.

Conidia bacilliform to filliform, straight or slightly curved.

Chemistry: substictic acid present.

Ecology: It grows on siliceous rocks, limestone, schistose limestone and serpentine, often growing side by side with other taxa of the same genus.

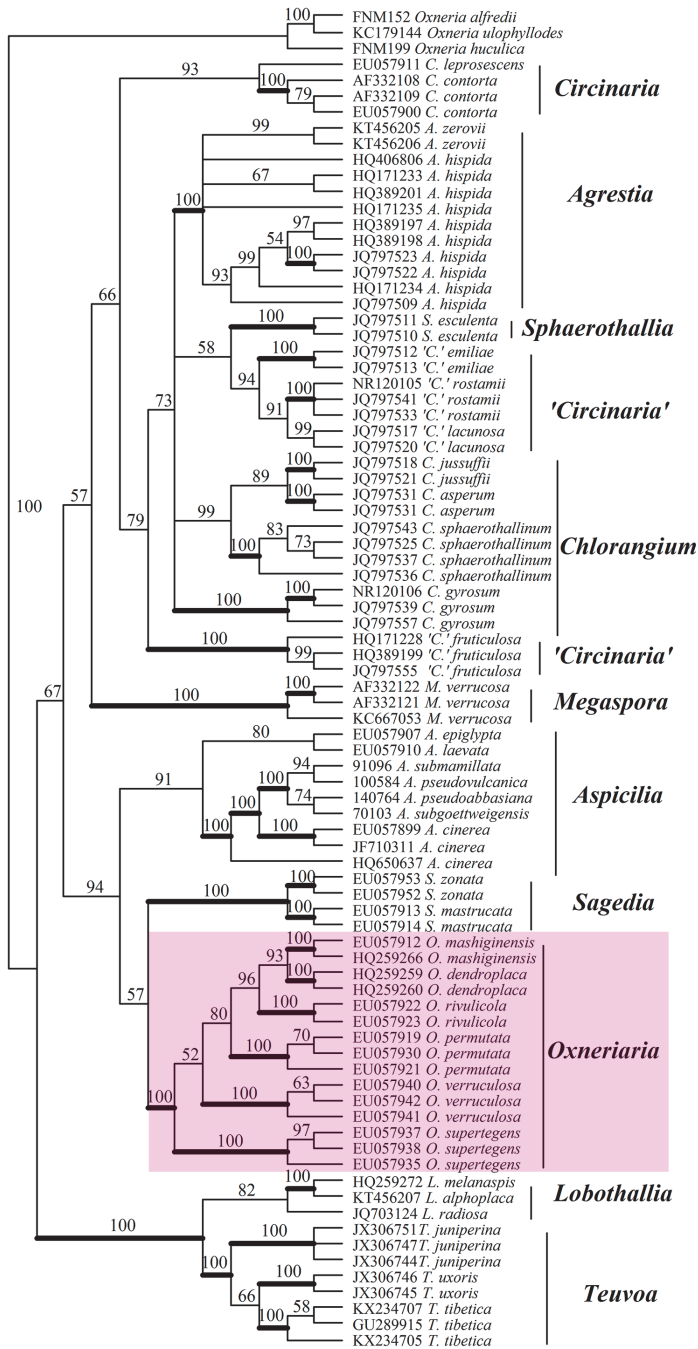


Fig. 9. Combined phylogenetic tree of the members of the Megasperaceae based on ITS and 28S nrLSU, and 12S mtSSU sequences

**Etymology:** It is named after the well-known Ukrainian lichenologist Alfred Oxner (1898–1973) (Kiev, Ukraine) who provided important contribution to taxonomy of aspicilioid lichens and to biodiversity of polar lichens, i.e.: he prepared the first key to Eurasian species of the genus *Aspicilia* as well as for the first time provided geographic analysis of the Eurasian Arctic lichen flora based on the zonal approach, where this group of aspicilioid lichens was especially well represented. A. Oxner also prepared the first Handbook of lichens of the former Soviet Arctics (which unfortunately has been never published but this manuscript was used by several generations of Soviet lichenologists in the 20th century), as well as he has for the first time included type species of this group, i.e. *Oxneriaria mashiginensis* to the genus *Aspicilia* in his time (Oxner 1971).

**Distribution and species diversity:** from rare to rather widely distributed taxa in cold polar and high altitude localities of Eurasia and the northern hemisphere. So far only nine species are confirmed by molecular data, while a number of taxa are still waiting on the further revision.

**Taxonomic notes:** After three gene phylogeny based on nrITS, 28S nrLSU and 12S mtSSU sequences the genus *Oxneriaria* for the former *Aspicilia mashiginensis* group found to be positioned in separate robust monophyletic branch in sister position to the *Sagedia* branch and positioning in distant position from the *Aspicilia* / *Circinaria* clade. Our results confirm data of previous authors that the genus *Oxneriaria* is positioned after nrITS analysis together with the genera *Aspicilia* s. str. and *Sagedia* in separate clade (in the clade II sensu Nordin with colleagues (Nordin *et al.* 2007), or the *Aspicilia dendroplaca* – *A. supertegens* group sensu Nordin with colleagues (Nordin *et al.* 2010) (see also Kondratyuk *et al.* 2016b, and Fig. 3 of this paper)). However, after combined phylogenetic data based on nrITS, 28S nrLSU and 12S mtSSU sequences the genus *Oxneriaria* is positioned in the same robust monophyletic branch as *Aspicilia* s. str. and *Sagedia* (Fig. 9).

Status of the former *Aspicilia mashiginensis* group as separate robust monophyletic branch found to be supported by combined phylogenetic analysis based on three gene phylogeny (i.e.: nrITS, 28S nrLSU and 12S mtSSU sequences), while after separate analysis position of this group much depends of number of taxa included into analysis. Thus from ITS data set the genus *Oxneriaria* is still not well supported as separate branch in case of specimens included in our analysis (it still in the *Aspicilia* clade, see Fig. 3), while after three gene phylogeny the genus *Oxneriaria* has support as separate robust monophyletic branch (Fig. 9).

The members of the genus *Oxneriaria* mainly distributed in cold polar and high altitude localities of Eurasia and the northern hemisphere.

## New combinations

***Oxneriaria dendroplaca*** (H. Magn.) S. Y. Kondr. et L. Lőkös, *comb. nova.*  
– MycoBank nr.: MB 822417. – Bas.: *Lecanora dendroplaca* H. Magn., K. svenska Vetensk.-Akad. Handl., ser. 3, 17 (no. 5): 156 (1939). ≡ *Aspicilia dendroplaca* (H. Magn.) Oxner, in Kopachevskaya *et al.*, *Opredelitel' Lisainikov SSSR Vypusk* (Handbook of the lichens of the U.S.S.R.) (Leningrad) 1: 207 (1971). Nom. inval., Art. 41.5 (Melbourne).

***Oxneriaria haeyrenii*** (H. Magn.) S. Y. Kondr. et L. Lőkös, *comb. nova.*  
– MycoBank nr.: MB 822418. – Bas.: *Lecanora haeyrenii* H. Magn., K. svenska Vetensk.-Akad. Handl., ser. 3, 17 (no. 5): 43 (1939). ≡ *Aspicilia haeyrenii* (H. Magn.) Creveld, *Bibl. Lichenol.* 17: 270 (1981).

***Oxneriaria mashiginensis*** (Zahlbr.) S. Y. Kondr. et L. Lőkös, *comb. nova.*  
– MycoBank nr.: MB 822419. – Bas.: *Lecanora mashiginensis* Zahlbr., *Rep. Sci. Res. Norw. Exped. Novaya Zemlya, 1921*: 20 (1928). ≡ *Aspicilia mashiginensis* (Zahlbr.) Oxner, *Nov. sist. Niz. Rast.* 9: 289 (1972).

***Oxneriaria nikrapensis*** (Darb.) S. Y. Kondr. et L. Lőkös, *comb. nova.* – MycoBank nr.: MB 822420. – Bas.: *Aspicilia nikrapensis* Darb., *Rep. 2nd Norw. Arctic Exped. Fram., 1898–1902*, 21: 12 (1909).

***Oxneriaria permutata*** (Zahlbr.) S. Y. Kondr. et L. Lőkös, *comb. nova.* – MycoBank nr.: MB 822421. – Bas.: *Lecanora permutata* Zahlbr., *Cat. Lich. Univers. 5*: 338 (1928). ≡ *Aspicilia permutata* (Zahlbr.) Clauzade et Rondon, *Revta Fac. Cien. Univ. Lisboa, Ser. 2, C 14*: 17 (1966).

***Oxneriaria rivulicola*** (H. Magn.) S. Y. Kondr. et L. Lőkös, *comb. nova.* – MycoBank nr.: MB 822422. – Bas.: *Lecanora rivulicola* H. Magn., *Bot. Notiser*: 401 (1928). ≡ *Aspicilia rivulicola* (H. Magn.) Räsänen, *Ann. Acad. Sci. fenn., Ser. A 34* (no. 4): 73 (1931).

***Oxneriaria supertegens*** (Arnold) S. Y. Kondr. et L. Lőkös, *comb. nova.* – MycoBank nr.: MB 822423. – Bas.: *Aspicilia supertegens* Arnold, *Verh. zool.-bot. Ges. Wien* 27: 567 (1877).

***Oxneriaria verruculosa*** (Kremp.) S. Y. Kondr. et L. Lőkös, *comb. nova.* – MycoBank nr.: MB 822424. – Bas.: *Aspicilia verruculosa* Kremp., *Denkschr. Kgl. Bayer. Bot. Ges., Abt. 2 4*: 283 (1861). ≡ *Lecanora verruculosa* (Kremp.) J. Steiner, *Öst. Bot. Z.* 65: 278 (1915).

***Oxneriaria virginea*** (Hue) S. Y. Kondr. et L. Lőkös, *comb. nova.* – MycoBank nr.: MB 822425. – Bas.: *Aspicilia virginea* Hue, *Nouv. Arch. Mus. Hist. Nat., Paris, 5 ser. 2*: 70 (1912)[1910]. ≡ *Lecanora virginea* (Hue) Zahlbr., *Cat. Lich. Univers. 5*: 359 (1928).



## CONCLUSIONS

The new for science species *Megaspora iranica* M. Haji Moniri et S. Y. Kondr. from NE Iran, similar to *M. rimisorediata*, but differing in having larger thallus, smaller soredia, thicker cortical layer of thallus, thicker hymenium, and narrower ascospores is described.

The recently described species *Megaspora rimisorediata* found to be much wider distributed in Eurasia (from Eastern Ukraine and Armenia to central China). Here it is for the first time recorded from Europe, from eastern Ukraine (Kharkiv oblast).

There are hitherto data on four species of the genus *Megaspora* (i.e. *M. verrucosa*, *M. cretacea*, *M. rimisorediata*, *M. iranica*), while some data submitted to GenBank as '*Megaspora* sp.' belong to still unidentified member of the *Aspicilia* / *Circinaria* clade.

Results presented in this paper also confirm our previous data on phylogenetic analysis of aspicilioid lichens based on ITS nrDNA sequences (Kondratyuk et al. 2016b) that *Aspicilia pseudoabbasiana*, *A. pseudovulcanica*, *A. subepiglypta*, *A. subgeographica*, *A. subgoettweigensis*, and *A. submamillata* belong to the *Aspicilia* clade.

Status of the former *Aspicilia mashiginensis* group, which found to be positioned in separate robust monophyletic branch in sister position to the *Sagedia* branch and in distant position from the *Aspicilia* / *Circinaria* clade after three gene phylogeny based on nrITS, 28S nrLSU and 12S mtSSU sequences, is for the first time lifted to the generic level. Species diversity of the newly described genus *Oxneriaria* as well as its diagnostic characters will be clarified with accumulation of the further molecular data on the further taxa of aspicilioid lichens.

\*

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## APPENDIX

Voucher specimens and NCBI GenBank accession numbers of the nrITS, nrLSU and mtSSU sequences used in the phylogenetic analyses

Taxon name	Country, voucher, reference	ITS1/ITS2	LSU	mtSSU
<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. l.	USA, Sohrabi <i>et al.</i> (2011a)	HQ171234		
<i>Agrestia hispida</i> s. str.	Russia, Kalmyk, Sohrabi <i>et al.</i> (2011a)	HQ171235		
<i>Agrestia hispida</i> s. str.	Iran, Golestan, Sohrabi 15099 (hb. M. Sohrabi), Sohrabi <i>et al.</i> (2013a)	JQ797509	JQ797503	JQ797488
<i>Agrestia hispida</i> s. str.	Turkey, Candan 11 (ANES), Nordin <i>et al.</i> (2010)		HM060760	HM060722
<i>Agrestia hispida</i> s. str.	Iran, (hb. M. Sohrabi), Sohrabi <i>et al.</i> (2013a)	JQ797522		
<i>Agrestia hispida</i> s. str.	Iran, (hb. M. Sohrabi), Sohrabi <i>et al.</i> (2013a)	JQ797523		
<i>Agrestia hispida</i> s. str.	Iran, (hb. M. Sohrabi), Sohrabi <i>et al.</i> (2013a)	HQ389201		
<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>	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), Kondratyuk <i>et al.</i> (2015 as <i>Circinaria</i> )	KT456205	KT456208	

Taxon name	Country, voucher, reference	ITS1/ITS2	LSU	mtSSU
<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> (2014a 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), Kondratyuk <i>et al.</i> (2015 as <i>Circinaria</i> )	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> (2014a as <i>Circinaria hispida</i> )			KP059053
<i>Aspicilia blastidiata</i>	Paukov <i>et al.</i> (2016)	KX129963		
<i>Aspicilia caesiocinerea</i>	AFTOL-ID 653, Miadlikowska <i>et al.</i> (2006)			DQ986892
<i>Aspicilia cinerea</i>	AFTOL-ID 647, Schnull <i>et al.</i> (2011)	HQ650637		
<i>Aspicilia cinerea</i>	AFTOL-ID 647, Miadlikowska <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 <i>et al.</i> (2011)	JF710311		
<i>Aspicilia cinerea</i>	South Korea, Kondratyuk <i>et al.</i> (2016b)	KY249596		
<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 epiglypta</i>	Sweden, Nordin 6303 (UPS), Nordin <i>et al.</i> (2011)	HQ259261		
<i>Aspicilia goettweigensis</i>	Paukov <i>et al.</i> (2016)	KX159289		
<i>Aspicilia goettweigensis</i>	Paukov <i>et al.</i> (2016)	KX159292		
<i>Aspicilia indissimilis</i>	Nordin <i>et al.</i> (2007)	EU057909		
<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>Aspicilia pseudoabbassiana</i>	South Korea, 140764, Kondratyuk <i>et al.</i> (2016b)	KY249599		

Taxon name	Country, voucher, reference	ITS1/ITS2	LSU	mtSSU
<i>Aspicilia pseudoab-bassiana</i>	South Korea, 100188, Kondratyuk <i>et al.</i> (2016b)	KY249600		
<i>Aspicilia pseudovulcanica</i>	South Korea, 090722, Kondratyuk <i>et al.</i> (2016b)	KY249602		
<i>Aspicilia pseudovulcanica</i>	South Korea, 100584, Kondratyuk <i>et al.</i> (2016b)	KY249601		
<i>Aspicilia subepiglypta</i>	South Korea, 100438, Kondratyuk <i>et al.</i> (2016b)	KY249606		
<i>Aspicilia subgeographica</i>	South Korea, 130359, Kondratyuk <i>et al.</i> (2016b)	KY249611		
<i>Aspicilia subgeographica</i>	South Korea, 120356, Kondratyuk <i>et al.</i> (2016b)	KY249610		
<i>Aspicilia subgoettweigensis</i>	South Korea, 120188, Kondratyuk <i>et al.</i> (2016b)	KY249613		
<i>Aspicilia subgoettweigensis</i>	South Korea, 130234, Kondratyuk <i>et al.</i> (2016b)	KY249614		
<i>Aspicilia subdepressa</i>	France, Roux <i>et al.</i> (2011)	JF703123		
<i>Aspicilia submamillata</i>	South Korea, 090631, Kondratyuk <i>et al.</i> (2016b)	KY249618		
<i>Aspicilia submamillata</i>	South Korea, 091073, Kondratyuk <i>et al.</i> (2016b)	KY249619		
<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, 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> (2010)	GU289916		
<i>Chlorangium cf. asperum</i>	Russia, Astrakhan region, Sohrabi <i>et al.</i> (2013a)	JQ797531		
<i>Chlorangium cf. asperum</i>	Aras <i>et al.</i> (unpubl.)			DQ401569
<i>Chlorangium gyrosom</i>	Spain, Sohrabi <i>et al.</i> (unpubl.)	JX306734		
<i>Chlorangium gyrosom</i>	Iran, Sohrabi <i>et al.</i> (2013a)	NR_120106		
<i>Chlorangium gyrosom</i>	Iran, East Azerbaijan, Sohrabi 10085 (hb. M. Sohrabi), Sohrabi <i>et al.</i> (2013a)	JQ797540	JQ797504	
<i>Chlorangium gyrosom</i>	Iran, Sohrabi <i>et al.</i> (2013a)	JQ797539		
<i>Chlorangium gyrosom</i>	Spain, Sohrabi <i>et al.</i> (2013a)	JQ797557		

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<i>Chlorangium gyrosum</i>	Iran, East Azerbaijan, Sohrabi 10401A (hb. M. Sohrabi), Sohrabi <i>et al.</i> (2013a)	JQ797528		JQ797487
<i>Chlorangium jussufii</i>	Morocco, Sohrabi <i>et al.</i> (2013a)	JQ797521		
<i>Chlorangium jussufii</i>	Algeria, Esnault 2033 (GZU), Sohrabi <i>et al.</i> (2013a)	JQ797518	JQ797495	JQ797489
<i>Chlorangium sphaerothallinum</i>	Iran, Semnan, Sohrabi 9369 (hb. M. Sohrabi), Sohrabi <i>et al.</i> (2013a)	JQ797545	JQ797508	JQ797476
<i>Chlorangium sphaerothallinum</i>	Iran, Sohrabi <i>et al.</i> (2013a)	JQ797537		
<i>Chlorangium sphaerothallinum</i>	Iran, Sohrabi <i>et al.</i> (2013a)	JQ797536		
<i>Chlorangium sphaerothallinum</i>	Iran, Sohrabi <i>et al.</i> (2013a)	JQ797543		
<i>Chlorangium sphaerothallinum</i>	Armenia, Sohrabi <i>et al.</i> (2013a)	JQ797525		
<i>Circinaria affinis</i>	Russia: Astrakhan Region, Kulakov 1408B (M), Sohrabi <i>et al.</i> (2011b)	HQ389196		
<i>Circinaria affinis</i>	Russia: Astrakhan Region, Kulakov 1408B (M), Sohrabi <i>et al.</i> (2013a)		JQ797502	JQ797492
<i>Circinaria caesiocinerea</i>	Sweden, Nordin <i>et al.</i> (2007)	EU057897		
<i>Circinaria caesiocinerea</i>	Schmitt <i>et al.</i> (2006)		DQ780303	DQ780271
<i>Circinaria caesiocinerea</i>	United Kingdom: Wales, Orange (unpubl.)	FJ532372		
<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)	AF332108		
<i>Circinaria calcarea</i>	AFTOL-ID 1358, Miadłikowska <i>et al.</i> (2006)			DQ986876
<i>Circinaria cerebroides</i>	Kyrgyzstan, Innerer Tian-Shan, Ringel 5138(H), Sohrabi <i>et al.</i> (2013a)	JQ797534	JQ797506	JQ797484
<i>Circinaria contorta</i>	Sweden, Nordin <i>et al.</i> (2007)	EU057900		

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<i>Circinaria contorta</i>	Austria (GZU), Ivanova and Hafellner (2002)	AF332108		
<i>Circinaria contorta</i>	Austria (GZU), Ivanova and Hafellner (2002)	AF332109		
<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>	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 gibbosa</i>	Sweden, Uppland, Nordin 5878 (UPS), Nordin <i>et al.</i> (2007)	EU05790		
<i>Circinaria gibbosa</i>	Sweden, Uppland, Nordin 5878 (UPS), Nordin <i>et al.</i> (2010)		HM060740	HM060702
<i>Circinaria leproscens</i>	Sweden, Uppland, Nordin 5906 (UPS), Nordin <i>et al.</i> (2007)	EU05791		
<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</i> ' <i>emiliae</i>	Kazakhstan, Atyrau, Kulakov 3702 (UPS), Sohrabi <i>et al.</i> (2013a)	JQ797512		
' <i>Circinaria</i> ' <i>emiliae</i>	Kazakhstan, Atyrau, Kulakov 3702 (UPS), Nordin <i>et al.</i> (2010)		HM060728	HM060690
' <i>Circinaria</i> ' <i>emiliae</i>	Kazakhstan, Atyrau, Kulakov 3702B (UPS), Sohrabi <i>et al.</i> (2013a)	JQ797513		
' <i>Circinaria</i> ' <i>emiliae</i>	Kazakhstan, Atyrau, Kulakov 3798 (UPS), Nordin <i>et al.</i> (2010)		HM060729	HM060691
' <i>Circinaria</i> ' <i>fruticulosa</i>	Ukraine: Crimea, Sohrabi <i>et al.</i> (2013a)	JQ797555		
' <i>Circinaria</i> ' <i>fruticulosa</i>	Turkey, Sohrabi <i>et al.</i> (2013a)	JQ797535		
' <i>Circinaria</i> ' <i>fruticulosa</i>	Kazakhstan, Tarbagatai, Lange 5186 (H), Sohrabi <i>et al.</i> (2013b)	HQ171228	JQ797505	JQ797486
' <i>Circinaria</i> ' <i>lacunosa</i>	Kazakhstan, Sohrabi <i>et al.</i> (2013a)	JQ797520		



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' <i>Circinaria</i> ' <i>lacunosa</i>	China, Xinjiang, Abbas 940003 (H), Sohrabi <i>et al.</i> (2013a)	JQ797517	JQ797494	JQ797490
' <i>Circinaria</i> ' <i>rostamii</i>	Iran, East Azerbaijan, Sohrabi 10212 (IRAN), Sohrabi <i>et al.</i> (2013a)	JQ797538	JQ797507	JQ797491
' <i>Circinaria</i> ' <i>rostamii</i>	Iran, Sohrabi <i>et al.</i> (2013a)	JQ797533		
' <i>Circinaria</i> ' <i>rostamii</i>	Iran, Sohrabi <i>et al.</i> (2013a)	JQ797541		
<i>Lobothallia alphoplaca</i>	USA, Sohrabi <i>et al.</i> (unpubl.)	JX306737		
<i>Lobothallia alphoplaca</i>	USA, Sohrabi <i>et al.</i> (unpubl.)	JX306738		
<i>Lobothallia alphoplaca</i>	USA, Sohrabi <i>et al.</i> (unpubl.)	JX306739		
<i>Lobothallia alphoplaca</i>	China, Kou <i>et al.</i> (2013)	JX476025		
<i>Lobothallia alphoplaca</i>	SK A20, Ukraine, Kondratyuk <i>et al.</i> (2015)	KT456207	KT456210	KT456211
<i>Lobothallia melanaspis</i>	Norway, Valadbeigi <i>et al.</i> (2011)	JF825524		
<i>Lobothallia melanaspis</i>	Sweden, Jämtland, Nordin 6622 (UPS), Nordin <i>et al.</i> (2011)	HQ259272		
<i>Lobothallia melanaspis</i>	Sweden, Jämtland, Nordin 6622 (UPS), Nordin <i>et al.</i> (2010)		HM060726	HM060688
<i>Lobothallia preradiosa</i>	China, Ismayil and Abbas (unpubl.)	KT180161		
<i>Lobothallia radiosa</i>	Sweden, Roux <i>et al.</i> (2011)	JF703124		
<i>Lobothallia radiosa</i>	Switzerland, Lumbsch (F), Schmitt <i>et al.</i> (2006)		DQ780306	DQ780274
<i>Lobothallia recedens</i>	Sweden, Dalarna, Nordin 6582 (UPS), Nordin <i>et al.</i> (2010)		HM060762	HM060724
<i>Megaspora cretacea</i>	Zakeri <i>et al.</i> (2016)	KX253974		
<i>Megaspora cretacea</i>	Zakeri <i>et al.</i> (2016)	KX253975		
<i>Megaspora iranica</i>	Iran, Haji Moniri M. 13.12.2013 (KW-L, SK D67), this paper	150318		
<i>Megaspora iranica</i>	Iran, Haji Moniri M. 13.12.2013 (BP, SK D69), this paper	141053		
<i>Megaspora rimisorediata</i>	Iran, Valadbeigi <i>et al.</i> (2011)	JF825525		
<i>Megaspora rimisorediata</i>	China, Ismayil (unpubl.)	KT443787		
<i>Megaspora rimisorediata</i>	China, Ismayil (unpubl.)	KT443788		
<i>Megaspora rimisorediata</i>	China, Ismayil (unpubl.)	KT443789		
<i>Megaspora rimisorediata</i>	China, Ismayil (unpubl.)	KT443790		
<i>Megaspora verrucosa</i>	Austria? /1996, Trinkaus (GZU), Ivanova and Hafellner (2002)	AF332121		
<i>Megaspora verrucosa</i>	Austria(?), Hafellner 48544 and Ivanova (GZU), Ivanova and Hafellner (2002)	AF332122		

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<i>Megaspora verrucosa</i>	USA, Sohrabi <i>et al.</i> (2013a)	KC667053		
<i>Megaspora verrucosa</i>	Sweden, Jämtland, Nordin 6495 (UPS), Nordin <i>et al.</i> (2010)		HM060725	HM060687
<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, Kinalioğlu 1679 (B), Sohrabi <i>et al.</i> (2013a)		JQ797497	JQ797482
<i>Megaspora verrucosa</i>	China, Xinjiang, XJU 200753	KT443786		
<i>Megaspora verrucosa</i>	China, Xinjiang, XJU 200724	KT443785		
<i>Oxneria alfredi</i>	FNM 152, Fedorenko <i>et al.</i> (2009)	EU681344		EU680932
<i>Oxneria huculica</i>	FNM 199, Fedorenko <i>et al.</i> (2009)	EU681346		EU680931
<i>Oxneria huculica</i>	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>	Arup <i>et al.</i> (2013)		KC179283	
<i>Oxneriaria dendroplaca</i>	Nordin 5952, Nordin <i>et al.</i> (2011)	HQ259259		
<i>Oxneriaria dendroplaca</i>	T 538, Nordin <i>et al.</i> (2010)		HM060706	
<i>Oxneriaria dendroplaca</i>	T747 5952, Nordin <i>et al.</i> (2010)		HM060720	HM060706
<i>Oxneriaria dendroplaca</i>	Nordin 6366, Nordin <i>et al.</i> (2011)	HQ259260		
<i>Oxneriaria mashiginensis</i>	Nordin <i>et al.</i> (2007)	EU057912		
<i>Oxneriaria mashiginensis</i>	T455, Nordin <i>et al.</i> (2010)		HM060732	HM060694
<i>Oxneriaria mashiginensis</i>	T23557, Nordin <i>et al.</i> (2011)	HQ259266		
<i>Oxneriaria permutata</i>	Nordin <i>et al.</i> (2007)	EU057919		
<i>Oxneriaria permutata</i>	T550, Nordin <i>et al.</i> (2010)		HM060747	HM060709
<i>Oxneriaria permutata</i>	Nordin <i>et al.</i> (2007)	EU057921		
<i>Oxneriaria permutata</i>	Nordin <i>et al.</i> (2007)	EU057930		
<i>Oxneriaria rivulicola</i>	Nordin <i>et al.</i> (2007)	EU057922		
<i>Oxneriaria rivulicola</i>	T668, Nordin <i>et al.</i> (2010)		HM060715	
<i>Oxneriaria rivulicola</i>	Nordin <i>et al.</i> (2007)	EU057923		
<i>Oxneriaria supertegens</i>	Nordin <i>et al.</i> (2007)	EU057935		
<i>Oxneriaria supertegens</i>	T610, Nordin <i>et al.</i> (2010)		HM060713	
<i>Oxneriaria supertegens</i>	T508, Nordin <i>et al.</i> (2010)		HM060704	
<i>Oxneriaria supertegens</i>	Nordin <i>et al.</i> (2007)	EU057937		
<i>Oxneriaria supertegens</i>	Nordin <i>et al.</i> (2007)	EU057938		
<i>Oxneriaria verruculosa</i>	T507, Nordin <i>et al.</i> (2007)	EU057940		
<i>Oxneriaria verruculosa</i>	T507, Nordin <i>et al.</i> (2007)		HM060741	HM060703

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<i>Oxneriaria verruculosa</i>	T507, Nordin <i>et al.</i> (2007)	EU057941		
<i>Oxneriaria verruculosa</i>	T507, Nordin <i>et al.</i> (2007)	EU057942		
<i>Oxneriaria virginea</i>	Nordin <i>et al.</i> (2011)	HQ259270		
<i>Oxneriaria virginea</i>	Nordin <i>et al.</i> (2011)	HQ259271		
<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	M060699
<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 mastrucata</i>	Nordin <i>et al.</i> (2007)	EU057915		
<i>Sagedia mastrucata</i>	Nordin <i>et al.</i> (2007)	EU057916		
<i>Sagedia mastrucata</i>	Nordin <i>et al.</i> (2007)	EU057917		
<i>Sagedia nunatakensis</i>	Jiri (unpubl.)	KT630250		
<i>Sagedia simoensis</i>	Nordin <i>et al.</i> (2007)	EU057926		
<i>Sagedia simoensis</i>	Nordin <i>et al.</i> (2010)		HM060739	HM060701
<i>Sagedia simoensis</i>	Nordin <i>et al.</i> (2007)	EU057929		
<i>Sagedia simoensis</i>	Ivanova and Hafellner (2002)	AF332113		
<i>Sagedia simoensis</i>	Ivanova and Hafellner (2002)	AF332115		
<i>Sagedia simoensis</i>	Jiri (unpubl.)	KT630249		KT630251
<i>Sagedia zonata</i>	Nordin <i>et al.</i> (2007)	EU057949		
<i>Sagedia zonata</i>	Sweden, Nordin 6006 (UPS), Nordin <i>et al.</i> (2007)	EU057951		
<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
<i>Sphaerothallia esculenta</i>	Sohrabi <i>et al.</i> (2013a)	JQ797510		
<i>Teuvoa juniperina</i>	742, Sohrabi <i>et al.</i> (2013a)	JX306747	JX306754	JX306758
<i>Teuvoa juniperina</i>	765, Sohrabi <i>et al.</i> (2013a)	JX306745	KC667058	JX306757
<i>Teuvoa juniperina</i>	766, Sohrabi <i>et al.</i> (2013a)	JX306741	JX306760	

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<i>Teuwoa juniperina</i>	766, Sohrabi <i>et al.</i> (2013a)	JX306746	KC667057	
<i>Teuwoa juniperina</i>	767, Sohrabi <i>et al.</i> (2013a)	JX306751	JX306755	JX306761
<i>Teuwoa juniperina</i>	843, Sohrabi <i>et al.</i> (2013a)	JX306748	JX306762	
<i>Teuwoa juniperina</i>	850, Sohrabi <i>et al.</i> (2013a)	JX306777	JX306756	
<i>Teuwoa tibetica</i>	Sohrabi <i>et al.</i> (2013a)	GU289915		
<i>Teuwoa tibetica</i>	Zhang <i>et al.</i> (2016) (unpubl.)	KX234705		
<i>Teuwoa tibetica</i>	Zhang <i>et al.</i> (2016) (unpubl.)	KX234707		

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