


## Standard Paper

# Contributions to the knowledge of lichenicolous fungi growing on *Rhizoplaca* s. lat., including five new taxa and an identification key

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### Abstract

Sixteen species and two varieties of lichenicolous fungi are reported from *Rhizoplaca* s. lat. Four species and one variety are described as new to science: *Caeruleoconidia ahtii* Zhurb. (on *Rhizoplaca* s. str.), with hyaline to pale greyish turquoise, comparatively large conidia; *Cercidospora mongolica* Zhurb. & Cl. Roux (on *Rhizoplaca* s. str.), with a reddish brown (above) to pale brownish grey to colourless (below) exciple, mostly 4-spored asci, and (0-)1(-2)-septate ascospores, mostly 23–28.5 µm long; *C. tyanshanica* Zhurb. & Cl. Roux (on *Protoparmeliopsis* and *Rhizoplaca* s. str.), with a uniformly grey exciple, mostly 4-spored asci, and (0-)1(-2)-septate ascospores, mostly 25.5–31.5 µm long; *Stigmidium pseudosquamariae* Zhurb. (on *Protoparmeliopsis*), inducing brown cerebriform galls, with consistently immersed ascomata and well-developed pseudoparaphyses of type b *sensu* Roux & Triebel (1994); and *Arthonia clemens* var. *peltata* Zhurb. (on *Protoparmeliopsis*), with a brown epihymenium without grey shade. An unidentified species of *Leptosphaeria* growing on *Protoparmeliopsis peltata*, and *Lichenostigma* cf. *chlaroterae* growing on *P. peltata* and *Rhizoplaca chrysoleuca* are briefly characterized. *Arthonia clemens* is newly reported for Kazakhstan, Kyrgyzstan and the Republic of Sakha (Yakutia) in Russia; *Cercidospora melanophthalmae* is new to Kazakhstan, Kyrgyzstan and Mongolia; *Didymocyrtis rhizoplacae* is new to Russia; *Lichenocmium lecanorae* and *Muellerella erratica* are new to Kyrgyzstan; *Stigmidium squamariae* s. lat. is new to Kazakhstan, Kyrgyzstan and Turkmenistan. *Didymocyrtis rhizoplacae* is documented for the first time on *Rhizoplaca subdiscrepans*, and *Pyrenidium actinellum* s. lat. on *Protoparmeliopsis*. A key to 36 species of lichenicolous fungi and lichens known to occur on *Rhizoplaca* s. lat. is provided.

**Keywords:** Ascomycota; Central Asia; lichen parasites; taxonomy

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### Introduction

The genus *Rhizoplaca* (*Lecanoraceae*, *Lecanorales*) was established based on *R. opaca* (Ach.) Zopf (= *R. melanophthalma* (DC.) Leuckert & Poelt; Zopf 1905) and until recently included c. 10 species, distinguished from *Lecanora* by a mainly peltate-umbilicate thallus attached with an umbilicus, the lack of distinctly radiating marginal lobes, the loose medulla, and thick lower cortex (Ryan 2002). Subsequent molecular phylogenetic studies have greatly modified the concept of this genus, in particular by transferring *Rhizoplaca peltata* Ramond ex Leuckert & Poelt to *Protoparmeliopsis* and including a number of placodioid *Lecanora* species (Zhao *et al.* 2016). Kondratyuk *et al.* (2019) proposed a further transfer of some *Rhizoplaca* species to the genera *Omphalodina* and *Sedelnikovaea*; however, these proposals require verification as the phylogenetic trees justifying them do not indicate branch support values, so there is no way to assess the reliability of the proposed tree topology. According to Zhang *et al.* (2024), the genus *Rhizoplaca* s. str. currently includes c. 25 species distributed worldwide.

While investigating the lichenicolous fungi of Mongolia, the author found a number of rare, poorly known or apparently undescribed species growing on *Rhizoplaca* s. lat. *sensu* Ryan (2002), species of which are common there on rock (Zhurbenko *et al.* 2019, 2020). A subsequent survey of *Rhizoplaca* s. lat. specimens mainly from some other countries of Central Asia revealed a number of additional interesting specimens of lichenicolous fungi. The aims of this paper are to present the results of the revision of this material, including the description of four new species and one new variety, and to provide a first identification key to the species of lichenicolous fungi and lichens growing on *Rhizoplaca* s. lat.

### Material and Methods

The study is based on 65 specimens of lichenicolous fungi and lichens growing on *Rhizoplaca chrysoleuca* (Sm.) Zopf, *R. melanophthalma*, *R. subdiscrepans* (Nyl.) R. Sant. and *Protoparmeliopsis peltata* Ramond ex Arup *et al.* ( $\equiv$  *Rhizoplaca peltata*), mainly from Kazakhstan, Kyrgyzstan, Mongolia, Russia and Turkmenistan, deposited in the herbarium of the Komarov Botanical Institute of RAS, St Petersburg, Russia (LE). The age of the specimens ranges from 1–72 years and can be easily calculated from the cited labels.

Microscopy was carried out and images were captured using a Zeiss Axio Zoom V16 stereomicroscope fitted with an AxioCam

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712 colour digital camera, and a Zeiss Axio Imager A1 compound microscope equipped with Nomarski differential interference contrast optics and fitted with an AxioCam 807 colour digital camera. Microscopic characters were studied using sections hand-cut with a razor blade and mounted in water, 10% potassium hydroxide (K), Lugol's iodine directly (I) or after K pretreatment (K/I), or 50% aqueous solution of nitric acid (N). Measurements and descriptions refer to water mounts unless otherwise indicated. When the number of measurements ( $n$ ) > 10, the dimensions of ascospores, conidiomata, asci, ascospores, conidia and some other microstructures, as well as the length/width ratio ( $l/w$ ) of the ascospores and conidia, are given as (min-)( $\bar{x}$  - SD) - ( $\bar{x}$  + SD)(-max), where min and max are the extreme values observed,  $\bar{x}$  the arithmetic mean, and SD the corresponding standard deviation. Dimensions of the microstructures, both newly obtained and taken from the literature, were rounded to the nearest 0.5  $\mu\text{m}$ . Standard statistical tests (Mann-Whitney U test and Student's  $t$ -test) were used to assess the reliability of differences in ascospore size. Colours are named according to Kornerup & Wancher (1978).

## The Taxa

### *Arthonia clemens* (Tul.) Th. Fr. var. *clemens*

Epithymenium light brown to brown, usually with an additional grey shade, viz. greyish brown throughout or brown above, grey below (Fig. 1D). Ascospores (10-)11.5-13(-15)  $\times$  (5-)5.5-6.5  $\mu\text{m}$ ,  $l/w = (1.6-)$ 1.9-2.3(-2.6) ( $n = 68$ ), which agrees with the dimensions given by Grube (2007), viz. 10-15  $\times$  4-7  $\mu\text{m}$ .

New to Kazakhstan, Kyrgyzstan and the Republic of Sakha (Yakutia) in Russia.

*Selected specimens examined (all except LE 310304 on apothecial discs of Rhizoplaca chrysoleuca).* **Kazakhstan:** Karaganda Region: 25 km SW of Kenistas settlement, Konurtube (Konyrtobe) Mts, 49°41'40"N, 73°03'27"E, 13 vii 1967, E. Leont'eva (LE 310305).—**Kyrgyzstan:** Terskey Alatau, Altyn-Arashan Canyon, Kel'dyne River, 17 ix 1954, A. N. Sobolev (LE 310311); southern slope of the Kyrgyz Alatau Ridge, Shamsi River valley, 30 km NW of Kochkorki settlement, 2100 m, 1972, L. I. Bredkina 1441b (LE 310323b). Issyk-Kul' Region: 40 km E of Karakol town, Terskey Alatau Ridge, Turgen'-Aksu Canyon, 42°34'48"N, 78°53'15"E, 1979, L. I. Bredkina 2821a (LE 310302a); Alai Ridge, 1979, L. I. Bredkina 3425b (LE 310310).—**Mongolia:** Arkhangai Region: Tevshrulekh District, 15 km NW of Tevshrulekh, Urd'-Tamir River valley, rocks in mountain steppe, on *Rhizoplaca subdiscrepans* (apothecial discs), 13 vii 1970, L. G. Biazrov (LE 310304) [Identification is somewhat uncertain as the epithymenium lacks grey shade]; Khotont District, foot of Mt Tsagaan Uul, 47°13'19.8"N, 102°18'51.6"E, 1690 m, 2023, M. P. Zhurbenko 23104 (LE 310307). Bayan Khongor Region: Zhargalant District, NE of Zhargalant settlement, near Egiin Davaa Pass, 47°12'26.3"N, 99°50'33.5"E, 2560 m, 2023, M. P. Zhurbenko 2385 (LE 310308).—**Russia:** Republic of Sakha (Yakutia): Oimyakon District, near Ust'-Nera settlement, right bank of Indigirka River, 64°30'N, 143°10'E, 1000 m, 1992, M. P. Zhurbenko 92571c (LE 310316c); Moma District, 56 km NNW of Tiubeliakh settlement, right bank of Indigirka River, 65°52'N, 143°01'E, 250 m, 1992, M. P. Zhurbenko 92570 (LE 310309).

### *Arthonia clemens* (Tul.) Th. Fr. var. *peltatae* Zhurb. var. nov.

MycoBank No.: MB 854767

Distinguished from *Arthonia clemens* var. *clemens* mainly by the brown versus greyish brown epithymenium, and a different host selection, *Protoparmeliopsis* versus *Rhizoplaca* (both in *Lecanoraceae*).

Type: Mongolia, Zavkhan Region, 10 km NE of Erdene Hairkhan District, Kotlovina Ozer (Lake Basin), between Gurvan Bulak Ula and Tsakhir Ula Mts, upper Khungui River, on *Protoparmeliopsis peltata* (apothecial discs), 20 August 1979, U. Tsogt 1089 (LE 310318—holotype).

(Fig. 1A-C)

*Ascomata* apothecia, erumpent, without a distinct margin, disc blackish, matt,  $\pm$ rounded to irregularly elongated in surface view, slightly convex, up to 1 mm diam., smooth or eventually finely fissured, arising singly or in groups, sometimes confluent. *Exciple* indistinct. *Epithymenium* conspicuous, light to medium brown, 10-15  $\mu\text{m}$  thick, usually with deposits of orange-white crystalline granules penetrating the hymenium. *Hymenium* subhyaline to pale brownish orange, 30-40  $\mu\text{m}$  tall, with widely spaced asci, hymenial gel I+ red, K/I+ blue; *subhymenium* rather indistinct, the same colour as the hymenium, up to 30  $\mu\text{m}$  tall. *Paraphysoids* branched, anastomosed, apices light brown to brown, occasionally branched, often somewhat enlarged, 2.5-5  $\mu\text{m}$  diam. *Asci* clavate, mainly stalked, (32-)33.5-39.5(-43)  $\times$  15-18(-19.5)  $\mu\text{m}$  ( $n = 15$ ), 8-spored. *Ascospores* hyaline, 1-septate, narrowly obovate with wider and often longer upper cell, (9.5-)11-13(-14)  $\times$  (4-)4.5-5(-5.5)  $\mu\text{m}$ ,  $l/w = (1.8-)$ 2.3-2.9(-3.3) ( $n = 55$ , in water or I), smooth-walled, without a gelatinous sheath, irregularly biseriolate in the ascus.

*Asexual morph* not observed.

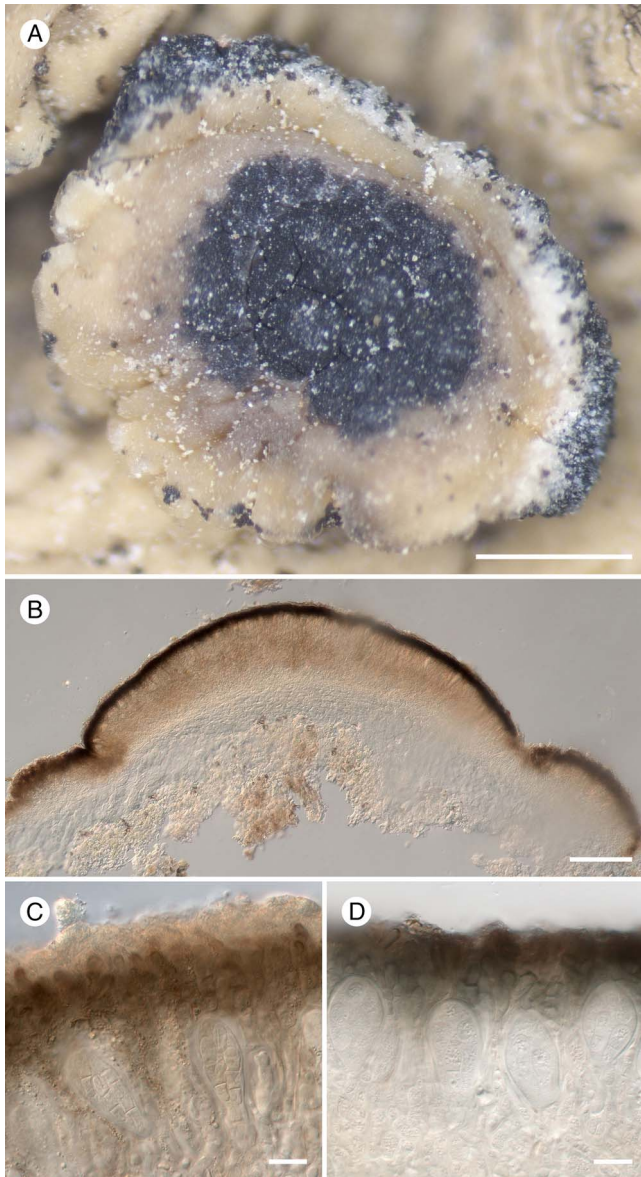
*Etymology.* The epithet refers to the host lichen *Protoparmeliopsis peltata*.

*Distribution and host.* The new variety is known from two collections in Central Asia (Kyrgyzstan and Mongolia), growing on apothecial discs of *Protoparmeliopsis peltata*. Deleterious effects on the host were not observed.

*Notes.* *Arthonia clemens* was described on *Rhizoplaca chrysoleuca* (Tulasne 1852) and according to Grube (2007) is probably confined to this host. The new variety described on *Protoparmeliopsis peltata* is mainly distinguished by the absence of grey shade in the epithymenium coloration. It may also have narrower ascospores, mostly 4.5-5  $\mu\text{m}$  versus mostly 5.5-6.5  $\mu\text{m}$  wide as in the *Arthonia clemens* var. *clemens* specimens presented above. This difference is confirmed by a Student's  $t$ -test with a probability of 99%. However, this assumption needs to be checked since in *Arthonia clemens* var. *peltatae*, spores were measured only in the asci, whereas in the type variety they were measured mainly outside the asci.

A report on *Protoparmeliopsis peltata* from Greenland (Alstrup & Hawksworth 1990: 16, based on Fries (1871)) probably belongs to the same variety.

*Additional specimen examined.* **Kyrgyzstan:** Terskey Alatau Ridge, on *Protoparmeliopsis peltata* (apothecial discs), 17 viii 1953, A. N. Sobolev (LE 310337).



**Figure 1.** *Arthonia clemens* var. *peltatae* (A & B, holotype; C, LE 310337). A, habitus of fused ascomata. B, ascomata in cross-section. C, epihymenium. *Arthonia clemens* var. *clemens* (LE 310307). D, epihymenium. B–D = in water. Scales: A = 500  $\mu\text{m}$ ; B = 100  $\mu\text{m}$ ; C & D = 10  $\mu\text{m}$ . In colour online.

### *Caeruleoconidia ahtii* Zhurb. sp. nov.

Mycobank No.: MB 854768

Distinguished from *Caeruleoconidia ochrolechia* Zhurb. & Diederich mainly by the hyaline to occasionally pale greyish turquoise versus greenish blue, larger conidia,  $(6.5\text{--}7.5\text{--}9.5\text{--}11) \times (5\text{--}5.5\text{--}7\text{--}8) \mu\text{m}$  versus  $(4\text{--}5\text{--}7\text{--}10.5) \times (3\text{--}4\text{--}5.5\text{--}6.5) \mu\text{m}$ , and a different host selection, *Rhizoplaca* (*Lecanorales*) versus *Ochrolechia* (*Pertusariales*).

Type: Mongolia, Khovd Region, Must District, Bodonch Gol River valley,  $46^{\circ}31'53''\text{N}$ ,  $92^{\circ}23'28''\text{E}$ , 2400 m, sandstone boulders in steppe, on *Rhizoplaca chrysoleuca* (thallus), 14 July 2019, M. P. Zhurbenko 19364 (LE 310278—holotype).

(Fig. 2)

*Conidiomata* initially immersed in the host thallus, then erumpent, becoming superficial,  $(45\text{--}60\text{--}95\text{--}145) \mu\text{m}$  diam. ( $n = 27$ ), mostly  $35\text{--}70 \mu\text{m}$  tall, initially almost closed, pycnidoid, then saucer-shaped, sporodochial, with a widely exposed conidiogenous layer, irregularly circular to somewhat elongated in surface view, with a greyish green (best visible at  $\geq \times 100$ ) flat centre surrounded by a thick, black, elevated margin, arising singly or in groups, sometimes contiguous to confluent up to eight together. Lateral wall of mature conidiomata  $7\text{--}26 \mu\text{m}$  thick, greyish turquoise combined with brown, K–, composed of irregularly orbicular to somewhat elongated cells,  $(3.5\text{--}5\text{--}7.5\text{--}10.5) \times (3\text{--}4\text{--}6\text{--}7) \mu\text{m}$  ( $n = 35$ ), with walls  $0.5\text{--}1 \mu\text{m}$  thick. Basal stroma hyaline to greyish turquoise, K–, composed of suborbicular to somewhat elongated cells, c.  $4\text{--}9 \times 3\text{--}6 \mu\text{m}$ , located in the centre, and of smaller, tangentially elongated cells,  $(3.5\text{--}4\text{--}6.5\text{--}9) \times (1.5\text{--}2\text{--}3\text{--}4) \mu\text{m}$  ( $n = 28$ ), located on the periphery. Conidiophores originating from the basal stroma, poorly differentiated from the underlying stromatic cells, hyaline to greyish turquoise, K–, composed of suborbicular to somewhat elongated cells,  $(3.5\text{--}5\text{--}8\text{--}10) \times (2.5\text{--}3.5\text{--}5.5\text{--}7) \mu\text{m}$  ( $n = 31$ ). Conidiogenous cells integrated, poorly differentiated. Conidia hyaline to occasionally pale greyish turquoise, with rounded edges, angular rounded, ellipsoid (sometimes asymmetric), ovate, occasionally oblong, reniform, cuneiform, ampulliform, triangular or irregular,  $(6.5\text{--}7.5\text{--}9.5\text{--}11) \times (5\text{--}5.5\text{--}7\text{--}8) \mu\text{m}$ ,  $l/w = (1.0\text{--}1.2\text{--}1.6\text{--}1.8)$  ( $n = 44$ ), aseptate, solitary, dry, with a smooth wall c.  $0.5 \mu\text{m}$  thick, sometimes with a few small guttules. Sexual morph not observed.

**Etymology.** The species is dedicated to the eminent Finnish lichenologist Teuvo Ahti, on the occasion of his 90th birthday.

**Distribution and host.** The new species is known only from the type collection in Central Asia (Mongolia), growing on the thallus of *Rhizoplaca chrysoleuca*, not visibly damaging the host.

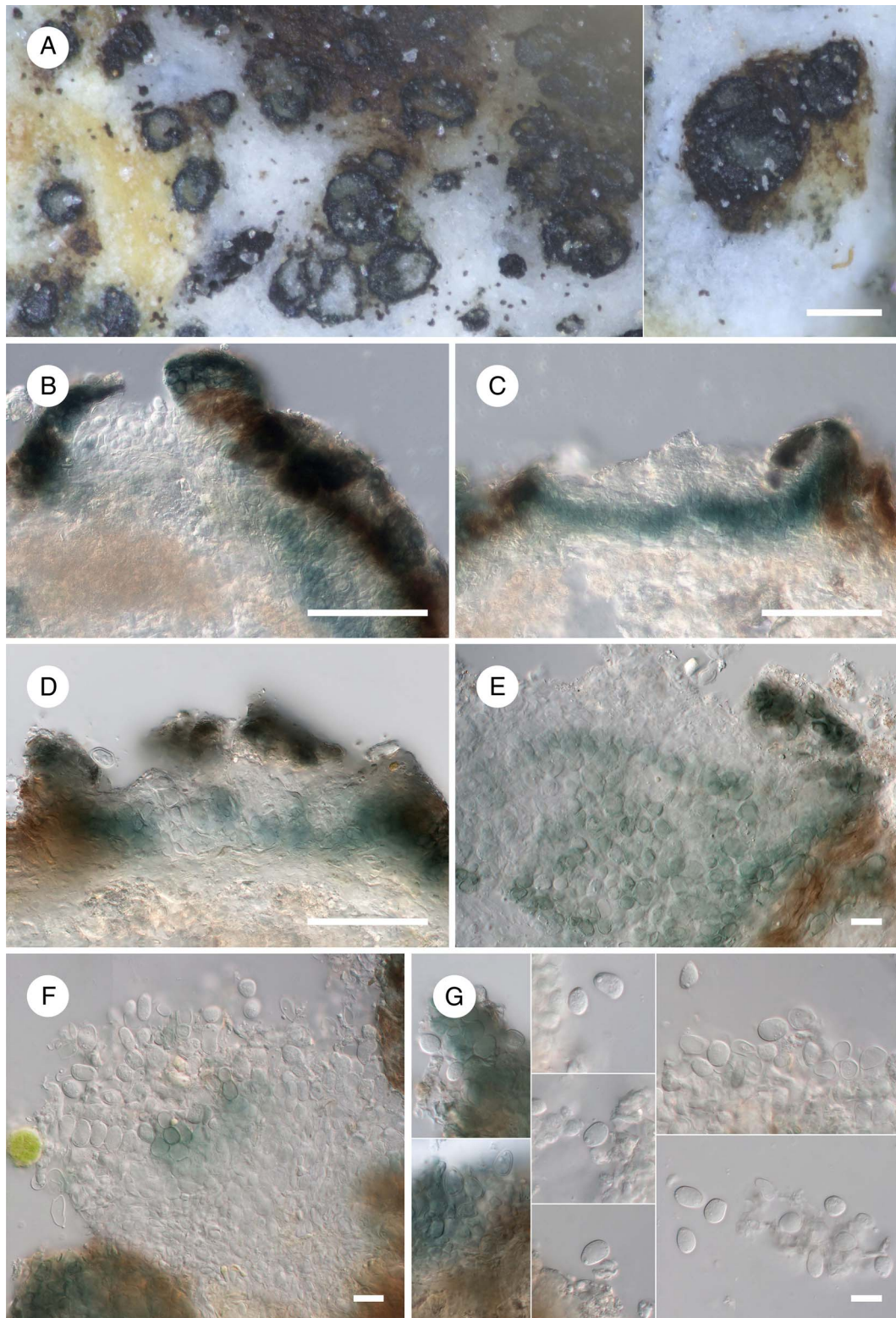
**Notes.** With its mainly sporodochial conidiomata, hyaline to greyish turquoise conidiophores aggregated in a compact basal stroma, surrounded by a lateral wall, integrated conidiogenous cells, and hyaline to occasionally pale greyish turquoise, aseptate, smooth-walled, rounded or slightly elongated conidia of various shapes, the new species fits well the current concept of *Caeruleoconidia* (Zhurbenko *et al.* 2015). It is well distinguished from the two previously known species of the genus, viz. *C. biazrovii* Zhurb. (growing on *Cladonia*; Zhurbenko & Pino-Bodas 2017) and *C. ochrolechia* (growing on *Ochrolechia*; Zhurbenko *et al.* 2015), by the partially brown pigmentation of the lateral wall of the conidiomata, the mainly hyaline versus greenish blue or bluish green conidia, and the host preference. Additionally, conidia of the compared species are smaller,  $(3\text{--}3.5\text{--}5\text{--}6.5) \times (2.5\text{--}3\text{--}4.5\text{--}5.5) \mu\text{m}$  and  $(4\text{--}5\text{--}7\text{--}10.5) \times (3\text{--}4\text{--}5.5\text{--}6.5) \mu\text{m}$ , respectively.

### *Carbonea* cf. *aggregantula* (Müll. Arg.) Diederich & Triebel

The material examined fits well the species description presented in Cannon *et al.* (2022) except for the smaller apothecia,  $80\text{--}270 \mu\text{m}$  versus  $200\text{--}400 \mu\text{m}$  diam., and wider ascospores,  $(8\text{--}9\text{--}11\text{--}13) \times (4\text{--}4.5\text{--}5\text{--}5.5) \mu\text{m}$ ,  $l/w = (1.5\text{--}1.8\text{--}2.4\text{--}2.7)$  ( $n = 36$ ) versus  $9.5\text{--}12 \times 3\text{--}4 \mu\text{m}$ .

**Specimens examined (both on lobe underside and stalk of *Rhizoplaca chrysoleuca*).** Kyrgyzstan: Terskey Alatau Ridge, 16





**Figure 2.** *Caeruleoconidia ahtii* (holotype). A, habitus of conidiomata. B–D, conidiomata in cross-section. E, basal stroma giving rise to conidiophores (in K). F, basal stroma giving rise to conidiophores, conidiogenous cells and conidia. G, conidia. B–D, F & G = in water. Scales: A = 100  $\mu$ m; B–D = 50  $\mu$ m; E–G = 10  $\mu$ m. In colour online.

vii 1953, A. N. Sobolev (LE 310282a).—**Mongolia:** *Bayan Khongor Region:* Gurvan Bulag District, NW of Buga settlement, near Khukh nuur Lake, 47°31'32.5"N, 98°31'19.8"E, 2630 m, 2023, M. P. Zhurbenko 2398d (LE 310283).

*Cercidospora cf. crozalsiana* (H. Olivier) Nav.-Ros., Cl. Roux & Casares

Ascomata perithecioid, externally black, mainly subglobose, 170–320  $\mu$ m diam., protruding in the ostiolar region to semi-

immersed,  $\pm$ dispersed. Exciple in the upper part green, greenish grey, greyish turquoise or olive, sometimes brown on the outside, rarely with violet speckles throughout, medium coloured internally, darkly coloured externally and near the ostiole, colourless to pale coloured (brown, orange-grey or dull green) at the base. Paraphysoids abundant, filiform, occasionally branched, septate, with many guttules. Asci (sub)cylindrical, (2-)4(-8)-spored. Ascospores hyaline, distinctly heteropolar, clavate, with a wider upper (relative to the position in the ascus) part to occasionally almost homopolar, fusiform, ends rounded to rather acute or occasionally attenuated, (17.5-)22-29(-38)  $\times$  (5.5-)6.5-8(-9)  $\mu\text{m}$ ,  $l/w = (2.4-)3.0-4.2(-5.5)$  ( $n = 183$ ) (according to the Mann-Whitney U test, the difference in spore length between samples on different hosts is not significant with a 99% probability), (0-)1-septate, septum sometimes slightly to strongly displaced towards the narrow or wide end of the spore, not or slightly constricted at the septum, guttulate, smooth-walled, rarely halonate, mainly diagonally uniseriate in the ascus. Pycnidiospores hyaline, short bacilliform, 3.5-4.5  $\times$  1-1.5  $\mu\text{m}$ .

This description probably refers to more than one taxon, but clear morphological differences are difficult to articulate. In the description of *Cercidospora crozalsiana* presented in Calatayud *et al.* (2013), the exciple is characterized as blue-green in its upper part and colourless at the base, the ascospores as more elongated (main range of  $l/w = 3.7-5.5$ ), only slightly heteropolar, and mainly with a distinct halo, and the host genus is *Squamarina* (*Stereocaulaceae*) versus *Rhizoplaca* (*Lecanoraceae*, both *Lecanorales*). The examined material is also reminiscent of *C. macrospora* (Uloth) Hafellner & Nav.-Ros., reliably reported from *Lecanora*, *Protoparmeliopsis* and *Rhizoplaca* (*R. novomexicana* (H. Magn.) S.D. Leav. *et al.* and *R. phaedrophthalma* (Poelt) S.D. Leav. *et al.*) (Calatayud *et al.* 2013). However, *Cercidospora macrospora* is characterized by smaller (mostly 20-25  $\times$  4-6  $\mu\text{m}$ ) and more elongated ascospores (main range of  $l/w = 3.8-5.4$ ), that are only rarely slightly heteropolar (Calatayud *et al.* 2013).

**Specimens examined.** **India:** Jammu and Kashmir State: near Khardung-La Pass, 34°19.890'N, 77°38.810'E, 4650 m, mountain desert, on *Rhizoplaca melanophthalma* (discs and margins of apothecia, thallus), 2013, M. P. Zhurbenko 1359 (LE 260918) (previously published as *Cercidospora melanophthalmae* Nav.-Ros. *et al.* (Zhurbenko 2013)).—**Mongolia:** Arkhangai Region: Bulgan District, Khul Sayayn Davaa Pass, 46°49'52"N, 100°48'45"E, 2800 m, on *R. chrysoleuca* (thallus), 2019, M. P. Zhurbenko 19358 (LE 310056); Taryat District, NW of Taryat settlement, near Khorgo Uul Volcano, 48°11'28"N, 99°49'47"E, 2080 m, on *R. subdiscrepans* (thallus), 27 vii 2019, S. Javkhlan (LE 310151) (previously published as *Cercidospora cf. macrospora* (Zhurbenko *et al.* 2020)). Khovd Region: Must District, Bodonch Gol River valley, 46°31'53"N, 92°23'28"E, 2400 m, on *R. chrysoleuca* (apothecia, thallus), 2019, M. P. Zhurbenko 19360 (LE 310058), S. Javkhlan (LE 310060).—**Russia:** Republic of Adygeya: Caucasian Biosphere Reserve, north-eastern spur of Mt Tybga, 43°52'48"N, 40°15'59"E, 2480 m, on *R. melanophthalma* (apothecial discs, rarely margins), 2014, M. P. Zhurbenko 14188 (LE 264366) (previously published as *Cercidospora cf. macrospora* (Zhurbenko & Kobzeva 2016)). Krasnodar Territory: Caucasian Biosphere Reserve, northern spur of Mt Armovka, 43°52'28"N, 40°39'20"E, 2250 m, on *R. melanophthalma* (apothecial discs, rarely margins), 2014, M. P. Zhurbenko 14189 (LE 264336) (previously published as *Cercidospora cf. macrospora* (Zhurbenko & Kobzeva 2016)).

### *Cercidospora melanophthalmae* Nav.-Ros., Calat. & Hafellner

The material examined differs slightly from the species protologue (Calatayud *et al.* 2013). Ascomata are not always completely immersed in the host but also often 1/8 to rarely 1/2 protruding. Exciple medium to dark greyish turquoise, bluish grey or dull blue inside, brown with occasional violet stripes outside in the upper part, pale greyish brown in the lower part versus 'blue-green in its upper part, sometimes violaceous brown in the outermost part, colourless towards its base'. Ascospores (13-)17.5-22.5(-26.5)  $\times$  (3-)5-7  $\mu\text{m}$ ,  $l/w = (2.4-)2.9-3.9(-4.6)$  ( $n = 74$ ) versus (16-)18-22(-24)  $\times$  (4-)5-6.5(-7)  $\mu\text{m}$ , not always (0-)1-septate but rarely also 3-septate.

New to Kazakhstan, Kyrgyzstan and Mongolia.

**Specimens examined** (all on apothecia, occasionally thallus of *Rhizoplaca melanophthalma*). **Kazakhstan:** Zailiyskiy Alatau Ridge, 1971, L. I. Bredkina 1203 (LE 310293).—**Kyrgyzstan:** Terskey Alatau Ridge, 17 viii 1953, A. N. Sobolev (LE 310285); Chu River valley, 1971, L. I. Bredkina 268a (LE 310286).—**Mongolia:** Arkhangai Region: Tevshrulekh District, watershed of Khukh-Sumein-Gol and Tsetserleg-Gol Rivers, Mt Khaikhan, 47°15'N, 101°50'E, 2400 m, 3 viii 1979, L. G. Biazrov (LE 310284).

### *Cercidospora mongolica* Zhurb. & Cl. Roux sp. nov.

Mycobank No.: MB 854769

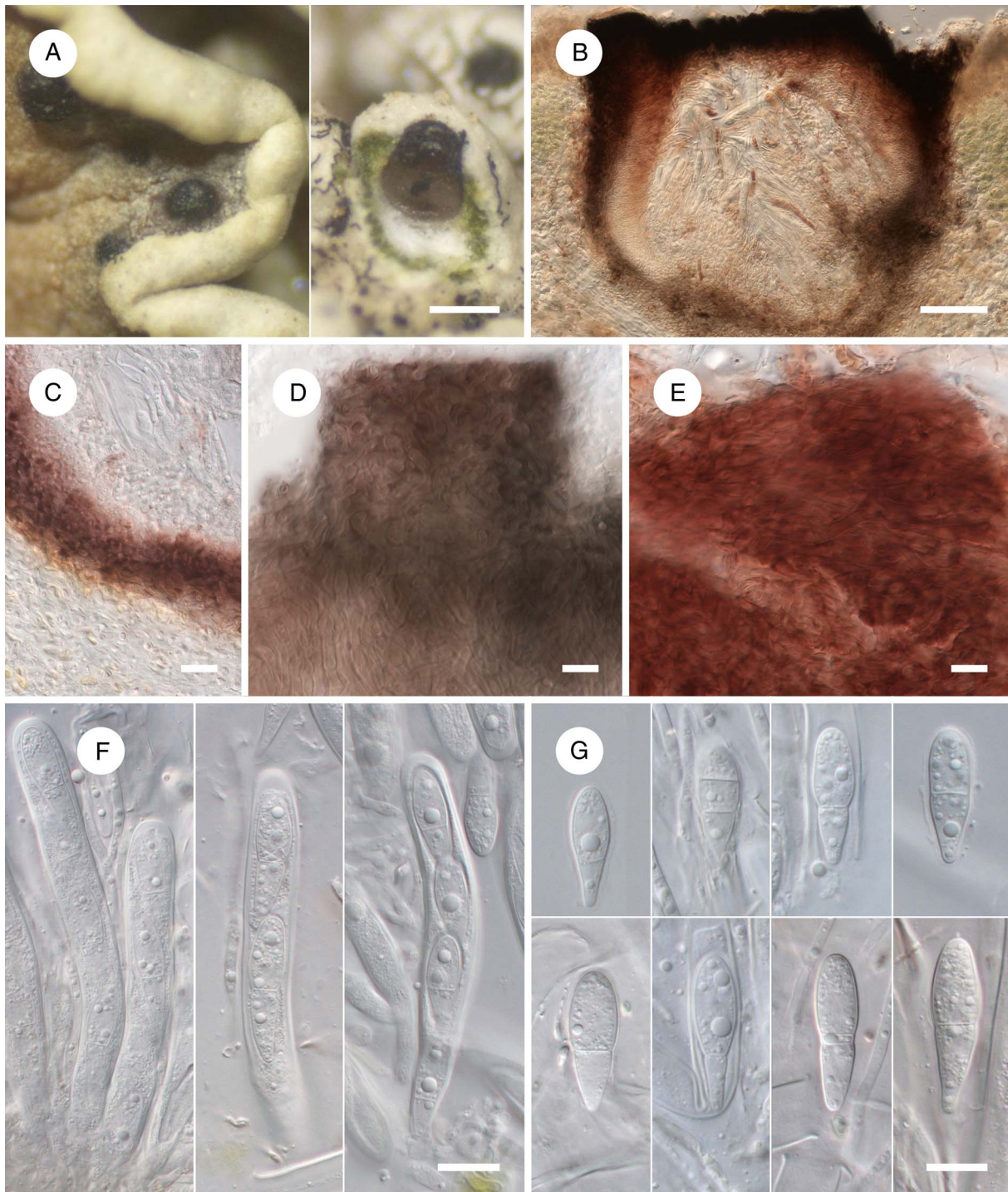
Distinguished from *Cercidospora barrenoana* Calat. & Nav.-Ros. by the mainly reddish brown versus mainly violaceous exciple, often strongly heteropolar, shorter ascospores, mostly 23-28.5  $\mu\text{m}$  versus mostly 30-38  $\mu\text{m}$  long, and a different host selection, *Rhizoplaca* versus *Protoparmeliopsis* (both in *Lecanoraceae*).

Type: Mongolia, Khovd Region, Must District, Bodonch Gol River valley, 46°31'53"N, 92°23'28"E, 2400 m, sandstone boulders in steppe, 14 July 2019, on *Rhizoplaca chrysoleuca* (thallus), M. P. Zhurbenko 19359a (LE 310057—holotype).

(Fig. 3)

Ascomata perithecioid, externally black, subglobose to ampulliform, usually flattened at the top, occasionally shortly papillate, sometimes flattened at the base, (195-)200-330(-360)  $\mu\text{m}$  diam. ( $n = 17$ ), with an ostiole 15-40  $\mu\text{m}$  diam., protruding in the ostiolar region to rarely semi-immersed, dispersed or occasionally loosely aggregated. Exciple in the upper part reddish brown, occasionally greyish brown on the outside, K-, N+ intensifying the red hue, medium coloured internally, darkly coloured externally and near the ostiole, in the lower part pale brownish grey to colourless, in surface view of *textura intricata* combined with *textura globulosa*, in cross-section of *textura globulosa*, 10-20  $\mu\text{m}$  thick at the base, up to 50  $\mu\text{m}$  thick near the ostiole. Paraphysoids abundant, growing along the entire inner surface of the ascoma from the base to the ostiole, filiform, occasionally branched, septate, mostly 2-3  $\mu\text{m}$  thick, varying slightly in thickness within a single filament, with many guttules. Asci (sub)cylindrical, short-stalked, (75-)87-108(-120)  $\times$  (10-)11-12(-13)  $\mu\text{m}$  ( $n = 16$ ), (2-)4(-8)-spored, I-, K/I- except for the ascoplasm turning orange-brown. Ascospores hyaline, slightly to mainly strongly heteropolar, more or less clavate, with a wider upper (relative to the position in the ascus) part, and an attenuated, narrower lower part, (19-)23-28.5(-36.5)  $\times$  (4.5-)6.5-8(-9)  $\mu\text{m}$ ,  $l/w = (2.5-)3.1-4.3(-5.6)$  ( $n = 165$ ), (0-)1(-rarely 2)-septate, septum often much shifted towards





**Figure 3.** *Cercidospora mongolica* (A, LE 309872, LE 310153; B, LE 310323a; C, LE 310153; D, LE 310312; E, holotype; F, holotype, LE 309872; G, LE 309872, LE 310153). A, habitus of ascomata. B, ascoma in cross-section. C, exciple in cross-section. D, exciple in surface view (in K). E, exciple in surface view (in N). F, asci. G, ascospores. B, C, F & G = in water. Scales: A = 200  $\mu$ m; B = 50  $\mu$ m; C–G = 10  $\mu$ m. In colour online.

the narrower end, sometimes constricted at the septum, smooth-walled, often with a halo up to 1.5  $\mu$ m thick, with many guttules, diagonally uniseriate in the ascus.

*Asexual morph* not observed.

**Etymology.** The epithet refers to Mongolia, where the holotype and most other specimens were collected.

**Distribution and hosts.** The new species is known from six collections in Central Asia (Kyrgyzstan and Mongolia), growing on the apothecia and thallus of *Rhizoplaca chrysoleuca* (mostly) and *R. subdiscrepans*. Deleterious effects on the host were not observed.

**Notes.** The new species fits well the concept of *Cercidospora* presented in Navarro-Rosinés *et al.* (2004). It may also be confused

with a species of *Zwackhiomyces* (type *Z. coepulonus* (Norman) Grube & R. Sant.) but differs from this genus in such features as the non-uniformly coloured exciple, partly of *textura intricata*, without a distinct cloudy granulate pigmentation, only occasionally branched versus regularly branched and anastomosed paraphysoids, and (sub)cylindrical versus clavate asci; halonate, non-verruculose ascospores are also not typical for the species of *Zwackhiomyces* (Grube & Hafellner 1990; Roux *et al.* 2023; specimen of *Zwackhiomyces coepulonus* examined for comparison).

According to the recent treatment of *Cercidospora* species growing on *Lecanora* s. lat., *Protoparmeliopsis*, *Rhizoplaca* and *Squamarina* (Calatayud *et al.* 2013), only three species of this genus growing on these hosts are characterized by asci mostly with 4 spores that are similar in size, viz. *C. barroana* (on *Protoparmeliopsis*), *C. crozalsiana* (on *Squamarina*) and *C. macrospora* (on *Lecanora*, *Protoparmeliopsis* and *Rhizoplaca*). Two other similar species, *Cercidospora tyanshanica* Zhurb. & Cl. Roux (on *Protoparmeliopsis* and *Rhizoplaca*) and *C. cf. crozalsiana* (on *Rhizoplaca*), are described herein. Of these, *Cercidospora barroana* differs in the predominantly violaceous exciple, larger asci, 90–145 × 10–15 µm, and only slightly heteropolar, narrowly ellipsoid-fusiform to almost cylindrical, longer ascospores, (27–)30–38(–40) × (5–)6–8 µm,  $l/w = (3.6–)4.3–5.8(–7.2)$ . *Cercidospora crozalsiana* is distinct in the blue-green exciple and the only slightly heteropolar, somewhat longer ascospores, mostly 24.5–31.5 µm long; *C. cf. crozalsiana* can be distinguished by its mainly green, greyish turquoise or olive upper part of the exciple. *Cercidospora tyanshanica* differs in having more submerged ascomata, a uniformly grey, evenly coloured exciple, the occurrence of strong swellings at paraphysoids, rare formation of a gelatinous perispore, and the gall induction. *Cercidospora macrospora* differs in having smaller ascomata, 150–220 µm diam., a green-blue exciple, and somewhat smaller ascospores, (19–)20–25(–30) × (4–6(–7) µm, that are usually homopolar with a median septum.

**Additional specimens examined (all except LE 310153 on apothecia and thallus of *Rhizoplaca chrysoleuca*).** **Kyrgyzstan:** southern slope of the Kyrgyz Alatau Ridge, Shamsi River valley, 30 km NW of Kochkorki settlement, 2100 m, 1972, *L. I. Bredkina* 1441a (LE 310323a).—**Mongolia:** *Arkhangai Region:* Tevshrulekh District, 16 km N of Tevshrulekh, 1610 m, 22 viii 1978, *L. G. Biazrov* (LE 310312). *Bayan-Ulgii Region:* Tolbo District, 15 km E of Tolbo settlement, Mt Sairyn Uul, 48°22'39"N, 90°29'29"E, 3050 m, 2019, *M. P. Zhurbenko* 19279a (LE 310059a). *Khovd Region:* Altai District, near Barlag settlement, 45°53'42"N, 93°12'24"E, 1850 m, on *Rhizoplaca subdiscrepans* (apothecia, thallus), 2019, *M. P. Zhurbenko* 19315 (LE 310153). *Khuvsugul Region:* Ulaan-Uul District, Khugiin Gol River, S slope of Mt Khara-Khabo, 50°59'15"N, 99°01'37"E, 1650 m, 2018, *M. P. Zhurbenko* 18145 (LE 309872) (previously published as *Cercidospora* sp. (Zhurbenko *et al.* 2019)).

**Specimen of *Zwackhiomyces coepulonus* examined for comparison.** **Austria:** *Steiermark:* on *Rusavskia elegans*, 2001, *W. Obermayer* 13627 (LE F-342129) (Hafellner, *Lichenicolous Biota* no. 240).

### *Cercidospora tyanshanica* Zhurb. & Cl. Roux sp. nov.

Mycobank No.: MB 854770

Distinguished from *Cercidospora crozalsiana* by the grey versus mainly blue-green exciple, and a different host selection, *Protoparmeliopsis* and *Rhizoplaca* (both in *Lecanoraceae*) versus *Squamarina* (*Stereocaulaceae*).

Type: Kazakhstan, Zailiyskiy Alatau Ridge, Syugoty Mts, on *Protoparmeliopsis peltata* (apothecia, thallus), 5 July 1970, *L. I. Bredkina* 40a (LE 310287a—holotype).

(Fig. 4)

*Ascomata* perithecioid, externally black, subglobose, usually shortly papillate, (120–)200–300 µm diam. ( $n = 11$ ), protruding only in the ostiolar region, dispersed or occasionally loosely aggregated. *Exciple* uniformly light to dark grey, sometimes tinged with olive or brown, evenly coloured or occasionally paler to rarely almost colourless at the base, K+ brown to greyish brown, N+ reddish/violet-brown, greyish red or light brown, in surface view of *textura intricata* combined with *textura globulosa*, in cross-section of *textura globulosa*, 15–30 µm thick at the base and laterally, 25–50 µm thick near the ostiole. *Subhymenium* colourless, up to 30 µm tall. *Paraphysoids* abundant, growing along the entire inner surface of the ascoma from the base to the ostiole, filiform, occasionally branched and anastomosed, septate, mostly 2 µm thick, varying in thickness within a single filament, occasionally locally swollen up to 7 µm diam, without distinct guttules. *Asci* (sub)cylindrical, short-stalked, (82–)92–116(–132) × (11–)12–15 µm ( $n = 30$ ), (2–)4(–8)-spored, mostly with 4 mature spores, occasionally with 2 or 6 mature spores or 8 immature spores, I–, K/I– except for the ascoplasm turning orange-brown. *Ascospores* hyaline, homopolar to slightly heteropolar, narrowly ellipsoid-fusiform or with a slightly wider upper (relative to the position in the ascus) part, and slightly attenuated, narrower lower part (sometimes located in the ascus with the narrow end facing upwards), (19.5–)25.5–31.5(–34.5) × (5.5–)6.5–7.5(–9) µm,  $l/w = (2.3–)3.5–4.5(–5.3)$  ( $n = 186$ ), (0–)1 (–rarely 2)-septate, septum median or slightly shifted towards the wider end, not constricted at the septum, smooth-walled, rarely with a halo up to 1.5 µm thick, without distinct guttules, diagonally uniseriate in the ascus.

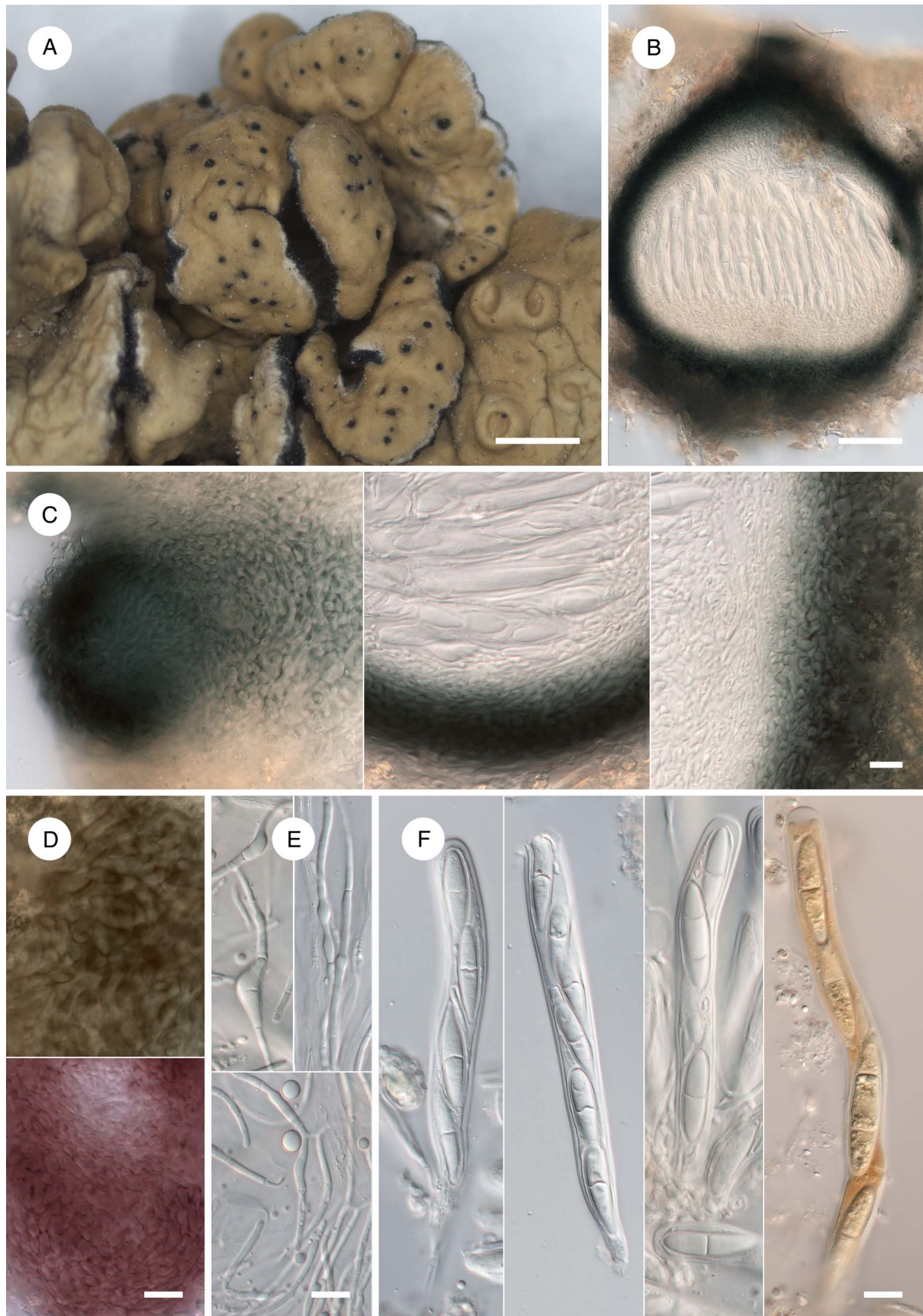
*Pycnidiospores* hyaline, short bacilliform, 4.5–5 × 1 µm.

**Etymology.** The epithet is derived from Tyan'-Shan', a vast mountain system in Central Asia, where most specimens of the new species were collected.

**Distribution and hosts.** The new species is known from seven collections in Central Asia (Kazakhstan, Kyrgyzstan and Turkmenistan), growing on the apothecia and thallus of *Protoparmeliopsis peltata* and *Rhizoplaca chrysoleuca*. On *Protoparmeliopsis peltata*, the parasite induces gall-formation in the form of conspicuous swellings of the host thallus up to 3 mm diam.

**Notes.** *Cercidospora tyanshanica* is similar to *C. crozalsiana*, a species known from many collections in Europe (mainly in the Mediterranean region) and one in Western Asia (Turkey), always growing on *Squamarina* species, and characterized by the following coloration of the exciple: greenish blue/blue-green near the ostiole and colourless at the base/pale brownish red in the lower part, blue-green throughout or reddish in some of the older ascomata (Navarro-Rosinés *et al.* 1995; Candan & Halıcı 2011; Calatayud *et al.* 2013). The new species differs from *Cercidospora crozalsiana* in the uniformly grey exciple, less





**Figure 4.** *Cercidospora tyanshanica* (A, LE 310289; B–D, LE 310324; E, LE 310291; F, LE 310291, LE 310324). A, infection inducing galls on thallus of *Protoparmeliopsis peltata*. B, ascoma in cross-section. C, upper, central and basal parts of exciple. D, exciple in K (above) and N (below). E, paraphysoids. F, asci with spores, in water and K/I (far right). B, C & E = in water. Scales: A = 1000  $\mu$ m; B = 50  $\mu$ m; C–F = 10  $\mu$ m. In colour online.



elongated ascospores (main range of  $l/w = 3.5\text{--}4.5$  versus  $3.7\text{--}5.5$ ), gall induction, and different host genera. A comparison of *Cercidospora tyanshanica* with *C. mongolica* has been given above under the latter species. *Cercidospora barroana*, also growing on *Protoparmeliopsis peltata*, differs in the violaceous, sometimes with a greenish shade exciple, longer ascospores, mostly  $30\text{--}38\ \mu\text{m}$  long, and the absence of gall induction (Calatayud *et al.* 2013).

*Zwackhiomyces zareii* S.Y. Kondr. described from Iran growing on *Rhizoplaca melanophthalma* (type) and *Protoparmeliopsis peltata* (Kondratyuk *et al.* 2011), is morphologically similar to the new species. However, *Cercidospora tyanshanica* differs from the species of *Zwackhiomyces* by the same features given above for *C. mongolica*, except for the uniformly coloured exciple. In addition, ascomata of *Zwackhiomyces zareii* have been characterized as ‘black to black eruginose .... pale brown to dirty hyaline in the immersed parts, pigment extracellular’ and the asci as (6–)8-spored (Kondratyuk *et al.* 2011: 837).

**Additional specimens examined. Kazakhstan:** Zailiyskiy Alatau Ridge, Syugoty Mts, on *Protoparmeliopsis peltata* (apothecia, thallus), 1970, L. I. Bredkina 32b (LE 310288).—**Kyrgyzstan:** Terskey Alatau Ridge, mountain station, on *Rhizoplaca chrysoleuca* (thallus), 15 vii 1953, A. N. Sobolev (LE 310291); same ridge, Altyn-Arashan Canyon, Kel’dyne River, on *R. chrysoleuca* (thallus), 17 ix 1954, A. N. Sobolev (LE 310292); Atbashi Ridge, 492 km from Frunze to Torugart Ridge, 3250 m, on *P. peltata* (thallus), 1973, L. I. Bredkina 2082 (LE 310289); same ridge, Karasu River valley, on *R. chrysoleuca* (thallus), 1971, L. I. Bredkina 1209 (LE 310290).—**Turkmenistan:** North-West Kopetdag, foothills of Kurendag Ridge, Danata gorge, near Danata spring,  $39^{\circ}06'N$ ,  $55^{\circ}06'E$ , on *P. peltata* (thallus), 2 xi 1952, A. D. Pochaeva & I. G. Gringof (LE 310324).

#### *Didymocyrtis rhizoplacae* Y. Joshi & K. Bisht

This species has been described from India growing on *Rhizoplaca chrysoleuca* (Joshi *et al.* 2018) and subsequently reported from Mongolia on the same host (Zhurbenko *et al.* 2019, 2020). Analysis of new and previously published specimens revealed a number of differences from the species protologue: 1) interascal filaments  $1.5\text{--}4.5\ \mu\text{m}$  thick, branched, occasionally anastomosed; 2) ascospores larger,  $(7.5\text{--})10.5\text{--}13.5\text{--}(17) \times (4.5\text{--})5\text{--}6\text{--}(7)\ \mu\text{m}$ ,  $l/w = (1.6\text{--})1.8\text{--}2.4\text{--}(3.5)$  ( $n = 125$ ) versus  $10\text{--}12 \times 4\text{--}5\ \mu\text{m}$ , 1(rarely 2–3)-septate versus 1-septate, apparently

sometimes with a halo *c.*  $2\ \mu\text{m}$  thick; 3) conidia  $(4\text{--})5\text{--}7.5\text{--}(9) \times (3.5\text{--})4\text{--}5.5\text{--}(6.5)\ \mu\text{m}$ ,  $l/w = (1.0\text{--})1.1\text{--}1.5\text{--}(2.1)$  ( $n = 60$ ) versus  $(4\text{--})5 \times 3\ \mu\text{m}$ .

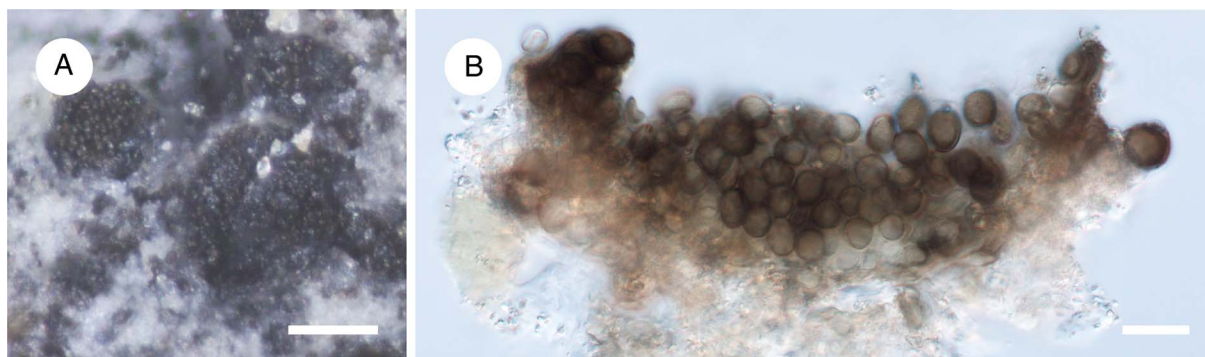
New to Russia. *Rhizoplaca subdiscrepans* is a new host species.

**Specimens examined. Mongolia:** Bayan Khongor Region: Gurvan Bulag District, NW of Buga settlement, near Khukh-Nuur Lake,  $47^{\circ}31'32.5''N$ ,  $98^{\circ}31'19.8''E$ , 2630 m, on *Rhizoplaca chrysoleuca* (thalline margin of apothecia), 2023, M. P. Zhurbenko 2398b (LE 310315).—**Russia:** Karachaevo-Cherkesiya Republic: 6 km E of Teberda town, Dzhemagatskoe Canyon, right bank of Goralykol River,  $43^{\circ}27'13''N$ ,  $41^{\circ}49'11''E$ , 2130 m, on *R. chrysoleuca* (apothecia), 2012, M. P. Zhurbenko 1276 (LE 261151) (anamorph); Teberda town, left bank of Teberda River, 1.5 km upstream of Teberdinskii Reserve office,  $43^{\circ}25'28''N$ ,  $41^{\circ}43'50''E$ , 1350 m, on *R. subdiscrepans* (apothecial disc, thallus), 2012, M. P. Zhurbenko 12181a (LE 261275a).

#### *Katherinomyces cetrariae* Khodos.

Vegetative hyphae immersed, well developed, branched, pale brown,  $3\text{--}7\text{--}(12)\ \mu\text{m}$  diam. Conidiomata sporodochial (Fig. 5), erumpent, cupulate, black,  $(45\text{--})55\text{--}85\text{--}(105)\ \mu\text{m}$  diam. ( $n = 30$ ), up to  $70\ \mu\text{m}$  tall, crowded up to 100 together, forming blackish patches of infection up to 2 mm diam. Conidiomatal wall composed of 2–3 layers of poorly differentiated, tangentially compressed brown cells. Conidiophores, conidiogenous cells and form of conidiogenesis are hard to interpret. Conidia initially subhyaline, then brownish orange, greyish brown and eventually brown, oblong, ellipsoid, occasionally subglobose, reniform, cuneiform, triangular, square or irregular, with rounded ends, without a basal scar,  $(5\text{--})6.5\text{--}10\text{--}(12.5) \times (4.5\text{--})5\text{--}6.5\text{--}(7.5)\ \mu\text{m}$ ,  $l/w = (1.0\text{--})1.1\text{--}1.7\text{--}(2.2)$  ( $n = 180$ ), varying markedly in shape and size between specimens, 0(–2)-septate, wall *c.*  $0.5\text{--}1\ \mu\text{m}$  thick, granulate, arising singly or sometimes joined in twos when young.

The material examined revealed some differences from the species protologue where vegetative hyphae were given as  $3\text{--}4\ \mu\text{m}$  diam., conidiomata  $30\text{--}50\ \mu\text{m}$  diam., ‘sometimes resembling pycnidia’, and conidia aseptate and narrower,  $(4.5\text{--})6.5\text{--}10.5\text{--}(16.5) \times (3\text{--})3.5\text{--}4.5\text{--}(6)\ \mu\text{m}$  (Khodosovtsev *et al.* 2016). This fungus is morphologically very close to species of *Coniambigua* (Etayo & Diederich 1995), from which it might be distinguished by its well-developed brown mycelium.



**Figure 5.** *Katherinomyces cetrariae* (A, LE 310053; B, LE 310319). A, habitus of conidiomata. B, conidioma in cross-section (in water). Scales: A =  $50\ \mu\text{m}$ ; B =  $10\ \mu\text{m}$ . In colour online.

**Specimen examined.** **Mongolia:** Arkhangai Region: Khotont District, foot of Mt Tsagaan Uul, 47°13'19.8"N, 102°18'51.6"E, 1690 m, on *Rhizoplaca chrysoleuca* (damaged thalline margins of apothecia), 2023, M. P. Zhurbenko 23109 (LE 310319).

### *Leptosphaeria* sp.

Vegetative hyphae not observed. Ascomata perithecioid, black, obpyriform (somewhat attenuated above), 100–170 µm diam., with an ostiole c. 20 µm diam., 1/3–1/4 protruding, loosely aggregated (Fig. 6). Exciple medium reddish brown throughout, K+ brown, thin, in surface view of textura angularis. Periphyses present. Interascal filaments well developed, 1.5–2 µm diam. Asci subcylindrical to somewhat clavate, short-stalked, apex not or slightly thickened up to 2 µm, sometimes with a poorly visible tiny indentation 0.5 µm tall, 8-spored, K/I–. Ascospores medium brown, narrowly ellipsoid to fusiform, sometimes slightly narrower below, (14–)14.5–16(–16.5) × (4.5–)5–5.5(–6) µm, l/w = (2.5–)2.7–3.1(–3.2) ( $n = 17$ ), 3-septate, not or slightly constricted at median septum, smooth-walled, non-halonate, often with one large guttule in each cell, diagonally uniseriate to biseriate in the ascus.

**Specimen examined.** **Turkmenistan:** North-West Kopetdag, foothills of Kurendag Ridge, Danata gorge, near Danata spring, 39°06'N, 55°06'E, bottom of dry stony bed, on *Protoparmeliopsis peltata* (thallus), 2 xi 1952, A. D. Pochaeva & I. G. Gringof (LE 310338).

### *Lichenconium lecanorae* (Jaap) D. Hawksw.

Infections were always associated with damaged areas of host apothecia, rarely thallus.

New to Kyrgyzstan.

**Selected specimens examined.** **Kyrgyzstan:** Terskey Alatau Ridge, on *Rhizoplaca chrysoleuca*, 16 vii 1953, A. N. Sobolev (LE 310282b). **Issyk-Kul' Region:** 40 km E of Karakol town, Terskei Alatau Ridge, Turgen'-Aksu Canyon, 42°34'48"N, 78°53'15"E, on *R. chrysoleuca*, 1979, L. I. Bredkina 2821b (LE 310302b).—**Mongolia:** Arkhangai Region: Ikhtamir District, upper reaches of Khoid Tamir Gol River, near Khokh Nuur Lake, 47°05'47.4"N, 102°28'49.7"E, 2670 m, on *R. chrysoleuca*, 29 vii 2023, O. Enkhtuya & S. Javkhlan (LE 310296b). **Bayan Khongor Region:** Zhargalant District, NE of Zhargalant settlement, near Egiin Davaa Pass, 47°12'26.3"N, 99°50'33.5"E, 2560 m, on *R. chrysoleuca*, 2023, M. P. Zhurbenko 23108 (LE 310297). **Dzabkhan Region:** Tsagan-Chuluta District, top of unnamed Mt 2653, on *R. subdiscrepans*, 1978, L. G. Biazrov 8837 (LE 310295).—**Russia:** Krasnoyarsk Territory: Putorana Plateau, N of Ayan Lake, 69°20'N, 93°30'E, 800 m, on *R. subdiscrepans* (apothecia), 1984, M. P. Zhurbenko 84146b (LE 310299b); Taimyr Peninsula, S of Levinson-Lessing Lake, 74°24'N, 98°49'E, 100 m, on *R. melanophthalma*, 1995, M. P. Zhurbenko 95621 (LE 310300). **Republic of Sakha (Yakutia):** Oimyakon District, near Ust'-Nera settlement, right bank of Indigirka River, 64°30'N, 143°10'E, 1000 m, on *R. chrysoleuca*, 1992, M. P. Zhurbenko 92571b (LE 310316b).

### *Lichenostigma* cf. *chlaroterae* (F. Berger & Brackel) Ertz & Diederich

Conidiomata stromatic, superficial, black, irregularly discoid, flattened, sometimes centrally depressed, (25–)35–79(–120) µm diam.



**Figure 6.** *Leptosphaeria* sp. (LE 310338). A, squashed ascoma (in water). B, asci with spores in K/I. Scales: A = 20 µm; B = 10 µm. In colour online.

( $n = 56$ ), arising singly or occasionally aggregated to confluent; entirely composed of spherical or occasionally elongated cells; external cells brown, mostly 5–8 µm diam., granulate, internal cells hyaline to pale brown, mostly 3–5 µm diam., smooth (Fig. 7). Conidiophores absent. Conidiogenous cells subhyaline to light grey or pale brownish grey, clavate/shortly subcylindrical (6.5–8 × 3–4 µm) or indistinguishable from conidial cells, forming conidia by budding. Conidia originating in the interior part of the stroma, typically cross-shaped, (8–)9.5–11.5(–12) × (6.5–)7.5–9(–10) µm ( $n = 63$ ), composed of (2–)4(–5) cells (including a conidiogenous cell); conidial cells light grey to pale brownish grey, angularly rounded, broadly ellipsoid, trapezoid or occasionally triangular, (3.5–)4–5(–5.5) µm diam. ( $n = 77$ ), with a somewhat darker, greyish brown wall, 0.5–1 µm thick, smooth to indistinctly finely granulate; cells in a conidium often varying significantly in size. Ascomata not observed. No change in coloration of the infected apothecial discs was noted, but the host thallus was sometimes slightly darkened under heavy infections.

The material studied differs from typical *Lichenostigma chlaroterae*, mainly growing on corticolous *Lecanora* species, by the (2–)4(–5)-celled versus (3–)4–9(–16)-celled conidia (Berger & Brackel 2011; Ertz *et al.* 2014). Perhaps it represents a separate taxon but the data obtained are insufficient to test this hypothesis.

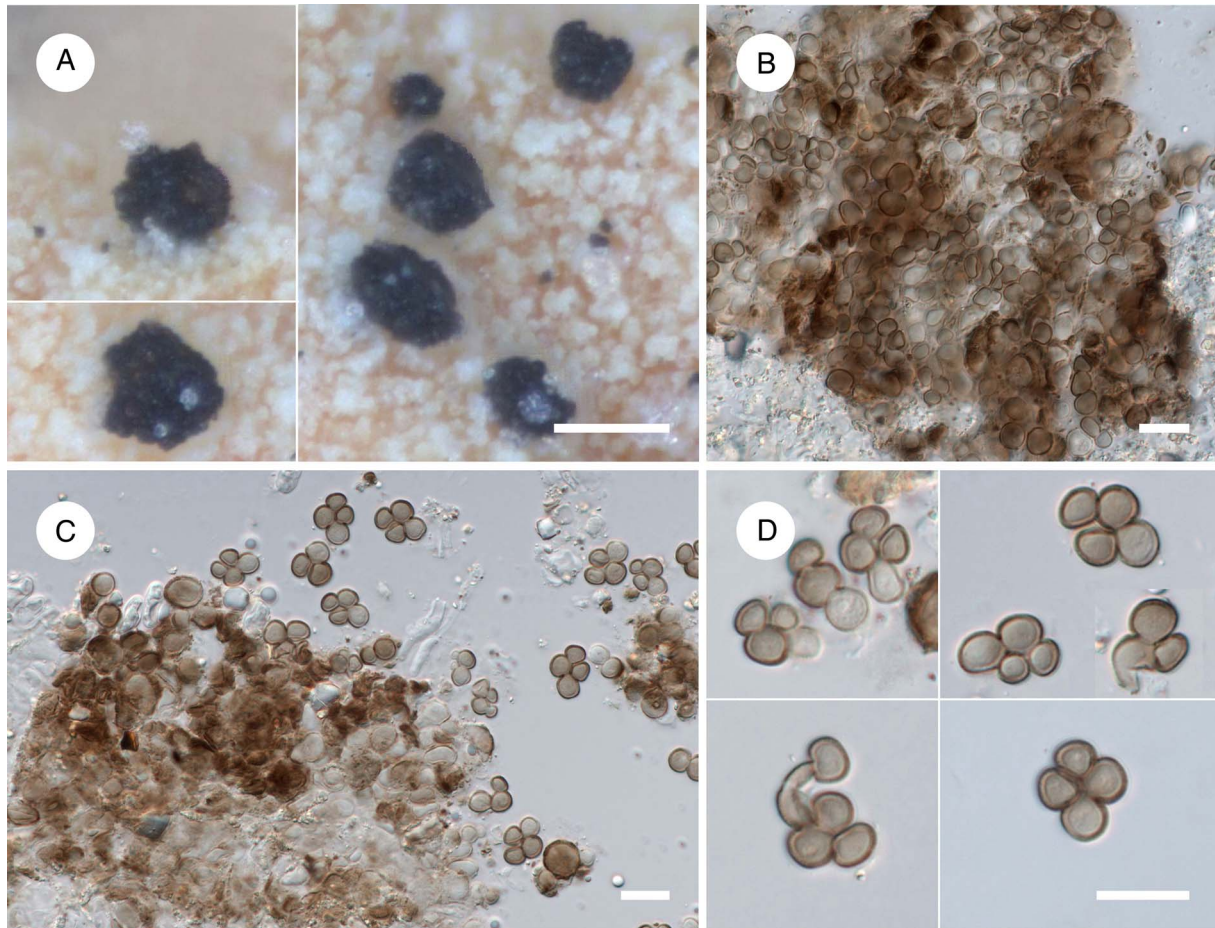
**Specimens examined.** **Kazakhstan:** Zailiyskiy Alatau Ridge, Syugoty Mts, on *Protoparmeliopsis peltata* (apothecia, thallus), 1970, L. I. Bredkina 40b (LE 310287b).—**Kyrgyzstan:** Susamyrtau Ridge, Kekemeran River valley, 25 km NW of Aral settlement, 1800 m, on *P. peltata* (apothecia, thallus), 1973, L. I. Bredkina 1935 (LE 310326).—**Mongolia:** Khovd Region: Must District, Bodonch Gol River valley, 46°31'53"N, 92°23'28"E, 2400 m, sandstone boulders in steppe, on *Rhizoplaca chrysoleuca* (apothecia, thallus), 2019, M. P. Zhurbenko 19367 (LE 310325).

### *Muellerella erratica* (A. Massal.) Hafellner & V. John

Ascumata 135–190 µm diam. ( $n = 14$ ). Asci 32–64-spored. Ascospores 6.5–7.5(–8) × (3.5–)4–4.5(–5) µm, l/w = (1.4–)1.6–1.8(–2) ( $n = 41$ ). The examined material fits well the species description presented in Triebel (1989).

New to Kyrgyzstan.





**Figure 7.** *Lichenostigma* cf. *chlaroteriae* (LE 310325). A, habitus of conidiomata. B & C, squashed conidiomata. D, conidia. B, C & D = in water. Scales: A = 50  $\mu\text{m}$ ; B–D = 10  $\mu\text{m}$ . In colour online.

*Specimens examined (both on thallus of Rhizoplaca chrysoleuca).* **Kyrgyzstan:** Terskey Alatau Ridge, 16 vii 1953, A. N. Sobolev (LE 310280a); Alai Ridge, 1979, *L. I. Bredkina* 3425d (LE 310279).

***Pyrenidium actinellum* Nyl. s. lat.**

Ascomata c. 400  $\mu\text{m}$  diam., without blue-green flecks in the ostiolar region. Asci 8-spored. Ascospores 3-septate, (34–)35.5–42.5(–46)  $\times$  (11.5–)12–13.5(–14)  $\mu\text{m}$ , l/w = (2.7–)2.8–3.2(–3.5) ( $n = 18$ ). Induction of galls not observed.

Understood broadly, this species has been reported from many distantly related lichen genera (Brackel 2014; Huanraluek *et al.* 2019) but is documented for the first time here on *Protoparmeliopsis*.

*Specimen examined.* **Turkmenistan:** Badkhyz Nature Reserve, 3 km SE from Akar-Cheshme cabin, 35°42'N, 61°49'E, on *Protoparmeliopsis peltata* (thallus), 27 iv 1964, A. A. Yunatov (LE 310313).

***Stigidium pseudosquamariae* Zhurb. sp. nov.**

MycoBank No.: MB 854771

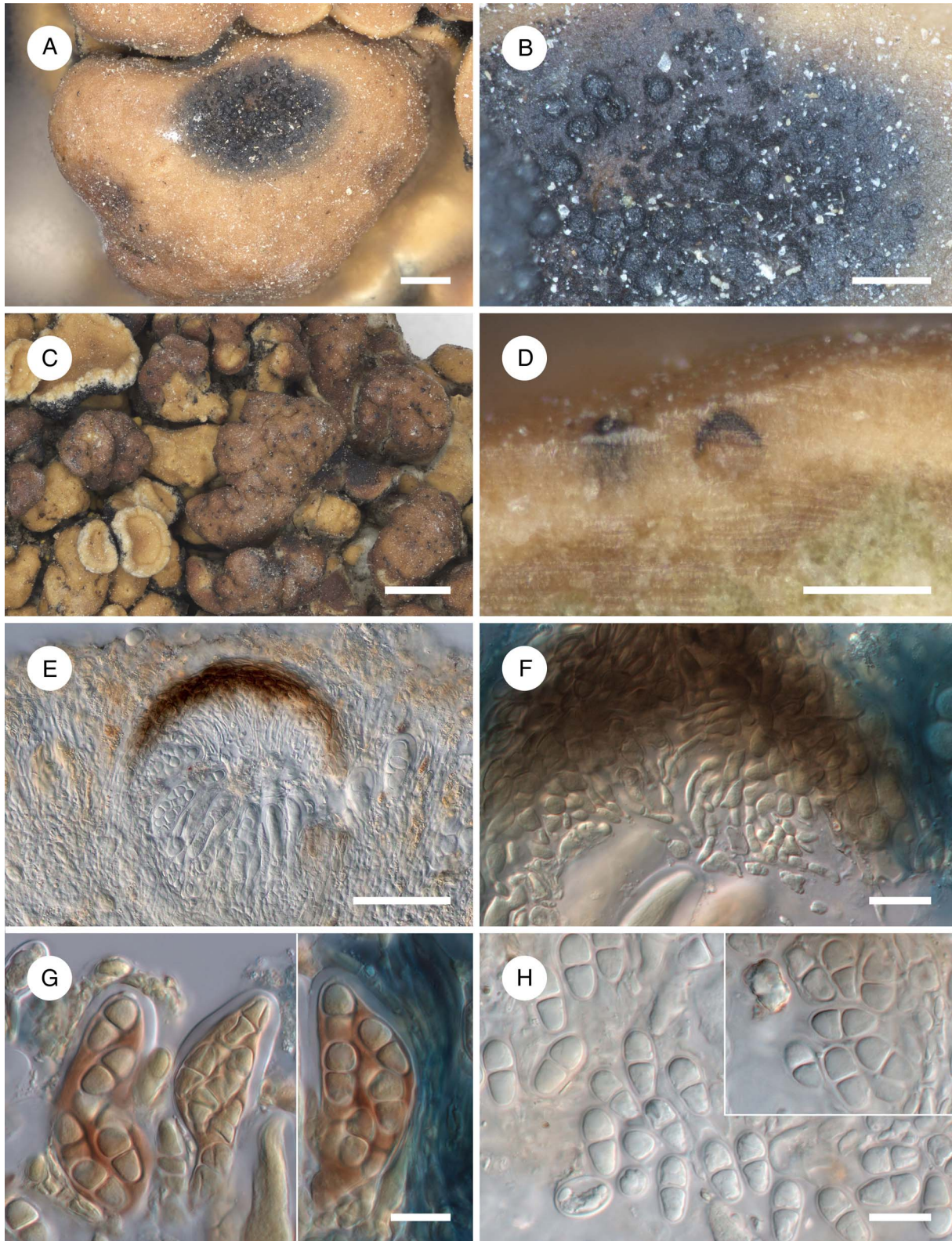
Distinguished from *Stigidium squamariae* (B. de Lesd.) Cl. Roux & Triebel mainly by the consistently immersed versus semi-immersed ascomata and the induction of brown galls.

Type: Kyrgyzstan, Alai Ridge, on *Protoparmeliopsis peltata* (apothecial discs, thallus), 10 August 1979, *L. I. Bredkina* 3425a (LE 3103333—holotype).

(Fig. 8C–H)

Distinct *vegetative hyphae* not observed. *Ascomata* perithecioid, immersed with only the black ostiolar region visible on the outside, subglobose, (55–)57–85(–105)  $\mu\text{m}$  diam. ( $n = 19$ ), with an ostiole 5–10  $\mu\text{m}$  diam., dispersed. *Exciple* medium brown above, colourless at the base, 10–15  $\mu\text{m}$  thick (thicker above), in cross-section composed of 2–4 layers of tangentially elongated cells, in surface view of *textura angularis*, composed of cells 4–12  $\times$  3–7  $\mu\text{m}$ . *External periphyses* rather inconspicuous, pale to medium brown, 5–10  $\times$  1–3  $\mu\text{m}$ , 0(–1)-septate. *Internal periphyses* intermingled with *pseudoparaphyses* of type b *sensu* Roux & Triebel (1994) and difficult to distinguish from each other, well developed along the entire length of the exciple from the ostiole to the base, 8–35  $\times$  1–4  $\mu\text{m}$ , occasionally branched, 1–5-septate. *Asci* ellipsoid, ovoid or broadly clavate, stalk short or indistinct, apex thickened up to 3  $\mu\text{m}$ , with an internal apical beak c. 2–3  $\mu\text{m}$  wide and 1–1.5  $\mu\text{m}$  tall, (35–)37–47(–50)  $\times$  14–20(–22) ( $n = 14$ , in water or I), I–, K/I– except for the ascoplasm turning orange-brown. *Ascospores* hyaline, 1-septate, narrowly obovate (usually with wider upper cell relative to the position in the ascus), (8.5–)11–13(–14.5)  $\times$  (4.5–)5.5–6.5(–7)  $\mu\text{m}$ , l/w = (1.5–)1.7–2.2(–2.5)





**Figure 8.** *Stigmidium squamariae* (LE 310328). A & B, infection on apothecium of *Protoparmeliopsis peltata*. *Stigmidium pseudosquamariae* (holotype). C, infection inducing galls on thallus of *Protoparmeliopsis peltata*. D, ascomata submerged in host thallus in cross-section. E, ascoma in cross-section. F, pseudoparaphyses of type b *sensu* Roux & Triebel (1994) (in l.). G, asci (in l.). H, ascospores. E & H = in water. Scales: A = 500  $\mu\text{m}$ ; B = 200  $\mu\text{m}$ ; C = 1000  $\mu\text{m}$ ; D = 100  $\mu\text{m}$ ; E = 50  $\mu\text{m}$ ; F–H = 10  $\mu\text{m}$ . In colour online.



(*n* = 78), not or slightly constricted at the septum, non-halonate, rarely with a large guttule in a cell, irregularly biseriolate in the ascus. *Asexual morph* not observed.

**Etymology.** The epithet reflects the morphological similarity of the ascoma structure with *Stigmidium squamariae*.

**Distribution and host.** The new species is known from three collections in Central Asia (Kyrgyzstan), growing on the apothecia and thallus of *Protoparmeliopsis peltata*. The parasite induces gall-formation, infected parts of apothecial discs and thallus become darker (light brown to brown), swollen, cerebriform, up to 7 mm diam. However, in the infected host hymenium perithecia of the parasite are adjacent to host asci with mature spores.

**Notes.** *Stigmidium pseudosquamariae* is morphologically very similar to *S. squamariae* s. lat. described below, but the infection symptoms are strikingly different, viz. the formation of large brown cerebriform galls on the host apothecia and thallus versus the formation of blackish spots on its apothecial discs or no symptoms at all. Additionally, *Stigmidium pseudosquamariae* differs from *S. squamariae* s. lat. in the consistently immersed versus often semi-immersed ascomata, somewhat longer pseudo-paraphyses, and slightly wider ascospores (according to the Student's *t*-test, difference in this last parameter from the examined specimens of *S. squamariae* s. lat. is significant with a 99% probability). In two (LE 3103333, LE 3103336) of the three collections examined, both species grew together on different individuals of *Protoparmeliopsis peltata* and were clearly distinct macroscopically.

**Additional specimens examined (both on apothecial discs of *Protoparmeliopsis peltata*).** **Kyrgyzstan:** Terskey Alatau Ridge, 16 vii 1953, A. N. Sobolev (LE 3103335); 17 viii 1953, A. N. Sobolev (LE 3103336).

***Stigmidium squamariae* (B. de Lesd.) Cl. Roux & Triebel s. lat.**

Presumed vegetative hyphae conspicuous, brown, 4–7 µm diam., septate, constricted at the septa (toruloid), immersed, at least sometimes attached to the lower part of the ascoma; often causing

blackening of infected parts of the host hymenium (Fig. 8A & B). Ascomata perithecioid, black, subglobose, (50–)61–91(–102) µm diam. (*n* = 65), with an ostiole 5–10 µm diam., mainly semi-immersed, aggregated, sometimes contiguous. Exciple brown, medium to dark coloured above, pale at the base, 10–15 µm thick, in surface view of *textura angularis*, composed of cells 6–12 × 4.5–10 µm. Periphyses hyaline to pale brown (when exterior), 5–12 × 1.5–3 µm, 0–1-septate. Pseudoparaphyses of type b *sensu* Roux & Triebel (1994) 10–25 × 1–2 µm (10–15 × 2–3.5 µm *vide* Roux & Triebel (2005)), 0–3-septate. Asci ellipsoid, ovoid or broadly clavate, stalk short or indistinct, (27–)31–42(–44) × (11–)12–17(–19) µm (*n* = 36). Ascospores hyaline, 1-septate, narrowly obovate (usually with wider upper cell relative to the position in the ascus), (8–)9.5–11.5(–13.5) × (4–)4.5–5.5(–6.5) µm, l/w = (1.6–)1.9–2.3(–2.5) (*n* = 100), not or slightly constricted at the septum, not pseudotetrablastic, rarely with an inconspicuous halo *c.* 0.5 µm thick, occasionally with 1–3 large guttules in a cell, irregularly biseriolate in the ascus.

The material examined differs from specimens of this species from Europe and North America studied by Roux & Triebel (1994) in the characteristics of the vegetative hyphae. In the latter specimens they are colourless, not visible without staining. However, the upper part of their ascoma sometimes bears brown hyphoid appendages (Roux & Triebel 1994: fig. 3). Further studies are needed to clarify the nature and taxonomic significance of the brown toruloid hyphae observed here.

*Stigmidium squamariae* has not previously been reported from Kazakhstan, Kyrgyzstan or Turkmenistan.

**Specimens examined (all on apothecial discs of *Protoparmeliopsis peltata*).** **Kazakhstan:** Zailiyskiy Alatau Ridge, Syugoty Mts, 1970, L. I. Bredkina 32a (LE 310329).— **Kyrgyzstan:** Terskey Alatau Ridge, 17 viii 1953, A. N. Sobolev (LE 310328); Susamyrtau Ridge, Kekemeran River valley, 25 km NW of Aral settlement, 1800 m, 1973, L. I. Bredkina 2317 (LE 310331); Alay Valley, 1979, L. I. Bredkina 3388 (LE 310327); Alay Ridge, 1979, L. I. Bredkina 3425c (LE 310330).— **Turkmenistan:** North-West Kopetdag, foothills of Kurendag Ridge, Danata gorge, near Danata spring, 39°06'N, 55°06'E, 2 xi 1952, A. D. Pochaeva & I. G. Gringof (LE 310334).

**A key to the species of lichenicolous fungi and lichens growing on *Rhizoplaca* s. lat.**

The key does not include some species, evidently from the genera *Lichenostigma* and *Sphaerellothecium*, that the author encountered but could not identify. A poorly understood *Sphaerellothecium* ‘*rhizoplacae*’ ined. (Noell & Hollinger 2019: 82) is also not included. References are given to the main publications on parasite taxonomy and their occurrence on the specified hosts. Lichenized species are denoted by <sup>L</sup>.

- 1 Conidiomata or ascomata absent; presence of sterile, erumpent, pastel red, subspherical, ellipsoid or irregular bulbils, 80–250 µm diam., composed of subspherical to elongate, catenate cells; on *Rhizoplaca chrysoleuca* and *R. subdiscrepans* (Diederich 2003; Diederich *et al.* 2022) ..... **Marchandiomyces corallinus**
- Conidiomata or ascomata present ..... 2
- 2(1) Conidiomata present ..... 3
- Ascomata present ..... 12
- 3(2) Conidiomata superficial, subspherical, discoid or elongate, closed, entirely composed of subspherical or occasionally elongated stromatic cells with grey to brown conidia developing between them ..... 4
- Conidiomata different ..... 5

4(3)	Conidia 4-22-celled; on <i>Protoparmeliopsis peltata</i> (Halıcı <i>et al.</i> 2007; Ertz <i>et al.</i> 2014) . . . . .	<b>Lichenostigma alpinum</b>	
	Conidia (2-)4(-5)-celled; on <i>Protoparmeliopsis peltata</i> and <i>Rhizoplaca chrysoleuca</i> (Berger & Brackel 2011; Ertz <i>et al.</i> 2014; present paper) . . . . .	<b>Lichenostigma cf. chlaroterae</b>	
5(3)	Conidiomata initially sometimes pycnidoid, eventually sporodochial . . . . .		6
	Conidiomata true pycnidia . . . . .		7
6(5)	Conidiomata in groups of up to 100, forming blackish infection patches up to 2 mm diam.; conidia initially subhyaline, then brownish orange, greyish brown, and eventually brown; on <i>Rhizoplaca chrysoleuca</i> (Khodosovtsev <i>et al.</i> 2016; Zhurbenko <i>et al.</i> 2020; present paper) . . . . .	<b>Katherinomyces cetrariae</b>	
	Conidiomata arising singly or in smaller groups; conidia hyaline to pale greyish turquoise; on <i>Rhizoplaca chrysoleuca</i> (present paper) . . . . .	<b>Caeruleoconidia ahtii</b>	
7(5)	Conidia hyaline . . . . .		8
	Conidia brown . . . . .		9
8(7)	Conidia orbicular, broadly oblong or broadly ellipsoid; on <i>Rhizoplaca chrysoleuca</i> and <i>R. subdiscrepans</i> (Joshi <i>et al.</i> 2018; Zhurbenko <i>et al.</i> 2019, 2020; present paper) . . . . .	<b>Didymocyrtis rhizoplacae</b>	
	Conidia Y-shaped; on <i>Rhizoplaca chrysoleuca</i> (Hawksworth 1976, 1981) . . . . .	<b>Spirographa lichenicola</b> agg.	
9(7)	Conidia aseptate . . . . .		10
	Conidia septate . . . . .		11
10(9)	Conidiogenous cells (4-)5-7(-8) $\mu\text{m}$ long; on <i>Rhizoplaca chrysoleuca</i> , <i>R. melanophthalma</i> and <i>R. subdiscrepans</i> (Hawksworth 1977, 1981; present paper) . . . . .	<b>Lichenoconium lecanorae</b>	
	Conidiogenous cells (5-)7-9(-11) $\mu\text{m}$ long; on <i>Rhizoplaca melanophthalma</i> (Hawksworth 1977; Olech & Alstrup 1996) . . . . .	<b>Lichenoconium usneae</b>	
11(9)	Conidia 1-septate; on <i>Rhizoplaca chrysoleuca</i> and <i>R. melanophthalma</i> (Hawksworth & Dyko 1979; Alstrup & Hawksworth 1990). Note: probably an asexual stage of <i>Muellerella lichenicola</i> (Muggia <i>et al.</i> 2015) . . . . .	<b>Lichenodiplis lecanorae</b>	
	Conidia (1-)3-septate; on <i>Rhizoplaca chrysoleuca</i> (Calatayud & Etayo 2001) . . . . .	<b>Lichenohendersonia varians</b>	
12(2)	Ascomata superficial, subspherical, discoid or elongate, entirely composed of subspherical, dark brown and verrucose (external) to hyaline and smooth (internal) stromatic cells multiplying by budding, with asci, containing eight 1-septate, hyaline spores developing between them; on <i>Protoparmeliopsis peltata</i> (Halıcı <i>et al.</i> 2007; Ertz <i>et al.</i> 2014) . . . . .	<b>Lichenostigma alpinum</b>	
	Ascomata different . . . . .		13
13(12)	Ascomata apothecia . . . . .		14
	Ascomata perithecia . . . . .		22
14(13)	Ascospores hyaline . . . . .		15
	Ascospores brown . . . . .		21
15(14)	Ascospores aseptate . . . . .		16
	Ascospores 1-septate . . . . .		18
16(15)	Lichenized thallus present; on <i>Rhizoplaca melanophthalma</i> (Øvstedal 1986: 67, as ' <i>Lecidea</i> ' <i>oroantarctica</i> Øvstedal; Cannon <i>et al.</i> 2022) . . . . .	<b>Carbonea vorticosa</b> <sup>L</sup>	
	Lichenized thallus absent . . . . .		17
17(16)	Apothecia mainly densely aggregated, disc strongly convex; ascospores 4-5.5 $\mu\text{m}$ wide, apices rounded; on <i>Rhizoplaca subdiscrepans</i> (Rambold & Triebel 1992; Cannon <i>et al.</i> 2022; present paper) . . . . .	<b>Carbonea cf. aggregantula</b>	
	Apothecia dispersed to loosely aggregated, disc concave to flat; ascospores 4.5-7 $\mu\text{m}$ wide, apices attenuated; on <i>Rhizoplaca subdiscrepans</i> (Santesson <i>et al.</i> 2004; Cannon <i>et al.</i> 2022) . . . . .	<b>Carbonea supersparsa</b>	
18(15)	Lichenized thallus present; apothecia with blackish to occasionally red margin; ascospores polarilocular; on <i>Protoparmeliopsis peltata</i> , <i>Rhizoplaca chrysoleuca</i> , <i>R. melanophthalma</i> and <i>R. subdiscrepans</i> (Hansen <i>et al.</i> 1987; Rambold & Triebel 1992; Santesson <i>et al.</i> 2004) . . . . .	<b>Caloplaca epithallina</b> <sup>L</sup>	
	Lichenized thallus absent; apothecia without blackish or red margin; ascospores not polarilocular . . . . .		19



- 19(18) Ascomata convex, subhymenium brownish, apical cells of paraphyses with black caps; on *Rhizoplaca melanophthalma* (Alstrup & Hansen 2001) ..... **Arthonia glacialis**  
Ascomata slightly convex, subhymenium hyaline, apical cells of paraphyses without black caps ..... 20
- 20(19) Epithymenium greyish brown throughout or brown above, grey below; on *Rhizoplaca chrysoleuca*, *R. melanophthalma* (?) and *R. subdiscrepans* (?) (Santesson *et al.* 2004; Grube 2007; present paper) ..... **Arthonia clemens** var. **clemens**  
Epithymenium light brown to brown, without grey shade; on *Protoparmeliopsis peltata* (present paper) .....  
..... **Arthonia clemens** var. **peltatae**
- 21(14) Apothecia 0.2–0.5 mm diam., margin always distinct; ascospores 9–12.5 × 5–6.5 μm; on *Rhizoplaca melanophthalma* and *Rhizoplaca* sp. (Hafellner 1979; Alstrup *et al.* 2000; Roux *et al.* 2006) ..... **Sclerococcum rimulicola**  
Apothecia 0.4–1 mm diam., margin sometimes indistinct; ascospores 16–20 × 7–10 μm; on *Rhizoplaca melanophthalma* (Calatayud & Barreno 1995) ..... **Buellia vouauxii**
- 22(13) Ascospores hyaline or occasionally pale yellowish in *Placocarpus americanus* ..... 23  
Ascospores brown ..... 33
- 23(22) Ascospores aseptate or occasionally 1-septate in *Placocarpus americanus*; juvenile parasites, eventually developing an independent lichenized thallus ..... 24  
Ascospores persistently or mostly 1-septate; not lichenized ..... 25
- 24(23) Ascospores 12.5–22.5 × 5–9 μm; on *Rhizoplaca chrysoleuca*, *R. melanophthalma* (?) and *R. novomexicana* (?) (Knudsen *et al.* 2009, 2013; Zhurbenko & Notov 2015; Noell & Hollinger 2019) ..... **Placocarpus americanus**<sup>L</sup>  
Ascospores 15.5–27 × 6–12 μm; on *Rhizoplaca melanophthalma* (Roux & Gueidan 2011; Roux & Bertrand 2016) .....  
..... **Placocarpus melanophthalmosus**<sup>L</sup>
- 25(23) Ascomata mostly up to 100 μm diam.; ascospores up to 14.5 μm long ..... 26  
Ascomata larger than 150 μm diam.; ascospores longer ..... 27
- 26(25) Induces formation of brown cerebriform galls up to 7 mm diam. on the host apothecia and thallus, ascomata consistently immersed; on *Protoparmeliopsis peltata* (present paper) ..... **Stigmatidium pseudosquamariae**  
Galls absent, ascomata often semi-immersed; on *Protoparmeliopsis peltata*, *Rhizoplaca melanophthalma*, *R. novomexicana* and *R. phaedrophthalma* (Roux & Triebel 1994, 2005; Zhurbenko *et al.* 2012; Noell & Hollinger 2019; present paper) .....  
..... **Stigmatidium squamariae** s. lat.
- 27(25) Asci mostly 8-spored ..... 28  
Asci mostly 4-spored ..... 29
- 28(27) Ascospores mostly 24–31 × 7–8.5 μm; on *Protoparmeliopsis peltata* and *Rhizoplaca melanophthalma* (Kondratyuk *et al.* 2011) .....  
..... **Zwackhiomyces zareii**  
Ascospores mostly 17.5–22.5 × 5–7 μm; on *Rhizoplaca melanophthalma* (Calatayud *et al.* 2013; present paper) .....  
..... **Cercidospora melanophthalmae**
- 29(27) Ascospores mostly 30–38 μm long; exciple violaceous, sometimes with a greenish shade; on *Protoparmeliopsis peltata* (Calatayud *et al.* 2013) ..... **Cercidospora barrenoana**  
Ascospores mostly up to 31.5 μm long; exciple differently coloured ..... 30
- 30(29) Exciple mainly green or green-blue ..... 31  
Exciple differently coloured ..... 32
- 31(30) Ascospores mostly 20–25 μm long; exciple green-blue; on *Rhizoplaca melanophthalma*, *R. novomexicana* and *R. phaedrophthalma* (Calatayud *et al.* 2013; Noell & Hollinger 2019) ..... **Cercidospora macrospora**  
Ascospores mostly 22–29 μm long; exciple mainly green, greenish grey, greyish turquoise or olive; on *Rhizoplaca chrysoleuca*, *R. melanophthalma* and *R. subdiscrepans* (present paper) ..... **Cercidospora** cf. **crozalsiana**
- 32(30) Ascospores mostly 23–28.5 μm long; exciple reddish brown above, brownish grey to colourless below; on *Rhizoplaca chrysoleuca* and *R. subdiscrepans* (present paper) ..... **Cercidospora mongolica**  
Ascospores mostly 25.5–31.5 μm long; exciple uniformly grey; on *Protoparmeliopsis peltata* and *Rhizoplaca chrysoleuca* (present paper) ..... **Cercidospora tyanshanica**
- 33(22) Asci 8-spored ..... 34  
Asci polyspored ..... 37

- 34(33) Ascospores 3-septate . . . . . 35  
 Ascospores mostly/consistently 1-septate . . . . . 36
- 35(34) Ascomata c. 400 µm diam.; ascospores 34–46 × 11.5–14 µm; on *Prototermeliopsis peltata* (present paper) . . . . .  
 . . . . . **Pyrenidium actinellum** s. lat.  
 Ascomata 100–170 µm diam.; ascospores 14–16.5 × 4.5–6 µm; on *Prototermeliopsis peltata* (present paper) . . . . .  
 . . . . . **Leptosphaeria** sp.
- 36(34) Ascomata 40–80 µm diam.; asci ovoid to broadly ellipsoid or almost spherical; ascospores 1-septate, smooth-walled, irregularly  
 arranged in the ascus; on *Rhizoplaca melanophthalma* (Triebel 1989; Triebel *et al.* 1991) . . . . .  
 . . . . . **Sphaerellothecium contextum**  
 Ascomata 90–150 µm diam.; asci cylindrical; ascospores 1(–3)-septate, verruculose, ±uniseriate; on *Rhizoplaca chrysoleuca* and  
*R. subdiscrepans* (Joshi *et al.* 2018; Zhurbenko *et al.* 2019, 2020; present paper) . . . . . **Didymocyrtis rhizoplacae**
- 37(33) Asci c. 100-spored; ascomata mostly 100–125 µm diam.; ascospores pale brown, mostly 5–6 × 2.5–3 µm; on *Rhizoplaca melano-*  
*nophthalma* (Triebel 1989; Alstrup 2002) . . . . . **Muellerella lichenicola**  
 Asci c. 20–64-spored; ascomata larger; ascospores larger and mainly darker . . . . . 38
- 38(37) Asci 32–64-spored; ascomata mostly 125–200 µm diam.; ascospores pale to medium brown, mostly 6–8 × 3–4.5 µm; on  
*Rhizoplaca chrysoleuca* and *R. melanophthalma* (Triebel 1989; Joshi *et al.* 2016; present paper) . . . **Muellerella erratica**  
 Asci c. 20–32-spored; ascomata mostly 175–250 µm diam.; ascospores medium to dark brown, mostly 8–10 × 4–5 µm; on  
*Prototermeliopsis peltata* and *Rhizoplaca melanophthalma* (Triebel 1989; Hafellner & John 2006; Hawksworth &  
 Iturriaga 2006) . . . . . **Muellerella pygmaea**

## Discussion

As follows from the data presented in the key above, a total of 32 species of lichenicolous fungi and four species of lichenicolous lichens have so far been recorded on *Rhizoplaca* s. lat.; of these, three species and one variety were recorded only on *Prototermeliopsis peltata*, six species only on *Rhizoplaca* s. str. and another two species are confined to both of these host genera (Table 1).

Of the c. 25 known species of *Rhizoplaca* s. str., lichenicolous fungi and lichens were observed on five species: *R. chrysoleuca* (17 species of parasites), *R. melanophthalma* (19), *R. novomexicana* (3), *R. phaedrophthalma* (2) and *R. subdiscrepans* (8). A total of 25 parasite species have been observed on *Rhizoplaca* s. str., thus the ratio of the number of parasite species to the number of host species for this lichen genus is 1.0 (compare similar data in Zhurbenko & Ohmura (2020)).

**Table 1.** Taxa of lichenicolous fungi recorded on *Prototermeliopsis peltata* and/or *Rhizoplaca* s. str. Based on data from the key. Parasite species known only on these host genera are shown with an asterisk (\*). Lichenized species are denoted by <sup>L</sup>.

	On <i>Prototermeliopsis peltata</i>	On <i>Rhizoplaca</i> s. str.
<i>Arthonia clemens</i> var. <i>clemens</i>		+
<i>A. clemens</i> var. <i>peltatae</i> *	+	
<i>A. glacialis</i> *		+
<i>Buellia vouauxii</i> *		+
<i>Caeruleoconidia ahtii</i> *		+
<i>Caloplaca epithallina</i> <sup>L</sup>	+	+
<i>Carbonea</i> cf. <i>aggregantula</i>		+
<i>C. supersparsa</i>		+
<i>C. vorticosa</i> <sup>L</sup>		+
<i>Cercidospora barroana</i> *	+	
<i>C.</i> cf. <i>crozalsiana</i>		+
<i>C. macrospora</i>		+
<i>C. melanophthalmae</i> *		+
<i>C. mongolica</i> *		+

(Continued)




Table 1. (Continued)

	On <i>Protoparmeliopsis peltata</i>	On <i>Rhizoplaca</i> s. str.
<i>C. tyanshanica</i> *	+	+
<i>Didymocyrtis rhizoplacae</i> *		+
<i>Katherinomyces cetrariae</i>		+
<i>Leptosphaeria</i> sp.*	+	
<i>Lichenocodium lecanorae</i>		+
<i>L. usneae</i>		+
<i>Lichenodiplis lecanorae</i>		+
<i>Lichenohendersonia varians</i>		+
<i>Lichenostigma alpinum</i>	+	
<i>L. cf. chlarotherae</i>	+	+
<i>Marchandiomyces corallinus</i>		+
<i>Muellerella erratica</i>		+
<i>M. lichenicola</i>		+
<i>M. pygmaea</i>	+	+
<i>Placocarpus americanus</i> <sup>L</sup>		+
<i>P. melanophthalmosus</i> <sup>L</sup>		+
<i>Pyrenidium actinellum</i> s. lat.	+	
<i>Sclerococcum rimulicola</i>		+
<i>Sphaerellothecium contextum</i>		+
<i>Spirographa lichenicola</i> agg.		+
<i>Stigmatidium pseudosquamariae</i> *	+	
<i>S. squamariae</i> s. lat.	+	+
<i>Zwackhiomyces zareii</i> *	+	+

In this study, we were able to identify 16 species of lichenicolous fungi growing on *Rhizoplaca* s. lat., representing half of their known species diversity. The most frequently collected species in the study area were *Arthonia clemens* (10 finds), *Lichenocodium lecanorae* (8), *Cercidospora* cf. *crozalsiana* (7), *C. mongolica* (6) and *Stigmatidium squamariae* (6). Four (25%) of these 16 species are described as new to science, which corresponds to the level of taxonomic novelty in recent studies of lichenicolous fungi on such host groups as *Siphula*-like lichens (38% spp. nov.; Motiejūnaitė *et al.* 2019), *Sphaerophoraceae* (33% spp. nov.; Zhurbenko 2023) or *Thamnolia* (30% spp. nov.; Zhurbenko 2012).

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