



New species and new records in the lichen genus *Rinodina* (Physciaceae) from India

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ABSTRACT: A new species, *Rinodina indica* Vishal Kumar, R. Ngangom & Nayaka is described from India. It is characterized by ochraceous, areolate, blastidiate thallus with brown, 1-septate *Teichophila*-type ascospores. Eight additional species of the genus viz., *R. archaea* (Ach.) Arnold, *R. dolichospora* Malme, *R. mniaroeiza* (Nyl.) Arnold, *R. obnascens* (Nyl.) H. Olivier, *R. oleae* Bagl., *R. plana* H. Magn., *R. pyrina* (Ach.) Arnold and *R. trevisanii* (Hepp) Körb., are reported for the first time from India. Detailed description, illustration and distribution for new species and new records are provided. A key to all species of *Rinodina* presently known from India is also provided.

KEY WORDS: Biodiversity, Caliciales, lichenized fungi, *Rinodina herrei*, *Rinodina indica*, revision, taxonomy.

INTRODUCTION

The genus *Rinodina* (Ach.) Gray is a cosmopolitan, polyphyletic genus belonging to order Caliciales, family Physciaceae and comprises about 300 species (Wijayawardene *et al.*, 2020). The genus is characterized by crustose to sub-squamulose, rarely lobate or squamulose thallus, *lecanorine* or rarely *lecideine*-type of apothecia with brown to black discs, a hyaline hymenium, a brown, red-brown or rarely blue-grey epihymenium, clavate asci, brown, 1-septate (rarely 3-septate) to sub-muriform ascospores with well-developed septa and variously thickened walls (Mayrhofer and Moberg, 2002; Sheard, 2004, 2010).

The genus has been systematically studied in Australia, New Zealand (e.g., Mayrhofer, 1983; Mayrhofer *et al.*, 1999; Kaschik, 2006), Europe (e.g., Mayrhofer and Poelt, 1979; Mayrhofer, 1984; Giralt, 2001; Mayrhofer and Moberg, 2002) and North America (e.g., Sheard, 2004, 2010, 2018). However, less attention has been paid to the revision of the genus in Asia (e.g., Mayrhofer 1984; Kondratyuk *et al.*, 2013, 2016; Joshi *et al.*, 2013; Aptroot and Moon, 2014; Sheard *et al.*, 2017; Zheng and Ren, 2020) and South Africa (e.g., Matzer and Mayrhofer, 1996; Mayrhofer *et al.*, 2014).

The genus *Rinodina* is a common and wide-spread genus in India, however it has hitherto not been critically studied for taxonomic diversity and geographical distribution. Awasthi (1991) mentioned the occurrence of nine species from India. Mayrhofer *et al.* (2001) synonymized *R. megaspora* (D.D. Awasthi & M.R. Agarwal) D.D. Awasthi, a species described from India with *Rinodina intermedia* Bagl. Sheikh *et al.* (2006) reported two species of *Rinodina* from Jammu and Kashmir as new to India. Singh and Sinha (2010) in their checklist of Indian lichens enumerated the 11 species of

Rinodina from India. During the ongoing revisionary study of the genus from India several interesting specimens were encountered, one of it is described as new to science while eight species as new distributional records to the country. In present state of knowledge, the genus *Rinodina* in India is represented by 20 species.

MATERIALS AND METHODS

The present study is based on lichen specimens lodged in the herbarium of the CSIR-National Botanical Research Institute, Lucknow (LWG) and fresh collections. The morphological observations of specimens were made using a stereo-zoom microscope (Leica S8APO) and anatomy of ascomatal structures were observed under compound microscope (Leica DM2500), both equipped with camera and image analysis software. The fine hand-cut sections of ascomata were mounted in water and squashed to release the ascospores for detailed study. All the measurements were taken in water mounts and only mature ascospores were considered. The colour spot tests were carried out using routine reagents - potassium hydroxide (K), calcium hypochlorite (C) and para-phenylenediamine (P). The secondary metabolites were detected through thin-layer chromatography (TLC) following Orange *et al.* (2001) in solvent system C, and illustrations of Sheard (2010) were followed for the nomenclature of ascospore types (Fig. 1).

TAXONOMIC TREATMENT

Rinodina indica Vishal Kumar, R. Ngangom & Nayaka, *sp. nov.* **Fig. 2A–E**

Type: India, Uttar Pradesh, Bhadohi district, Lakhansenpur, 30 km. after Varanasi towards Bhadohi, N 25°21'18.9" E 82°42'29.3", elev. 105 m, on bark of

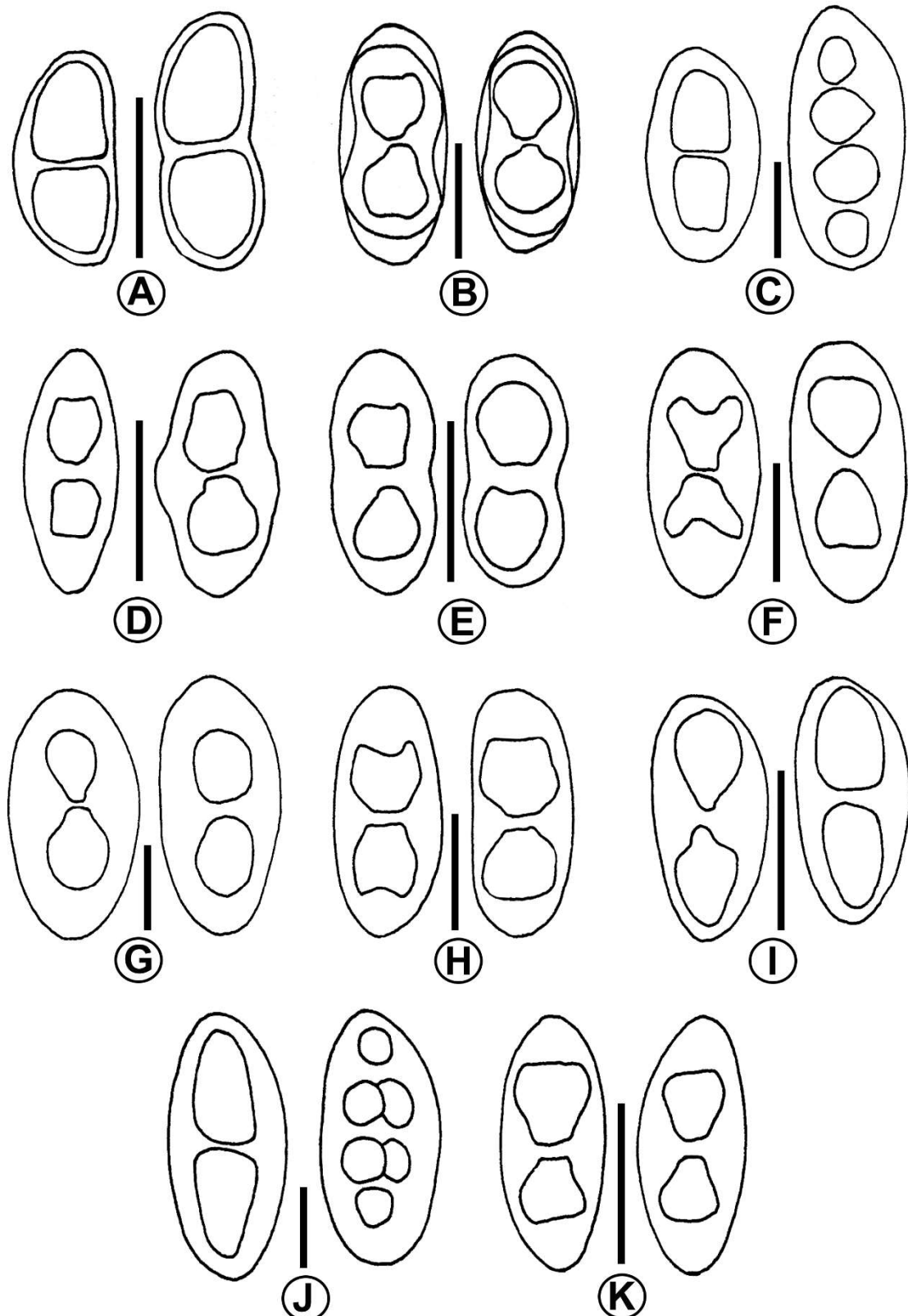


Fig. 1. Ascospore types in *Rinodina* species known from India. A. *Beltraminia*-type, *Rinodina mackenziei*. B. *Bicineta*-type, *R. straussii*. C. *Conradia*-type, *R. conradii*. D. *Dirinaria*-type, *R. oleae*. E. *Milvina*-type, *R. sophodes*. F. *Mischoblastia*-type, *R. oxydata*. G. *Pachysporaria*-type, *R. dolichospora*. H. *Physcia*-type, *R. plana*. I. *Physconia*-type, *R. trevisanii*. J. *Submuriform*-type, *R. intermedia*. K. *Teichophila*-type, *R. indica*. Scale = 10 μ m.

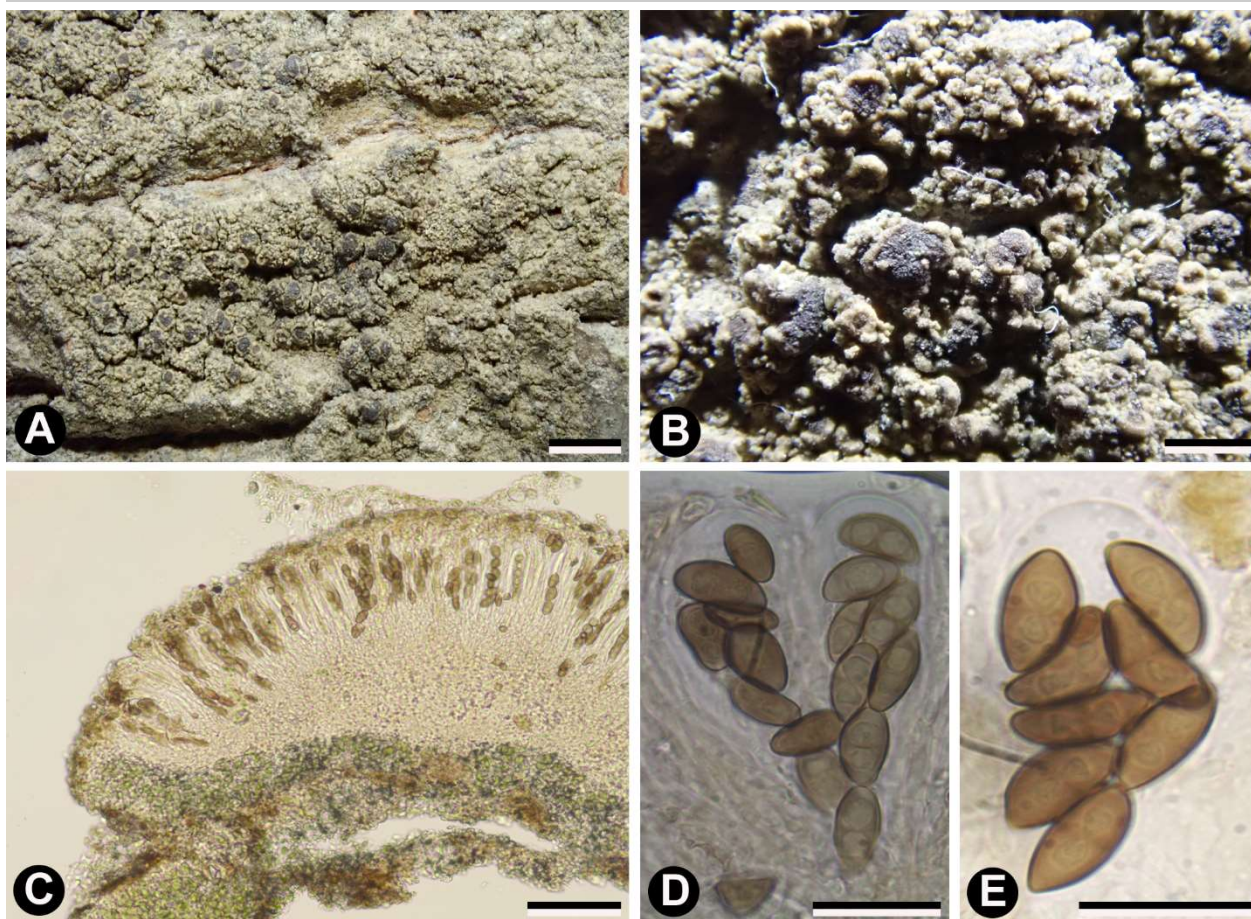


Fig. 2. *Rinodina indica*. **A.** thallus with habitat; **B.** thallus and apothecia showing blastidia; **C.** vertical section of apothecium; **D.** immature ascospores in ascus & **E.** mature ascospores. Scale bars: **A** = 5 mm; **B** = 1 mm; **C** = 5 μ m; **D** & **E** = 20 μ m.

Mangifera indica, 14 October 2012, Nayaka *et al.* 12-018235 (holotype, LWG).

Mycobank no.: MB#838885

Diagnosis: *Rinodina indica* is similar to *R. herrei* H. Magn., but differs in having persistent thalline margin and smaller ascospores of size 11.5–19 \times 5.5–8.5 μ m.

Description: Thallus crustose, 2.5 cm across, ochraceous to brown, areolate, areoles 0.6–1.8 mm wide, thick, slightly raised, blastidiate, blastidia arising from areole margins, occasionally cortex breaking at tips, margin determinate. Prothallus absent. Apothecia lecanorine, immersed to erumpent, 1–4 apothecia per areole, narrowly attached to broadly attached, becoming contiguous, 0.5–1 mm in diam., disc dark brown to black, plane to slightly convex, margin concolourous with thallus, persistent, 80–100 μ m thick, frequently becoming blastidiate. Apothecial cortex 12–18 μ m thick. Epithemium light to dark brown, 12–16 μ m, crystals absent. Proper exciple light brown, 12–25 μ m wide, thalline exciple 55–75 μ m across with green algal cells. Hymenium hyaline, 35–55 μ m high. Paraphyses simple, not conglutinate, 1.5–2.0 μ m thick, apical cell swollen,

pigmented at tips. Hypothecium slightly yellowish, 90–140 μ m high. Asci clavate, 8-spored, 40–55 \times 14–18 μ m. Ascospores brown, 1-septate, *Teichophila*-type, (11.5–) 13.0–16.0(–19.0) \times (5.5–) 6.0–7.5(–8.5) μ m, average l/w ratio 1.7–2.6 μ m, ontogeny of Type B, spore walls not ornamented, torus not observed. Pycnidia not seen.

Chemistry: Thallus K–, C–, KC–, PD–, UV–; TLC: No lichen substance detected.

Etymology: The epithet *indica* refers to the country India from where the new species is being reported.

Remarks: The new species is characterized by its corticolous habitat, ochraceous to brown, areolate thallus, presence of blastidia on thallus and apothecial margins, *Teichophila*-type of ascospores with smooth outer walls and lack of lichen compounds. It does not resemble with any *Rinodina* species known from the country. It is close to *R. herrei* H. Magn., a corticolous species endemic to North America (Sheard, 2010) by lacking chemistry and blastidia developing occasionally on areole margins, but easily gets distinguished by ascospore size and ontogeny. The lumina in immature ascospores of *R. indica* are *Physcia*-type, which becomes *Teichophila*-type at maturity. Whereas in case of *R. herrei* immature ascospores

**Table 1:** Comparison of *Rinodina indica* with some closely related species.

Species	<i>R. herrei</i>	<i>R. indica</i>	<i>R. juniperina</i>
Ascomata size (mm)	0.45–0.70	0.5–1	0.35–0.80
Apothecia	Frequent, rarely contiguous, broadly attached	Immersed to erumpent, becoming contiguous, narrowly attached at first, becoming broadly attached	Innate to erumpent, dense, not contiguous, broadly attached
Disc	Dark brown to black, convex to markedly convex	Dark brown to black, slightly convex	Black, plane, becoming fissured or markedly convex
Thalline margin	Concolourous with thallus, rarely blastidiate, often consorediate, frequently becoming excluded in mature ascomata	Concolourous with thallus, frequently blastidiate, persistent	Concolourous with thallus or flaked epinecral layer, entire, persistent or becoming excluded
Spores	(16.0–) 19.5–20.0(–23.5) × (8.0–) 10.0–11.0(–13.0) μm, Physcia-type lumina in immature stage, becomes Mischoblastia-type in mature and Pachysporaria-type in over mature ascospores	(11.5–) 13.0–16.0(–19.0) × (5.5–) 6.0–7.5(–8.5) μm, Physcia-type in immature stage but becomes Teichophila-type in mature ascospores	(12.5–) 16.0–17.0(–20.5) × (6.5–) 8.0–8.5(–9.5) μm, Physcia-type
Reference/s	Sheard, 2010	Present	Sheard, 2010; Sheard & Mayrhofer, 2002

are *Physcia*-type but become *Mischoblastia*-type at maturity and *Pachysporaria*-type in over mature ascospores. Further, *R. herrei* has larger ascospores [16–23.5 × 8–13 μm] and frequently excluding thalline margin in mature ascomata (Sheard, 2010). It was also been reported that *R. herrei* often possess consoredia (Sheard, 2010) which are not observed in the new species. Another similar species is *R. juniperina* Sheard, also has raised areole margins which sometimes develop blastidia, but easily gets distinguished by its *Physcia*-type ascospores (Table 1).

Habitat & Ecology: The new taxon is known only from Indo-Gangetic plain region of Uttar Pradesh. It was found growing luxuriantly on bark of *Mangifera indica* between elevations ranging from 85–105 m.

Additional specimens examined: INDIA, Uttar Pradesh, Bhadohi district, Chak Bhasuhi village 10 km from Bhadohi, N25°21'07.73" E 82°28'52.26" elev. 85 m, on bark of *Mangifera indica*, 14 October 2012, *Nayaka et al.* 12-029071 (LWG); Bhadohi district, Shambhupur village en route to Varanasi, N25°19'49.66" E82°47'42.86", elev. 89 m, on bark of *Mangifera indica*, 14 October 2012, *Nayaka et al.* 12-029072 (LWG).

NEW RECORDS

Rinodina archaea (Ach.) Arnold, Flora, Regensburg 64: 195 (1881) **Fig. 3A**

Parmelia sophodes var. *archaea* Ach. Methodus Lichenum (Stockholmiae): 156 (1803).

Thallus crustose, brownish grey, thick, areolate to rimose-areolate, becoming continuous, minutely verrucose, margin indeterminate, vegetative propagules and prothallus absent. Apothecia lecanorine, dense, broadly attached, becoming contiguous, 0.2–0.6 mm in diam., disc dark brown to black, plane, rarely slightly convex, margin concolourous with thallus. Apothecial cortex 10–18 μm. Epihymenium dark red-brown, 10–15

μm. Proper exciple hyaline, 7–15 μm wide, thalline exciple 93–110 μm with green algal cells. Hymenium 85–102 μm, hyaline. Paraphyses conglomerate, 1.0–2.5 μm thick. Hypothecium hyaline, 34–50 μm. Asci clavate, 8-spored. Ascospores brown, 1-septate, ellipsoidal, broadly lumened, *Physconia*-type, 14.0–22.0 × 6.0–10.0 μm. Pycnidia not seen.

Chemistry: Thallus K –, C –, KC –, PD –; TLC: No lichen substance detected.

Habitat & distribution: The species was found growing on bark of conifer tree in temperate Himalayan region in Himachal Pradesh state at an elevation of 2250 m. Earlier the species was reported from British Columbia, Southern California, Arizona, Europe, Siberia and Scandinavia (Sheard, 2010).

Remarks: *Rinodina archaea* is usually confused with *R. trevisanii* (Hepp) Körb. due to the presence of *Physconia*-type of ascospores, but the later species differs by having persistent rimose thallus and smaller ascospores of size 17.5–18.5 × 8.5–9.5 μm (Sheard, 2010).

Specimen examined: INDIA, Himachal Pradesh, Kullu district, Parvati river valley, just above Pulga rest house, elev. 2250 m, on conifer tree trunk, 19 June 1975, *D.D. Awasthi & K. Dange* 75133 (LWG-LWU).

Rinodina dolichospora Malme, Bih. K. Svenska Vetensk.-Akad. Handl., 28(III/1): 30 (1902)

Fig. 3B

Thallus crustose, light grey, thick, continuous to rimose-areolate, becoming sub-squamulose, glossy, margin indeterminate, vegetative propagules and prothallus absent. Apothecia lecanorine, scattered, broadly attached, sometimes contiguous, 0.4–0.8 mm in diam., disc dark brown to black, plane, margin concolourous with thallus. Apothecial cortex indistinct. Epihymenium red-brown, 8–15 μm. Proper exciple hyaline, 7–15 μm wide,



thalline exciple 70–105 µm with green algal cells. Hymenium hyaline, 65–110 µm high. Paraphyses not conglutinate, 1.5–2.5 µm thick. Hypothecium hyaline, 40–70 µm high. Asci clavate, 8-spored. Ascospores brown, 1-septate, ellipsoidal, *Pachysporaria*-type I, 19–35 × 14–17 µm. Pycnidia not seen.

Chemistry: Thallus K –, C –, KC –, PD –; TLC: No lichen substance detected.

Habitat & distribution: This species is being reported from the North-eastern state, Arunachal Pradesh, where it was found growing on bark at an elevation of 700 m. Its occurrence has been reported from Australia (Mayrhofer *et al.*, 1999), Brazil and south-western Europe (Giralt *et al.*, 2009), Russia (Kotlov, 2008, Sheard *et al.*, 2017) and USA (Sheard, 2010; Lendemer *et al.*, 2013, 2014).

Remarks: *Rinodina dolichospora* does not resemble any other *Rinodina* species reported so far from the country. However, it is close to *R. tenuis* Müll. Arg., in ascospore type and size but the latter species possess pannarin which is lacking in *R. dolichospora*. It also shows some similarities with *R. ascociscana* (Tuck.) Tuck. in thallus characteristics but the latter species has radially cracked apothecial margins and larger ascospores [(22.5–)30.0–32.0(–39.5) × (10.5–)13.5–14.5(–17.5) µm] of *Physcia*-type (Sheard 2010).

Specimens examined: INDIA, Arunachal Pradesh, Dibang valley district, Roing, Deopani, elev. 700 m, on bark, 01 June 1984, D.K. Upreti & B.C. Upreti L81720 (LWG); Tamil Nadu, Nilgiri Hills, Ootacamund, Botanic Garden, 7000 feet, on bark of conifer tree, 05 January 1971, D.D. Awasthi & K.P. Singh 71.281 (LWG-LWU); Nilgiri Hills, Emerald road near Muthorai, on bark of tree, 01 December 1973, K.P. Singh 73.494 (LWG-LWU).

Rinodina mniaroeiza (Nyl.) Arnold, *Flora*, Regensburg 53(30–31): 469 (1871) [1870] **Fig. 3C**

Lecanora mniaroeiza Nyl., *Flora*, Regensburg 53: (1870)

Thallus crustose to sub-squamulose, light greyish, areolate, continuous, margin indeterminate, vegetative propagules and prothallus absent. Apothecia lecanorine, 0.5–1.5 mm in diam., frequent, broadly attached, disc dark brown, convex, thalline margin concolourous with thallus, often excluding. Apothecial cortex indistinct. Epithymenium red-brown, 10–15 µm high. Proper exciple hyaline, 10–25 µm wide, thalline exciple 70–110 µm wide. Hymenium hyaline, 80–110 µm high, not interspersed. Paraphyses conglutinate, 2.0–3.0 µm thick. Hypothecium hyaline to slightly yellowish, 45–70 µm high. Asci clavate, 8-spored. Ascospores brown, 1-septate, *Physcia*-type, 24.5–32.0 × 10.0–14.0 µm. Pycnidia not seen.

Chemistry: Thallus K+ yellow, C –, KC –, PD + faint yellow; TLC: atranorin.

Habitat & distribution: *Rinodina mniaroeiza* is being reported from the mountainous region of Western Himalayan state Himachal Pradesh at an elevation of 3200 m where it was found growing on soil. Earlier, its occurrence was reported from Norway, Sweden, Greenland, Finland, North America (Mayrhofer and

Moberg, 2002) and Nepal (Awasthi, 1991).

Remarks: *Rinodina mniaroeiza* is close to *R. turfacea* (Wahlenb.) Körb. in having large ascospores of *Physcia*-type and similar habitat but the latter species differs in having plane to concave disc and persistent thalline margin with crystals of sphaerophorin (Sheard, 2010).

Specimen examined: INDIA, Himachal Pradesh, Lahul Spiti district, Lahul Valley, Chhatree, elev. 3200 m, on soil along the river, 03 August 2002, Upreti & Divakar 02-000050/B (LWG).

Rinodina obnascens (Nyl.) H. Olivier, *Bull. Acad. Intern. Géogr. Bot.* 15: 210 (1905)

Fig. 3D

Lecanora obnascens Nyl., *Flora*, Regensburg 69: 462 (1886)

Thallus crustose, lichenicolous, saxicolous, dark brownish, areolate, areoles 0.4–0.7 mm wide, margin indeterminate, prothallus absent, dark brown consoredia present, arising from areole margins. Apothecia lecanorine, 0.3–0.75 mm in diam., narrowly attached, scattered, rarely contiguous, disc brown to black, plane, thalline margin entire, concolourous with thallus. Epithymenium dark brown 12–15 µm high. Proper exciple hyaline, 24–35 µm wide, thalline exciple 65–80 µm wide. Hymenium 65–80 µm high, not interspersed. Paraphyses not conglutinate, 2.0–3.5 µm thick. Hypothecium hyaline, 70–85 µm high. Asci clavate, 8-spored. Ascospores brown to dark brown, ellipsoid, 1-septate, *Milvina*-type, 13.5–16.0 × 7.0–9.5 µm, with well-developed torus. Pycnidia not seen.

Chemistry: Thallus K –, C –, KC –, PD –; TLC: No lichen substance detected.

Habitat & distribution: This species is being reported from the temperate Central Himalayan region in Uttarakhand state, where it was found growing on crustose, saxicolous *Aspicilia* sp. at an elevation of 2611 m. Previously its occurrence was reported from North America, California, France (Sheard, 2010), Spain (Giralt, 2001), Switzerland (Mayrhofer, 1984), Bulgaria (Mayrhofer *et al.* 2005) and Sweden (Nordin, 2004).

Remarks: The spore size of Indian specimen is slightly smaller as compared to descriptions of the species from North America and Iberian Peninsula. *Rinodina obnascens* resembles with *R. milvina* (Wahlenb.) Th. Fr. in its lichenicolous habitat, ascospore size and type, but differs in external morphology and having dark brownish consoredia (Sheard, 2010).

Specimen examined: INDIA, Uttarakhand, North-West Himalayas, district Almora, on rock, 1970, D.D. Awasthi 75937 (LWG-LWU).

Rinodina oleae Bagl., *Mém. R. Accad. Sci. Torino, Ser.* 2 17: 403 (1857) **Fig. 3E**

Thallus crustose, dark grey to brownish grey, thin, areolate, areoles 0.2–0.4 mm wide, becoming continuous, rugose, margin determinate, vegetative propagules and prothallus absent. Apothecia lecanorine, 0.3–0.6 mm in diam., adnate to sessile, frequent, disc black, plane, sometimes becoming convex, thalline margin entire,



concolourous with thallus. Apothecial cortex absent. Epithymenium dark brown, 12–18 µm high. Proper exciple hyaline, 5–20 µm wide, thalline exciple 60–90 µm wide. Hymenium hyaline, 68–82 µm high. Paraphyses not conglutinate, 2–2.5 µm thick. Hypothecium hyaline, 25–45 µm high. Asci clavate, 8-spored. Ascospores brown, 1-septate, ellipsoid, *Dirinaria*-type, 12.5–17.0 × 6.0–8.5 µm. Pycnidia not seen.

Chemistry: Thallus K –, C –, KC –, PD –; TLC: No lichen substance detected.

Habitat & distribution: *Rinodina oleae* is being reported from the coastal areas of arid region in Gujarat state, where it was growing on the bark of tree at an elevation of 74 m. Earlier, it was reported from Western North America (Alaska, California), Sierra Nevada (Sheard, 2010), Europe (Giralt 2001), China (Ren and Zheng, 2020), Japan and Russia (Sheard *et al.*, 2017) and South Korea (Joshi *et al.*, 2013).

Remarks: *Rinodina oleae* is close to *R. gennarii* Bagl. in thallus characteristics and lacking chemistry, but the latter species differs in having primarily saxicolous habitat and more broadly ellipsoid ascospores (Sheard, 2010).

Specimen examined: INDIA, Gujarat, Kutch district, Lakhpat taluka, near Kutch cement factory, N23°48'00.2" E068°48'13.5", elev. 74 m, on bark, 4 June 2014, K.K. Ingle, S. Nayaka & team 15-025555 (LWG).

Rinodina plana H. Magn., Meddn Göteb. Bot. Trädg. 17: 298 (1947) **Fig. 3F**

Thallus crustose, greyish-white, verrucose, becoming areolate, margin indeterminate, delimited by a prothallus of light brown colour, vegetative propagules absent. Apothecia frequent, lecanorine, broadly to narrowly attached, becoming contiguous, 0.3–0.6 mm in diam., disc dark brown, plane to concave, margin concolourous with thallus. Epithymenium pale-brown, 08–15 µm. Proper exciple hyaline, 7–15 µm wide, thalline exciple 80–105 µm with green algal cells. Apothecial cortex indistinct. Hymenium 65–90 µm, hyaline, not interspersed. Paraphyses simple, unbranched, not conglutinate, 2.0–2.5 µm thick. Hypothecium hyaline, 20–30 µm pale-yellowish brown to hyaline. Asci clavate, 8-spored. Ascospores brown, 1-septate, ellipsoidal, *Physcia*-type, 18.5–24.5 × 10–13.5 µm. Pycnidia not seen.

Chemistry: Thallus K –, C –, KC –, PD –; TLC: No lichen substance detected.

Habitat & distribution: The species was found growing on tree trunk in temperate Himalayan region in Himachal Pradesh state at an elevation of 2850 m. Previously its occurrence has been reported from Spain, Mediterranean region (Giralt, 2001) and Central Europe (Ropin and Mayrhofer, 1993; and Nadyeina *et al.*, 2010).

Remarks: *Rinodina plana* resembles *R. exigua* (Ach.) Gray in ascospore type but the latter species differs in having atranorin and smaller ascospores (15.0–17.0 ×

7.0–8.5 µm). It also resembles *R. septentrionalis* Malme in lacking chemistry and ascospore type, but latter species gets distinguished with smaller ascospores (13.5–)16–17(–19.5) × (6.5–)7.5–8.0(–9.5) µm (Sheard, 2010).

Specimens examined: INDIA, Himachal Pradesh, Kullu district, Parvati river valley, above Pulga rest house, elev. 2850 m, on tree trunk, 20 June 1975, D.D. Awasthi & K. Dange 75239D (LWG-LWU), 75236D (LWG-LWU).

Rinodina pyrina (Ach.) Arnold, Flora 64: 196 (1881)

Fig. 3G

Lichen pyrinus Ach., Lich. Suec. Prodr. (Linköping): 52 (1799) [1798]

Thallus crustose, whitish grey to brownish, plane, continuous to rimose, margin indeterminate, vegetative propagules and prothallus absent. Apothecia lecanorine, 0.2–0.4 mm in diam., broadly attached, frequent, scattered to contiguous, disc dark brown to black, plane, sometimes becoming convex, thalline margin concolourous with thallus, persistent to becoming excluded. Apothecial cortex absent. Epithymenium pale brown, 08–15 µm high. Proper exciple hyaline, 10–20 µm wide, thalline exciple 70–95 µm wide. Hymenium hyaline, 65–80 µm high. Paraphyses not conglutinate, simple, 2.0–2.5 µm thick. Hypothecium hyaline to slightly yellowish, 35–45 µm high. Asci clavate, 8-spored. Ascospores pale brown, 1-septate, *Physconia*-type, 12.0–16.0 × 5.0–8.0 µm. Pycnidia not seen.

Chemistry: Thallus K –, C –, KC –, PD –; TLC: No lichen substance detected.

Habitat & distribution: The species was found growing on the bark of tree in the temperate region of Western Himalayan state, Himachal Pradesh at an elevation of 2850 m. Earlier, it was reported from Australasia, British Isles, Norway, Sweden, Finland, North America, northern Africa, central and southern Europe (Mayrhofer and Moberg, 2002), Taiwan (Aptroot *et al.*, 2003), Japan (Kurokawa and Kashiwadani, 2006) South Korea (Joshi *et al.* 2013) and China (Ren and Zheng, 2020).

Remarks: *Rinodina pyrina* is close to *R. orculata* Poelt & M. Steiner in thallus and ascospore characteristics but the latter species differs in having *Physcia*-*Physconia*-type ascospores and dark brown epithymenium (Giralt, 2001). It can also be mistaken with *R. imshaugi* Sheard for its *Physconia*-type similar ascospores however ascospores in *R. imshaugi* are significantly larger in size (12.5–15.5–16.5(–19) × (6.0–)7.0–7.5(–8.5) µm (Sheard, 2010).

Specimens examined: INDIA, Himachal Pradesh, Kullu district, Parvati river valley, above Pulga rest house, elev. 2850 m, on bark of tree, 20 June 1975, D.D. Awasthi & K. Dange 75234A (LWG-LWU), *ibid.*, on bark of tree, D.D. Awasthi & K. Dange 75236E (LWG-LWU).

Rinodina trevisanii (Hepp) Körb., *Parerga Lichenol.* (Breslau) 1: 70 (1859) [1865] **Fig. 3H**

Psora trevisanii Hepp, Flecht. Europ.: no. 80 (1853).

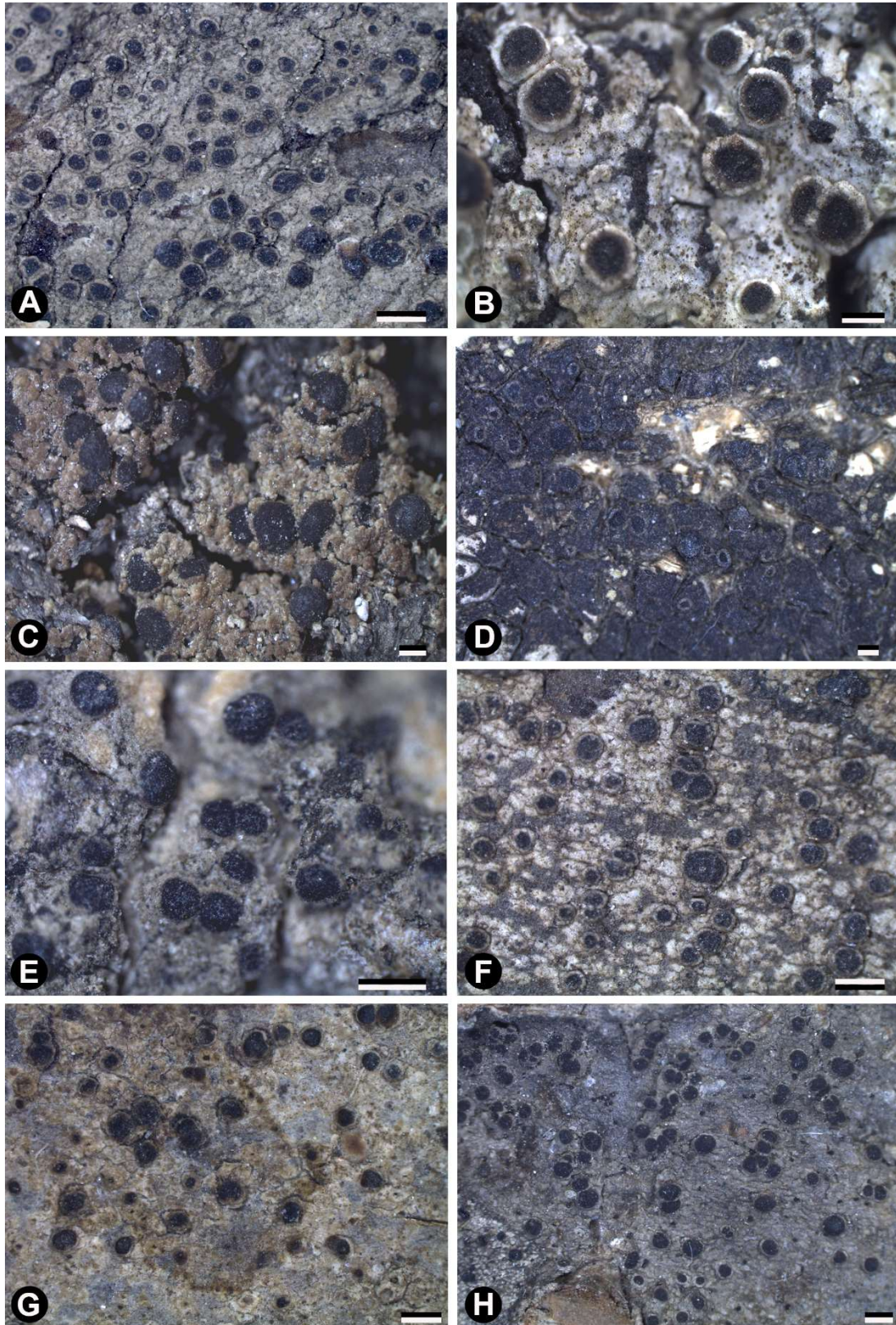


Fig. 3. **A.** *Rinodina archaea* with rimose-areolate thallus and dense apothecia; **B.** Sub-squamulose thallus of *Rinodina dolichospora* with apothecia; **C.** Thallus of *Rinodina mniaroeiza* with sub-squamules and apothecia; **D.** *Rinodina obnascens* with apothecia and consoredia; **E.** Thallus and apothecia of *Rinodina oleae*; **F.** Thallus of *Rinodina plana* with apothecia; **G.** *Rinodina pyrina* with apothecia & **H.** *Rinodina trevisanii* with plane-rimose thallus and scattered apothecia. (Scale bars: **A - H** = 0.5 mm)



Thallus crustose, greenish to pale grey, continuous to rimose, surface plane, margin indeterminate, vegetative propagules and prothallus absent. Apothecia lecanorine, scattered, broadly attached, 0.3–0.7 mm in diam., disc dark brown to black, frequently convex, thalline margin concoloured with thallus, entire, becoming excluded. Apothecial cortex indistinct. Epihymenium brown to yellowish brown, 10–12 µm high. Proper exciple light brown 10–20 µm wide, thalline exciple 40–80 µm wide. Hymenium hyaline, not interspersed, 40–50 µm high. Paraphyses conglutinate, simple, unbranched, 2–2.5 µm thick. Hypothecium hyaline, 30–60 µm high. Asci clavate, 8-spored. Ascospores brown, 1-septate, *Physconia*-type 15.0–18.0 × 6.0–8.0 µm. Pycnidia not seen.

Chemistry: Thallus K⁻, C⁻, KC⁻, PD⁻; TLC: No lichen substance detected.

Habitat & distribution: *R. trevisanii* is reported from the North-eastern state Sikkim where it was found growing on bark. This species is widely distributed across Scandinavia and Siberia and is scattered in montane localities in the Southern Alps, Asia (Caucasus, Turkey, Siberia), (Mayrhofer and Sheard, 2007; Sheard, 2010) Minor and western North America (Mayrhofer and Sheard, 2007). It has been widely reported from the Russian Far East (Chabanenko, 2002), Western Mongolia (Hauck *et al.*, 2013b), Kazakhstan (Hauck *et al.*, 2013a) and China (Zheng and Ren, 2020).

Remarks: *Rinodina trevisanii* shows similarity with *R. archaea* (Ach.) Arnold in having *Physconia*-type ascospore but the latter species gets distinguished by having larger ascospores (14.0–22.0 × 6.0–10.0 µm), thick and areolate thallus and often contiguous apothecia with persistently plane discs (Mayrhofer and Sheard, 2007; Sheard, 2010).

Specimen examined: INDIA, Nagaland, Tuensang district, way to Mokochung near, Cardamon plantation, N 26°12'31.70", E 94°44'40.00", elev. 2084 m, on bark, 02 October 2018, *R. Ngangom 18-035396* (LWG).

Key to the *Rinodina* species from India

- 1a. Thallus saxicolous 2
- 1b. Thallus otherwise 5
- 2a. Thallus K⁺ yellow (atranorin present), thin, whitish to pale grey, composed of discrete areoles; ascospores *Mischoblastia*-type, 14–22 × 7.0–10.0 µm *R. oxydata* (A. Massal.) A. Massal.
- 2b. Thallus K⁻, ascospores different 3
- 3a. Ascospores *Milvina*-type, 13.5–16.0 × 7.0–10.0 µm, thallus lichenicolous, dark brown, consoredia dark brown to blackish arising from areole margins *R. obnascens* H. Olivier
- 3b. Ascospores otherwise, thallus independent 4
- 4a. Ascospores *Bicineta*-type, 18.0–22 × 9.0–12.0 µm, thallus white to greyish, pruinose, apothecia to 1 mm in diam. *R. straussii* J. Steiner
- 4b. Ascospores *Teichophila*-type, 16.0–22.0 × 9.0–15 µm, thallus grey to brown, areolate, apothecia 0.3–1 mm in diam. *R. tephrae* (Tuck.) Herre
- 5a. Thallus corticolous 6
- 5b. Thallus terricolous, muscicolous or on decaying plant debris 19
- 6a. Ascospores 3-septate or submuriform 7
- 6b. Ascospores 1-septate 8
- 7a. Ascospores consistently 3-septate, 20.0–32.0 × 10.0–12.0 µm,

- thallus inconspicuous, brownish grey to dark brown, continuous, plane, apothecia 0.5–0.8 mm in diam. *R. conradii* Körb.
- 7b. Ascospores submuriform at maturity, 24–39 × 13–18 µm, thallus light brown to ochraceous, continuous, plane to rugose with small marginal lobes, apothecia 0.8–1.5 mm in diam. *R. intermedia* Bagl.
- 8a. Thallus with vegetative propagules 9
- 8b. Thallus lacking vegetative propagules 10
- 9a. Epihymenium blue-grey, K⁺ violet, areoles with marginal consoredia, ascospores *Dirinaria*-type, 16.0–22.0 × 10.0–12.0 µm *R. colobina* (Ach.) Th. Fr.
- 9b. Epihymenium brownish, K⁻, areoles with frequent blastidia, ascospores *Teichophila*-type 11.5–19 × 5.5–8.5 µm *R. indica* Vishal Kumar, R. Ngangom & Nayaka
- 10a. Ascospores *Pachysporaria*-type 11
- 10b. Ascospores otherwise 12
- 11a. Ascospores 19.0–35.0 × 14.0–17.0 µm, thallus light grey, areolate, becoming sub-squamulose *R. dolichospora* Malmé
- 11b. Ascospores 14.0–22.0 × 8.0–11.0 µm, thallus ochraceous, continuous to rimose *R. intrusa* (Nyl.) Malmé
- 12a. Ascospores *Milvina*-type, 13.0–16.0 × 7.0–8.0 µm, thallus grey to brown, continuous to areolate, apothecia up to 1 mm in diam. *R. sophodes* (Ach.) A. Massal.
- 12b. Ascospores otherwise 13
- 13a. Ascospores *Physcia* or *Physconia*-type 14
- 13b. Ascospores otherwise 18
- 14a. Ascospores *Physcia*-type 15
- 14b. Ascospores *Physconia*-type 16
- 15a. Ascospores 15.0–17.0 × 7.0–8.5 µm, thallus K⁺, light to dark grey, areolate, apothecia 0.3–0.8 mm in diam. *R. exigua* (Ach.) Gray
- 15b. Ascospores 18.5–24.5 × 10.0–13.5 µm, thallus K⁻, greyish-white, verrucose, becoming areolate, apothecia 0.3–0.6 mm in diam. *R. plana* H. Magn.
- 16a. Ascospores 12.0–16.0 × 5.0–8.0 µm, thallus whitish grey to brownish, continuous to rimose, apothecia 0.2–0.4 mm in diam. *R. pyrina* (Ach.) Arnold
- 16b. Ascospores larger 17
- 17a. Ascospores 14.0–22.0 × 6.0–10.0 µm, thallus brownish grey, rimose-areolate, apothecia 0.2–0.6 mm in diam. *R. archaea* (Ach.) Arnold
- 17b. Ascospores 15.0–18.0 × 6.0–8.0 µm, thallus greenish to pale grey, continuous to rimose, apothecia 0.3–0.7 mm in diam. *R. trevisanii* (Hepp) Körb.
- 18a. Ascospores *Beltraminia*-type, 13.0–17.0 × 7.0–8.0 µm, thallus dark brown, continuous, apothecia 0.1–0.3 mm in diam. *R. mackenziei* Räsänen
- 18b. Ascospores *Dirinaria*-type, 12.5–17.0 × 6.0–8.5 µm, thallus dark grey to brownish grey, apothecia 0.3–0.6 mm in diam. *R. oleae* Bagl.
- 19a. Ascospores 3-septate or submuriform 20
- 19b. Ascospores 1-septate 21
- 20a. Ascospores consistently 3-septate, 20.0–32.0 × 10.0–12.0 µm, thallus inconspicuous, brownish grey to dark brown, continuous, plane, apothecia 0.5–0.8 mm in diam. *R. conradii* Körb.
- 20b. Ascospores submuriform, light brown to ochraceous, continuous, plane to rugose with small marginal lobes, apothecia 0.8–1.5 mm in diam. ascospores, 24–39 × 13–18 µm *R. intermedia* Bagl.
- 21a. Apothecial cortex well developed, sphaerophorin present, thallus K⁻, ashy white to brownish grey, areolate, apothecia 1–1.5 mm in diam., ascospores 1-septate *Physcia*-type, 26–35 × 11.0–14.0 µm *R. turfacea* (Wahlenb.) Körb.
- 21b. Apothecial cortex indistinct, sphaerophorin absent, thallus K⁺ yellow, light grey, sub-squamulose, apothecia up to 1.5 mm in diam., ascospores *Physcia*-type 24.5–32.0 × 10.0–14.0 µm *R. mniaroelza* (Nyl.) Arnold.

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