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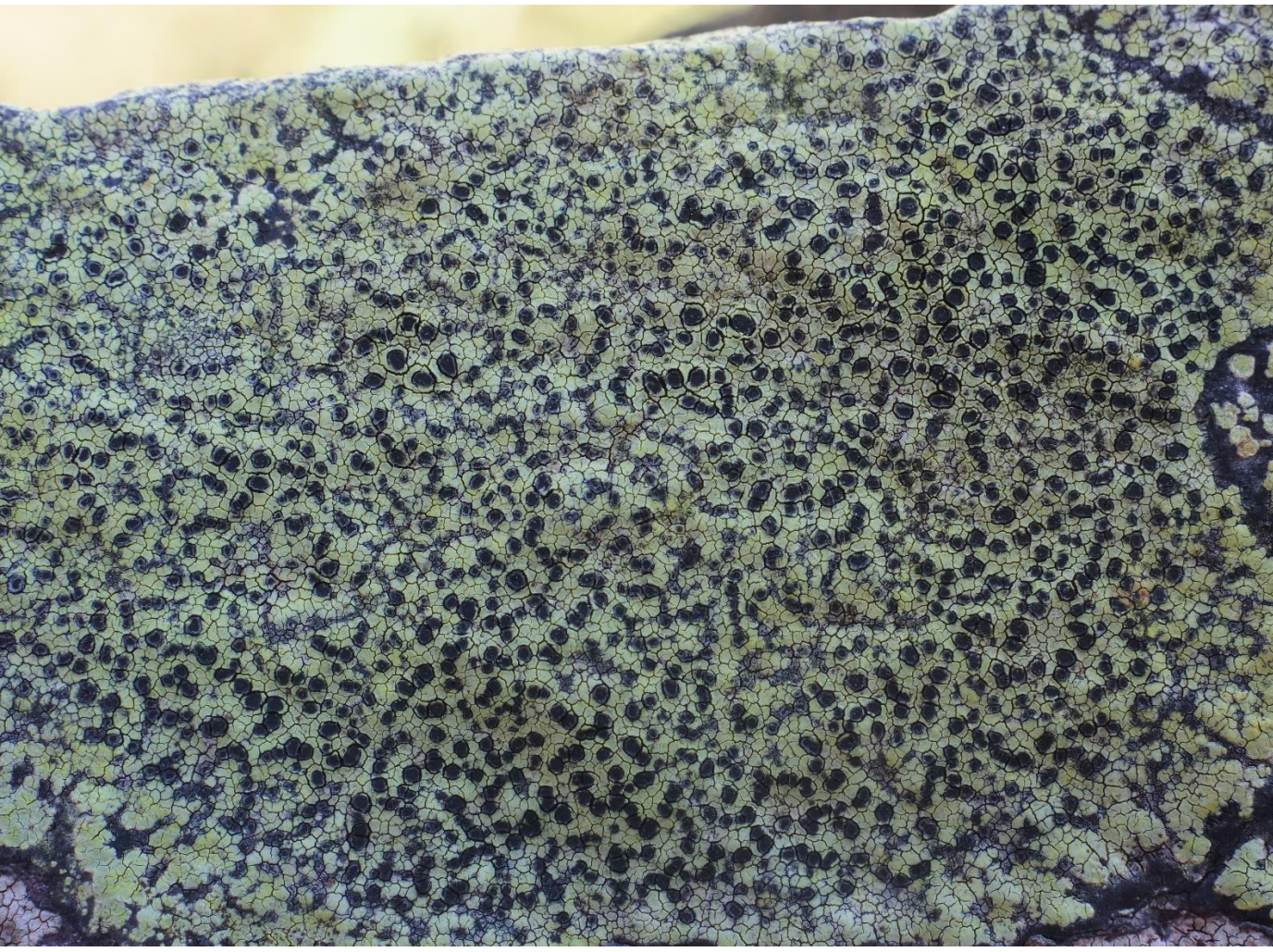

Rhizocarpales

Cover image: *Rhizocarpon geographicum*, on maritime mudstone, Hartland Point, N. Devon, England.

Revisions of British and Irish Lichens is a free-to-access serial publication under the auspices of the British Lichen Society, that charts changes in our understanding of the lichens and lichenicolous fungi of Great Britain and Ireland. Each volume will be devoted to a particular family (or group of families), and will include descriptions, keys, habitat and distribution data for all the species included. The maps are based on information from the BLS Lichen Database, that also includes data from the historical Mapping Scheme and the *Lichen Ireland* database. However, these are not comprehensive and there are many further records that have not yet been digitized. The choice of subject for each volume will depend on the extent of changes in classification for the families concerned, and the number of newly recognized species since previous treatments.

To date, accounts of lichens from our region have been published in book form. However, the time taken to compile new printed editions of the entire lichen biota of Britain and Ireland is extensive, and many parts are out-of-date even as they are published. Issuing updates as a serial electronic publication means that important changes in understanding of our lichens can be made available with a shorter delay. The accounts may also be compiled at intervals into complete printed accounts, as new editions of the *Lichens of Great Britain and Ireland*.

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Rhizocarpales

including *Catolechia*, *Epilichen*, *Haugania*, *Poeltinula* and *Rhizocarpon* (Rhizocarpaceae), and *Sporastatia* and *Toensbergia* (Sporastatiaceae)

by

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RHIZOCARPACEAE M. Choisy ex Hafellner (1984)

Thallus crustose to squamulose or placodioid, rimose, smooth or warted, variously coloured, usually corticate, sometimes lichenicolous at an early stage or remaining so, either forming an independent thallus or merely forming ascomata on the host thallus. **Soralia** or **blastidia** present in a few species. **Photobiont** chlorococcoid. **Ascomata** apothecia, immersed in the thallus or sessile on the thallus or the hypothallus, black, marginate or not, discoid, angular or rarely lirelliform, flat or convex, lecideine. **True exciple** variously developed, sometimes becoming excluded, of radiating or intertwined hyphae, sometimes containing crystals visible in polarized light. **Hymenium** colourless, I+ blue. **Hamathecium** of paraphysoids, usually branched and anastomosed, often with swollen apices and sometimes with a dark apical cap. **Asci** clavate to cylindrical, fissitunicate, with a well-developed tholus that is K/I+ blue near the apex, with an outer K/I+ blue gelatinized layer, 1- to 8-spored. **Ascospores** colourless to dark green or brown, 1-septate to muriform when mature, usually with a gelatinous perispore. **Conidiomata** pycnidia, rarely seen, sometimes chambered, immersed in the thallus. **Conidia** cylindrical to elongate. **Chemistry**: rhizocarpic acid present in the cortex of some species, rarely in the medulla, giving thalli a yellow-green coloration; various depsides, depsidones, and fatty acids often present in the medulla. **Ecology**: on siliceous or basic rocks, rarely on acid soils.

The family contains five genera, all of which are represented in Britain and Ireland. The Sporastatiaceae (see below), which is also included within the Rhizocarpales, has unbranched paraphysoids, asci with a tholus that is entirely IK/I+ blue, and 2- or multispored asci containing aseptate ascospores (Bendiksby & Timdal 2013, Lücking *et al*. 2017).

Literature:
Bendiksby & Timdal (2013), Hafellner (1978, 1984), Ihlen & Ekman (2002), Lücking *et al*. (2017).

1 Thallus squamulose to placodioid, on ± vertical acid rocks faces, bright yellow-green..... ***Catolechia***
Thallus crustose, on siliceous or basic rock or lichenicolous on *Baeomyces*; variously coloured.....2

2(1) Apothecia lirelliform, sometimes branched..... ***Poeltinula***
Apothecia discoid or angular.....3

3(2) Thallus well-developed, usually thick, variously coloured, primarily saxicolous or sometimes lichenicolous on other crustose species; ascospores with a gelatinous perispore 4
Thallus thin, often poorly-developed, yellow-green; lichenicolous on *Baeomyces*; ascospores without a perispore..... ***Epilichen***

4(3) Thallus rust-coloured; apothecia with an umbonate to gyrose apothecial disc; ascospores relatively small (average length less than 30 µm), 3-septate to submuriform, persistently colourless ..... ***Haugania***
Thallus yellow-green, whitish or various shades of brown; apothecial disc usually ± smooth; ascospores variously sized, 1-septate to muriform, colourless or pigmented ..... ***Rhizocarpon***

CATOLECHIA Flot. (1850)

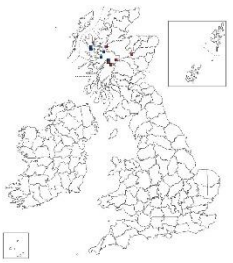
As this is a monotypic genus the description below (*C. wahlenbergii*) incorporates the generic description.

Catolechia resembles *Epilichen* in both ascus structure and the nature of the hamathecial filaments

but differs in the squamulose thallus and the position of the apothecia. Unpublished research indicates that these differences are insignificant in phylogenetic terms, and even that *C. wahlenbergii* and *E. scabrosus* are congeneric. However, this work has not been formally published, and the genera are accepted in their traditional circumscription for the present.

Literature:
Gilbert & Hawksworth (2009), Hafellner (1978).

Catolechia wahlenbergii (Flot. ex Ach.) Körb. (1855) **VU**



Thallus squamulose to ± placodioid, up to 15 cm diam., thick, puckered and ± folded in ridges, lobed at the margins, bright yellow-green, sometimes stained brownish in parts, the surface interspersed with yellowish crystals; photobiont chlorococcoid (*Elliptochloris*); medulla well-developed, I–, dark brown beneath, with rhizines attaching it to the substratum; prothallus absent. Apothecia to 2 mm diam., arising between the squamules; adjacent cortical tissues dark red in section; true exciple soon excluded, dark reddish brown; cells with scarcely distinct lumina; thalline margin absent. Epithecium dark olive-green, K–, N+ magenta; hymenium 100–120 µm tall; hypothecium dark brown, reddish in parts. Asci elongate-clavate, the outer coat K/I+ blue, ± thickened at the apex, with an internal K/I+, deep blue, meniscus-like cap, 8-spored, 50–70 × 14–17 µm. Ascospores ellipsoidal, rounded at the ends, brown, 0- to 1- (to 3-) septate, smooth, lacking a distinct perispore, the central septum with an internal torus, (12–) 13–17 (–18) × 7–10 µm. Conidiomata not known. Thallus C–, K–, KC–, Pd+ yellow-orange (two pulvinic acid derivatives and additional unknown compounds). **BLS 0325**.

On the vertical side of large boulders, overgrowing mosses and in rock crevices above 900 m; very rare. Scotland, where it is centred in the Ben Nevis range with outlying populations in Glen Coe, on Ben Alder, the Cairngorms, north to West Ross (Fisherfield Forest) and on basalt and gabbro on the Isle of Skye.

When sterile may be confused with *Arthrorhaphis alpina* which has squamules up to 1 mm diam. with a matt upper surface and a Pd– medulla.

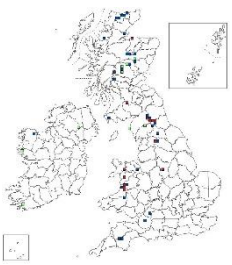
EPILICHEN Clem. (1909)

Thallus crustose, areolate to subsquamulose, or absent. **Prothallus** absent; distinct cortex lacking. **Soralia** and **isidia** absent. **Photobiont** chlorococcoid algae. **Ascomata** apothecia. **Thalline margin** absent. **True exciple** black. **Epithecium** brownish. **Hypothecium** thick, dark brown. **Hamathecium** a branched and anastomosing net of paraphysoid-like filaments, not distinctly capitate. **Asci** elongate-clavate, the apex of the tholus and the hymenial gelatine K/I+ blue. **Ascospores** brown, 1-septate, the septum with a toroid ring around it. **Conidiomata** not known. **Chemistry**: two pulvinic acid derivatives and additional unknown compounds. **Ecology**: lichenicolous lichens, sometimes developing an independent thallus following death of the host mycobiont.

Formerly included in *Buellia*, but that genus differs in having broader, true paraphyses which are branched only at the swollen and deeply pigmented apices as well as having *Lecanora*-type asci. *Catolechia* is distinguished by the different thallus type, ecology and apparently, the early stages of development of the ascomata (but see above). There are two species known (Ihlen 1998), only one of which occurs in our region. The status of a third species (lichenicolous on a *Lecidea* species from E. Russia) needs confirmation; see Triebel (1989).

Literature:
Gilbert & Hawksworth (2009b), Hafellner (1978), Ihlen (1998), Minter & Cannon (2021), Triebel (1989).

Epilichen scabrosus (Ach.) Clem. (1909) **Nb**



Thallus variably developed, seemingly converted from the thallus of the host lichen, eventually forming small patches 1–3 (–4) cm diam., crustose, areolate to subsquamulose, bright green-yellow, the areoles/squamules sometimes strongly convex. Prothallus not distinct, the cortex not well-differentiated. Apothecia developing individually or in small ± confluent groups from between the squamules, 0.25–0.4 (–0.65) mm diam., discoid to shallowly convex, black, not pruinose; true exciple not well-developed, internally composed of an outer layer of dark grey-brown globose cells 5–9 µm diam. accompanied by amorphous melanized material, and an inner layer of colourless to pale brown thin-walled globose to ellipsoidal cells interspersed with copious crystalline inclusions; hypothecium dark brown, not changing colour in K; hymenium 70–100 µm tall, the asci and paraphysoids immersed in a K/I+ blue gel matrix; epithecium olive to greenish black, amorphous. Paraphysoids branched and anastomosed, thick-walled, 2–2·5 µm diam., the apices not strongly swollen but with an outer layer of pigment that forms the epithecium. Asci 50–60 × 19–27 µm, clavate, with a short tapering stalk, thick-walled but not fissitunicate, the apex rounded with a well-developed tholus, K/I+ blue with the tip of the tholus staining more deeply, 8-spored. Ascospores arranged irregularly, (11–) 12.5–15 (–16·5) × 5–7 (–7·5) µm, cylindric-ellipsoidal with the apices obtuse to rounded, dark brown, usually strongly constricted at the median to slightly submedian septum, thick-walled with the septum often with toroidal thickening, smooth, without a perispore. Conidiomata not known. Chemistry: thallus C–, K–, Pd+ yellow-orange, UV+ orange, with unidentified pulvinic acid derivatives and additional compounds. **BLS 0510**.

Initially on thalli of *Baeomyces* spp. (principally *B. rufus*, also *B. placophyllus* in Scandinavia) but developing an independent thallus; frequent especially around old mine-workings and on spoil heaps. England (Dartmoor, Mendips, N. Pennine ore-field), mid-Wales, scattered through Scotland, a few records in W. Ireland.

This species is easily recognized in the field, forming small, bright green patches on thalli of *Baeomyces rufus* but persisting with its own thallus once the host tissues have degraded. *E. glauconigellus* (not recorded from our region) is also lichenicolous on *Baeomyces* (Ihlen 1998) but does not develop its own thallus and the apothecia have a better-developed true exciple. *Arthroraphis* species (e.g. *A. alpina*) may be distinguished by a well-developed and persistent true exciple.

HAUGANIA E.J. Möller & Timdal (2024)

Differs from *Rhizocarpon* in the combination of rust-coloured thallus, umbonate to gyrose apothecial disc, and relatively small (average length less than 30 µm), 3-septate to submuriform, persistently colourless ascospores.

According to an unpublished phylogenetic study (Möller et al. in prep.), *Haugania oederi* and the non-British *H. pycnocarpoides* occupy an isolated position within *Rhizocarpon* s.l. This was shown already for *H. oederi* by Ihlen & Ekman (2002), though based on a relatively small taxon sampling. The isolated position of the family Rhizocarpaceae makes rooting the phylogeny problematic and it remains open to further study if *Haugania* is basal in the family or nested within a paraphyletic *Rhizocarpon* that should be further subdivided. The genus and its two constituent species are formally introduced in this publication on p. 27 below.

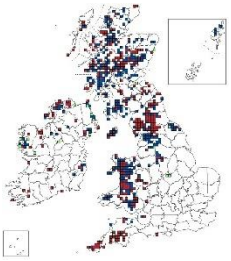
Literature:

Ihlen & Ekman (2002).

Haugania oederi (Ach.) E.J. Möller & Timdal (2024) **LC**

Rhizocarpon oederi (Ach.) Körb. (1861)

Thallus to 5 cm diam., often coalescing to form extensive patches, crustose, rimose or areolate; prothallus indistinct; areoles to 0.2 (–0.5) mm diam., matt, usually angular, flat to convex, ochre to deep orange-brown.



Apothecia to 0.5 mm diam., not pruinose, angular to flexuose; disc usually umbonate or subgyrose, uneven; true exciple distinct, internally brown-black, K–; epithecium olive-green or green-black, K–; hymenium colourless to faintly green in upper part; hypothecium dark brown, K–; no crystals or granules in the apothecia. Ascospores 12–18 × 3–7 µm, mainly 3-septate, persistently colourless. Lichen products not detected by TLC. **BLS 1267**.

On siliceous rocks rich in iron minerals; locally frequent. Mainly N. & W. Britain and Ireland.

Characterised by the rust-red thallus, gyrose-umbonate apothecia and 3-septate, colourless ascospores. *Tremolecia atrata* has a similarly coloured, areolate thallus but the apothecia are smooth and shiny, with a concave disc and the ascospores are aseptate.

There is a single record of an unidentified *Endococcus* sp. on this host.

Haugania pycnocarpoides (Eitner) E.J. Möller & Timdal (2024), known from Central Europe and Scandinavia, is morphologically similar but differs in having larger, mainly muriform ascospores and more sessile, more regularly rounded, umbonate (not gyrose) apothecia with a thicker margin. It should be looked for in our area on metal-rich rock.

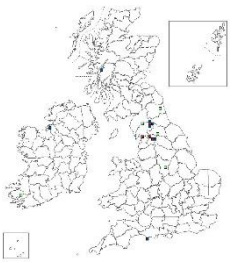
POELTINULA Hafellner (1984)

Thallus crustose. **Photobiont** chlorococcoid. **Ascomata** apothecia, angular to shortly lirelliform, occasionally forked, sometimes contorted, black. **Disc** slit-like to expanded. **True exciple** prominent and inflexed, dark reddish-brown, K± reddish intensifying. **Hymenium** colourless, I+ blue. **Hypothecium** dark reddish brown. **Hamathecium** of narrow paraphysoids, mostly unbranched but sometimes anastomosed or branched near the apices, apices slightly swollen, some with a thin, blackish apical cap. **Asci** clavate, *Rhizocarpon*-type, 8-spored. **Ascospores** ellipsoidal to cylindrical, 1-septate, at first colourless, soon becoming grey-green to violet-black, N+ red, with a distinct ± gelatinous perispore. **Conidiomata** unknown. **Chemistry**: no lichen substances reported. **Ecology**: on limestone.

The genus has been confused in the past with *Encephalographa* (type *E. elisae*, not known from our region), which is now referred to the Melaspileaceae (Ertz & Diederich 2015). Three species are known, only one of which occurs in our region. Unpublished research indicates that the genus nests within a broad concept of *Rhizocarpon*, but a more detailed revision is needed before any changes are accepted.

Literature:
Ertz & Diederich (2015), Gilbert (2009), Hafellner (1984).

Poeltinula cerebrina (DC.) Hafellner (1984) **VU**



Thallus mostly rather thick, to 0.6 mm, chalky white, ± bluish tinged, continuous to areolate, sometimes eroded and undulating, effuse or weakly delimited; photobiont cells 7–15 µm diam. Apothecia 0.5–2 mm diam.; angular or elongate, sometimes with a cruciform disc, scattered or in groups, sessile; epithecium olive-grey or olive-brown, K–, N+ red; hymenium 70–100 µm tall; paraphysoids 1.5–3 µm diam., apices with a dark pigmented hood to 5 µm diam. Ascospores 15–23 × 8–12 µm, cylindric-ellipsoidal, slightly constricted at the septum, becoming violet-black but remaining ± colourless around the septum. **BLS 0501**.

On hard limestone, especially vertical surfaces; habitat ranges from exposed outcrops to beside rivers; rare. Centred on the Carboniferous limestone of the N. Pennines with outlying populations on Jurassic limestone in Dorset, W. Scotland (Lismore), mid-Wales & W. Ireland.

In the field could be mistaken for an *Opegrapha* with a well-developed thallus.

RHIZOCARPON Ramond ex DC. (1805)

Thallus crustose or absent in some lichenicolous species; when present usually areolate, the areoles arising discretely on the prothallus or through secondary cracking, more rarely partly immersed or continuous, rimose, warted, or somewhat effigurate at the margin, green to yellow-green, white, grey or brown, rarely sorediate or blastidiate. **Prothallus** usually present, black or sometimes white to brown-grey. **Upper cortex** usually well developed. **Lower cortex** absent. **Photobiont** chlorococcoid. **Medulla** I+ violet or I–. **Ascomata** apothecia, black, ± concave to strongly convex, round to angular, attached to prothallus or on, or at the edges of areoles. **Thalline margin** absent. **True exciple** ± well-developed, clearly evident when young, persistent or becoming excluded, or thin and indistinct; internally composed of radiating or unorientated hyphae, with a brown- or green-blue margin and usually a paler or rarely colourless inner part, frequently containing crystals visible in polarised light. **Epithecium** brown, green or purple-red, frequently containing crystals visible in polarised light. **Hymenium** K/I+ blue. **Hypothecium** medium to dark brown, lacking crystals. **Hamathecium** of paraphysoids, usually strongly conglutinate, usually richly branched and anastomosed, rarely almost simple and lax, apical cell slightly to distinctly swollen. **Asci** 1- to 8-spored, clavate to cylindrical, discharge fissitunicate, with a well-developed tholus that is K/I– in the lower part and K/I+ blue near the apex, lacking an ocular chamber, *Rhizocarpon*-type. **Ascospores** colourless to grey-green, blue-black or dark brown, 1-septate to muriform, ± ellipsoidal, with a swollen perispore (halonate). **Conidiomata** pycnidia, known for a few species only, simple or chambered, associated with the prothallus or immersed in the areoles. **Conidiogenous cells** terminal and flask-shaped, or pleurogenous with bayonet-like processes. **Conidia** cylindrical to acicular. **Chemistry**: rhizocarpic acid in the cortex of all yellow-green species, usually with depsides, depsidones or aliphatic compounds in the medulla (barbatic, bourgeanic, diffractaic, gyrophoric, norstictic, psoromic and stictic acids; also hyperstictic acid and confriesiic acid in extra-British material). **Ecology**: predominantly on hard, siliceous rocks; some species, especially those with white thalli, on limestone or other basic rocks; a few species parasitic or commensalistic on other crustose lichens on rocks.

Conidiomata are seldom seen but can occur directly in the prothallus between the areoles. The crystals in the epithecium and exciple, which are visible only under polarised light, are strongly correlated with the presence of stictic or norstictic acids in the thallus.

Buellia and *Catillaria* species on rocks are distinguished by their unbranched paraphyses, generally smaller ascospores that lack a swollen perispore and different ascus structure. *Poeltinula cerebrina*, which occurs on hard limestones, has 2-celled ascospores with a distinct perispore as in *Rhizocarpon*, but the apothecia are shortly lirelliform to angular with a thick, black, opaque exciple.

Phylogenetic studies of *Rhizocarpon* are few (surprisingly for such a prominent genus), but unpublished preliminary research suggests that the *R. geographicum* and *R. hochstetteri* groups form separate clades, and that *Catolechia*/*Epilichen*, *Haugania* and *Poeltinula* form clades within a broader *Rhizocarpon* assemblage. However, the number of species included in the study was relatively small, and further research is needed before a revision can be attempted.

Rhizocarpon transiens Eitner (1911) has been incorrectly recorded from Britain and Ireland, and *R. grande* has been reported from N. Wales but a voucher specimen has not been traced.

Literature:
Davydov & Yakovcheno (2017), Feuerer (1978, 1991), Fletcher *et al.* (2009), Fryday (1996, 2000, 2002), Hafellner (2006), Ihlen (2004), Ihlen & Ekman (2002), Timdal & Holtan-Hartwig (1988).

1 Non-lichenized, thallus absent 2
Lichenized, thallus present (one species initially lichenicolous; see *R. viridiatrum*) 3

2(1) Ascospores 1-septate; on *Pertusaria* spp. ..... ***advenulum***
Ascospores submuriform; on *Ochrolechia parella* ..... ***ochrolechiae***

3(1) Thallus ± bright yellow-green; ascospores soon becoming dark green-blue to brown 4
Thallus white, grey, brown or orange-brown; ascospores colourless or becoming dark green-blue to brown 11

4(3) Areoles with punctiform-capitate soralia ..... ***ridescens***
Areoles lacking soralia 5

5(4) Ascospores 1-septate 6
Ascospores 3-septate, submuriform, or muriform 8

6(5) Ascospores 20–34 × 9–17 µm 7
Ascospores 12–20 × 6.5–9.5 µm ..... ***superficiale***

7(6) Epithecium green; medulla K+ red, Pd+ yellow (norstictic acid), or Pd–, K– (bourgeanic acid) ..... ***atroalbescens***
Epithecium brown; medulla K–, Pd+ yellow (psoromic acid) ..... ***alpicola***

8(5) Ascospores transversely (1-) 3-septate, rarely with an additional oblique to longitudinal septum ..... ***intermediellum***
Ascospores submuriform to muriform 9

9(8) Medulla I± faint blue; epithecium brown-black, granular; ascospores with 5–9 cells visible in optical section; thallus lichenicolous on other lichens at least when young ..... ***viridiatrum***
Medulla I+ blue; epithecium green, green-brown or red-brown, non-granular; ascospores with 5–30 cells visible in optical section; thallus not lichenicolous 10

10(9) Areoles forming a crescent-shaped to entire, pseudolecanorine margin around apothecia; epithecium green-brown, K– or green intensifying, N+ red; medulla K+ yellow, Pd+ orange (stictic acid) ..... ***lecanorinum***
Areoles not or rarely crescent-shaped, not forming a pseudolecanorine margin around apothecia; epithecium green-brown, K– or green intensifying, or red-brown, K+ purple-red; medulla K–, Pd– (barbatic acid or bourgeanic acid) or K+ yellow, Pd+ yellow (psoromic acid)..... ***geographicum***

11(3) Ascospores 1-septate (occasionally 3-septate or submuriform) 12
Ascospores 3-septate to muriform 26

12(11) Ascospores remaining colourless (over-mature spores sometimes becoming brown, but then usually distorted) 13
Ascospores soon becoming dark green-blue (occasionally brown) 22

13(12) Medulla I+ blue; ascospores occasionally becoming 3-septate or submuriform 14
Medulla I–; ascospores usually remaining 1-septate 15

14(13) Thallus usually C+ red (gyrophoric acid, often also stictic acid); epithecium K–, always coastal ..... ***richardii***
Thallus C– (no lichen substances or stictic acid); epithecium K+ purple-red, mainly upland ***polycarpum***

15(13) On base-rich rock 16
On siliceous rock 19

16(15) On slightly calcareous rocks (epidiorite, basalt, andesite) in oceanic areas; rarely on semi-inundated siliceous rocks further east (Scotland); thallus grey, K–, Pd–; apothecia flat to slightly convex, to 1.5 mm diameter, ± immarginate; ascospores 16–18 (–19) × 7–8 µm; epithecium aeruginose, especially in K ..... ***caesium***
Usually on more strongly basic rock, especially limestone; thallus white; apothecia smaller; epithecium olive to brown 17

17(16) Epithecium K+ purple-red ..... ***chioneum***
Epithecium K– 18

18(17) Exciple K–; apothecial disc usually pruinose; thallus K+ yellow, Pd+ orange (stictic acid) ..... ***caeruleoalbum***
Exciple K+ purple-red; apothecial disc not pruinose. Thallus K–, Pd– (no lichen substances) ..... ***expallescens***

19(15) Paraphysoids with only slightly swollen pigmented caps, remaining ± conglutinate in K; ascospores usually becoming brown when old; ..... ***hochstetteri***
Paraphysoids with ± distinct, abruptly swollen pigmented caps, ± separating in K; ascospores rarely becoming brown when old; 20

20(19) Thallus thin, olive-brown, ± continuous; K–, Pd–; apothecia with thin, persistent exciple; ascospores 19–21 × 9–11 µm; epithecium brown; frequent in oceanic areas; usually in shaded woodlands ..... ***infernulum*** f. ***sylvaticum***
Thallus white, grey or brown, areolate to slightly warted; apothecia with thicker exciple or occasionally ± immarginate; ascospores 14–16 (–18) × 7–8 µm; epithecium brown or blue-black; upland or montane 21

21(20) Thallus pale grey to brown, areolate; K+ yellow, Pd+ orange (stictic acid) or K–, Pd– (no lichen substances); epithecium blue-black (occasionally olive-brown); paraphysoids separating in K, cap brown-pigmented ..... ***infernulum*** f. ***infernulum***
Thallus white or pale grey, warted-areolate, K+ red, Pd+ yellow (norstictic acid) or rarely K+ yellow, Pd+ orange (stictic acid); epithecium and paraphysoid cap blue-black; paraphysoids less distinctly capitate and only slightly separating in K; on disused metal-mine spoil, montane rocks and coastal shingle ..... ***cinereovirens***

22(12) Medulla I+ blue; ascospores 12–16 × 6–8 µm; exciple K+ purple-red ..... ***simillimum***
Medulla I–; ascospores larger, exciple K+ purple-red or K– 23

23(22) Epithecium K+ purple-red..... 24
Epithecium K– 25

24(23) Thallus dark brown, K± yellow, KC–, Pd± orange (stictic acid or no lichen substances) ..... ***badioatrum***
Thallus pinkish to brownish grey, K–, KC+ reddish, Pd– (gyrophoric acid) ..... ***sinense***

25(23) Thallus of flat to convex, cream-white to grey-brown areoles to 1 mm diam.; K+ red, Pd+ yellow (norstictic acid) or K+ yellow, Pd+ orange (stictic acid); apothecia, flat to convex, margin indistinct; epithecial pigment diffuse; on shaded rocks or sides of boulders at intermediate altitudes or on tops of exposed montane boulders ..... ***copelandii***
Thallus usually brown, areoles to 1.5 mm diam.; K+ yellow, Pd+ orange (stictic acid); epithecial pigment less diffuse; apothecia remaining flat with a persistent thick raised exciple; usually associated with areas of semi-permanent snow patches ..... ***jemtlandicum***

26(11) Ascospores predominantly 3-septate (if medulla I+ blue, see 33a) 27
Ascospores usually with some longitudinal septa 28

27(26) Thallus orange to rust-red; apothecia umbonate to gyrose; usually on metal-rich rocks ***Haugania oederi***
Thallus grey; apothecia smooth; on montane rocks ..... ***submodestum***

28(26) Ascospores dark brown..... 29
Ascospores colourless, sometimes becoming greenish or brownish with age..... 30

29(28) AscI 2-spored; ascospores 45–68 × 18–28 µm..... ***geminatum***
Asci 8-spored; ascospores 24–29 (–33) x 9.5–12 µm ..... ***intersitum***

30(28) On calcareous rocks 31
On siliceous rocks 32

31(30) Thallus grey to white; exciple at most slightly pruinose, disc not pruinose; ascospores strongly muriform (3–9 transverse, 1 or 2 longitudinal septa), 20–50 × 10–24 µm; often on weakly calcareous rocks ..... ***petraeum***
Thallus chalk-white; exciple thickly pruinose, disc usually pruinose; ascospores less strongly muriform (3 or 4 transverse, l (-2) longitudinal septa), 15–30 × 9–16 µm; on strongly calcareous rocks ..... ***umbilicatum***

32(30) Thallus continuously, finely isidiate-sorediate (blastidia); on metal-rich rocks; apothecia rare ..... ***furfurosum***
Thallus otherwise; apothecia usually present 33

33(32) Asci 2-spored ..... ***subgeminatum***
Asci 8-spored 34

34(33) Medulla I+ blue; epithecium usually K+ purple-red; exciple K+ purple-red ..... ***distinctum***
Medulla I– 35

35(33) Epithecium or rim of exciple K+ purple-red 36
Epithecium and rim of exciple K– 37

36(35) Apothecia innate; on semi-inundated rocks ..... ***amphibium***
Apothecia sessile; on montane rocks ..... ***subpostumum***

37(35) Ascospores submuriform (less than eight cells), usually <25 µm long; apothecial disc smooth ..... ***postumum***
Ascospores eumuriform, usually >25 µm long 38

38(37) Ascospores 33–50 µm long 39
Ascospores usually <35 µm long 40

39(38) Thallus grey to white; exciple not swollen; ascospore length/breadth ratio 1.5–2.0; on slightly basic rocks ..... ***petraeum***
Thallus usually pale brown; apothecia with a thick tumid exciple; ascospore length/breadth ratio 2.0–3.0; usually on damp siliceous rocks ..... ***lavatum***

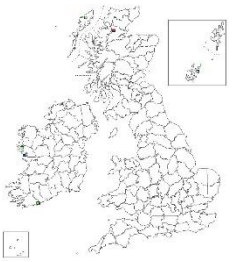
40(38) Thallus well-developed, K+ yellow or K+ red 41
Thallus lacking lichen substances (K–, Pd–) 42

41(40) Thallus K+ yellow, Pd+ orange (stictic acid); common species of rocks and pebbles, often on recently exposed surfaces ..... ***reductum***
Thallus K+ red, Pd + yellow (norstictic acid); poorly known but apparently rare ..... ***rubescens***

42(40) Thallus brown (sometimes with orange patches), granular-areolate; ascospores 22–33 × 11–19 µm; usually only brown pigments present internally; epithecium K+ grey (at least in places); alpine and metal-rich rocks ..... ***anaperum***
Thallus grey or grey-pruinose, cracked-areolate; ascospores 17–36 × 11–20 (–25) µm; brown and blue pigments present internally; epithecium K+ aeruginose-blue (at least in places), exciple edge K+ aeruginose-blue 43

43(42) Thallus grey, thin, cracked-areolate; areoles flat ..... ***sublavatum***
Thallus brown, ± grey-pruinose, areoles convex to bullate ..... ***timdalii***

Rhizocarpon advenulum (Leight.) Hafellner & Poelt (1976) **NE**

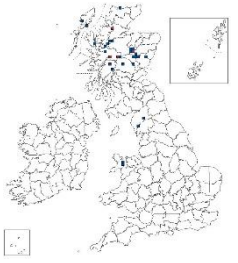


Thallus inconspicuous, immersed in the host lichen; vegetative hyphae I+ blue. Apothecia 0.4–0.7 mm diam., flat or slightly convex, scattered or in small groups on the host thallus; true exciple well-defined when young, eventually becoming occluded, dark brown; epithecium brown; hymenium 80–90 µm high, colourless; hypothecium dark brown. Ascospores blue-black to brown, 18–23 × 11–15 µm, 1-septate, guttulate. **BLS 1956**.

On *Pertusaria* spp., esp. *P. pseudocorallina* and *P. flavicans*; rare. N. Wales, N. Scotland (E. Ross, Outer Hebrides, Orkney), W. Ireland.

The species has been illustrated by Klepsland (2020). *R. ochrolechiae* is also lichenicolous but has submuriform ascospores and occurs on *Ochrolechia parella*.

Rhizocarpon alpicola (Anzi) Rabenh. (1861) **Nb**

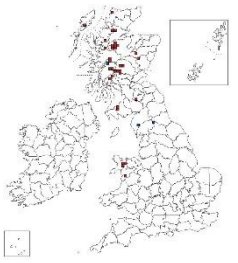


Thallus to 15 cm diam., often wide-spreading, areolate; prothallus black, well-developed; areoles to 1.5 (–3) mm diam., green-yellow, matt, contiguous to widely dispersed on the prothallus, rather thick, round to angular or irregular, flat to moderately convex, often finely and extensively fissured, smooth or rarely minutely scabrid; medulla I–. Apothecia to 1.5 mm diam., black, round to angular, flat to weakly convex; true exciple indistinct, internally red-brown, K± purple-red; epithecium pale or partly dark brown, K+ faintly purple-red or rarely locally olive-brown and K± greener; hymenium colourless. Ascospores 20–33 × 9–17 µm, 1-septate, infrequently with 1 to 2 additional thin transverse septa, dark brown. Medulla K–, Pd+ yellow (rhizocarpic and psoromic acids). **BLS 1245**.

On exposed montane siliceous rocks, mostly above 850 m; local. N. Wales, N.W. England (Lake District), Scotland.

The combination of a brown epithecium and Pd+ yellow, K– thallus (containing psoromic acid) separates *R. alpicola* from *R. atroalbescens*, which has a green epithecium and reacts Pd+ yellow-orange, K+ red (norstictic acid) or Pd–, K– (bourgeanic acid).

Rhizocarpon amphibium (Fr.) Th. Fr. (1874) **Nb**



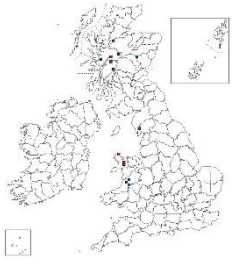
Thallus in ± discrete patches 2–5 cm diam., grey, areolate, areoles 0.2–0.5 mm diam., flat. Apothecia black, innate (aspicilioid), flat, (0.4–) 0.6–0.8 (–1.0) mm diam.; true exciple hardly present, thin (<0.03 mm) and barely raised, internally composed of radiating hyphae, pale brown, outer cells blue-grey; hymenium colourless, 150–200 µm high, epithecium dilute red-brown, K+ purple-red; hypothecium mid- to dark brown; paraphysoids branched and anastomosing, 1.5–2.0 µm diam., scarcely swelling at the apex, without a strongly delimited pigmented cap. Asci 85–100 × 25–30 µm, cylindrical. Ascospores colourless, submuriform, with 5–10 cells in optical section, 8 per ascus, 23–27 × 10.5–12 µm. Conidiomata not seen. Chemistry: C–, K–, KC–, Pd–. No lichen substances detected by TLC. **BLS 1683**.

On semi-inundated rocks; rare. N. Wales, montane N. England & Scotland.

Distinguished by its habitat of semi-inundated siliceous boulders in upland areas, its aspicilioid apothecia and combination of colourless, submuriform ascospores and K+ purple-red epithecium.

Reported lichenicolous fungi are *Endococcus fusiger* Th. Fr. & Almq. (1867) and *E. propinquus* (Körb.) D. Hawksw. (1979).

Rhizocarpon anaperum (Vain.) Vain. (1922) **Nb**



Thallus effuse, usually in small patches 1–2 cm diam. but sometimes coalescing into larger areas, composed of small, flat to strongly convex areoles, sometimes appearing granulose, chestnut or dark brown, occasionally with bright orange patches; areoles 0.02–0.1 mm diam., prothallus rarely visible. Apothecia small, black, sessile, 0.2–0.4 (–0.6) mm diam.; true exciple persistent, raised, *ca* 0.08 mm thick, internally composed of radiating hyphae, dark brown-black, usually with a violet tinge (K–); hymenium colourless, 140–150 µm high; epithecium brown (K–, N–); hypothecium mid- to dark brown; paraphysoids slender, *ca* 1.0 µm diam., scarcely swelling at the

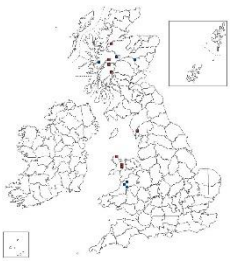
apex, without a delimited, pigmented cap. Asci *ca* 100 × 35 µm, clavate. Ascospores colourless, muriform, 20–38 cells in optical section, 8 per ascus but often only 1–4 developing, broadly ellipsoidal, 23–36.5 × 11–19.5 µm. Conidiomata not seen. Chemistry, C–, K–, KC–, Pd–. No lichen substances detected by TLC. **BLS 1099**.

On montane rocks and metal-rich spoil; Mid and N. Wales, Cumbria, Highland Scotland; rare.

Occurring alongside *R. reductum* (on mine spoil), *R. sublavatum* and *R. lavatum*. Pre 1990 collections were misidentified as *R. grande* or *R. furfurosum*. The original description of this species describes the thallus as ± endolithic and the apothecia as minute and with an olivaceous epithecium. It is probable that British collections represent a different, possibly undescribed species.

Rhizocarpon atroalbescens (Nyl.) Zahlbr. (1926) **Nb**

Rhizocarpon eupetraeoides auct., non (Nyl.) Blomb. & Forssell (1880)



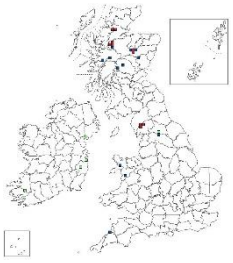
Thallus to 5 cm diam. (in British populations), areolate; prothallus usually well-developed, black; areoles to 1.5 mm diam., green-yellow, matt, contiguous to somewhat dispersed on the prothallus, often somewhat fissured, round to angular, flat to moderately convex; medulla I+ blue, sometimes I– in part. Apothecia to 1.5 mm diam., black, ± round, flat to weakly convex; true exciple distinct to indistinct, internally olivaceous brown at the rim, pale brown to colourless in the inner part, K– (intensifying green) or K+ red (forming acicular crystals); epithecium olive-green to green-brown, green pigment intensifying in K, or K+ red (forming acicular crystals); hymenium colourless to pale green, often subdivided by dark brown bands or columns extending upward from the hypothecium. Ascospores 22–34 × 9–17 µm, 1-septate, infrequently aseptate or with one or more additional, thin, transverse or oblique septa, dark brown. Medulla, exciple and epithecium either K+ yellow to red, Pd+ yellow-orange (rhizocarpic and norstictic acids) or K–, Pd– (rhizocarpic and bourgeanic acids). **BLS 1253**.

On exposed montane siliceous rocks; rare. N. Wales (Carneddau massif, Yr Ole Wen, 820-950 m), Scotland (Ben Nevis 1200-1340 m; Cairngorm mtns, Ben Macdhui 1300 m).

Distinguished by the 1-septate ascospores, green-brown epithecium (green intensifying in K) and usually (though not always) I+ blue medulla. The Welsh collections contain bourgeanic acid and could represent a different, possibly undescribed taxon.

Previously called *R. eupetraeoides* (Nyl.) Blomb. & Forssell, but that name has been misapplied and is a later synonym of *R. cinereovirens*. Previous reports of the similar *R. inarense* (Vain.) Vain. (1922) from Britain (N. Scotland, Ben Hope) are referable to *R. superficiale*, and other records need confirmation. An unpublished molecular study indicates that *R. inarense* should actually be included in *R. atroalbescens*. See also *R. alpicola*.

Rhizocarpon badioatrum (Florke ex Schaer.) Th. Fr. (1874) **Nb**



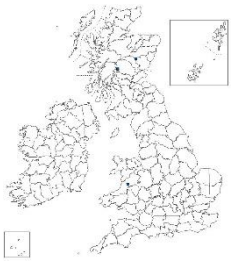
Thallus to 10 cm diam., areolate; prothallus usually well-developed, black; areoles to 2 mm diam., medium to dark brown, often with a pink- to red-brown tinge, sometimes partly grey-brown, matt, contiguous, thick, usually angular or ± scattered and crenulate, ± flat. Apothecia to 1 mm diam., black, not pruinose, round or angular, between the areoles, remaining ± flat; true exciple distinct, internally red-brown in the inner part, rim brown-black, K+ purple-red; epithecium red-brown, K+ purple-red, sometimes with minute red granules dissolving in K; hymenium colourless, 110–120 µm high; hypothecium medium brown, K–. Ascospores 27–38 × 13–19 µm, 1-septate, soon becoming dark blue-green or brown. Medulla K– or K+ yellow, I–, Pd– or Pd+ orange (no lichen substances detected by TLC or rarely stictic acid). **BLS 1246**.

On siliceous rocks in open situations, montane. Highland Scotland, Cumbria, N. Wales, N. Cornwall, with a few old records from Ireland.

The soon dark brown, 1-septate ascospores and brown, K+ purple-red epithecium separate this species from *R. jemtlandicum*, which has a K–, olive to green-black epithecium. The stictic acid chemotype was previously recognised as *R. cinereonigrum* Vain., a species occurring in Scandinavia and North America. Molecular studies should decide where British material containing stictic acid belongs.

Two closely related species have recently been described and identified from Scandinavia (Timdal *et al.* 2024). *R. sinense* Zahlbr. (with gyrophoric acid; medulla K–, Pd–, C+ red) is now recognized from an old collection from Ben Lawers (see below), whereas *R. vulgare* Timdal, E.J. Möller & Bendiksby (with diffractaic acid; medulla K–, Pd–, C–) has not yet been recorded from our region but may well occur.

Rhizocarpon caeruleoalbum (Kremp.) Zahlbr. (1926) **Nb**

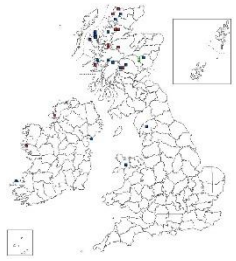


Thallus to 1 cm diam., areolate or rimose to partly continuous; prothallus poorly developed or absent, black, ± white-pruinose; areoles to 1.5 mm diam., white or white-grey, dull, pruinose, contiguous, mainly angular, flat to weakly convex. Apothecia to 0.4 mm diam., black, mainly orbicular, flat to weakly convex; disc not or rarely faintly pruinose; true exciple thick, persistent and usually distinctly pruinose, internally dark green-brown at the rim, the inner part pale brown to colourless, containing crystals partly dissolving in K, K+ yellow; epithecium olive-green, turning more brightly green in K, containing crystals dissolving in K, crystals K+ yellow; hymenium colourless; hypothecium dark brown, K–. Ascospores 16–20 × 8–10 µm, 1-septate, remaining colourless or only turning faintly green when old. Medulla K+ yellow, Pd+ orange (stictic acid). **BLS 1247**.

On calcareous rocks; very rare. C. Scotland (Angus, Caenlochan, Glen Isla), Mid Wales.

This species appears to be separated from *R. expallescens* only by the presence of stictic acid in the thallus and a K+ purple-red exciple. *R. chioneum* differs in having a K+ purple-red epithecium and exciple. The differences between these three species deserve further investigation. Superficially, *R. caeruleoalbum* resembles some morphs of *R. petraeum* with irregularly distributed apothecia, but has smaller, 1-septate, not muriform, ascospores. Scandinavian material has thalli to 3 cm diam. and has apothecia to 1.5 mm diam.

Rhizocarpon caesium Fryday (2002) **Nb**

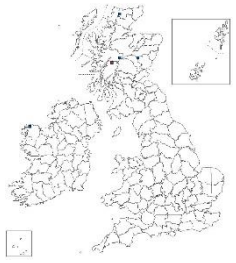


Thallus areolate to rimose, blue-grey, occasionally with slightly rust-red patches; areoles 0.2–0.5 mm diam., flat. Apothecia black, innate, flat to slightly convex, 0.8–1.3 (–2.0) mm diam., margin (if differentiated) thick but barely raised; internally usually thin, of radiating hyphae, pale brown with dark brown outer cells if the apothecium is sessile; hymenium colourless, 110–120 µm high, epithecium bright aeruginose blue; hypothecium dark brown; paraphysoids *ca* 2.5 µm diam., scarcely swelling at the apex (to 3.0 µm) with a sharply delimited, bright blue cap (cinereorufa-green; K+ intensified, N+ red), becoming brown towards the exciple, sparsely branched and anastomosing. Asci *ca* 70 × 30 µm, 8-spored. Ascospores colourless, 1-septate, 13.5–15 (–18) × 7–8.5 µm, often slightly constricted at the septum. Conidiomata not seen. Chemistry: C–, K–, KC–, Pd–. No lichen substances detected by TLC. **BLS 0968**.

On slightly base-rich igneous rocks, or on mica-schist near streams; occasional. Montane, N. Wales, Cumbria, N. & W. Scotland, coastal Ireland.

Distinguished by the blue-grey thallus, large, innate, flat apothecia and base-rich habitat. Previously confused with *R. infernulum* (as *R. hochstetteri*) and *R. expallescens*.

Rhizocarpon chioneum (Norman) Th. Fr. (1874) **Nb**

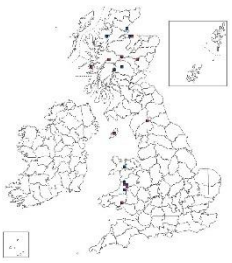


Thallus to 1 cm diam., sometimes with several thalli confluent, continuous to rimose, somewhat uneven, white, pruinose, matt; prothallus indistinct. Apothecia to 1 mm diam., black, ± immersed; disc usually not pruinose, round, remaining ± flat; true exciple uneven, persistently pruinose, internally dark brown at the rim, inner part paler brown, K+ purple-red, containing crystals dissolving in K, crystals K+ yellow; epithecium dull grey to ± red- brown, K+ purple-red; hymenium colourless to pale brown, containing crystals at least partly dissolving in K; hypothecium brown, K–. Ascospores 12–16 × 6–10 µm, 1-septate, long remaining colourless, usually becoming unevenly green or brown with age. Thallus reactions negative (stictic acid often present but probably restricted to the apothecia). **BLS 1248**.

On calcareous rocks, montane; very rare. C. & N. Scotland (Angus, Caenlochan, Glen Isla; Inverness, Ben Alder; Sutherland), W. Ireland.

R. chioneum forms small chalk-white orbicular patches with ± immersed apothecia. The combination of small, 1-septate, colourless ascospores and a brown, K+ purple-red epithecium is diagnostic. See *R. caeruleoalbum* for differences from that species and *R. expallescens*.

Rhizocarpon cinereovirens (Müll. Arg.) Vain. (1922) **Nb**

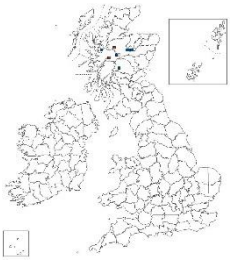


Thallus small (usually less than 1 cm diam.), cracked-areolate or with more or less dispersed areoles, these white to pale grey (occasionally pale brown), 0.3–0.4 mm diam., flat (*ca* 0.1 mm thick) to bullate (0.4–0.7 (–0.8) mm thick); prothallus rarely apparent, occasionally present at the margins, fimbriate, forming small patches <1 mm diam., or wide-spreading. Apothecia black, lecideine, flat and innate to slightly convex, (0.3–) 0.4–0.6 mm diam.; true exciple persistent but barely raised, *ca* 0.04 mm thick, occasionally strongly convex with an excluded exciple; internally exciple poorly developed, composed of radiating hyphae, pale brown within a darker cortex; hymenium colourless, 70–90 µm high; epithecium olive-green to blue-black (cinereorufa-green); K+ green-blue, N+ red-brown); hypothecium dark to medium brown; paraphysoids *ca* 2.5 µm diam., scarcely swelling at the apex (to *ca* 3.0 µm) with a sharply delimited green-blue cap; richly branched and anastomosing, not separating in K. Asci 40–70 × 25–30 µm. Ascospores colourless, 1-septate, 8 per ascus, 11–18 × 5.5–8.5 µm. Conidiomata not seen. Chemistry: C–, K+ red, Pd+ yellow (norstictic acid), very rarely K+ orange, Pd+ yellow (stictic acid). **BLS 1800**.

On exposed siliceous rocks, metal-rich spoil, on montane summits and in coastal heath; occasional. Wales, Caernarfon, Cardigan; Isle of Man; W., C. & N.E. Scotland.

British collections differ from the type material (from C. Europe) and many other collections in having a thallus composed of white to pale grey bullate areoles and ± immarginate apothecia. However, they are anatomically identical to the type collection and so are included in this species. Morphologically they resemble *R. discoense* Lynge (1937), but that species has a K+ purple-red epithecium and exciple. Material of the British morphotype has also been collected from Scandinavia and N. America (Maine). *R. cinereovirens* differs from *R. infernulum* in usually containing norstictic acid (stictic or no lichen substances in *R. infernulum*), but also in the less well-developed exciple with a colourless interior, and more richly branched and anastomosing paraphysoids with less sharply defined caps that are green-blue rather than brown.

Rhizocarpon copelandii (Körb.) Th. Fr. (1874) **Nb**



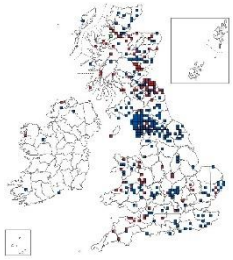
Thallus to 3 cm diam., of creamy-white convex to bullate areoles 0.6–0.8 mm diam. (to 1.3 mm diam. when fertile) or grey to brown, flat areoles in exposed situations. Apothecia black, lecideine, 0.7–1.0 (–1.3) mm diam, flat to convex, immarginate or with a thick (*ca* 0.1 mm across), barely raised margin; exciple poorly developed, internally of radiating hyphae, pale brown within a darker cortex; hymenium colourless, 120–150 µm high; epithecium clear blue to blue-black; hypothecium dark to medium brown; paraphysoids 2.5–3.0 µm thick, scarcely swelling at the apex and without a sharply delimited cap; richly branched and anastomosing, shortly septate, almost moniliform, not separating in K. Asci *ca* 90 × 35–40 µm, disintegrating early. Ascospores dark green-blue but soon becoming dark brown, 1-septate, 8 per ascus, 18–35 × 10–17 µm. Conidiomata not seen. Chemistry: C–, K+ red (acicular crystals in section), Pd+ yellow, or K+ yellow, Pd+ orange (norstictic or stictic acids). **BLS 1845**.

On exposed to sheltered siliceous rocks at mid to high altitudes in the Scottish Highlands.

An extremely variable species in gross morphology. Specimens from shaded habitats at intermediate altitudes usually have a thallus composed of creamy-white, bullate areoles containing norstictic acid, and strongly convex, immarginate apothecia, whereas those from exposed boulders at high altitudes have grey or brown, flat areoles and apothecia with a thick, barely raised true exciple. However, intermediates are known from Scandinavia and as they are uniform in apothecial anatomy they are retained in a single species. Very close to *R. jemtlandicum*, which has a thallus composed of larger areoles that always contain stictic acid (never norstictic acid) and apothecia with a better defined epithecium. The two species are related phylogenetically (McCune *et al.* 2016). An unpublished phylogenetic study confirms that the two chemotypes of *R. copelandii* are conspecific. Morphs with a white thallus of bullate areoles containing norstictic acid are easily mistaken for *R. cinereovirens* in the field, but are easily separated microscopically by the spore pigmentation.

Rhizocarpon distinctum Th. Fr. (1874) **LC**

Thallus to 5 cm diam., areolate; prothallus well-developed, black; areoles to 0.4 mm diam., dark brown, matt, contiguous or more rarely scattered, mainly angular, flat to weakly convex; medulla I+ blue. Apothecia to 0.6 mm diam., black, orbicular to angular, remaining ± flat; true exciple narrow, persistent, internally brown-black



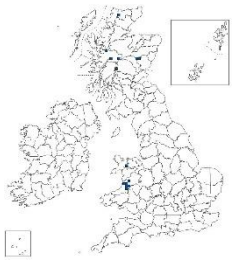
at the rim, the inner part paler brown, K+ purple-red; epithecium dark brown, K+ purple-red; hymenium colourless; hypothecium dark brown, K–; no crystals or granules in the apothecia. Ascospores 16–27 × 8–13 µm, 3-septate to submuriform, persistently colourless or becoming green-brown with age. Medulla K+ yellow, Pd+ orange (stictic acid). **BLS 1251**.

On siliceous rocks and walls, bricks, tiles, memorials; local. Throughout Britain and Ireland.

Distinguished by the I+ blue medulla, 8-spored asci, K+ purple-red epithecium, the presence of stictic acid and the initially colourless, slowly colouring, 3-septate or submuriform ascospores. It is morphologically similar to *R. polycarpum* which differs mainly in having 1-sepate ascospores. Specimens containing gyrophoric acid additionally to stictic acid or gyrophoric acid alone are known from Scandinavia. An unpublished molecular study indicates that the species consists of two genetic linages, possibly deserving species recognition.

Sometimes parasitized by *Endococcus exerrans* Nyl. (1879).

Rhizocarpon expallescens Th. Fr. (1874) **Nb**

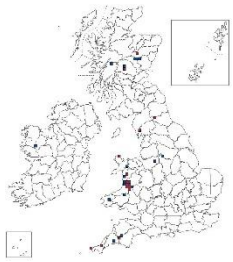


Thallus to 5 cm diam., rimose to areolate; prothallus usually distinct, black; areoles to 0.5 mm diam., grey-white to medium grey, matt, contiguous or often scattered, ± angular, flat. Apothecia to 1 mm diam., black, not pruinose, orbicular, remaining flat or becoming moderately convex; true exciple narrow, internally brown-black at the rim, inner part paler brown, K+ purple-red; epithecium bright green to blue-black, K–; paraphysoids with a sharply delimited green-pigmented cap; hymenium colourless; hypothecium brown, K–; no crystals or granules in the apothecia. Ascospores 14–17 × 6–9 µm, 1-septate, persistently colourless. Lichen products not detected by TLC. **BLS 1254**.

On basic schists, in high montane areas and mine sites. N. Scotland (Highlands; W. Inverness, Sutherland, Angus), also Wales (Ceredigion, Montgomery).

A poorly known and probably rare species in Britain. See *R. caeruleoalbum* for differences from that species and *R. chioneum*.

Rhizocarpon furfurosum H. Magn. & Poelt (1955) **NT**



Thallus effuse, to 5 cm diam., sometimes confluent, continuous to rimose, sometimes obscurely areolate in patches near the margin; prothallus poorly developed, black; areoles to 1 mm diam., contiguous, dull ochre- brown to dark grey, often with a faint violet tinge, matt, mainly angular, densely and often completely covered with minute fragile blastidia, at first somewhat minutely warted. Apothecia to 0.8 mm diam., infrequent, black, orbicular; disc persistently flat or becoming weakly convex, sometimes with an umbonate disc; true exciple thick, persistent, internally dark brown at the rim, the inner part paler brown, K+ yellow, containing crystals partly dissolving in K; epithecium medium brown, K+ yellow, containing crystals dissolving in K; hymenium colourless or pale brown; hypothecium dark brown, K–. Ascospores 14–24 × 7–12 µm, muriform, persistently colourless. Medulla and exciple K+ yellow, Pd+ orange (stictic acid). **BLS 1694**.

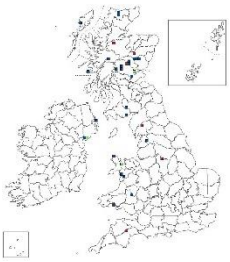
On siliceous rock and old walls rich in iron minerals, often on vertical faces, especially in old mine workings where the species can be locally abundant. Upland areas of S.W. and N. England, Wales and Scotland, with one record from W. Ireland.

Usually sterile and forming extensive, scurfy patches. The thallus texture is somewhat reminiscent of the coastal *Lecidella meiococca* which is, however, C+ orange. Likely to be confused with *Lambiella furvella* (Trapeliaceae) at first glance. That species is more effuse and slightly paler brown in comparison, along with the difference in chemistry (C+ pink or K+ yellow to red).

Rhizocarpon geminatum Körb. (1855) **Nb**

Thallus to 10 cm diam., areolate; prothallus well-developed, black; areoles to 0.8 mm diam., red- or dark brown and pale to medium grey-pruinose, matt, scattered to contiguous, orbicular to angular, flat to semi-globose. Apothecia to 1 mm diam., black, ± elevated, not pruinose, ± orbicular, flat to weakly convex; true exciple usually

indistinct, internally brown-black at the rim, pale brown in the inner part, K+ purple-red, usually containing crystals dissolving in K; epithecium red-brown, K+ purple-red, usually containing crystals dissolving in K; hymenium colourless; hypothecium dark brown, K–. Asci 2-spored. Ascospores 45–68 × 18–28 µm, strongly muriform, soon becoming dark green-brown. Medulla K± yellow, Pd± orange (stictic and/or norstictic acid, or no lichen products detected). **BLS 1256**.

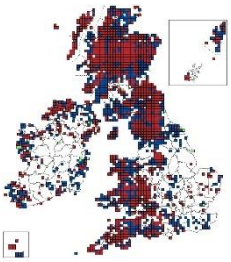


On damp, siliceous rocks, especially near streams and on lake shores. N. and W. Britain, with a few records from N. Ireland.

Characterised by the 2-spored asci, the large dark ascospores and red-brown, K+ purple-red epithecium. A chemotype containing rhizocarpic acid in the medulla is known from Central Europe and Scandinavia. *Rhizocarpon disporum* (Nägeli ex Hepp) Müll. Arg. (1879), which differs in having only one spore per ascus, has not been correctly reported from Britain and Ireland. *R. grande* (Florke ex Flot.) Arnold (1871) is similar but has 8-spored asci, smaller ascospores and a thallus containing gyrophoric acid (C+ red). There are two records from Wales (Denbigh, Glamorgan) but voucher specimens have not been traced and its status remains doubtful. Previous reports of *R. grande* from Britain and Ireland have proved to be of *R. polycarpon*, *R. reductum*, *R. richardii* or *R. anaperum*.

Rhizocarpon geographicum (L.) DC. (1805) **LC**

Thallus to 15 cm diam., areolate; prothallus usually well-developed, black; areoles 0.2–1.8 (–2.5) mm diam., pale to vivid green-yellow, rarely (in montane populations) with orange hues, matt or shiny, contiguous or less often dispersed on the prothallus, ± angular, flat to convex or rarely slightly concave, usually smooth; medulla I+ blue. Apothecia to 1.5 mm diam., black, not pruinose, round or angular, flat to slightly convex; true exciple thick to indistinct, internally dark brown at the rim, inner part paler brown, usually K+ purple-red; epithecium red-brown (K+ purple-red, often diffusing) or brown to olive-green (K± green intensifying); hymenium colourless to faintly green or faintly brown. Ascospores 20–50 × 10–20 µm, muriform with 5–22 cells in optical section, dark brown. Medulla Pd+ yellow or K–, Pd– (rhizocarpic and either psoromic or barbatic acids, rarely bourgeanic acid; gyrophoric acid sometimes present, but in low concentration and not giving a definite C+ red reaction). **BLS 1257**.



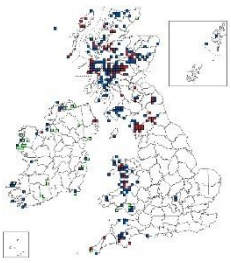
On siliceous rocks, walls, roofing tiles and monuments in exposed sunny situations, from seashores to mountain summits; common and conspicuous in upland areas. Throughout Britain and Ireland, though rare in S.E. England.

An extremely polymorphic and still poorly understood species complex (Roca-Valiente *et al.* 2016). Phylogenetic studies have been few to date, but based on preliminary data (e.g. Halici *et al*. 2022) it seems likely that multiple species are involved.

R. riparium Räsänen (1942) was separated by a brown to olive-green (K± more intensely green), not red-brown (K+ purple-red) epithecium, but this character is often difficult to assess unequivocally; the epithecial pigments may be faint or both red and green pigments in variable amounts can occur in single apothecia. The barbatic acid chemotype might prove to be worthy of taxonomic recognition. Intergradations occur amongst the various described infraspecific taxa and specimens often cannot be assigned with certainty to a particular one. Morphs referable to subsp. *prospectans* (Räsänen) D. Hawksw. & Sowter (1969), with rounded apothecia and areoles arising through fissuring of the ± continuously lichenized, vivid green-yellow thallus and subsp. *geographicum*, with angular apothecia and somewhat less intensely yellow areoles arising discretely in the prothallus, are predominant at middle elevations and on rocky seashores. At higher elevations, these subspecies grade into a highly variable complex including morphs resembling subsp. *diabasicum* (Räsänen) Poelt & Vězda (1980), with thicker areoles and relatively many-septate ascospores (12–20 cells in optical section), and subsp. *frigidum* (Räsänen) Hertel (1976), with small areoles and few-septate (5- to 11-celled) ascospores. A few specimens from N. Wales (Yr Ole Wen) and Scotland (Ben Nevis) are referable to subsp. *arcticum* (Runemark) Hertel (1976); this has rounded apothecia, few-septate ascospores and matt, pale yellow areoles dispersed on a black to grey prothallus. In addition to these chemo- and morphotypes, others sharing some but not all of the characteristics of *R. macrosporum* Räsänen (1943) and *R. sphaerosporum* Räsänen (1944) are present in montane areas of N. Wales and Scotland. See also *R. lecanorinum*.

Host to *Endococcus macrosporus* (Arnold) Nyl. (1878) and more rarely *E. perpusillus* Nyl. (1857) and *Muellerella pygmaea* (Körb.) D. Hawksw. (1979; also to the lichenicolous lichen *Miriquidica atriseda*.

Rhizocarpon hochstetteri (Körb.) Vain. (1922) **LC**



Thallus grey- to red-brown, moderately thick to thick (0.1–0.35 mm), cracked-areolate; areoles flat to convex, 0.2–1.0 mm diam.; medulla I–. Apothecia frequent, black, flat to slightly convex, 0.6–1.0 (–1.2) mm diam., sessile when well-developed or innate among areoles; exciple persistent but often poorly formed, internally composed of radiating dark brown hyphae; hymenium 95–150 µm high, epithecium usually with aeruginose to blue-black pigment (cinereorufa-green; K–, N+ red), but occasionally brown (K–, N–); hypothecium dark brown; paraphysoids 2.5–3.0 µm diam. (swelling at apex to *ca* 3.5 µm), with sharply delimited, brown caps. Asci 85–100 × 30–35 µm. Ascospores colourless, becoming brown when over-mature, 8 per ascus, 1-septate, 21–25 × 8.5–12 µm. Conidiomata not seen. Chemistry: C–, K± yellow, Pd± orange (stictic acid or no lichen substances detected by TLC). **BLS 1262**.

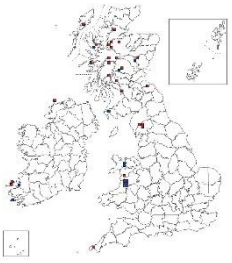
On exposed siliceous rocks, usually montane, sometimes lowland; common. Wales, N. and S.W. England, Scotland; scattered throughout Ireland.

Preliminary studies indicate that the species is highly polymorphic in phylogenetic terms, and it is likely to be subdivided in future.

Specimens containing stictic acid mostly occur at higher elevations. Unlike other *Rhizocarpon* species with colourless, 1-septate ascospores, those of *R. hochstetteri* are large and often become brown when over-mature. The medulla is I–, compared with the I+ blue medulla of *R. richardii* and *R. polycarpum*, with which it has sometimes been confused. Older accounts included *R. infernulum*, which has smaller ascospores.

There is a single record of an unidentified *Endococcus* sp. on this host.

Rhizocarpon infernulum (Nyl.) Lynge (1934) **Nb**



Thallus crustose, rimose to cracked-areolate, brown or grey to very pale grey; areoles 0.3–0.4 mm diam., flat. Apothecia black, flat and innate to slightly convex, 0.3–0.4 (–0.5) mm diam.; true exciple (if apparent) thick (0.02–0.03 mm) but barely raised; internally exciple well-developed, composed of radiating hyphae, pale brown with dark brown, carbonaceous outer cells; hymenium colourless, 70–90 µm high; epithecium usually aeruginose blue to blue-black (K–, N+ red); hypothecium brown (arnoldiana-brown); paraphysoids *ca* 2.5 µm thick, scarcely swelling at the apices (to 3.0 µm), with sharply delimited brown caps, branched and anastomosing. Asci *ca* 70 × 30 µm. Ascospores colourless, 1-septate, 8 per ascus, 15–18 × 7–8.5 µm. Conidiomata not seen. Chemistry: C–, K± yellow, Pd± orange (± stictic acid or no lichen substances detected by t.l.c.). **BLS 2334**.

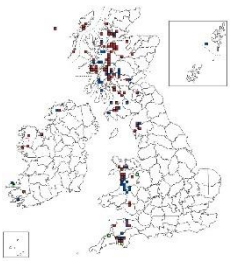
Forming small (<2 cm diam.) patches on siliceous rocks, especially metal-rich, at all altitudes. Most frequent in Wales, less so in Scotland and W. Ireland.

Separated from *R. hochstetteri* by the smaller ascospores and from *R. cinereovirens* by paraphysoids with brown caps (blue-green in *R. cinereovirens*), although this is often masked by a blue-green epithecial pigment. The thallus of *R. cinereovirens* also usually contains norstictic acid.

Preliminary research suggests that *R. infernulum* is well-delimited in phylogenetic terms and clearly separable both from the *R. hochstetteri* complex and from *R.infernulum* f. *sylvaticum* (see below).

There is a single report of *Endococcus rugulosus* Nyl. (1855) on this host.

Rhizocarpon infernulum f. **sylvaticum** Fryday (2002) **Nb**

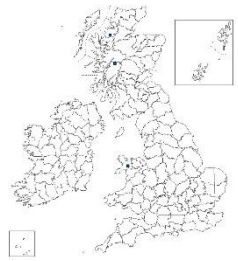


Thallus thin, 0.05–0.08 mm thick, pale brown, smooth, rimose, becoming areolate in thicker areas, areoles flat, 0.2–0.5 mm diam. on a well-developed black prothallus, Apothecia black, sessile, with a thin, raised, persistent true exciple, (0.2–) 0.3–0.5 (–0.7) mm diam.; internally composed of radiating hyphae, pale brown, with dark brown, carbonaceous outer cells; hymenium colourless, 75–90 µm high; epithecium brown (K–, N–), rarely with blue pigment (K–, N+ red), not granular; hypothecium medium-brown; paraphysoids *ca* 1.5 µm diam., swelling at the apices to 3.0 µm, with sharply delimited, brown caps, sparingly branched and anastomosing, readily separating in K. Asci 60–70 × 25–28 µm. Ascospores colourless, 1-septate, 8 per ascus, 17.5–20 × 8.5–11 µm. Conidiomata not seen. Chemistry: C–, K–, KC–, Pd–. No lichen substances detected by TLC. **BLS 1037**.

Frequent on damp siliceous rocks and boulders in oceanic woodlands in western Britain and on damp rocks at high altitude in Scotland and S.W. England, also S.W. Ireland.

The taxon intergrades with *R. infernulum* f. *infernulum* (see above) in morphology. An unpublished phylogenetic study indicates that species rank is more appropriate for this taxon but also that it does not belong in *Rhizocarpon* s. str. and so we do not make that combination here. It is distinguished by its habitat, its thin continuous olive-brown thallus and sessile apothecia with prominent margins. Previously, often misidentified as *R. hochstetteri* but usually lacks the blue-green, N+ red pigment in the epithecium and has smaller ascospores. The 1-sepate hyaline ascospores and lax paraphysoids with swollen pigmented apices give this species the aspect of a species of *Catillaria* but it is differentiated from that genus by its ascus type and generally wider ascospores.

Rhizocarpon intermediellum Räsänen (1943) **Nb**



Thallus to 2 cm diam., areolate, growing on the thallus of other crustose lichens when young, later becoming ± independent; prothallus ± indistinct, black; areoles 0.1–0.5 (–0.7) mm diam., green-yellow, contiguous or partly dispersed, often in small groups, mainly angular, flat to moderately convex, smooth or minutely scabrid; medulla I+ blue. Apothecia to 0.5 mm diam., black, not pruinose, orbicular to angular, flat; true exciple rather thin, persistent, internally brown-black at the rim, paler in the inner part (K± faintly purple-red); epithecium brown, K+ purple-red; hymenium colourless to pale brown. Ascospores 16–23 × 7–10 µm, mostly with 3, less often 1 or 2, transverse septa (submuriform spores not observed in British material), dark blue-green to brown. Medulla K–, Pd+ yellow (psoromic acid) or K–, Pd– (rhizocarpic acid only). **BLS 1891**.

Lichenicolous, at least when young, on thalli of *Lecidea lactea* and possibly other crustose lichens, on exposed siliceous rocks; rare, but possibly overlooked. N. Wales (Glyderrau, 890 m), Scotland (Glen Coe, 120 m; Allt Dearg, 245-305 m).

The central European *R. furax* Poelt & V. Wirth (1970), which is lichenicolous on *Lecidea lapicida* s. lat., may be conspecific with *R. intermediellum*. Distinguished by its small size, I+ blue medulla, transversely septate ascospores and semi-lichenicolous habit when young.

Rhizocarpon intersitum Arnold (1877) **NE**

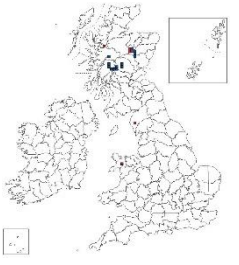
Thallus small, 2–3 cm diam., thin (to 0.25 mm thick), areolate or rarely rimose-areolate in places, greyish brown to pale brownish; areoles to *ca* 0.5 mm diam., matt, smooth, angular to irregular, dispersed to usually contiguous. Hypothallus black. Apothecia black, to 0.7 mm diam., scattered or contiguous in clusters of up to 8, roundish-angular, ± sessile, constricted below, sitting between the areoles; disc flat to slightly concave, matt, the margin moderately thick, persistent, often flexuous. Exciple brown-black externally, internally brown to reddish brown and sometimes blue-green-olivaceous in the upper part, purplish in K; hypothecium brown; hymenium pale, to 130 µm high; epithecium pale blue-green to olivaceous. Asci clavate to broadly clavate, 8-spored. Spores 4- to 12-celled with 3-4 transsepta and 1-2 longisepta, soon dark-coloured, grey-green to brown-black, 24–29 (–33) x 9.5–12 µm. Thallus K–, C–, P–. **BLS 2590**.

On roof slate, Scotland (Midlothian) and on a maritime pebble (Moray).

Similar to *R. distinctum* but spores in that species long remain colourless and are 3- (to 4-) septate or submuriform, and the thallus is Pd+ orange (stictic acid). The non-British *R. grande* and *R. eupetraeum* also have pigmented, muriform spores but these species both have an amyloid (I+ violet) medulla and a thallus that produces lichen substances: gyrophoric acid (C+ red) in *R. grande* and norstictic acid (K+ red) in *R. eupetraeum*.

The description has been adapted in part from North American material described by Anderson (1965).

Rhizocarpon jemtlandicum (Malme) Malme (1914) **Nb**



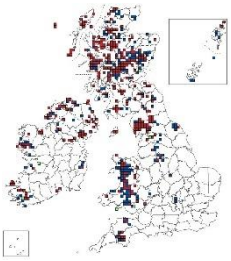
Thallus to 10 cm diam., areolate; prothallus well-developed, black; areoles to 1 mm diam., dark brown, usually with a faintly grey tinge, matt, contiguous, irregularly rounded or angular, flat to weakly convex. Apothecia to 1.5 mm diam., black, not pruinose, orbicular, remaining ± flat or convex with age; true exciple thick, persistent, internally K–, containing crystals dissolving in K; epithecium olive-green, intensifying in K, containing crystals dissolving in K; hymenium colourless; hypothecium brown-black, K–. Ascospores 25–30 × 13–15 µm, 1-septate, soon

becoming dark blue-green or brown. Medulla K+ yellow, Pd+ orange (stictic acid). **BLS 1726**.

On siliceous rocks at *ca* 1000 m alt. in areas with late snow lie; rare and very local. Scotland (Nevis Range, Cairngorms), also Cumbria and N. Wales.

Identified by the dark 1-septate ascospores, olive-brown, K– epithecium containing crystals as well as the I– medulla. *R. badioatrum*, with which it may occur, has a brown, K+ purple-red epithecium. See under *R. copelandii* for differences from that species.

Rhizocarpon lavatum (Fr.) Hazsl. (1884) **LC**



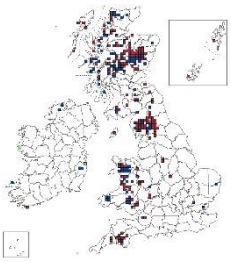
Thallus to 10 cm diam., rimose; prothallus indistinct; areoles to 0.5 (-1) mm diam., grey to pale ochre-brown, matt, angular, flat. Apothecia to 1.5 mm diam., black, round, weakly concave to weakly convex; disc sometimes umbonate; true exciple thick, persistent, internally dark brown at the rim, inner part paler brown, K–; epithecium olive-green to olive-brown, K± purple-red in patches; hymenium colourless; hypothecium red-brown, K–; lacking crystals or granules in the apothecia. Ascospores 30–40 × 14–18 µm, muriform, persistently colourless or becoming faintly brown with age. Lichen products not detected by TLC. **BLS 1264**.

On damp siliceous rocks, occasionally on mildly basic rocks, often on those subject to inundation by unpolluted streams and lakes, upland; local. N. & W. Britain and Ireland.

Rhizocarpon lavatum is a species of damp, siliceous rocks, often by lake- or stream-sides but up to the highest elevations in moist sites, and often subject to temporary inundation or late snow-lie. It has a rather obscurely thickened, tumid exciple and often a pronounced ochre-brown tinge to the thallus. *R. reductum* has smaller ascospores, a narrower, more elevated exciple and a thallus that usually contains stictic acid.

Host to *Dacampia rhizocarpicola* D. Hawksw. (2008), *Endococcus fusiger*, *E. rugulosus*, *E. verrucosus* Hafellner (1994), *Muellerella pygmaea*, *M. ventosicola* (Mudd) D. Hawksw. (2003), *Phaeospora parasitica* (Lönnr.) Zopf (1874), *P. rimosicola* (Leight. ex Mudd) Hepp ex Stein (1879) and *Tremella rhizocarpicola* Diederich, Millanes & Wedin (2014).

Rhizocarpon lecanorinum Anders (1923) **LC**

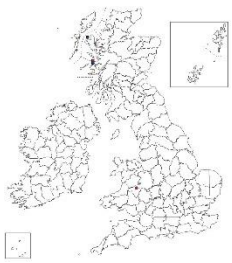


Thallus to 4 cm diam., but thalli often coalescing to cover large areas, areolate; prothallus distinct, black; areoles to 1–2 mm diam., bright yellow to green-yellow, matt, smooth, contiguous to somewhat dispersed on the prothallus, initially round and convex, but soon curving around adjacent apothecia and becoming crescent-shaped, eventually entirely surrounding the apothecia and forming a pseudo-lecanorine margin; medulla I+ blue. Apothecia to 1 mm diam., black, not pruinose, ± round, flat to concave; true exciple persistent but often thin and indistinct, internally brown-black at the rim, the inner part colourless, K–; epithecium pale olive-brown, K– or intensifying green; hymenium colourless to faintly green; hypothecium thin, brown-black, K–; no crystals or granules in the apothecium. Ascospores 34–57 × 15–24 µm, muriform, with 15–38 cells in optical section, dark brown. Medulla K+ yellow, Pd+ orange (stictic acid, often in low concentration, and rhizocarpic acid). **BLS 1265**.

On siliceous rocks, slate roofs and walls; local. N. and S.W. England, Wales, Scotland, rare in Ireland.

The crescent-shaped areoles, pale olive-brown epithecium, usually green hymenium and Pd+ orange, K+ yellow medulla (stictic acid) are diagnostic. *R. ferax* H. Magn. (1948) is known from a single record from Ireland. It is said to differ from *R. lecanorinum* in the more abundantly septate ascospores and in the occurrence of psoromic, not stictic acid, as the main medullary substance. The material on which the Irish record is based has not been located and the presence of this species in our region needs confirming.

Rhizocarpon ochrolechiae (Poelt & Nimis) Hafellner (1992) **Nb**



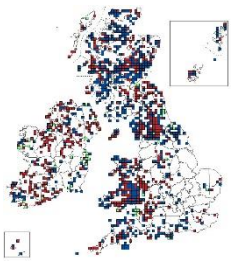
Lichenicolous, without an independent thallus, the host thallus deteriorating and becoming grey. Apothecia superficial, sometimes confluent, flat to convex, 0.3–0.9 (–1.1) mm diam.; epithecium purple-brown, K+ purple-red, hypothecium red-brown. Ascospores blue-black to brown, submuriform, 18–40 × 10–19 µm, with 5–9 (or more) cells in optical section. **BLS 1892**.

On saxicolous *Ochrolechia parella*. On xeric supralittoral seashores, W. Scotland

(Skye and Muck) and on inland siltstone, Wales (Radnorshire). Likely to be under-recorded.

Scottish material has ascospores that are notably larger than those of the type from Sardinia [these are quoted as 18–27 × 10–12.5 µm, versus 24–35 (–40) × 12–17 (–19) µm in Scottish specimens].

Rhizocarpon petraeum (Wulfen) A. Massal. (1852) **LC**



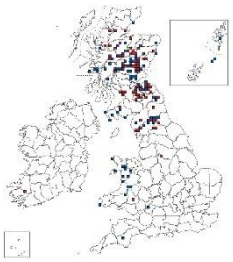
Thallus to 5 cm diam., crustose, continuous to rimose, more rarely areolate in part; prothallus poorly developed, black; areoles to 0.5 mm diam., dull, chalk-white to medium-grey, matt, contiguous, mainly angular, flat. Apothecia to 1 mm diam., black; disc not pruinose, usually orbicular, flat; true exciple faintly to distinctly pruinose, persistent, internally brown to dark blue-green at the rim, inner part colourless to pale brown, K+ yellow, containing crystals partly dissolving in K; epithecium olive-brown, crystals K+ yellow, dissolving in K; hymenium colourless, 150–200 µm high; hypothecium dark brown, K–. Ascospores 20–50 × 13–25 µm, muriform, colourless, becoming pigmented when over-mature. Medulla K+ yellow, Pd+ orange (stictic acid). **BLS 1249**.

On hard siliceous rocks close to mortar, ± base-rich rocks and walls, or coastal rocks; common. Throughout Britain and Ireland, but rare in the south and east.

The apothecia are frequently arranged in ± concentric rings, but may also be randomly dispersed. *R. umbilicatum* usually has randomly scattered apothecia with a thicker, somewhat chalky-white thallus, is restricted to pure limestones and has smaller, submuriform ascospores.

Host to *Muellerella lichenicola*, *Phaeospora parasitica*, *P. rimosicola* and *Polycoccum arnoldii* (Hepp) D. Hawksw. (1979).

Rhizocarpon polycarpum (Hepp) Th. Fr. (1874) **Nb**

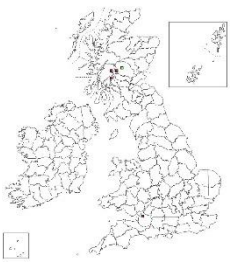


Thallus to 5 cm diam., areolate; prothallus well-developed, black; areoles to 0.5 mm diam., dark brown, usually with a faint grey or pink tinge, matt, contiguous or scattered, orbicular to angular, flat to weakly convex; medulla I+ blue. Apothecia to 0.7 mm diam., black, not pruinose, orbicular or angular, sometimes slightly flexuose, usually remaining flat; true exciple narrow, persistent, brown-black, K–; epithecium dark brown, K± purple-red; hymenium colourless; hypothecium dark brown, K–; no crystals or granules in the apothecia. Ascospores 17–30 × 8–13 µm, mainly 1-septate, persistently colourless or becoming pale brown with age. Medulla K± yellow, Pd± orange (stictic acid or, more frequently, lichen products absent). **BLS 1720**.

On hard siliceous rocks, coastal and montane; local. N. & W. Britain, one record from W. Ireland.

Differs from other species with 1-septate ascospores in the combination of I+ blue medulla, dark brown, K± purple-red (never green) epithecium and colourless ascospores; *R. badioatrum* has an I– medulla and pigmented ascospores, and *R. richardii* has an olivaceous (K–) epithecium and is mostly restricted to coastal rocks.

Rhizocarpon postumum (Nyl.) Arnold (1870) **DD**



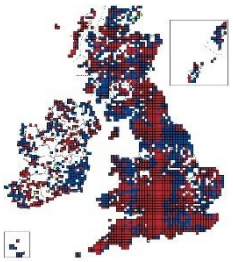
Thallus 1–3 cm diam., crustose, cracked to areolate, often very thin and sometimes partly immersed; prothallus indistinct; areoles to 0.2 mm diam., often scattered, minute, pale brown, sometimes with a grey tinge, matt, not pruinose, ± angular, smooth. Apothecia to 0.4 mm diam., scattered or in groups, brown-black to black, not pruinose, ± shining, orbicular; true exciple persistent, ± irregular, roughened or crenulate, sometimes gnarled, olive-brown or green-black, K–; epithecium brown, containing crystals dissolving in K, K–; hymenium colourless; hypothecium red-brown to brown or partly olive-brown, K–. Ascospores 17–24 × 8–11 (–13) µm, submuriform (5–7 cells in optical section), persistently colourless. Medulla K± yellow, Pd± orange (stictic acid present). **BLS 1271**.

On siliceous rocks; very rare or overlooked. The British distribution is unclear because of confusion with *R. reductum*. The type collection is from coastal rocks in Scotland.

The separation of this species from *R. reductum* follows Ihlen (2004), who separates them by *R. postumum* having submuriform ascospores (eumuriform in *R. reductum*) and smooth apothecial disc (rough in *R. reductum*). However, there is a continuum of ascospore septation from sub- to eumuriform and the roughness of the disc

appears to be related to the presence of an olivaceous pigment in the epithecium, which is, in turn, related to degree of exposure (Fryday 2002).

Rhizocarpon reductum Th. Fr. (1874) **LC**



Thallus effuse or in discrete patches 1–2 cm diam., sometimes coalescing to cover large areas, grey to brown, cracked-areolate, thin to moderately thick, very rarely almost subsquamulose; areoles 0.2–0.4 mm diam., slightly convex or flat; prothallus usually present, particularly at the margin, sometimes dominant especially in shaded situations. Apothecia black, innate to sessile, flat to slightly convex, with a rough disc, becoming more strongly convex when over-mature, (0.2–) 0.4–0.6 (–0.8) mm diam.; true exciple usually well-developed and slightly raised but often excluded in convex apothecia, internally composed of radiating hyphae, outer cells blue-black; hymenium colourless, 120–140 µm high; epithecium olive-green (K+ blue, N+ red), rarely brown; hypothecium mid- to dark-brown; paraphysoids slender, *ca* 1.0 µm thick, scarcely swollen at the apex, without a strongly delimited pigmented cap. Asci 65–80 × 25–33 µm, slightly clavate. Ascospores colourless, eumuriform, with (6–) 8–13 (–17) cells in optical section, 8 per ascus, 25–35 × 10–15 µm. Conidiomata not seen. Chemistry: usually C–, K+ yellow, Pd+ orange (stictic acid), rarely K–, Pd– (no lichen substances). **BLS 1266**.

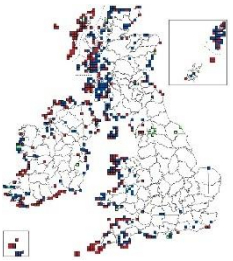
On siliceous rocks, often on pebbles, particularly common on gravestones, ± exposed, rare at high altitudes; throughout Britain and Ireland.

The commonest non-yellow *Rhizocarpon* species, usually distinguished by the small, muriform ascospores and usually the K+ yellow, Pd+ orange colour reactions of the thallus. A number of ecotypes occur; var. *fimbriata* has small thalli with a conspicuous, fimbriate prothallus, often on fine-grained rocks and pebbles; f. *dispersa*, on vertical surfaces, has ± flat areoles, widely dispersed on a black prothallus; var. *cinerea* has a pale grey thallus and ± concentrically arranged apothecia resembling *R. petraeum*. The status of all of these requires further examination.

Collections with K+ yellow to red (norstictic acid) thalli may be *Rhizocarpon rubescens* (q.v.). For differences between *R. reductum* and *R. postumum* see the latter species.

Host to *Endococcus perpusillus*, *E. propinquus*, *Muellerella erratica* (A. Massal.) Hafellner & Volk. John (2006), *M. pygmaea*, *Phaeospora parasitica* and *Polycoccum arnoldii*.

Rhizocarpon richardii (Lamy ex Nyl.) Zahlbr. (1926) **LC**



Thallus to 8 cm diam., areolate, often in small patches that sometimes coalesce; prothallus well-developed, black; areoles to 0.5 mm diam., brown, usually with a faintly grey-violet tinge, matt, contiguous, angular, ± flat; medulla I+ blue. Apothecia to 1 mm diam., black, not pruinose, ± orbicular, remaining flat or becoming weakly convex; true exciple indistinct but usually persistent, internally brown-black at the rim, pale brown to colourless in the inner part, containing crystals dissolving in K, K–; epithecium dark olive-green to grey-black, containing crystals dissolving in K, K– or intensifying green, N+ red; hymenium colourless; hypothecium dark, red-brown, K–. Ascospores 22–27 × 11–14 µm, mainly 1-septate but secondary pseudo-septa may occur in one or both cells of the primary division, persistently colourless, only becoming faintly grey-brown with age. Medulla C± red, K± yellow, Pd± orange (± gyrophoric, ± stictic and norstictic acids). **BLS 1250**.

On coastal xeric-supralittoral siliceous rocks and pebbles or stable shingle; locally abundant. N. and W. Britain and Ireland.

This species is distinguished by a combination of the thallus colour, I+ blue medulla, K– epithecium, colourless, 1-septate ascospores (sometimes with secondary pseudosepta) and coastal habitat. *R. polycarpum* has a K+ purple-red epithecium. *R. sinense* is also C+ red but has an I– medulla and pigmented spores.

Host to *Endococcus perpusillus*.

Rhizocarpon ridescens (Nyl.) Zahlbr. (1905) **NT**

Thallus to 10 cm diam., areolate, prothallus well-developed, black; areoles to 1 mm diam., bright green-yellow, matt, ± round, moderately dispersed on the prothallus, strongly convex, each usually developing a discrete, initially punctiform, then capitate soralium; soredia granular, green-yellow; medulla I+ blue. Apothecia rare, to

1 mm diam., black, ± round, flat, with a persistent margin; true exciple internally dark red-brown at the rim, paler inward; epithecium red-brown, K+ purple-red. Ascospores 20–30 × 12–16 µm, muriform, usually with only 5–7 cells in optical section, dark brown. Medulla K–, Pd+ yellow (rhizocarpic and psoromic acids). **BLS 2408**.

On a south-facing metal-rich vertical siliceous crag at 430 m alt., Scotland (near Braemar).

Unmistakable as the only sorediate *Rhizocarpon* in our region, although some species of *Lecanora* can be similar and the brown *R. furfurosum* has blastidia.

Rhizocarpon rubescens Th. Fr. (1874) **NE**

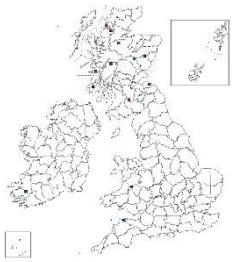
Thallus areolate; areoles (4–) 7–13 (–17) per mm^2, convex, rounded, often containing small granules, grey to greyish brown, not pruinose; medulla I–; prothallus distinct, black. Apothecia irregularly arranged or sometimes arranged in a circular pattern, (0.4–) 0.6–1 (–1.6) mm diam.; disc flat to distinctly convex, black; margin (40–) 50–90 (–100) µm thick, distinct when young, concolorous with the disc; exciple in section dark brown (K– or K+ intensifying, occasionally K+ purple). Hymenium colourless, often with a greenish tinge (K–, N+ red, HCl+ bright blue), (100–) 130–210 (–250) mm high; epithecium dark brown and greenish intermixed. Asci 8-spored. Ascospores narrowly ellipsoidal to ellipsoidal (25–) 26–35 (–40) × 12–16 (–18) µm, eumuriform, with (6–) 9–13 (–15) cells in optical section. Chemistry: thallus K+ yellow to red (norstictic acid), C–. **BLS 1275**.

.Poorly known in our region but most records reported as "*R. plicatile*" belong here. Recently reported by Orange (2022) on siliceous stone from a mine spoil tip in N. Wales (Gwydir Forest).

Distinctive for its K+ yellow to red thallus and large apothecia. The description has been adapted from Ihlen (2004).

Rhizocarpon simillimum (Anzi) Lettau (1912) **Nb**

Thallus to 5 cm diam., areolate; prothallus well-developed, black; areoles to 0.3 mm diam., dark brown, usually with a faintly grey tinge, occasionally dark grey, matt, contiguous or scattered, orbicular to angular, flat; medulla I+ blue. Apothecia to 0.8 mm diam., black, orbicular or angular, sometimes slightly flexuose, remaining ± flat, not pruinose; true exciple narrow and persistent, internally brown-black, K± diffusing purple-red; epithecium brown-black, K± faintly purple-red; hymenium colourless or faintly brown; hypothecium dark brown, K± diffusing purple-red; without crystals or granules in the apothecia. Ascospores 12–16 × 6–8 µm, 1-septate, soon dark grey-brown-black. Gyrophoric acid (C+ red) or lichen products not detected by TLC. **BLS 1893**.



On sunny, siliceous rocks on ± vertical faces; rare. S.W. England (N. Devon), N.W. England (Westmorland, Langdale Pikes), Mid Wales (Radnorshire, Carneddau), scattered throughout Scotland.

The British records agree well with the type material; in microscope preparations the hypothecium exudes a red- to magenta-purple colour in K; other diagnostic features are the small, dark ascospores and the I+ blue medulla. The anastomosing paraphysoids and halonate ascospores separate *R. simillimum* from species of *Buellia*.

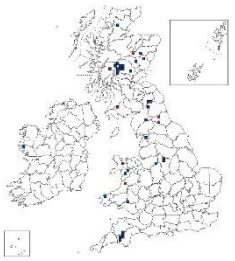
Rhizocarpon sinense Zahlbr. (1930) **NE**

Thallus crustose, epilithic, rather thick, pinkish to brownish grey, turning dark brown when wet, zoned, ± continuous in the centre of the thallus, areolate towards the edge, the areoles angular, to 1 mm diam., prothallus not differentiated. Apothecia developing from between the areoles, 0.4–1.4 mm diam., rounded to angular, scattered, sparsely tuberculate in the centre, not pruinose; true exciple thin, black or reddish; epithecium red-brown, K+ purplish; hymenium dark brown above, violet in K and N, 150–160 µm thick, I+ dark blue. Hypothecium thick, dark or blackish-brown. Paraphysoids filiform, not swollen at the apices. Asci generally 8-, rarely 4-spored. Ascospores olivaceous to dark brown, broadly ellipsoidal or subovoid, 1-septate, constricted at the septum, 29–38 × 13–17 (–19) µm. Thallus cortex K–, C–, KC+ reddish, medulla I–, K–, Pd–. **BLS 2882**.

On south-east facing schistose rocks, Scotland (Ben Lawers).

Described by Gilbert *et al.* (1988) as *Rhizocarpon* "sp. B", and contrasted with *R. badioatrum* which was considered as similar but with a darker brown thallus and a KC– cortex and PD+ orange medulla.

Rhizocarpon subgeminatum Eitner (1911) **Nb**

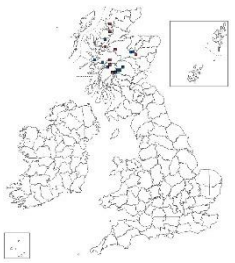


Thallus to 10 cm diam., areolate; prothallus well-developed, black; areoles to 1 mm diam., dark brown, matt, scattered to contiguous, ± orbicular and flat. Apothecia to 1 mm diam., black, not pruinose, ± orbicular, flat to weakly convex; true exciple persistent; internally brown-black at the rim, pale brown to colourless in the inner part; epithecium olive-green, K– (intensifying green). Asci 1–2 (–4)-spored. Ascospores 30–50 × 20–28 µm, strongly muriform, persistently colourless or becoming faintly green with age. Lichen products not detected by TLC in British and Irish material; barbatic acid often occurs in Scandinavia. **BLS 1276**.

On ± nutrient-enriched siliceous rocks and boulders; uncommon. S.W. England (Devon, Dartmoor), N. and W. Wales, N. England (Cumbria, Westmorland, Lancashire), Scotland, especially the central Highlands (Perth); also W. Ireland.

The non-British *R. suomiense* Räsänen (1939) is similar but contains norstictic acid. *R. geminatum* has ascospores that soon become dark brown and a K+ purple-red epithecium.

Rhizocarpon sublavatum Fryday (2002) **Nb**

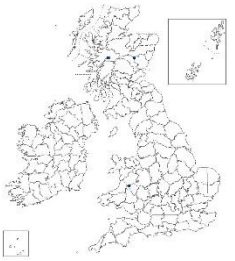


Thallus effuse, usually in small patches 1–2 cm diam., but sometimes coalescing to cover larger areas, cracked-areolate, thin, mid- to dark grey, occasionally brown-grey; areoles 0.2–0.3 (–0.4) mm diam., flat to slightly convex, the prothallus clearly visible. Apothecia black, innate when young, becoming sessile when mature, when sessile 0.3–0.5 (–0.8) mm diam.; true exciple persistent, thin and raised, internally composed of radiating hyphae, pale brown with darker outer cells (K+ blue-black); hymenium colourless, 120–140 µm high; epithecium olive-green to blue (K+ blue-green, N+ red); hypothecium mid- to dark brown; paraphysoids *ca* 2.0 µm thick, scarcely swelling at the apex (up to 3.0 µm), with a pigmented cap, sparingly branched and anastomosing. Asci 80–100 × (27–) 32–40 (–45) µm. Ascospores colourless, occasionally blue-black when mature, eumuriform, 11–41 cells in optical section, 8 per ascus, 17–38 × 11–25 µm. Conidiomata not seen. Chemistry: C–, K–, KC–, Pd–. No lichen substances detected by TLC. **BLS 1117**.

On damp montane siliceous rocks; rare. C. & N.W. Scotland above 700 m.

Similar to *Rhizocarpon lavatum* but with smaller, sessile apothecia with a much thinner margin and shorter and broader ascospores. *R. lavatum* has apothecia with a thick tumoid proper margin, a more rimose, browner thallus, often parasitised by *Endococcus* spp. that are apparently lacking on *R. sublavatum*. *R. reductum* has smaller ascospores, contains stictic acid (K+ yellow, Pd+ orange) and is rarely montane, and *R. anaperum* has a brown granular thallus, taller hymenium, narrower, more branched paraphysoids and lacks blue-black pigments in the apothecia.

Rhizocarpon submodestum (Vain.) Vain. (1922) **Nb**



Thallus grey-brown, to 2 cm diam., cracked to warted-areolate, areoles 0.2–0.4 (–0.6) mm wide; prothallus delimiting. Apothecia scattered or in groups, round or oval, flat with a thin margin; exciple internally brown to brown-black at the rim, paler within; hypothecium brown; hymenium 80–120 µm high, colourless, epithecium pale green-grey to grey-brown. Asci 80–100 × 20–30 µm, 8-spored. Ascospores 3-septate, colourless, 16–22 × 8–10 µm. Chemical substances unknown. **BLS 1387**.

On siliceous submontane rocks, Scotland and mid Wales.

Very similar to *Rhizocarpon postumum* and *R. reductum*, from which it is separated by its persistently 3-septate ascospores.

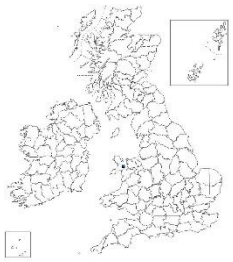
Rhizocarpon subpostumum (Nyl.) Arnold (1887) **Nb**

Thallus grey-brown, to 4 cm diam., areolate, areoles 0.3–0.6 mm diam.; prothallus inconspicuous. Apothecia scattered, round, flat with a thin margin or lacking a margin, 0.3–0.6 mm diam.; exciple internally brown to brown-black, K+ purple-red; hypothecium brown; hymenium colourless, 80–120 µm high; epithecium pale brown to blue- black. Ascus 80–100 × 20–30 µm, 8-spored. Ascospores 3-septate to submuriform, colourless but sometimes becoming pigmented, 17–25 × 9–13 µm. Chemical substances unknown. **BLS 1214**.

On siliceous submontane rocks; scattered. Scottish Highlands (Angus).

Similar to *Rhizocarpon postumum* and *R. reductum*, from which it is separated by its submuriform ascospores, often with 1-2 oblique septa, and K+ purple-red exciple.

Rhizocarpon superficiale (Schaer.) Malme (1914) **Nb**

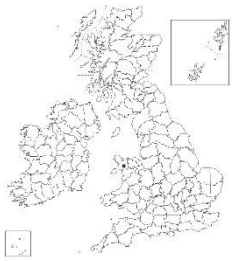


Thallus to 10 cm diam., areolate, prothallus well-developed, black or locally pale grey; areoles to 1.5 (–2.5) mm diam., green-yellow, matt, scattered to contiguous, angular to round, entire to sparsely fissured, weakly concave to strongly convex, smooth or scabrid. Apothecia to 1.0 (–1.4) mm diam., black, not pruinose, round to angular, flat to weakly convex, often slightly elevated above the areoles; true exciple usually persistent, internally brown-black (K+ purple-red) at the rim, inner part pale brown to colourless, K+ red (norstictic acid crystals); epithecium brown- to green-black (K–, intensifying green) or also in part with brown-red hues, sometimes K+ red (norstictic acid crystals); hymenium colourless. Ascospores 12–20 × 6–10 µm, 1-septate, dark brown. Medulla and exciple K+ red, Pd+ yellow-orange (rhizocarpic and norstictic acids). **BLS 1277**.

On exposed siliceous rocks, montane; rare. N. Wales (Glyderrau, Yr Ole Wen), Scotland (Ben Hope).

The dark rim of the true exciple is often partly eroded, exposing a paler inner part and imparting a grey-white tone to the apothecial edge. This feature and the smaller ascospores distinguish the species from *R. atroalbescens*, which can also have a K+ red thallus. A chemotype containing stictic acid as the major compound, occasionally also hypostictic acid, is known from Scandinavia. Previous reports of the similar *R. inarense* (Vain.) Vain. (1922) from Britain (N. Scotland, Ben Hope) are referable to *R. superficiale*.

Rhizocarpon timdalii Ihlen & Fryday (2002) **Nb**

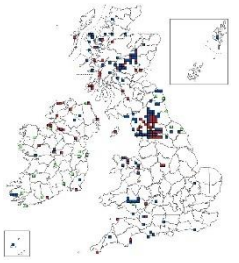


Thallus to 3 cm. diam., areolate; areoles ± convex, rounded, brown, sometimes with a grey tinge; medulla I–, crystals absent; hypothallus distinct, black. Apothecia scattered, rounded, black, (0.3–) 0.4–0.5 (–0.6) mm diam.; disc initially flat, distinctly convex when mature; true exciple (20–) 30–70 (–80) µm thick, at first distinct, becoming indistinct or absent when the disc is convex and mature; exciple in section dark blue-green, K–, N+ red, HCl+ blue (cinereorufa-green), or red-brown in water, at least in the lower part, K± intensifying, or K+ purple-red, N± intensifying, HCl± intensifying (atra-red); crystals absent; hypothecium brown in water, intensified in K, N– or N and HCl± intensifying; hymenium colourless, (100–) 125–190 (–250) µm high; epithecium mostly dark blue-green, K–, N+ red, HCl+ blue (cinereorufa-green), frequently with small brown patches, crystals absent; paraphysoids branched and anastomosing, (1.6–) 2.2–3.3 (–4.0) µm diam., with swollen apices when pigmented, (3–) 4–6 (–6.5) µm diam. Asci 8-spored, I+ slightly blue. Ascospores ± ellipsoidal, colourless, 24–48 × 13–23 µm, eumuriform, with 13–25 (–30) cells in optical view. Conidiomata not seen. Medulla C–, K–, Pd–. An unidentified fatty acid, or lichen products not detected by TLC. **BLS 2335**.

On siliceous rocks, sometimes with a high metal content, often near lakes; rare, N. Wales (Snowdon).

Differs from *Rhizocarpon reductum* in its blue-green epithecium, small convex areoles, longer and broader ascospores with more cells and lack of stictic acid. *R. sublavatum* has a cracked-areolate thallus and flat apothecia with a thin persistent raised margin, *R. anaperum* has a brown granular thallus and a brown epithecium, and *R. lavatum* has much larger apothecia with a thick margin, a smoother thallus and less strongly muriform ascospores.

Rhizocarpon umbilicatum (Ramond) Flagey (1894) **LC**



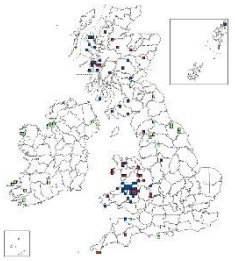
Thallus to 5 cm diam., crustose, continuous or partly rimose, white, matt, pruinose; prothallus usually poorly developed, black, white-pruinose. Apothecia to 1.5 mm diam., black, mainly orbicular, flat or becoming moderately convex; disc not pruinose; true exciple thick, usually persistent, distinctly pruinose; internally brown- or green-black at the rim, inner part pale brown to colourless, K+ yellow, with crystals partly dissolving in K; epithecium olive-brown, with some crystals K+ dissolving yellow as well as some K– crystals; hymenium colourless; hypothecium dark brown, K–. Ascospores 18–28 × 10–16 µm, submuriform, persistently colourless. Medulla K+ yellow, Pd+ orange (stictic acid). **BLS 1279**.

On calcareous rocks, especially hard limestones; local. Mainly W. & N. Britain, widespread in Ireland.

Separated from *Rhizocarpon petraeum* by the smaller, submuriform ascospores. For other differences see the account of that species.

Host to *Phaeospora parasitica* and *P. rimosicola*.

Rhizocarpon viridiatrum (Wulfen) Körb. (1855) **Nb**



Thallus to 2 cm diam., areolate, growing on the thallus of various crustose lichens, the central part sometimes eroding; prothallus indistinct or forming a narrow marginal band; areoles to 1 (–1.2) mm diam., green-yellow, matt, contiguous, flat to strongly convex, smooth, round to angular, medulla I–. Apothecia to 1 mm diam., black, not pruinose, ± round, flat to strongly convex, often slightly elevated above the areoles; true exciple usually becoming excluded; internally brown-black at the rim, paler in the inner part, K+ faintly purple-red; epithecium brown-black, K+ purple-red; hymenium colourless to pale brown. Ascospores dark brown, 17–32 × 10–16 µm, muriform, with 5–9 cells visible in optical section. Medulla C–, K–, Pd– (rhizocarpic and unidentified fatty acids). **BLS 1280**.

On siliceous to moderately base-rich rocks (e.g. basalt), initially parasitic on other crustose lichens, especially *Circinaria caesiocinerea*; local. S.W. England (Cornwall, Lizard Peninsula; Shropshire), W. & N. England, upland Wales, Scotland, Ireland.

This species often occurs as scattered patches or areoles amongst other lichens. Separated from other yellow species by its lichenicolous habit, dark granular epithecium, muriform ascospores and I– medulla.

SPORASTATIACEAE Bendiksby & Timdal (2013)

Thallus crustose (sometimes granular) or rarely subsquamulose. **Photobiont** chlorococcoid, lacking cephalodia. **Soralia** or **blastidia** present in some species. **Apothecia** discoid, dark red to black. **Thalline margin** present in one species, then thick and crenulate. **True exciple** narrow, brown or colourless internally. **Hamathecium** of mostly unbranched paraphysoids. **Asci** clavate, 2-spored or polysporous, with a well-developed, deeply amyloid tholus without further amyloid structures. **Ascospores** colourless, aseptate, thin- or very thick-walled, without a perispore. **Conidiomata** pycnidia where known. **Conidia** bacilliform, aseptate, colourless. **Chemistry**: with gyrophoric or alectorialic acids.

Described by Bendiksby & Timdal (2013) for the two genera *Sporastatia* and *Toensbergia*, occupying a basal clade of the Lecanoromycetidae. The family was placed in the Rhizocarpales by Lücking *et al*. (2017), although more research is needed to establish its true position. There are few unifying morphological characters, at both generic and family level.

Literature:
Bendiksby & Timdal (2013), Lücking *et al.* (2017), Spribille *et al*. (2020).

1 Asci polysporous, gyrophoric acid present ..... ***Sporastatia***
Asci 2-spored, or lichen lacking ascomata, alectorialic acid present..... ***Toensbergia***

SPORASTATIA A. Massal. (1854)

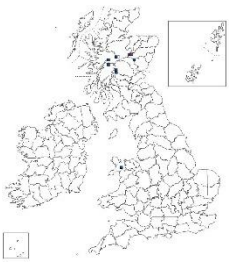
Thallus crustose, areolate; prothallus distinct, black, sometimes forming a rim around each areole as well as delimiting the thallus. **Cortex** of apically pigmented, anticlinal hyphae, with a colourless epinecral layer. **Soralia** and **isidia** not produced. **Photobiont** chlorococcoid. **Medulla** I−. **Ascomata** apothecia, immersed, black, not pruinose, flat to slightly convex; disc often rough or wrinkled. **Thalline margin** absent. **True exciple** narrow, thin, ± persistent, internally brown and K+ reddish at the outer edge, colourless within, or brown throughout. **Epithecium** brownish (K+ reddish, N+ red) to dark greenish (K+ green intensifying, N+ red). **Hymenium** colourless. **Hypothecium** colourless or pale brownish, K+ reddish. **Hamathecium** of mostly unbranched septate paraphysoids, apical cell ± clavate; I+ blue. **Asci** clavate, *ca* 100- to 200-spored; apical dome uniformly K/I+ blue. **Ascospores** small, aseptate, subglobose to globose, colourless, without a distinct perispore. **Conidiomata** pycnidia. **Conidia** bacilliform, aseptate, colourless. **Chemistry**: cortex and medulla C+ red (gyrophoric acid). **Ecology**: on sheltered or exposed hard siliceous rocks.

Distinguished from *Polysporina* and *Sarcogyne* (Acarosporales), which also have polysporous asci, by the K/I+ blue apical dome of the ascus and the generally better developed and delimited thallus containing gyrophoric acid (C+ red).

Literature:
Bendiksby & Timdal (2013), Gilbert & Coppins (2009), Yakovchenko & Davydov (2018).

1 Thallus bluish-grey to yellow- or brown-grey, matt; marginal areoles scarcely elongate; dark prothallus visible only at the thallus edge ..... ***polyspora***
Thallus yellow- to copper-brown, to brown-black, glossy; marginal areoles elongate and radiating; dark prothallus surrounding each areole and the entire thallus..... ***testudinea***

Sporastatia polyspora (Nyl.) Grummann (1963) **NT**



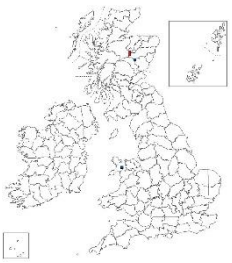
Thallus delimited, to 8 cm diam., pale blue-grey to yellow-grey or pale brown-grey, matt; areoles to 1 mm diam., flat to convex, angular to rounded, scarcely elongate at the thallus edge; epinecral layer thin; algal layer continuous; dark prothallus conspicuous only at the thallus edge. Apothecia 0.2–1 (–1.2) mm diam., epithecium blue-green to olivaceous. Ascospores subglobose, 3–5 × 2–4 µm. Pycnidia not seen. Thallus C+ red. **BLS 1806**.

On sheltered acid rocks above 800 m; rare. N. Wales (Snowdonia), Highland Scotland.

S. testudinea has delicately lobed margins and predominately brown areoles. British material of *S. polyspora* may not be conspecific with the type.

Host to *Polycoccum sporastatiae* (Anzi) Arnold (1874).

Sporastatia testudinea (Ach.) A. Massal. (1854) **NT**



Thallus delimited, forming neat rosettes, to 4 cm diam., yellowish brown to more usually copper-brown to blackish brown, glossy; conspicuously areolate, areoles to 0.6 mm diam., flat to convex, rounded in the centre of the thallus, but elongated and radiating at the margin; epinecral layer thick; algal layer discontinuous; prothallus usually forming a black rim around each areole, as well as around the whole thallus. Apothecia 0.2–0.6 mm diam.; epithecium blue-green. Ascospores 3–4 × 2–3 µm, globose to broadly ellipsoidal. Pycnidia rare; conidia 3–6 × *ca* 1 µm. Thallus C+ red. **BLS 1807**.

On exposed siliceous rocks above 800 m, at one site it is associated with persistent snow beds; rare. N. Wales (Snowdonia), N. Scotland (Cairngorm mountains).

The strongly areolate, C+ red, copper-coloured rosettes with delicately lobed margins are distinctive.

TOENSBERGIA Bendiksby & Timdal (2013)

Thallus granular to crustose or subsquamulose, grey-white to cream or pale green when fresh, indeterminate, sometimes extensive in size. Hypothallus absent, or blueish grey to blackish. **Soredia** or **blastidia** present, the soralia (when present) forming from papillate outgrowths of the thallus, the blastidia minutely coralloid. **Photobiont** chlorococcoid. **Ascomata** apothecia (not known in British and Irish material). **Thalline margin** well-developed, sometimes crenulate. **Disc** dark red to ± black. **Epithecium** red-brown. **Asci** clavate, 2-spored, *Pertusaria*-type. **Ascospores** large, thick-walled with two distinct layers, aseptate. **Conidiomata** not known. **Chemistry**: all species with alectorialic acid. **Ecology**: on soil, mossy boulders or coniferous bark.

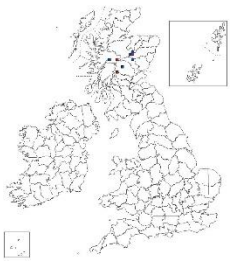
Described by Bendiksby & Timdal (2013) for a sterile sorediate species previously placed in *Hypocenomyce* (Ophioparmaceae, Umbilicariales) and subsequently *Pycnora* (Candelariales, Pycnoraceae). Two further species were added by Spribille *et al*. (2020), one a blastidiate sterile corticolous species known only from NW North America, and the other a terricolous/bryicolous apothecial lichen formerly placed in *Pertusaria* that occurs in our region.

Literature:
Bendiksby & Timdal (2013), Chambers *et al.* (2009), Coppins (2009), Spribille *et al*. (2020).

1 Thallus granular; soralia developing from papillate isidia-like structures; on mossy boulders in montane heaths; apothecia known from non-British material ..... ***geminipara***
Thallus crustose, areolate to subsquamulose; soralia mostly labriform to orbicular; on coniferous bark; not known fertile ..... ***leucococca***

Toensbergia geminipara (Th. Fr.) T. Sprib. & Resl (2020) **NT**

Pertusaria geminipara (Th. Fr.) C. Knight ex Brodo (1984)



Thallus greyish or yellowish white, of thickly crowded, ± rounded granules 0.1–0.2 mm diam., which at times become ± papillate, apices bursting and sorediate; soralia contorted, coarsely granular and becoming efflorescent, 0.5–1.5 mm diam. Apothecia unknown in British material, to 2.5 mm diam.; disc dark red to purplish black; thalline margin thick, wavy or ± crenulate; epithecium red-brown, K± paler, dissolving. Asci 2-spored. Ascospores 22–40 × 15–20 µm, walls two-layered. Thallus C+ red, K+ yellow, KC+ red, Pd+ yellow-orange, UV– or deep orange (alectorialic, barbatolic acids, ± xanthones). **BLS 0923**.

On exposed mountain summit heaths, mossy boulders; very rare. Scotland (Central Highlands).

Dried collections turn red-brown in time and also stain packets pink-brown due to alectorialic acid. Morphs of *Trapeliopsis granulosa* are Pd– and K–; the colour and shape of the granules of *P. geminipara* is reminiscent of *Trapelia glebulosa*.

Toensbergia leucococca (R. Sant.) Bendiksby & Timdal (2013) **Nb**

Pycnora leucococca (R. Sant.) R. Sant. (2004)

Thallus crustose to subsquamulose, episubstratal, usually indeterminate, thick, forming small patches between other lichens or, more rarely, spreading irregularly up to 10 mm or more across, areolate, sorediate; prothallus usually as an indistinct pale greyish brown stain or, more rarely, distinctly brown, blue or blackish; areoles usually persistently discrete, rarely becoming contiguous or, very rarely, more or less imbricate, almost circular to irregular, often distinctly incised and constricted at the base (subsquamiform), occasionally tending to become raised at the edge, flat to convex, conspicuous, to 0.4 (–1.0) mm across, non-sorediate surface usually distinct, smooth, dull, greyish white, pale yellowish green or pale yellowish brown; in dried collections often becoming more distinctly yellowish brown or pink; soralia pale green to pale yellowish with a brown tinge (usually becoming distinctly yellowish brown in dried collections),

occasionally distinctly aeruginose due to a pigment (fading in K, N+ brown) in the external soredia, usually marginal and ± labriform, sometimes laminal and more or less orbicular, or apical and more or less capitate, usually delimited; soredia mostly fine, 20–45 µm diam.; wall distinct; medulla distinct, white. Apothecia and pycnidia not known. Thallus and soralia C+ red, K+ yellow, KC+ red, P+ yellow, UV+ yellow (alectorialic acid). **BLS 1868**.

On bark of *Pinus*; very rare. Scotland (Coulin Pinewood, W. Ross).

In Scandinavia, mostly on *Betula* and *Alnus*. The P+ yellow reaction separates it from similar-looking species of *Trapelia* or *Trapeliopsis*. Also similar to *Pycnora sorophora*, which also contains alectorialic acid, but that species forms an endosubstratal thallus with soralia bursting through the wood or, when well developed, small, rounded episubstratal areolae which are never lobed or subsquamiform and soon burst into soralia.

Nomenclature

HAUGANIA E.J. Möller & Timdal, gen. nov. **IF 902316**

Diagnosis: Differs from *Rhizocarpon* in the combination of rust-coloured thallus, umbonate to gyrose apothecial disc, and relatively small (average length less than 30 µm), 3-septate to submuriform, persistently colourless ascospores.

Type: *Haugania oederi* (Ach.) E.J. Möller & Timdal.

Etymology: The genus is named in honour of Reidar Haugan, acknowledging his great contribution to Nordic lichenology.

Haugania oederi (Ach.) E.J. Möller & Timdal, ***comb. nov***. **IF 902317**

Basionym: *Lecidea oederi* Ach., *Methodus*, Sectio prior (Stockholmiæ): 49 (1803), **nom. cons.**

Syn. *Lichen oederi* Weber, *Spicilegium Flora Goettingensis*: 182 (1778), *non Lichen oederi* Gunnerus (1776).
Rhizocarpon oederi (Ach.) Körber, *Parerga lichenol*. (Breslau) **3**: 232 (1861) [1865]

Haugania pycnocarpoides (Eitner) E.J. Möller & Timdal, ***comb. nov***. **IF 902318**

Basionym: *Rhizocarpon pycnocarpoides* ["*pycnocappoides*"] Eitner, *Jahresbericht der Schlesischen Gesellschaft für vaterländische Cultur* **88**: 46 (1911).

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