Revisions of British and Irish Lichens



British Lichen Society

Volume 34

September 2023



Pertusariales: Megasporaceae

Cover image: Aspiciliella intermutans, on mudstone, Jonathan's Hollow, All Stretton, Shropshire.

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. 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to compile new printed editions of the entire lichen biota of Britain and Ireland is extensive, and many parts are out-of-date even as they are published.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*.

Editorial Board

- Dr P.F. Cannon (Department of Taxonomy & Biodiversity, Royal Botanic Gardens, Kew, Surrey TW9 3AB, UK).
- Dr A. Aptroot (Laboratório de Botânica/Liquenologia, Instituto de Biociências, Universidade Federal de Mato Grosso do Sul, Avenida Costa e Silva s/n, Bairro Universitário, CEP 79070-900, Campo Grande, MS, Brazil)
- Dr B.J. Coppins (Royal Botanic Garden, Inverleith Row, Edinburgh EH3 5LR, UK)
- Dr A.M. Fryday (Department of Plant Biology, Michigan State University, 612 Wilson Rd., East Lansing, MI 48824, USA)
- Mr N.A. Sanderson (3 Green Close, Woodlands, Southampton, Hampshire SO40 7HU, UK)
- Dr J.A. Simkin (School of Natural and Environmental Science, Newcastle University, Newcastle upon Tyne NE1 7RU, UK)
- Dr R. Yahr (Royal Botanic Garden, Inverleith Row, Edinburgh EH3 5LR, UK)

Downloads can be obtained from the British Lichen Society website at https://www.britishlichensociety.org.uk/content/lgbi3

Made available under Creative Commons Licence CC BY-SA

ISSN 2634-7768

© British Lichen Society, 4 September 2023

Revisions of British and Irish Lichens vol. 34

Pertusariales: Megasporaceae

including the genera Aspicilia, Aspiciliella, Circinaria, Lobothallia, Megaspora and Sagedia

by Paul Cannon Royal Botanic Gardens, Kew, Surrey TW9 3AB, UK; email p.cannon@kew.org

Anders Nordin Museum of Evolution, Uppsala University, Villavägen 9, 752 36 Uppsala, Sweden

Brian Coppins Royal Botanic Garden Edinburgh, 20A Inverleith Row, Edinburgh EH3 5LR, UK

André Aptroot Laboratório de Botânica/Liquenologia, Instituto de Biociências, Universidade Federal de Mato Grosso do Sul, Avenida Costa e Silva s/n, Bairro Universitário, CEP 79070-900, Campo Grande, MS, Brazil

Neil Sanderson 3 Green Close, Woodlands, Southampton, Hampshire, SO40 7HU, UK

Janet Simkin School of Natural and Environmental Science, Newcastle University, Newcastle upon Tyne NE1 7RU, UK

This publication can be cited as:

Cannon, P., Nordin, A., Coppins, B., Aptroot, A., Sanderson, N. & Simkin, J. (2023). Pertusariales: Megasporaceae, including the genera *Aspicilia*, *Aspiciliella*, *Circinaria*, *Lobothallia*, *Megaspora* and *Sagedia*. *Revisions of British and Irish Lichens* 34: 1-15.

MEGASPORACEAE Lumbsch (1994)

Thallus usually crustose, weakly cracked to distinctly areolate, areoles contiguous to scattered, in some species foliose to placodioid with radiating marginal lobes; chalk-white, grey, green or brown, occasionally pruinose. **Isidia** and **soredia** present in some species. **Cortex** pseudoparenchymatous. Photobiont chlorococcoid, cells globose to ellipsoidal. Medulla I-. Ascomata apothecia, mostly immersed, sometimes initially poriform but usually widely emergent, more rarely \pm sessile. Thalline exciple poorly developed and becoming excluded, more rarely well developed and persistent, often little more than a slightly raised rim of thallus tissue, but well differentiated in some species. True exciple usually colourless and poorly developed, lateral to and below the hymenium, sometimes broadening above and concolorous with the epithecium. Disc flat to concave, black-brown, sometimes white-pruinose. **Epithecium** with green pigment, N+ intensifying green, $K\pm$ fading to brown ('Aspicilia green'). Hymenium usually more than 100 µm high, colourless, I+ green or blue. Hypothecium with photobiont below, colourless or very pale brown. Hamathecium of paraphyses, simple to sparingly branched, frequently anastomosed, short-celled and moniliform above, the apices cohering to form a well-defined epithecium. Asci 4- to 8-spored, cylindrical to clavate, thin outer coat K/I+ blue, wall and apical dome K/I-. Ascospores aseptate, ellipsoidal to globose, colourless, thinwalled, sometimes with a thin outer sheath, I-. Conidiomata pycnidia, immersed, elongate and flaskshaped to almost globose, scattered or in clusters; wall colourless, or at least in upper part brown or green (pigment as in epithecium) Conidiogenous cells sessile or on short conidiophores, subcylindrical. **Conidia** aseptate, bacilliform to shortly thread-like and \pm straight, colourless. **Chemistry:** some species with fatty acids (especially aspicilin), β -orcinol depsidones (especially norstictic and stictic acids), or unidentified terpenoids. Ecology: on calcareous and siliceous rocks, rarely on soil.

The Megasporaceae currently contains around ten genera, of which six occur in Great Britain and Ireland. Several of these are segregates from *Aspicilia*, which here has a more restricted circumscription than in the second edition of this publication (Fletcher *et al.* 2009). They are all monophyletic (see Nordin *et al.* 2010, Wheeler 2017, Zakeri *et al.* 2017) but are difficult to distinguish at generic level using field characters, so a key to the entire family is included below. In most species the apothecia are immersed within the thallus and broadly emergent (often described as 'aspicilioid'), but a number of unrelated genera show this feature.

Many species require collecting in winter and spring to obtain conidia, which are important for identification. The pycnidia are often restricted to the outer, younger parts of thalli so these portions should not be ignored as being 'sterile'. It is important that the cortex colour should be accurately recorded on collection as it may alter rapidly in dried collections.

Literature:

Clauzade & Roux (1984), Lutzoni & Brodo (1995), Nordin *et al.* (2007, 2010), Roux *et al.* (2011), Schmitt *et al.* (2006), Sohrabi *et al.* (2013), Wheeler (2017), Zakeri *et al.* (2017).

1	Thallus foliose, placodioid, scurfy or granular	2
	Thallus crustose, often areolate	4
2 (1)	Thallus not strongly delimited, scurfy or \pm granular, often strongly pruinose, on soil or mosses; apothecia poriform when young; ascospores very large (> 30 µm long) <i>Megaspora verruc</i> Thallus foliose or placodioid, on rock; apothecia immersed but not strongly poriform; ascospores	osa
	10–15 μm long	3
2 (1)	Thallus foliose, lobes >1 cm long (<i>Physcia</i> -like), K	spis
	Thallus placodioid, lobes K+ red (crystals)	iosa

4 (1)	On limestone, cement or base-enriched rocks
5 (4)	Thallus of widely scattered squamules <0.5 mm diam., black-sorediate below at the edges
	Thallus crustose, cracked-areolate, lacking soredia
6 (5)	Areoles circular, widely separated especially at the margin; prothallus very thin <i>Circinaria contorta</i> Areoles a continuous crust to the edge of the thallus; prothallus usually evident
7 (6)	Thallus margin abrupt, usually zonate; areoles elongated, separated by radiating cracks; cortex smooth
	Thallus margin effuse; areoles rimose, regular, lacking radiating cracks at the edge; cortex scabrid
8 (4)	Thallus with isidia, soralia or areoles with granules or marginal squamules or folioles
9 (8)	Thallus K+ yellow→red (norstictic acid); areoles with isidia or soralia; not strongly maritime
10 (9)	Thallus ± smooth, with dot-like soralia or scattered patches of smooth corticate branched isidia which develop to resemble soredia and eventually obscure the areoles
11(8)	Thallus Pd+ orange, K+ yellow or red 12 Thallus Pd-, K- 14
12 (11)	Thallus smooth, glossy, dark green-black; aquatic
13 (12)	Conidia 7–11 µm long; ascospores 22–28 µm long
14 (13)	On semi-inundated rocks in freshwater streams; thallus white; apothecial discs black. <i>Aspicilia aquatica</i> Thallus terrestrial, grey to brown, discs brown or black
15 (14)	Areoles obscured by dense large sessile apothecia; ascospores 12–14 μm long; conidia 3–5 μm long
16 (15)	Thallus a continuous rimose-areolate crust
17 (16)	Thallus typically pale to dark grey with a blueish tinge, not zonate; apothecia with a grey thalline margin; asci often with fewer than 8 spores

ASPICILIA A. Massal. (1852)

Thallus crustose, weakly to distinctly cracked or areolate, sometimes zonate, rarely granular with scattered areoles; mostly grey to brownish, in one species white to yellowish. Prothallus sometimes prominent, grey to black, occasionally fimbriate. Soralia present in some species. Photobiont chlorococcoid, cells globose to ellipsoidal. Medulla I-. Ascomata apothecia, mostly immersed, occasionally becoming emergent, more rarely lecanorine and soon emergent and ± sessile. Thalline **margin** poorly developed and becoming excluded, often little more than a slightly raised rim of thallus tissue, but well differentiated in some species. True exciple usually colourless and poorly developed, lateral to and below the hymenium, sometimes broadening above and concolorous with the epithecium. **Disc** flat to concave, black-brown, rarely pruinose. **Epithecium** pigment green, N+ intensifying green, K± fading to brown ('Aspicilia green'). Hymenium tall, colourless, I+ green or blue. Hypothecium with photobiont below, colourless or very pale brown. Hamathecium of paraphyses, unbranched or sparingly branched, frequently anastomosed, short-celled and moniliform above, the apices cohering to form a well-defined epithecium. Asci 4- to 8-spored, cylindrical to clavate, thin outer coat K/I+ blue, wall and apical dome K/I-. Ascospores as \pm globose, colourless, thin-walled, sometimes with a thin perispore, I-. Conidiomata pycnidia, immersed, elongate and flask-shaped to almost globose, single or in clusters; wall colourless, or at least in the upper part brown or green (pigment as in epithecium). Conidiogenous cells sessile or on short conidiophores, subcylindrical. **Conidia** aseptate, bacilliform to filiform and \pm straight, colourless. **Chemistry**: with β -orcinol depsidones (especially norstictic and stictic acids), or unidentified terpenoids. Ecology: on siliceous rocks.

Aspicilia in its phylogenetic interpretation is monophyletic (Nordin *et al.* 2010) and in Great Britain and Ireland can largely be defined using a combination of morphological and ecological criteria. Species have crustose thalli that are not usually strongly areolate, and occur on siliceous rather than calcareous rocks. The rare *A. tuberculosa* has not been sequenced and probably belongs in *Circinaria* rather than *Aspicilia*, but the species appears to be extinct in our area and more studies are needed before a transfer is appropriate. There are historical records of *A. subdepressa* Arnold (1869) from Wales, but they appear to be misidentified; a comprehensive description of the species can be found in Roux *et al.* (2011).

Aspicilia species from our region can be found in the key to all species of Megasporaceae above.

Literature:

Clauzade & Roux (1984), Fletcher *et al.* (2009), Fryday *et al.* (2021), Nordin (2015), Nordin *et al.* (2007, 2010, 2011), Paukov *et al.* (2017), Roux *et al.* (2011, 2016).

Aspicilia aquatica Körb. (1855)

Thallus thin, smooth, weakly rimose, white, tinged yellow in places; prothallus thick, grey, delimiting. Apothecia immersed, the disc black, turning translucent green when wet, concave; thalline margin thin and inconspicuous; hymenium 150-170 μ m high, I+ blue turning dark red-brown; epithecium green-olive, N+ intensifying green, fading to straw-brown in K; paraphyses branched, moniliform, the apical cell blackened, 2-3 μ m diam. Asci cylindrical, *ca* 140 × 35 μ m. Ascospores 25–35 × 14–20 μ m. Thallus K–, Pd–. **BLS 2396**.

On siliceous boulders in montane streams and lakes; apparently rare, but overlooked. Scotland (W. Sutherland, Westerness, Southern Uplands), N. and C. Wales.

Aspicilia aquatica may be confused with pale morphs of Circinaria caesiocinerea, which may grow in similar habitats but in less strongly inundated positions. *Ionaspis lacustris* also may form whitish thalli and occurs in freshwater habitats, but it has fawn to orange apothecial discs with a green N+ crimson epithecium.

The lichen *Placopyrenium formosum* is initially parasitic on *A. aquatica* (Orange 2009), but subsequently develops an independent thallus.



Aspicilia cinerea (L.) Körb. (1855)

Thallus areolate on a shiny black hypothallus, areoles very irregular, becoming warted or with knobbly papillae along margins in nutrient-rich environments, smooth, dull grey, becoming brown-tinged, grey-brown or rarely rust-coloured or green, to 1 mm diam.; prothallus black, delimiting. Apothecia (0.2-) 0.4-1.2 (-2) mm diam., slightly concave to flat, one or two per areole, at first immersed, later sometimes becoming sessile, round; thalline margin thick, even, persistent; disc concave, matt black. Asci (6-) 8-spored. Ascospores $12-22 \times 6-13 \mu m$, broadly cylindrical to ellipsoidal. Conidia $11-16 \times ca$ 1 µm. Thallus K+ red, Pd+ orange (norstictic acid). BLS 2350.

specimens in dried collections have proved to be Aspiciliella intermutans. N. & W. Britain, rare elsewhere.

Because of variations in colour and roughness of the areoles it is likely that several described species are included here. Thalli often resemble Circinaria caesiocinerea especially when they lose their brown colour after collection. See also the commoner Aspiciliella intermutans and the rare Aspicilia epiglypta, which have shorter and longer conidia respectively. Material is best collected in winter and spring to find conidia. As conidial length within a pycnidium is very variable, their maximum lengths need to be measured. Pertusaria chiodectonoides can superficially resemble A. cinerea and has similar chemical reactions, but has larger, more tuberculate areoles and more elevated, rounded apothecia.

Reports for when this species is not distinguished from Aspicilia epiglypta, Aspiciliella intermutans and *Circinaria caesiocinerea* are recorded as *Aspicilia cinerea s. lat.* (BLS 0104).

Host to Rosellinula haplospora (Th. Fr. & Almq. ex Th. Fr.) R. Sant. (1986). Additionally reported, but only for A. cinerea s. lat. are Endococcus rugulosus Nyl. (1855), Muellerella lichenicola (Sommerf.) D. Hawksw. (1979) and *M. pygmaea* (Körb.) D. Hawksw. (1979.

Aspicilia epiglypta (Norrl. ex Nyl.) Hue (1912)

Thallus crustose, rimose, shiny, becoming markedly cracked-areolate and matt, irregular, angular areoles to 1.5 mm diam., rounded-warted, usually smooth but at times roughened, usually pale grey with a yellow-fawn to brown tinge, usually markedly zonate at the margin, sometimes for up to 15 mm; prothallus black, delimiting, often broadly zonate at the margin. Apothecia 2–5 per areole, rarely single, small (0.2-0.3 (-1.0) mm diam.); thalline margin raised, thick, angular-indented or convoluted, persistent; disc black, flat, generally rough and appearing wrinkled or wavy-margined when old, even slit-like; paraphyses branched, moniliform, swollen to 5–6 µm diam. at the tip; epithecium dark olive-green, N+ intensifying to bright green; epithecium and true exciple with a colourless (dead?) outer layer of enlarged cells in

a gelatinous matrix. Ascospores $20-25 \times 12-15$ µm. Conidia $15-28 \times ca$ 1 µm. Thallus K+ red, Pd+ yelloworange (norstictic acid). BLS 0109.

On schists and granitic rocks, maritime, often in sunny, nutrient-rich situations; rare. N. and W. Britain, Channel Is, a few records from coastal Ireland.

The fawn-grey thallus and irregular apothecia are distinctive. It seems to be the rarest of a morphologically similar trio including A. cinerea and Aspiciliella intermutans, which differ principally in conidial and ascospore size, lack the yellow tinge, and have regular apothecial margins. It can resemble fertile forms of maritime Pertusaria pseudocorallina but lacks isidia and has characteristic irregular discs.

Aspicilia granulosa A. Nordin (2011)

Thallus grey or green-grey to brownish, often minutely white-spotted, thin, the inner part finely granular or subisidiate to vertucose or indistinctly areolate, the margin usually with elongate areoles forming a dendroid pattern. Areoles 0.1–0.2 mm wide and up to 1 mm long, often brown at the tips, in the central part indistinct, irregularly rounded, often nodulose or subdivided into granules, sometimes bursting open and exposing the medulla. Epinecral layer usually present, to 15 µm thick. Hypothallus dark brown to black, smooth, often fimbriate at the margins. Apothecia urceolate, irregularly rounded, 0.2-0.6 mm diam. Thalline margin indistinct, smooth to subcrenulate; disc black, smooth, concave, not pruinose; epithecium brown-green, N+ green, K+ brown; paraphyses branched and anastomosing, predominantly moniliform, the apical cells to 3 µm diam.

On exposed siliceous rocks; locally frequent but probably over-recorded as many

LC





NE

Nb

Ascospores $15-18.5 \times 9-12 \mu m$. Pycnidia not found. Thallus K+ yellow turning red, C-, Pd+ yellow-orange, containing norstictic and connorstictic acids. **BLS 2794**.

Confirmed records on old mine spoil, Cumbria and siliceous streamside rocks, Wales (Caernarvon) but probably more widespread and extending north to the Outer Hebrides.

Distinctive for its strongly granular thallus, with isidium-like structures that may form an extensive, erose crust of chunky knobbly propagules. The description has been largely adapted from Nordin *et al.* (2011).

Aspicilia laevata (Ach.) Arnold (1887)

Thallus continuous or slightly rimose, with few discrete areoles, smooth and even, thin, colour varying from black-green to pale green-grey, becoming grass-green when wet, usually glossy; with a black hypothallus and delimiting prothallus. Apothecia 2–5 per areole, round, even, immersed and inconspicuous until wetted, 0.2–0.5 mm diam., numerous and usually crowded, crater-like to emergent; thalline margin inconspicuous; true exciple inconspicuous, thin; disc brown, flat to concave; epithecium green, N+ intensifying, without colourless cells above the epithecium; paraphyses weakly branched, scarcely swollen at the tips. Asci 8-spored. Ascospores $13-20 \times 9-13 \mu$ m, broadly ellipsoidal. Conidia $18-25 \times ca 0.8 \mu$ m. Thallus K± yellow or red, Pd+ orange (stictic and ± norstictic acids, ± an unidentified terpenoid). **BLS 0115**.



On rocks and boulders in streams or woodland, especially in shaded situations; scarce. W. & N. Britain.

The thallus could be taken for a *Rhizocarpon. Aspicilia aquatica*, also found in montane streams, has a pale white-grey thallus that is K–, Pd–, and black discs. *Ionaspis lacustris* occasionally forms pale yellowish thalli, but has orange-red discs and is also K–.

Reported as host to Endococcus perpusillus and the lichenicolous lichen Rinodina parasitica.

ASPICILIELLA M. Choisy (1932)

Thallus crustose, rimose-areolate, partially continuous; photobiont chlorococcoid. **Apothecia** pale brown to dark grey or black. **True exciple** always present, rarely surrounded by an additional **thalline margin**. **Epithecium** green to olive green to greenish-brown, N+ light green. **Hypothecium** and subhymenium colourless, I+ blue to rusty red. **Hymenium** colourless, I+ blue to rusty red. **Asci** 8-spored, *Aspicilia*-type. **Ascospores** ellipsoidal, colourless, aseptate. **Conidia** straight, 7–11µm long. **Chemistry**: thallus K+ red, C–, UV–. TLC: norstictic acid and sometimes connorstictic and stictic acids.

Aspiciliella differs from Aspicilia in having small conidia, and ascospores that are always ellipsoidal. Only one species (as currently delimited) is known from our region.

Literature:

Fletcher et al. (2009), Zakeri et al. (2017, 2019).

Aspiciliella intermutans (Nyl.) M. Choisy (1932)

Aspicilia intermutans (Nyl.) Arnold (1887)

Like Aspicilia cinerea, but ascospores (20-) $22-28 \times (11-)$ $12-14 \mu m$ and conidia $7-11 \times ca$ 1 μm ; apothecia 2 or 3 per areole; epithecium dark olive, N+ green; paraphyses scarcely swollen, to 2 μm diam. at the tip; epithecium with an outer, clear cellular layer. Thallus K+ red, Pd+ orange (norstictic, connorstictic, constictic acids). **BLS 0114**.

On low-lying rocks, slate roofs, etc., especially maritime; rare but probably very much under-recorded;

Nb

scattered throughout Britain and Ireland. Many records of *Aspicilia grisea s. lat.* (see under *Sagedia simoensis* below) will belong to this species.

This species is virtually indistinguishable in morphological terms from *Aspicilia cinerea* and *A. epiglypta* apart from in conidial length and differences in ascospore size and shape. However, DNA evidence shows that it is more closely related to *Circinaria* and *Megaspora* than to *Aspicilia* (Zakeri *et al.* 2017). According to Zakeri *et al.* (2019), *A. intermutans* is a species complex containing at least six segregate taxa, but these have not been named to date and no British or Irish material was included in their study.

Reported as host to Endococcus perpusillus.

CIRCINARIA Link (1809)

Thallus crustose, sometimes strongly areolate or rimose, sometimes minutely squamulose or with scattered areoles; white to pale grey or blueish grey to brownish. Prothallus sometimes prominent, pale to dark grey, occasionally zonate. Soralia and/or isidia present in some species. Photobiont chlorococcoid, cells globose to ellipsoidal. Medulla I-. Ascomata apothecia, mostly immersed, occasionally becoming emergent. Thalline margin usually poorly developed and becoming excluded, often little more than a slightly raised rim of thallus tissue. True exciple usually colourless and poorly developed, lateral to and below the hymenium, sometimes broadening above and concolorous with the epithecium. Disc flat to concave, black-brown, sometimes pruinose. **Epithecium** pigment olive to green, N+ intensifying green, K± fading to brown ('Aspicilia green'). Hymenium tall, colourless, I+ green or blue. Hypothecium with photobiont below, colourless or very pale brown. Hamathecium of paraphyses, unbranched or sparingly branched, frequently anastomosed, short-celled and moniliform above, the apices cohering to form a well-defined epithecium. Asci 4- to 8-spored, cylindrical to clavate, thin outer coat K/I+ blue, wall and apical dome K/I-. Ascospores aseptate, \pm globose, colourless, thin-walled, sometimes with a thin perispore, I-. **Conidiomata** pycnidia, immersed, elongate and flask-shaped to almost globose, single or in clusters; wall colourless, or at least in the upper part brown or green (pigment as in epithecium). Conidiogenous cells sessile or on short conidiophores, subcylindrical. Conidia bacilliform to filiform and sometimes curved, colourless. **Chemistry**: some species with fatty acids (especially aspicilin), β orcinol depsidones (especially norstictic and stictic acids), or unidentified terpenoids. Ecology: on calcareous or siliceous rocks.

Not well delimited from *Aspicilia* in morphological terms, but species contain the fatty acid aspicilin and lack substictic acid which is present in some species of *Aspicilia* s. str. (Nordin *et al.* 2010). Most species of *Circinaria* have asci containing fewer than eight ascospores.

Literature:

Clauzade & Roux (1984), Fletcher et al. (2009), Nordin et al. (2010), Roux et al. (2011, 2016).

Circinaria caesiocinerea (Nyl. ex Malbr.) A. Nordin, Savić & Tibell (2010)

Aspicilia caesiocinerea (Nyl. ex Malbr.) Arnold (1886)

Thallus to 20 cm diam., rather thick, becoming wide-spreading, rimose at the edge to warted-areolate; areoles continuous, flat or convex, occasionally subsquamulose in the centre of the thallus, irregular to rounded, 0.3-1 (-2) mm wide, often uneven with distinct edges and a rough, matt surface, typically pale grey with a blue tinge, becoming dirty dark grey; prothallus, if present, grey, delimiting. Apothecia 0.2–0.8 mm diam., immersed, crater-

LC

like, sometimes becoming emergent, well separated; thalline margin evident from an early stage, thin, entire, somewhat wavy but rarely prominent; disc black, shiny, concave, becoming expanded. Asci (4–) 6–8-spored. Ascospores very variable in size, often poorly developed, $14-30 \times 7-16 \mu m$, broadly ellipsoidal to globose. Conidia 6– $12 \times ca \ 1 \mu m$. Cortex and medulla K–, Pd– (aspicilin). **BLS 0102**.

On nutrient-rich rocks, especially by lakes, seashores and bird-perching stones, also on walls and memorials; locally common. Widespread in Britain and Ireland, especially in N. & W. Britain.

The commonest K– *Aspicilia*-like lichen on siliceous rocks. Most British material previously identified as *Aspicilia gibbosa* seems to be this species.

The lichenicolous lichens *Placopyrenium formosum* and *Rinodina parasitica* are parasitic on *C. caesiocinerea* on siliceous rocks in streams, whereas *Rhizocarpon viridiatrum* can occur in drier situations. Non-lichen-forming lichenicolous fungi reported are *Endococcus perpusillus*, *E. rugulosus*, *E. verrucosus*, and *Sclerococcum* (*Dactylospora*) *attendendum* (Nyl.) Ertz & Diederich (2018). There are also three unidentified taxa reported from GB&I: *Lichenochora* sp. with 1-septate ascospores, $15-18 \times 6-7 \mu m$; *Minutoexcipula* sp. with 1-septate conidia, $6.6-9.5 \times ca 4 \mu m$; and *Roselliniella* sp. with 0–2-septate ascospores, $16.5-18 \times 9-10.5 \mu m$.

Circinaria calcarea (L.) A. Nordin, Savić & Tibell (2010)

Aspicilia calcarea (L.) Mudd (1861)

Thallus usually large, to 30 cm diam. or more, forming circular patches, thick, finely cracked-areolate; areoles radially orientated especially at the outer edge of the thallus, concave to flat when old, matt, chalk-white to pale grey, rarely stained rust-coloured, cortex smooth; prothallus usually delimiting, dark grey, conspicuously zoned. Apothecia 0.2–1 mm diam., immersed, rounded or angular; thalline margin thickened but only slightly raised; disc concave, black, rarely slightly white-pruinose. Asci 4-spored. Ascospores $18-30 \times 14-27 \mu m$, broadly ellipsoidal to subglobose, with a thin perispore. Conidia $7-11 \times 0.5-1 \mu m$. Thallus K–, Pd– (aspicilin). **BLS 0103**.

On hard limestones, tombstones and memorials, intolerant of nutrient enrichment;

frequent. Widespread in England, Ireland and Wales, with a more scattered distribution in Scotland. However, certainly over-recorded especially in urban areas as many specimens from concrete have proved to be *C*. *hoffmanniana*.

Aspicilia lilliei B. de Lesd. (1906), described from N.E. Scotland, is a doubtful species said to closely resemble *C. calcarea* but apparently differing in being yellow internally and in having much narrower ascospores $13-25 \times 5-6 \mu m$. *Hymenelia cyanocarpa* is superficially similar but is on siliceous rock. *H. heteromorpha* also can resemble *C. calcarea*; both *Hymenelia* species have *Trentepohlia* as photobiont and much smaller ascospores.

Lichenicolous fungi include *Kiliasia episema*, *Lichenostigma elongatum* Nav.-Ros. & Hafellner (1996), *Muellerella lichenicola*, *M. pygmaea*, *Opegrapha parasitica*, *Pyrenidium actinellum* Nyl. (1865) and *Weddellomyces macrosporus* D. Hawksw., Renob. & Coppins (1990). *Heteroplacidium fusculum* and *Placopyrenium canellum* initially grow on the thallus of *C. calcarea* but later assume an independent thallus.

Circinaria contorta (Hoffm.) A. Nordin, Savić & Tibell (2010)

Aspicilia contorta (Hoffm.) Kremp. (1861)

Thallus of circular, rounded areoles, chalk-white to pale grey, scattered, sometimes becoming crowded and angular due to compression, 0.2-1.2 (-1.8) mm diam., matt, often convex, with darker margins; prothallus white to pale grey, effuse, visible between areoles but indistinct at the perimeter. Apothecia 0.2-0.6 (-0.8) mm diam., mostly one per areole, often occupying almost the entire areole; epithecium olive, K+ yellow-orange, N+ green. Asci 4-spored. Ascospores $ca 20 \times 11 \,\mu\text{m}$. Thallus K–, Pd–, no lichen substances detected. **BLS 0107**.

On calcareous rocks and hard limestones, frequently on mortar, concrete and sandy limestones, tolerant of nutrient-enrichment; common. Throughout Britain and Ireland. Like a very dispersed form of *C. calcarea* but darker, with a poorly developed

prothallus and effuse at the perimeter. The circular, convex areoles are widely separated at the thallus perimeter and are distinctive, resembling miniature flying saucers but becoming angular when crowded in the thallus centre.

Reported lichenicolous fungi are Arthonia aff. urceolata (Elenkin) Calat., Barrena & V.J. Rico (2004),



LC





Lichenothelia renobalesiana D. Hawksw. & V. Atienza (2008), Muellerella lichenicola and Weddellomyces aspiciliicola Alstrup (1992).

Circinaria hoffmanniana (S. Ekman & Fröberg ex R. Sant.) A. Nordin (2016)

Aspicilia contorta subsp. hoffmanniana S. Ekman & Froberg ex R. Sant. (1993) Frequently confused with *Circinaria calcarea*, but is darker grey, thinner, scabrid or somewhat pruinose, with an effuse margin and with prominent apothecia. The areoles are flat and pressed together at the margin, unlike in *C. contorta* which has distinctive separated circular convex areoles at the thallus perimeter. **BLS 0113**.

Proving very common, and widespread, particularly on cement in urban areas, and on soft limestones, tolerant of nutrient-enrichment. Most certainly under-recorded historically through confusion with *C. calcarea*. Throughout Britain and Ireland, particularly common in the south and east.

Formerly treated as a subspecies of *C. contorta* and morphological intergradations exist, but preliminary molecular data (see Roux *et al.* 2016) indicates that two species are involved.

Host to *Muellerella lichenicola* and *Opegrapha parasitica*, and there is one report of the lichenicolous lichen *Placopyrenium canellum* on this host.

Circinaria leprosescens (Sandst.) A. Nordin, Savić & Tibell (2010)

Aspicilia leprosescens (Sandst.) Motyka (1995)

Thallus cracked-areolate, scurfy or mealy, areoles slightly convex, later ascending at the edges and resembling minute folioles, squamules or papillae, at times appearing granular, isidiate or sorediate, pale white-grey to dark blue-grey, later brown-grey; prothallus sometimes evident, dark green-grey, delimiting. Apothecia often absent, one or two per areole, 0.3–1 mm diam., round, at first deeply concave, later emergent; thalline margin thin, often granular or not obvious, mostly paler than the thallus, disc black. Asci (4–) 8-spored. Ascospores $14-30 \times 7-16 \mu m$, subglobose to ellipsoidal. Pycnidia black, gnarled, conidia curved, *ca* 25 μm long. Thallus K–, Pd– (aspicilin). **BLS 0116**.

On nutrient-rich siliceous rocks, forming conspicuous white films on rock pinnacles used as sea-bird perches, and in associated seepage tracks in the xeric supralittoral zone; locally frequent. Widespread on rocky shores in Britain and Ireland except in S. and E. England, very rarely inland on wind-exposed rocks (S. England, Wilts).

The ecology and minutely squamulose thallus make this species distinctive. Host to *Lichenochora aprica* Hafellner & Nik. Hoffm. (2000).

Circinaria tuberculosa (Ach.) Coppins (2023)

Aspicilia tuberculosa (Ach.) J.R. Laundon (1986)

Thallus of widely scattered regular hemispherical brown-grey shiny granules 0.1–0.3 (–0.7) mm diam., at times resembling isidia, on a wide-spreading dark grey-black fimbriate prothallus. Apothecia rare, sessile or almost stalked, sub-globose, *ca* 1 mm diam.; thalline margin swollen, undulating, smoothly granular like the thallus; disc flat, black, often pruinose. Asci (4–) 8-spored; paraphyses moniliform; epithecium olive, N+ green. Ascospores $22-28 \times 20-26 \,\mu\text{m}, \pm$ globose. Cortex and medulla K–, Pd– (aspicilin). The cortex has been reported to be uniquely C+ white. **BLS 1851**.

On flint nodules near the sea coast (Isle of Wight) and on chalk downs (Hampshire and Sussex); very rare and possibly extinct. Searches to rediscover a population reported from S. Hampshire in 1991 were unsuccessful.

Like an extremely dispersed form of *Circinaria caesiocinerea*, which has a continuous thallus, obscure prothallus and narrower ascospores. The status of this species needs further investigation. However, the presence of aspicilin indicates that a transfer to *Circinaria* is appropriate, and the species was contrasted with *C. caesiocinerea* by Laundon (1986).







LOBOTHALLIA (Clauzade & Cl. Roux) Hafellner 1991

Thallus crustose to foliose, without clearly differentiated rhizines, areolate, radiating and often conspicuously placodioid at the margin. **Apothecia** immersed and concave when young, later becoming sessile and flat or sometimes stalked. **Thalline margin** thick and prominent, sometimes undulating. **Disc** reddish brown to black, flat to concave, sometimes becoming contorted. **Epithecium** olivaceous to red-brown, N– or N+ greenish. **Paraphyses** simple or weakly branched, somewhat moniliform and swollen at the apices. **Asci** *Aspicilia*-like, 8-spored. **Ascospores** relatively small compared to other genera of Megasporaceae, broadly ellipsoidal, colourless, thin-walled. **Conidia** small, ellipsoidal or bacillar.

Distinguished by the lobate, often strongly radiating thallus, and the small, ellipsoidal to bacillar conidia. Nordin *et al.* (2010) demonstrated that the genus is monophyletic and clearly distinct in molecular terms. The three species known from Britain and Ireland are included in the key to species of the Megasporaceae above.

Literature:

Clauzade & Roux (1991), Fletcher et al. (2009), Hafellner (1991), Nordin et al. (2010).

Lobothallia melanaspis (Ach.) Hafellner (1991)

Aspicilia melanaspis (Ach.) Poelt & Leuckert (1973)

Thallus foliose, of elongate radiating overlapping lobes, several cm long, 0.5–1.5 mm wide, in large patches over 6 cm diam.; lobes convex, cylindrical, white, pale-grey or glaucous, darkened to blue-black at the widened and rounded tips, turning bright green when wet, white below, lacking distinct rhizines, very loosely appressed and readily removed from the substratum. Apothecia to 1.8 mm diam., sessile, constricted below, often stalked; thalline margin prominent; disc flat to convex, red-brown to blackbrown; epithecium red-brown, with a clear layer above, N+ green intensifying; hymenium 60–75 (–90) μ m tall; paraphyses weakly branched, cellular, widening to *ca* 3 μ m diam. Ascospores 10–13 × (6–) 8–10 μ m. Conidia 4.5–6 × *ca* 1 μ m. Thallus K–, Pd–, **BLS 0120**.

On siliceous lakeside rocks (quartzite) near 700 m altitude; rare, endangered. N. Scotland (W. Sutherland), with an unconfirmed report from Argyll.

The only foliose species of Megasporaceae in Britain. The large, loosely attached lobes and sessile apothecia resemble a white form of *Anaptychia runcinata* or a very large *Physcia* species.

Lobothallia radiosa (Hoffm.) Hafellner (1991)

Aspicilia radiosa (Hoffm.) Poelt & Leuckert (1973)

Thallus rather thin, medium grey, cracked-areolate towards the centre, radiating and placodioid-lobate at the margins, lobes slightly convex, forming conspicuous orbicular, closely appressed patches; surface matt, somewhat white-pruinose especially towards the ends of the lobes; marginal lobes narrow, 0.4-1 (-1.5) mm wide, contiguous, flat or slightly convex; prothallus not evident. Apothecia abundant, one to three per areole, becoming crowded towards the thallus centre, immersed and concave when young, later becoming sessile and flat; thalline margin thick, crowded and undulating; disc 0.2-0.6 mm diam., black, brown when wet. Ascospores $10-15 \times 6-9 \mu$ m, broadly ellipsoidal. Conidia $4-6 \times ca 1 \mu$ m. Thallus C–, K+ red, Pd+ orange (norstictic acid). **BLS 0124**.

On sunny calcareous rocks, memorials, bridge parapets etc., also on flints; frequent. Mainly in S. & E. Britain, extending northwards locally to eastern Scotland (E. Perth, Angus).

The thallus resembles a dark form of *Circinaria calcarea* which is K–, Pd–, or even *Diploicia canescens* which is pruinose, K–, and prefers shade.

In E. Scotland, L. radiosa has been found in three sites with the thallus parasitized by Lichenostigma elongatum.





EN(D)

Lobothallia recedens (Taylor) A. Nordin, Savić & Tibell (2010)

Aspicilia recedens (Taylor) Arnold (1896)

Thallus thick, coarsely warted to deeply cracked-areolate, areoles large, 2–2.5 mm diam., sharply angular, separated by deep cracks, rounded-wavy at the thallus edge, dark blue-grey or becoming brown, irregularly white-pruinose or minutely white-flecked (as with *Physcia* thalli). Apothecia very numerous, crowded and completely obscuring the areoles, 3–6 per areole, elevated, 0.3–1.0 mm diam., round, crowded, becoming irregular through compression, black when wet; thalline margin thin, persistent, with a white sheen, cracking radially when old; disc dark brown-black, matt, flat, becoming pseudogyrose when old; epithecium olive-green, N+ green, with a gelatinous layer of colourless cells above; paraphyses sparingly branched, moniliform, widening to *ca* 3 µm diam. at the tips. Ascospores (9–) $12-14 \times 7-9$ µm. Conidia 3–5 × *ca* 1 µm. Thallus K–, Pd– (unidentified compound by TLC). **BLS 0123**.



On rocks by the seashore; rare. N.W. Scotland (Eigg, Skye), Wales (Brecon), England (Westmorland); recorded in the nineteenth century from Wales (Merioneth, Barmouth, Llyn Bodlyn) and C. Scotland (Perth, Aberfoyle; Roxburgh, Kelso), Ireland (Kerry).

The areoles are usually completely hidden by the abundant large irregular apothecia. The species differs from other *Lobothallia* spp. by the poorly developed radial structure of the thallus, but molecular data indicate that it belongs in that genus.

MEGASPORA (Clauzade & Cl. Roux) Hafellner & V. Wirth (1987)

Thallus crustose, non-lobate, \pm pruinose. **Photobiont** chlorococcoid. **Ascomata** apothecia, deeply immersed in thalline warts. **Thalline margin** present. **True exciple** thin, colourless or pale straw, of strongly conglutinated vertically aligned hyphae. **Epithecium** brown-green, N+ bright green. **Hymenium** colourless, I+ blue. **Hypothecium** colourless. **Hamathecium** of paraphyses, richly branched and anastomosing, not swollen at apices, strongly conglutinate. **Asci** *Biatora*-type, (4–)8-spored, clavate or cylindric-clavate, thin-walled except towards the apex, with a K/I pale tholus. **Ascospores** large, aseptate, globose to shortly ellipsoidal, colourless, the wall uniformly thickened. **Conidiomata** not seen. **Chemistry**: lichen products not detected by TLC. **Ecology**: on soil, bryophytes or plant debris on calcareous substrata, or rarely corticolous.

The sessile, poriform apothecia with thick thalline margins, with the disc occupying one third or less of the apothecial width, are reminiscent of young *Ochrolechia* or *Pertusaria*. The sub-globose ascospores with uniformly thickened walls and thin, numerous anastomosing paraphyses also suggest a relationship with *Ochrolechia*. However, recent molecular studies have united the genus with *Aspicilia* in the family Megasporaceae.

Literature:

James & Fletcher (2009), Schmitt et al. (2006), Valadbeigi et al. (2011), Zakeri et al. (2016).

Megaspora verrucosa (Ach.) Hafellner & V. Wirth (1987)

Thallus continuous or dispersed in irregular patches, of compacted or loosely co-ordinated coarse confluent interconnecting granules or tubercles, \pm obscured by apothecia; granules white to grey-white, somewhat mottled, swollen, convex or unevenly flattened, the surface smooth, roughened or in part (especially near the apothecia) finely scabrid-areolate, tartareous or densely white-pruinose. Apothecia 0.5–1.5 mm diam., 1(-2) in coarse thalline warts; disc 0.2–0.4 (–0.7) mm diam., poriform or becoming expanded, grey-black or black, surface roughened but not pruinose, the disc colour extending outwards over the inner part of the thalline margin and

Nb

NT

true exciple, forming a dark halo around the disc; thalline margin like the cortex, with small, dense granular crystals; photobiont zone without granules; the medulla and area below apothecia also densely granular, not dissolving in K; epithecium grey-black in part, K+ brownish, non-granular; hymenium 200–250 µm tall. Asci 200–230 × 45–50 μ m. Ascospores (30–) 35–50 (–60) × (21–) 25–39 (–42) μ m, wall 1.5–2.5 μ m thick. BLS 0971.

On soil or, more frequently, over mosses and plant remains on calcareous rocks (epidiorite, mica-schist, limestone) and soils, usually in mountains, very rarely on consolidated dunes rich in shell sand; widely distributed but very local. S. England (Somerset, Isle of Wight & Sussex), N. Wales, N. England (Pennines) to N. & W. Scotland.

Reported lichenicolous fungi are Cercidospora verrucosaria (Linds.) Arnold (1874) (not seen since 1861) and Sclerococcum (Dactvlospora) urceolatum (Th. Fr.) Ertz & Diederich (2018).

SAGEDIA Ach. (1809)

Thallus crustose, weakly to distinctly cracked or areolate, sometimes zonate; mostly grey to pale brownish. Prothallus usually inconspicuous, grey to black, fibrous or fimbriate. Soralia present in some species, conglutinated in discrete patches. Photobiont chlorococcoid. Medulla I-. Ascomata apothecia, mostly immersed. Thalline margin thin and slightly raised. True exciple usually colourless and poorly developed, lateral to and below the hymenium, sometimes broadening above and concolorous with the epithecium. **Disc** \pm flat, black-brown, rarely pruinose. **Epithecium** pigment green, N+ intensifying green, K± fading to brown ('Aspicilia green'). Hymenium tall, colourless, I+ green or blue. Hypothecium with photobiont below, colourless or very pale brown. Hamathecium of paraphyses, unbranched or sparingly branched, frequently anastomosed, short-celled and moniliform above, the apices cohering to form a well-defined epithecium. Asci 8-spored, cylindrical to clavate, thin outer coat K/I+ blue, wall and apical dome K/I-. Ascospores aseptate, medium to large, ellipsoidal, colourless, thin-walled. Conidiomata pycnidia, immersed, elongate and flaskshaped to almost globose, single or in clusters; wall colourless, or at least in the upper part brown or green (pigment as in epithecium). **Conidiogenous cells** sessile or on short conidiophores. subcylindrical. Conidia aseptate, bacilliform to cylindrical and \pm straight, colourless. Chemistry: lichen products not detected by TLC. Ecology: on siliceous rocks.

Literature:

Fletcher et al. (2009), Nordin et al. (2010).

Sagedia simoensis (Räsänen) A. Nordin, Savić & Tibell (2010)

Aspicilia simoensis Räsänen (1925)

Aspicilia grisea Arnold (1891)

Thallus thin, rimose, becoming irregularly cracked-areolate, with a narrow zonate margin that may often be poorly delimited, medium to dark grey, medulla yellowwhite; areoles flat to convex, discrete, often rounded, 0.3–0.5 mm diam., petering out at the thallus edge; prothallus black, distinct; areoles bearing either scattered circular dot-like flat abraded soralia, or patches of smooth yellowish-grey corticate branched isidia. The soralia develop a few yellow-white farinose and erose soredia $50-80 \ \mu m$ diam. which are much paler than the cortex, sometimes developing shiny black tips and resembling isidia, while in isidiate morphs the isidia may fragment to produce soredia and may eventually cover the areoles. Apothecia 0.3-0.6 mm diam., LC





infrequent, sessile; true exciple well-developed; disc black, epithecium N+ green, with a thin colourless layer above the epithecium, paraphyses weakly branched, moniliform at the tips, widening to *ca* 3 μ m diam. Asci 8-spored. Ascospores ellipsoidal, 18–22 × 9–12 μ m. Thallus K+ yellow→red or K+ orange, Pd+ orange (norstictic or stictic acid). **BLS 0112**.

On well-lit siliceous rocks, especially when somewhat nutrient-enriched; rare. N. and W. Britain, scattered throughout Ireland.

Aspicilia grisea and Sagedia simoensis have been much confused, and while the types are definitely conspecific, not all British and Irish material may belong here and some European populations also may belong elsewhere. Many records identified *A. grisea* (not included in the map) should probably be assigned to *Aspicilia cinerea*. s.l. *A. grisea* has been understood to be sorediate and *S. simoensis* initially isidiate, but the distinction is not at all clear. The entity with small, delimited soralia has been referred to historically as *Aspicilia insolata* (H. Magn.) Hav. (1944), but the status of this species in Britain is uncertain. This is the version most seen on gravestones and slate roofs in lowland areas in England and S.E. Scotland.

Aspicilia grisea has the older epithet, but that cannot be taken up within Sagedia due to existence of the name S. grisea (Schleich. ex Schaer.) Anzi 1860, attached to a quite unrelated species.

Reported lichenicolous fungi are *Endococcus perpusillus* Nyl. (1857), *E. verrucosus* Hafellner (1994) and an unidentified *Lichenostigma* sp.

Sagedia zonata Ach. (1809)

Aspicilia zonata (Ach.) R. Sant. (1984)

Thallus crustose, dark grey with a brownish tinge, unevenly areolate, smooth to verrucose, orbicular or effuse, sometimes forming concentric rings, very variable in form; prothallus fibrous, dark-grey to black. Areoles to 2.5 mm diam., sometimes surrounded by zones where the white, necrotic prothallus shines through, with a cortex 25–35 μ m thick and cells 3–5 μ m diam. Isidia and soredia absent. Apothecia to 1.2 mm diam., often numerous and strongly crowded, level with the thallus or somewhat raised, with a well-defined rim that is concolorous with the disc; true exciple to 50 μ m thick, J+ pale to dark blue. Hymenium 85–95 μ m thick, gelatinous, with paraphyses that are somewhat swollen (submoniliform) at the apex with the upper two or three cells rounded; epithecium dark green (Caesiocinerea-green or Aspicilia-green), N+ emerald green, K+ brownish. Ascospores (14.5–) 17–20.5 (–22.5) × (7–) 8.5–11.5 (–13.5) μ m, colourless, aseptate. Conidia straight or rarely curved, 7–10 (–12.5) × *ca* 1 μ m. Thallus K–, Pd–; no secondary substances detected with TLC. **BLS 2625**.

On a siliceous boulder in an unshaded stream, Wales (Caernarvon). The only GBI material known is sterile, and identified using molecular methods.

Nomenclature

Circinaria tuberculosa (Ach.) Coppins, comb. nov.

Basionym: Lecanora tuberculosa Ach., Syn. Lich.: 164 (1814) (≡ Lichen tuberculosus Sm., Engl. Bot. 25: tab. 1733 (1807), non Lichen tuberculosus Hoffm., Enum. Lich.:, 1784).

Typification: Great Britain: England, Sussex, South Downs, on flints, *W. Borrer* s.n. [ex herb. Sm.] (BM—lectotype, selected by Laundon, *Lichenologist* 18: 170 (1986).

References

Clauzade, G. & Roux, C. (1984). Les genres Aspicilia Massal. et Bellemerea Hafellner et Roux. Bulletin de la Société botanique du Centre-Ouest, n.s. 15: 127–141.

- Fletcher, A., Purvis, O.W. & Coppins, B.J. (2009). Aspicilia. In Lichens of Great Britain and Ireland (Smith, C.W., Aptroot, A., Coppins, B.J., Fletcher, A., Gilbert, O.L., James, P.W. & Wolseley, P.A. eds): 181–188. London: British Lichen Society.
- Fryday, A.M., Wheeler, T.B. & Etayo, J. (2021). A new species of *Aspicilia* (Megasporaceae), with a new lichenicolous *Sagediopsis* (Adelococcaceae), from the Falkland Islands. *Lichenologist* **53**: 307–315.
- James, P.W. & Fletcher, A. (2009). Megaspora. In Lichens of Great Britain and Ireland (Smith, C.W., Aptroot, A., Coppins, B.J., Fletcher, A., Gilbert, O.L., James, P.W. & Wolseley, P.A. eds): 568–569. London: British Lichen Society.

IF901047

Nb

- Lutzoni, F.M. & Brodo, I.M. (1995). A generic redelimitation of the *Ionaspis–Hymenelia* complex (lichenized Ascomycotina). *Systematic Botany* **20**: 224–258.
- Nordin, A. (2015). New synonyms and lectotypes in *Aspicilia* (Megasporaceae, Ascomycota). *Phytotaxa* **192**: 197–200.
- Nordin, A., Owe-Larsson, B. & Tibell, L. (2011). Two new Aspicilia species from Fennoscandia and Russia. Lichenologist 43: 27–37.
- Nordin, A., Savić, S. & Tibell, L. (2010). Phylogeny and taxonomy of *Aspicilia* and Megasporaceae. *Mycologia* 102: 1339–1349.
- Nordin, A., Tibell, L. & Owe-Larsson, B. (2007). A preliminary phylogeny of *Aspicilia* in relation to morphological and secondary product variation. *Bibliotheca Lichenologica* **96**: 247–266.
- Nordin, A., Tibell, L. & Owe-Larsson, B. (2008). Aspicilia berntii, a new name for a poorly known species. Lichenologist 40: 127–133.
- **Orange**, A. (2009). Two parasitic species of *Placopyrenium* (Verrucariaceae) from freshwater habitats in northwest Europe. *Lichenologist* **41**: 131–139.
- Paukov, A., Nordin, A., Tibell, L., Frolov, I. & Vondrák, J. (2017). Aspicilia goettweigensis (Megasporaceae, lichenized Ascomycetes) – a poorly known and overlooked species in Europe and Russia. Nordic Journal of Botany 35: 595–601.
- Roux, C., Bertrand, M. & Nordin, A. (2016). Aspicilia serenensis Cl. Roux & M. Bertrand sp. nov., espèce nouvelle de lichen (groupe d'A. calcarea, Megasporaceae). Bulletin de la Société Linnéene de Provence 67: 165–182.
- Roux, C., Nordin, A., Tibell, L. & Sohrabi, M. (2011). Quelques espèces d'Aspicilia peu connues ou nouvelles des Pyrénées–Orientales (France). Bulletin de la Société Linnéene de Provence, numero spécial 14: 177–227.
- Schmitt, I., Yoshikazu, Y. & Lumbsch, H.T. (2006). Phylogeny of Pertusariales (Ascomycotina): resurrection of Ochrolechiaceae and new circumscription of Megasporaceae. J. Hattori Bot. Lab. 100: 753–764.
- Sohrabi, M., Leavitt, S.D., Rico, V.J., Halici, M.G., Shrestha, G. & Stenroos, S. (2013). *Teuvoa*, a new lichen genus in Megasporaceae (Ascomycota: Pertusariales), including *Teuvoa junipericola* sp. nov. *Lichenologist* 45: 347–360.
- Valadbeigi, T., Nordin, A. & Tibell, A. (2011). *Megaspora rimisorediata* (Pertusariales, Megasporaceae), a new sorediate species from Iran and its affinities with *Aspicilia* sensu lato. *Lichenologist* 43: 285–291.
- Wheeler, T.B. (2017). Multilocus phylogeny of the lichen family Megasporaceae. MSc thesis, University of Montana.
- Zakeri, Z., Divakar, P.K. & Otte, V. (2017). Taxonomy and phylogeny of *Aspiciliella*, a resurrected genus of Megasporaceae, including the new species *A. portosantana*. *Herzogia* 30: 166–176.
- Zakeri, Z., Gasparyan, A. & Aptroot, A. (2016). A new corticolous *Megaspora* (Megasporaceae) species from Armenia. *Willdenowia* 46: 245–251.
- Zakeri, Z., Otte, V., Sipman, H., Malíček, J., Cubas, P., Rico, V.J., Lenzová, V., Svoboda, D. & Divakar, P.K. (2019). Discovering cryptic species in the *Aspiciliella intermutans* complex (Megasporaceae, Ascomycota) – first results using gene concatenation and coalescent-based species tree approaches. *PLoS ONE* 14(5): e0216675.

Index

ASPICILIA, 4 Aspicilia aquatica, 4 Aspicilia caesiocinerea, 7 Aspicilia calcarea, 8 Aspicilia cinerea, 5 Aspicilia contorta, 8 Aspicilia contorta subsp. hoffmanniana, 9 Aspicilia epiglypta, 5 Aspicilia granulosa, 5 Aspicilia grisea, 12 Aspicilia intermutans, 6 Aspicilia laevata, 6 Aspicilia leprosescens, 9 Aspicilia melanaspis, 10 Aspicilia radiosa, 10 Aspicilia recedens, 11 Aspicilia simoensis, 12 Aspicilia tuberculosa, 9 Aspicilia zonata, 13 ASPICILIELLA, 6 Aspiciliella intermutans, 6 CIRCINARIA, 7 Circinaria caesiocinerea, 7 Circinaria calcarea, 8 Circinaria contorta, 8 Circinaria hoffmanniana, 9 Circinaria leprosescens, 9 Circinaria tuberculosa, 9 LOBOTHALLIA, 10 Lobothallia melanaspis, 10 Lobothallia radiosa, 10 Lobothallia recedens, 11 MEGASPORA, 11 Megaspora verrucosa, 11 SAGEDIA, 12 Sagedia simoensis, 12 Sagedia zonata, 13