

Revisions of British and Irish Lichens



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Collemopsidiales

Cover image: A mixed colony of *Collembosporium foveolatum* (small “black dots”) and *C. sublitorale* (larger “black dots”) on the barnacle *Chthamalus stellatus*, Ardwell Bay, Wigtownshire.

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to compile new printed editions of the entire lichen biota of Britain and Ireland is extensive, and many parts are out-of-date even as they are published.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

Editorial Board

Dr P.F. Cannon (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.M. 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)

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Collemopsidiales

including *Collemopsidium*, *Didymellopsis*, *Frigidopyrenia*, *Zwackhiomacromyces* and *Zwackhiomyces* (Xanthopyreniaceae)

by

Paul Cannon

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

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

Janet Simkin

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

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COLLEMOPSIDIALES Pérez-Ortega, Garrido-Benavent & Grube (2016)

The order contains a single family, the *Xanthopyreniaceae*.

XANTHOPYRENIACEAE Zahlbr. (1926)

Thallus crustose, epilithic or endolithic, or absent (lichenicolous). **Photobiont** (when present) cyanobacteria, filamentous or coccoid. **Stromata** absent. **Ascomata** perithecia, the ostiole sometimes widening to appear ± apothecial, solitary, unilocular. **Involucrellum** sometimes present. **Exciple** carbonized to colourless, composed of intertwined hyphae or isodiametric cells. **Hamathecium** of irregular branched and anastomosing, net-like pseudoparaphyses. **Hymenial gel** I–. **Asci** fissitunicate, ovoid to subcylindrical, usually stalked, the apex with an ocular chamber, I–, usually 8-spored. **Ascospores** colourless (rarely brownish in overmature collections), cylindrical to ovoid-fusiform, 1- to 3-septate, a gelatinous perispore usually present. **Conidiomata** pycnidia. **Conidiogenous** cells ± cylindrical, proliferating percurrently. **Conidia** bacilliform to ellipsoidal. **Chemistry**: lichen products not detected by TLC.

The family contains two genera, the lichenized *Collemopsidium* and the lichenicolous *Zwackhiomyces*, with several others likely to belong but for which sequence data are lacking (Pérez-Ortega *et al.* 2016). In our region, these include *Didymellopsis*, *Frigidopyrenia* and *Zwackhiomacromyces*. Close relatives of the family are difficult to establish.

Literature:

Pérez-Ortega *et al.* (2016).

- | | | |
|------|--|---------------------------|
| 1 | Lichenized..... | 2 |
| | Non-lichenized, lichenicolous..... | 3 |
| 2(1) | Thallus crustose, mostly on rock, many associated with marine or freshwater habitats... <i>Collemopsidium</i>
Thallus squamulose; on mosses and soil, montane | <i>Frigidopyrenia</i> |
| 3(1) | Pigment of the peridial cells amorphous and located in the cell walls; ascospores without a
perispore | <i>Didymellopsis</i> |
| | Pigment of the peridial cells forming fine granules and located in the intercellular areas;
ascospores surrounded by an often finely verruculose perispore | 4 |
| 4(3) | Ascospores large, mostly 3-septate | <i>Zwackhiomacromyces</i> |
| | Ascospores varied in size, usually 1-septate | <i>Zwackhiomyces</i> |

COLLEMOPSIDIUM Nyl. (1881)

Thallus crustose, superficial to immersed, usually subgelatinous, the hyphae generally vertically orientated. **Photobiont** a cyanobacterium (*Hyella* in the coastal species, *Gloeocapsa* or *Nostoc*) with orange, blue-green or violet cells, rarely a green alga. **Ascomata** perithecia, usually unilocular. **True**

exciple dark brown; wall \pm cellular, normally densely pigmented. **Involucrellum** present or absent. **Hamathecium** of sparingly to richly branched and anastomosing pseudoparaphyses, with numerous but inconspicuous septa; hymenial gel I–. **Asci** ovoid to subcylindrical, usually stalked, I–, usually 8-spored; wall thickened above, with an ocular chamber, fissitunicate, dehiscent asci with a distinct extruded rostrum. **Ascospores** colourless, cylindrical to ovoid-fusiform, 1-septate, the upper cell usually shorter and broader than the lower; a poorly defined gelatinous perispore sometimes present. **Conidiomata** pycnidia. **Conidiogenous cells** \pm cylindrical, proliferating percurrently. **Conidia** bacilliform or ellipsoidal. **Chemistry**: lichen products not detected by TLC. **Ecology**: on calcareous substrata in moist situations, on wet sand, or on acid or calcareous rocks in freshwater or coastal habitats.

Further molecular studies are needed, but Pérez-Ortega *et al.* (2016) suggested that the genus is phylogenetically diverse, and most species (especially *Collemopsidium foveolatum* and *C. halodytes*) are polyphyletic.

In studying littoral *Collemopsidium* species, care should be taken to avoid confusion with the lichenicolous fungus *Stigidium marinum* (Deakin) Swinscow (1965) which occurs on *Verrucaria* s.l. species, particularly *V. halizoa* and *Wahlenbergiella mucosa*, but is often observed to have a thallus (Van Herk *et al.* 2017). It resembles *C. halodytes* in habit and habitat, but has perithecia 0.15–0.20 mm diam., lacks interascal filaments, and has 1-septate ascospores constricted at the septum, 10–15 \times 4–6 μm .

Literature:

Coppins & Orange (2009), Kohlmeyer *et al.* (2004), Mohr *et al.* (2004), Nordin (2002), Orange (2013).

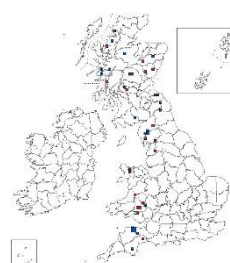
1	In terrestrial or freshwater habitats; involucrellum absent	2
	In marine habitats on rock, shells, barnacles or seaweeds; involucrellum often present	9
2(1)	On turf, soil, or bryophytes	3
	On rocks or mortar	6
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	Ascospores <25 μm long	5
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	Ascospores 27–44 μm long, thallus minutely squamulose; in montane habitats	<i>Frigidopyrenia bryospila</i>
5(3)	Ascospores 21–22 \times ca 8 μm , on inland sandy banks	<i>argilospilum</i>
	Ascospores 15–19 (–21) \times 5–7 μm ; in calcareous dune slacks or machair	<i>subarenisedum</i>
6(2)	Ascospores \pm cylindrical, the lower cell not markedly narrowed; photobiont <i>Trentepohlia</i>	<i>Naetrocymbe saxicola</i> [Naetrocymbaceae]
	Ascospores ovoid to ovoid-fusiform, the lower cell distinctly narrowed towards the base; photobiont cyanobacteria	7
7(6)	Thallus superficial, on siliceous rocks by rivers and lakes or on flushed outcrops	<i>angermannicum</i>
	Thallus immersed or superficial, on calcareous rocks	8
8(7)	Asci subcylindrical, pseudoparaphyses sparingly branched; on chalk stones or mortar	<i>monense</i>
	Asci obclavate to obpyriform, pseudoparaphyses richly branched; on flushed limestone or calcareous schists	<i>caesium</i>
9(1)	Growing on the seaweed <i>Pelvetia</i>	<i>pelvetiae</i>
	Growing on rocks or calcareous shells	10

- 10(9) Thallus superficial 11
 Thallus immersed in the (calcareous) substratum 12
- 11(10) Thallus with black ridges or warts *elegans*
 Thallus without black ridges or warts *halodytes*
- 12(10) Involucrellum intermixed with the substratum, wide-spreading, often covering more than one perithecium *ostrearum*
 Involucrellum not containing material from the substratum 13
- 13(12) Ascomata superficial or semi-immersed, 0.15–0.55 mm diam., involucrellum well-developed and either hemispherical or spreading laterally *sublitorale*
 Ascomata immersed in pits in the substratum, 0.10–0.24 mm diam., involucrellum lid-like, scarcely spreading laterally *foveolatum*

Collemopsidium angermannicum (Degel.) A. Nordin (2002)

NT

Thallus superficial, thin to moderately thick, 80–120 µm thick, smooth or cracked, mid green-brown to dark brown; photobiont cells isodiametric to slightly elongate. Ascomata 0.12–0.30 mm diam., more or less immersed in the thallus, partly immersed in a thalline wart, or almost sessile; globose or often slightly flattened, ostiole often in a depression and up to 90 µm diam. in larger ascomata; exciple pigmented throughout or slightly paler at the base, thickened around the ostiole; involucrellum absent; pseudoparaphyses densely branched and anastomosing. Asci obovoid, 85–100 × 19–25 µm. Ascospores 1-septate, 17–26 × 6–12 µm, the upper cell often wider than the lower. Pycnidia sessile or partly immersed in the thallus; conidia cylindrical-ellipsoidal, 2.9–3.3 × ca 1.2 µm. **BLS 1890.**



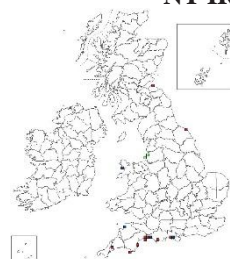
On siliceous rocks beside rivers and lakes, rarely on flushed rock surfaces, often with *Verrucaria* s.l. species. N. & W. Britain.

Distinguished from *C. caesium* by the superficial thallus.

Collemopsidium arenisedum (A.L. Sm.) Coppins & Aptroot (2008)

NT IR

Thallus whitish or grey, immersed; photobiont cells yellowish orange (*Hyella*). Ascomata 0.16–0.20 mm diam., ± globose with a conical apex, mostly half- to three-quarters immersed; involucrellum absent; pseudoparaphyses densely branched and anastomosed above. Asci 100–105 × 19–20 µm, subcylindrical, 4- to 8-spored. Ascospores 26–37 × (8–) 9–10 µm, ovoid-fusiform. **BLS 1889.**



On damp sand encrusted with calcareous deposits, in coastal dune slacks; ephemeral. S. & W. England (Cornwall, Devon, Dorset, Hampshire), N. England (Cheshire, Lancashire), Wales (Anglesey), Scotland (E. Lothian).

C. subarenisedum, which occurs in similar situations, has smaller ascospores.

Collemopsidium argilospilum (Nyl.) Coppins & Aptroot (2008) **DD IR**

Thallus dull olive-green, gelatinous when wet; photobiont cells blue-green. Ascomata ± globose, semi-immersed. Ascospores 21–22 × ca 8 µm, cylindrical-ovoid. **BLS 0077.**

A 19th century record from inland wet sand banks near Shrewsbury (Shropshire), and a more recent find record from Wales (Cardigan) which may need confirmation.

Grube (2005) discussed this poorly known species, which had been placed in *Magmopsis* Nyl. 1875, but concluded that it was not congeneric with the type of that genus. Its affinities remain obscure.



Collemopsidium caesium (Nyl.) Coppins & Aptroot (2008)

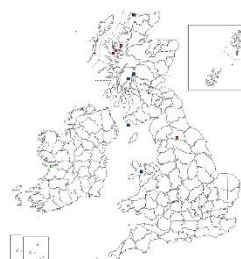
NT

Thallus mostly immersed in the substratum, but often reaching the surface as small dark brown flecks; photobiont cells yellowish or blue-green. Ascomata 0.15–0.40 (–0.50) mm diam., subconical to globose, often flattened, and depressed in the centre when dry; more or less sessile to half-immersed (often in soft deposits), rarely forming

well-defined pits in limestone; involucrellum absent; pseudoparaphyses richly branched and anastomosed. Asci elongate-clavate to obpyriform. Ascospores $20\text{--}30$ ($\text{--}33$) \times (7.5--) $8.5\text{--}12$ μm , ovoid to ovoid-fusiform, sometimes with additional pseudosepta. **BLS 0079.**

On damp base-rich siliceous rock and on limestone, often tufa-incrusted, in flushes, wet runnels and on dripping rocks, also on limestone rocks and walls; rare. Wales, N. England, Scotland, W. Ireland.

See notes under *C. monense*.



Nb

Collemopsidium elegans (R. Sant.) Grube & B.D. Ryan (2002)

Thallus superficial, very thin, dark brown, with irregular black warts $0.10\text{--}0.20$ ($\text{--}0.30$) mm wide, and black ridges to 150×500 ($\text{--}700$) μm , the ridges radiating and flattened near the thallus margin, elsewhere irregular and usually flat, but sometimes raised and rather sharp, to $35\text{--}50$ μm high; photobiont with yellowish brown cells. Ascromata usually rather sparse, sometimes abundant, prominent, $0.10\text{--}0.30$ ($\text{--}0.50$) mm diam., ostiole depressed; involucrellum well-developed, spreading. Ascospores (4-) 8 per ascus, not constricted at the septum, $11.5\text{--}18$ ($\text{--}20$) \times $3.5\text{--}7$ μm . Pycnidia immersed in the ridges. **BLS 0083.**

On siliceous rocks in the littoral zone of sea shores, usually with *Wahlenbergiella striatula*; occasional. S. England, Wales, N. & W. Scotland, S. & W. Ireland.

In the field, this species resembles a brown morph of *Wahlenbergiella striatula*, which differs in the aseptate ascospores and absence of interascal filaments. *C. halodytes* is very similar, but differs in the absence of warts or ridges on the thallus; some specimens with very few ridges may be difficult to name.

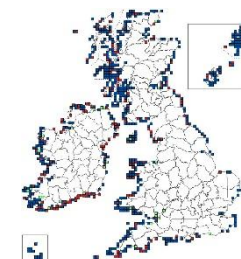


Collemopsidium foveolatum (A.L. Sm.) F. Mohr (2004)

Thallus immersed; photobiont in scattered groups or absent. Ascromata $0.10\text{--}0.24$ mm diam., usually entirely immersed in pits in the substratum, occasionally emerging; involucrellum lid-like, flat to slightly convex, scarcely spreading, sometimes absent. Ascospores $14\text{--}21 \times 5\text{--}9$ μm . Pycnidia common to absent, black, immersed. **BLS 0085.**

On calcareous rock and shells of barnacles, limpets and mussels in the littoral zone of sea shores; common. Coasts of Britain and Ireland. Distribution elsewhere uncertain due to taxonomic confusion.

This was for a long time called *Arthopyrenia halodytes* or *Pyrenocollema halodytes* by British authors, which differs by the presence of a superficial thallus. *C. sublitorale* differs in the usually sessile, generally larger ascromata, but some forms may be impossible to distinguish. *C. ostrearum* differs in the wide-spreading involucrellum mixed with particles of the substratum.



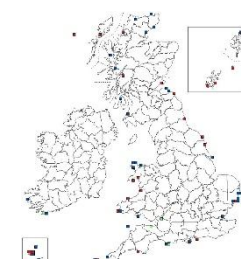
LC

Collemopsidium halodytes (Nyl.) Grube & B.D. Ryan (2002)

Thallus superficial, light brown, thin, continuous or scattered, without dark ridges; photobiont abundant. Ascromata $0.10\text{--}0.40$ mm diam., sessile, flattened; involucrellum spreading laterally. Ascospores $13\text{--}22 \times 5\text{--}9$ μm . Pycnidia common, resembling the ascromata but smaller and flatter. **BLS 0087.**

On siliceous and calcareous rock in the littoral zone of sea shores; common. Coasts of Britain and Ireland.

Distinguished from other coastal species on rock by the superficial thallus and sessile ascromata. *C. elegans* differs in the black ridges on the thallus, but very sparsely ridged forms may be difficult to distinguish. The species has sometimes been delimited broadly to include *C. elegans*, *C. foveolatum* and *C. sublitorale*, but these species, and *C. ostrearum*, are morphologically distinct and are at least in part supported by molecular data. *Verrucaria ditmarsica* differs in the aseptate ascospores and green photobiont.



Nb

Collemopsidium monense (Wheldon) Coppins & Aptroot (2008)

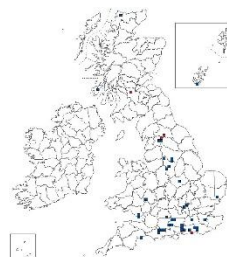
Thallus immersed to superficial, dull grey or green-grey, scurfy or filmy; photobiont cells yellowish or blue-

Nb

green. Ascomata 0.15–0.20 mm diam., half to three quarters immersed, ± globose; involucrellum absent; pseudoparaphyses sparingly branched. Asci 80–115 × 16–19 µm, narrowly obpyriform to subcylindrical. Ascospores 17–30 (–35) × 6–8 µm, ovoid to ovoid-fusiform. **BLS 0086**.

On chalk stones in grassy banks and woodland clearings, or mortar of shaded walls, lowland; rare. Scattered throughout Britain, apparently rare in Scotland and absent from Ireland.

C. caesium is said to differ in the broader asci and more densely branched pseudoparaphyses, and in the shape of the ascoma, but the relationship between the two species needs further study.



Collembosporium ostrearum (Vain.) F. Mohr (2004)

NE

Thallus immersed, occasionally partly delimited by a black line. Ascomata 0.34–0.60 mm diam., usually densely clustered, immersed; involucrellum very wide-spreading, intermixed with particles of the substratum; often more than one to many perithecium united under one involucrellum. Ascospores 23–25 × 9–11 µm. Pycnidia similar in appearance to ascomata but smaller, though overlapping in size. **BLS 2451**.

On calcareous rock and shell, in the littoral zone of sea shores; apparently rare. Ireland (Galway). Probably cosmopolitan, but its distribution is uncertain due to taxonomic confusion.

A poorly known species, distinguished from the other coastal species by the clustered ascomata, the large involucrellum mixed with substratum particles, and the larger ascospores.

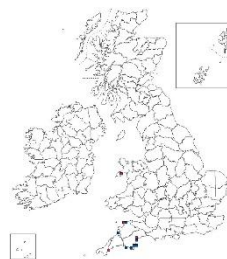
Collembosporium pelvetiae (G.K. Sutherl.) Kohlm., D. Hawksw. & Volk.-Kohlm. (2004)

DD

Thallus superficial, crustose, dark brown, film-like. Ascomata 0.12–0.34 mm diam., sometimes united in groups of two or three within a common stroma, shallowly conical; involucrellum present, extending into the associated photobiont colonies. Asci 40–60 × 13–18 µm. Ascospores 11.5–16 × 5–6.5 µm, elongate-ovoid. Pycnidia 40–70 µm diam.; conidia 2–2.5 × 1–1.5 µm. **BLS 0088**.

On fronds of the seaweed *Pelvetia canaliculata* on sheltered sea shores; occasional, overlooked. S.W. England, N. Wales, N. Scotland (Orkney Is).

This species is of particular biological interest as forming a three-biont association in which the lichen grows epiphytically on a second photosynthetic partner, *Pelvetia* (Phaeophyceae). Not to be confused with the very common *Stigmidium ascophylli* (Cotton) Aptroot (2006), which forms a systemic mycelium within fertile frond tips of *Pelvetia* and has immersed ascomata 0.05–0.13 (–0.16) mm diam. and larger ascospores 15–22.5 (–25) × 4.5–5.5 (–6.5) µm in size.



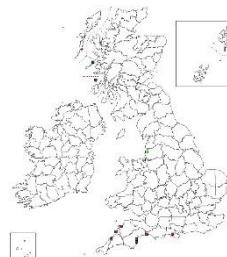
Collembosporium subarenisedum (G. Salisb.) Coppins & Aptroot (2008)

DD IR

Thallus whitish or ashy grey, effuse, very thin, somewhat gelatinous, immersed in soil. Algal cells blue-green, within a yellowish mucous coating. Ascomata 0.08–0.20 mm diam., ± globose to globose-conical, semi-immersed, the wall thick and carbonaceous. Asci 70–100 × 13–14 µm, subcylindrical. Ascospores 15–19 (–21) × 5–7 µm, ovoid to ovoid-fusiform. **BLS 0092**.

On soil in dune slacks and machair; ephemeral. S. & W. England (Cornwall, Devon, Dorset, Isle of Wight), N.W. England (Lancashire), W. Scotland (Coll, Colonsay).

Distinguished from *C. arenisedum* by the smaller ascospores.



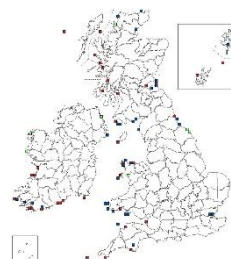
Collembosporium sublitorale (Leight.) Grube & B.D. Ryan (2002)

Nb

Thallus immersed; photobiont in scattered groups or absent. Ascomata 0.15–0.55 (–1.50) mm, usually sessile and globose; involucrellum ± appressed, hemispherical or semi-immersed and spreading. Ascospores narrowly ovoid, 15–25 × 5–10 µm. Pycnidia common to absent, immersed or semi-immersed, with a black, flattened involucrellum; usually smaller than ascomata but with the size ranges overlapping. **BLS 0093**.

On calcareous rocks and shells (of barnacles and limpets) in the littoral zone of sea shores; common. Scattered throughout coastal districts of Britain and Ireland. Distribution uncertain due to taxonomic confusion.

The morphologically most variable of all the marine *Collemopsidium* species, particularly with regard to perithecial size. The largest ascomatal sizes have been reported from soft chalk. *C. halodytes* differs in the superficial thallus; *C. foveolatum* differs in the smaller, immersed ascomata.



DIDYMELLOPSIS (Sacc. & D. Sacc.) Clem. & Shear (1931)

Thallus absent (lichenicolous). **Ascomata** perithecial, globose to pyriform, fully immersed in the host thallus or partially exposed when in degraded tissues. **Involucrellum** absent. **Ascomatal wall** black-brown to reddish brown, thicker in the ostiolar region, composed of thin-walled isodiametric cells, pigmentation primarily in the cell walls. **Hamathecium** of pseudoparaphyses within a gelatinous matrix, narrow and thin-walled, sometimes partially evanescent. **Asci** fissitunicate, thick-walled above with a distinct ocular chamber, cylindrical to clavate, not blueing in iodine, 4-, 6- or 8-spored. **Ascospores** colourless, 1-septate, ovoid, thin- and smooth-walled, often with a gelatinous perispore visible when young. **Conidiomata** not known.

A small group of lichenicolous fungi similar to *Zwackhiomyces* (see below) but with pigment primarily within the cell walls of the exciple (peridium) rather than in the intercellular spaces. The genus *Cercidospora* Körb. (1865) has similarities with *Didymellopsis* (Grube & Hafellner 1990) but has ascomatal walls that are blue-green (at least in the ostiolar region) rather than brown. No sequences are available for either genus.

Literature:

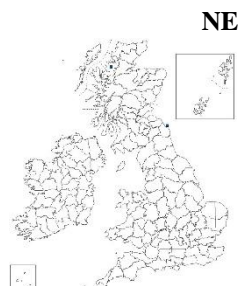
Fernández-Brime *et al.* (2020), Grube & Hafellner (1990).

- 1 Ascospores $20-26 \times 5-10 \mu\text{m}$*collematum*
Ascospores $14-21 \times 5-7 \mu\text{m}$*pulposi*

Didymellopsis collematum (J. Steiner) Grube & Hafellner (1990)

Ascomata (200–) 250–300 μm diam., globose to pyriform, scattered or in clusters, appearing as wart-like bulges on the host thallus which may be slightly bleached around the colonies. Peridium dark brown to black, 35–40 μm thick below and laterally, thicker in the apical region, composed of isodiametric, or slightly elongated cells, more heavily pigmented in the neck region, the pigment concentrated within the cell walls. Hamathecium of much-branched and anastomosing pseudoparaphyses. Asci 80–100 \times 13–15 μm , mostly cylindrical, fissitunicate, the wall gradually thickening towards the apex, 6- to 8-spored. Ascospores $20-26 \times 5-10 \mu\text{m}$, colourless, 1-septate, narrowly clavate, the upper cell larger and more rounded than the lower, not constricted at the septum, without an ornamented outer layer.

Recorded from thalli of *Collema glebulentum* and (with uncertainty) *Scytinium turgidum*, Scotland (W. Ross) and England (N. Northumberland). Known elsewhere from *Lathagrium auriforme*.



NE

Didymellopsis pulposi (Zopf) Grube & Hafellner (1990)

Ascomata 170–200 μm diam., broadly pyriform, immersed in clusters on the host thallus and apothecial margins. Peridium chestnut brown, 10–20 μm thick below and laterally, thicker in the apical region, composed of

NE

isodiametric flattened cells, more heavily pigmented in the neck region, the pigment concentrated within the cell walls. Hamathecium of narrow, much-branched and anastomosing pseudoparaphyses. Asci (40–) 45–70 (–90) × 10.5–13.5 μm, cylindrical to slightly clavate, fissitunicate, the wall gradually thickening towards the apex, 4-, 6- or 8-spored. Ascospores (13–) 14–21 (–22) × 5–7 μm, colourless, 1-septate, narrowly clavate, the upper cell larger and more rounded than the lower, not constricted at the septum, without an ornamented outer layer.

On *Blennothallia crispa*, *Lathagrium auriforme* and *Scytinium tenax* (inc. var *ceranoides*), scattered throughout England, Scotland and Wales (doubtless under-recorded) with one record from W. Ireland.

Apparently more common than *D. collematum*. There does not seem to be a clear distinction between the two species in host preference and molecular data would be useful to confirm their separation.



FRIGIDOPYRENIA Grube (2005)

As this is a monotypic genus the description below (*F. bryospila*) constitutes the generic description. *Collemopsidium* species differ in the strictly crustose habit, without anchoring hyphae below the thallus.

Literature:

Grube (2005), Orange (2009).

Frigidopyrenia bryospila (Nyl.) Grube (2005)

Thallus squamulose when well-developed; squamules to 0.5 mm diam., globose to flattened, dark olive-green to dark brown; outer parts composed of pseudoparenchymatous tissue; underside of squamules connected to each other and to the bases of the ascomata by brown hyphae 5–7 μm diam., with thickened walls 1.5–2 μm; photobiont a chroococcoid cyanobacterium, the cells 4–5 (–8) × 3–4 μm, with thin walls. Ascomata perithecial, globose to broadly pyriform, 400–450 μm diam., seated amongst the thallus squamules; involucrellum absent; exciple dark brown throughout, 55–65 μm thick in the upper part, 25–35 μm thick near the base, cells in basal parts tangentially flattened, more rounded above, with pigment in intercellular spaces; hamathecium of strongly branched and anastomosing filaments (paraphysoids), cells 6–10 × ca 1 μm, not constricted at the septa. Asci fissitunicate, cylindrical, 130–140 × 18–22 μm, 8-spored; wall becoming gradually thicker above, ocular chamber present. Ascospores 1-septate, (25–) 28–44 × 8–12 μm, colourless, becoming brownish and faintly warty when old. **BLS 0078.**

On mosses and schistose soil in montane localities, sometimes associated with metalliferous substrata; N.E. Scotland (Westernness: Ben Alder; Mid Perthshire: Ben Lawers) and Wales (Ceredigion).

No molecular data are available, and the relations with *Collemopsidium* need further investigation.

Nb



ZWACKHIOMACROMYCES Etayo & van den Boom (2014)

Thallus absent (**lichenicolous**). **Stromata** absent. **Ascomata** perithecia, black, pyriform, with a papillate ostiole, opening with radial splits. **Exciple** (peridium) dark, composed of several layers of pseudoparenchymatous cells, the outermost with extracellular, sometimes granulose pigment.

Hamathecium composed of narrow branched and anastomosed pseudoparaphyses, lacking periphyses and periphysoids. **Centrum** I-. **Asci** elongate-clavate, fissitunicate, thick-walled laterally, apically thickened and with an ocular chamber, 8-spored but sometimes with fewer developing. **Ascospores** ellipsoidal, (1-) 3-septate, colourless, without a germ pore or perispore, smooth-walled. **Conidiomata**: not known.

Two species are known, the type a biotrophic parasite on *Megalospora verrucosa* (not known from our region), and *Z. hyalosporus* described below. Neither has been sequenced and therefore the taxonomic position of this genus is uncertain, but it shares many features with *Zwackhiomyces* (q.v.) and is therefore treated for convenience in the Xanthopyreniaceae. *Zwackhiomyces* differs in the smaller dimensions of ascomata and ascospores, and 1-septate rather than multiseptate spores.

Literature:

Alstrup & Hawksworth (1990), Berger & Zimmermann (2016), Van den Boom & Etayo (2014).

Zwackhiomacromyces hyalosporus (Alstrup, D. Hawksw. & R. Sant.) Etayo & F. Berger (2016)

Pyrenidium hyalosporum Alstrup, D. Hawksw. & R. Sant. (1990)

NE

Ascomata perithecia, not stromatic, erumpent from host areoles, the host tissues slightly darker and greyer but otherwise apparently unaffected, with about half of the perithecia exposed, black, smooth, subglobose, 180–240 µm diam., with a minute but distinctly papillate ostiole. Exciple (peridium) dark brown, composed of several layers of subglobose to polyhedral cells, with the innermost layer of flattened, almost hyaline to pale brown cells. Interascal tissue of persistent narrow pseudoparaphyses 1.5–2 µm diam., densely branched and anastomosed, sometimes weakly moniliform, not staining blue in iodine. Asci 130–160 × 26–30 µm, cylindric-clavate, short-stalked, thick-walled and fissitunicate, the apex with a narrow to broad ocular chamber, 8-spored (sometimes with only two or four spores developing *vide* Alstrup & Hawksworth 1990). Ascospores arranged biserially, (36–) 37–42.5 × 11–13 µm, cylindric-ellipsoidal to broadly fusiform, sometimes slightly asymmetrical, the apices usually obtuse, mostly 3-septate but with a proportion with one or two septa, slightly to strongly constricted at the septa, hyaline (overmature spores may be pale brown to olivaceous), smooth to very faintly verrucose, thin-walled, lacking a well-defined perispore or appendages. Pycnidia not known.

On thalli of *Placopsis lambii*, the affected host thallus somewhat darker and greyer than the surrounding tissues. Known from a single collection in GBI from a former mine site in mid Wales (Cardigan).

ZWACKHIOMYCES Grube & Hafellner (1990)

Thallus absent (lichenicolous). **Ascomata** perithecial, pyriform to globose, sessile or rarely sunken within host tissues, scattered or clustered. **Ostiole** small, lined with paraphysoids that are usually weakly brown pigmented. **Involucrellum** absent. **Exciple** (peridium) brown, usually significantly thicker and more strongly pigmented at the apex, composed of irregular, often deformed cells with pigment deposited on the outside of the walls, especially at the ascoma/substratum interface; or concentrated in the intercellular spaces, the pigment finely granular at least in the ostiolar region. **Hamathecium** composed of narrow branched and anastomosed pseudoparaphyses, embedded in mucus. **Asci** fissitunicate, cylindrical to broadly cylindrical, the wall layers gradually thickened towards the apex; ocular chamber well-developed, 4-, 6- or 8-spored. **Ascospores** colourless, ± clavate, 1-septate, ± constricted at the septum, often warted when old due to degeneration of the perispore. **Conidiomata** pycnidia, similar in shape and wall structure to the ascomata but usually significantly smaller. **Conidiogenous cells** cylindrical to tapered, proliferating percurrently. **Conidia** colourless, unicellular, shortly cylindrical.

Distinguished by its lichenicolous habit, and by the pigmentation of the ascomatal walls

concentrated within intercellular spaces rather than in the cell walls. The key and many of the descriptions are partially adapted from Calatayud *et al.* (2007) and Grube & Hafellner (1990).

Zwackhiomyces sphinctrinoides (Zwackh) Grube & Hafellner (1990) is currently included in the British and Irish list based on a record on an unknown host from Essex. However, earlier checklists (Hawksworth 1983) do not include references to that species on Lecanoraceae (from which the original collection was made in Germany) and presence of this species in our region needs confirmation. It is included for reference in the key below.

Literature:

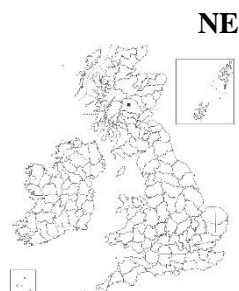
Calatayud *et al.* (2007), Darmostuk (2019), Grube & Hafellner (1990), Roux *et al.* (2023).

1	On crustose lichens	2
	On foliose lichens	10
2(1)	Ascospores aseptate; on species of <i>Myriolecis</i> (<i>Lecanora dispersa</i> agg.)	lecanorae
	Ascospores 1-septate	3
3(2)	Ascomata usually pyriform, with the wall composed of a clear inner layer and a dark outer layer; ascospores strongly ornamented, 16–23 × 4.5–8 µm, on <i>Lecanora campestris</i>	sphinctrinoides
	Ascomata mostly globose to pyriform, wall not clearly layered	4
4(3)	Ascospores mostly over 19 µm long	5
	Ascospores mostly below 19 µm long	7
5(4)	Ascospores 23–31 × 9–12 µm; on <i>Hymenelia lacustris</i>	lacustris
	Ascospores narrower than 9 µm	6
6(5)	Asci 14–18 µm diam., ascospores 17–25 × 7–8 µm; on <i>Protoblastenia rupestris</i>	dispersus
	Asci 11–14 µm diam., ascospores 17–30 × 5–8 µm; on “ <i>Lecidea</i> ” <i>berengeriana</i>	berengerianus
7(4)	Pseudothecia mostly 170–270 µm diam.; asci often 6-spored, ascospores 15–21 × 5.5–8.5 µm; on <i>Xanthoria parietina</i> (perhaps also on other Teloschistaceae)	coepulonus
	Pseudothecia mostly 90–170 µm diam.	8
8(7)	Pseudothecia 90–130 µm, sunken, ± gall-forming; ascospores 11–17 × 3–5.5 µm; on <i>Porpidia</i> spp.	martinianus
	Pseudothecia sessile to half immersed, infection not producing galls	9
9(8)	Asci (2–)4–6-spored; on <i>Verrucaria</i> and <i>Placopyrenium</i>	lithoiceae
	Asci 6–8-spored; on <i>Clauzadea</i> spp.	socialis
10(1)	Ascomata 100–150 µm diam.; asci 4- or 6-spored; on <i>Physcia caesia</i>	physciicola
	Ascomata 150–250 µm diam.; asci often 6-spored; on <i>Xanthoria parietina</i>	coepulonus

Zwackhiomyces berengerianus (Arnold) Grube & Triebel (1990)

Ascomata globose to pyriform, 125–180 (–200) µm diam., black, erumpent in clusters from the host thallus, without causing visible symptoms. Exciple (peridium) chestnut brown, 20–25 µm thick, composed of 6–8 layers of irregular ± isodiametric cells, hardly thickened apically, pigment deposited on the outside of the cell walls, or in intercellular spaces. Asci cylindrical, 70–90 (–95) × 12–13.5 µm, (6)8-spored. Ascospores colourless, ± equally 1-septate, the upper cell larger and slightly more rounded than the lower one, slightly constricted at the septum, with a clearly warty perispore, finally slightly brownish, 17–24 (–27) × 5–8 (–10) µm. **BLS 2274.**

Known in GBI from a single collection on “*Lecidea*” *berengeriana* from Scotland



(Ben Lawers). Known elsewhere from Austria and Italy.

Lichenochora inconspicua Hafellner (1989) occurs on the same host and similar habitat, and according to Grube & Hafellner it has similarly sized ascospores with the same type of ornamentation, but quite different asci and hamathecium. Both taxa are known from our region, and care should be taken to differentiate between the two species.

Zwackhiomyces coepulonus (Norman) Grube & R. Sant. (1990) NE

Ascomata globose to ovoid with a sometimes flattened apex, 150–250 µm diam., scattered, immersed to sessile on the host thallus (always sessile on host apothecia), black, the ostiole conspicuous. Exciple (peridium) chestnut brown, 15–20 µm thick, to ca 40 µm thick in the ostiolar region, composed of small irregular cells, pigment deposited on the outside of the cell walls, or in intercellular spaces. Asci cylindrical, 70–100 × 12–15 µm, mostly 6-, rarely 8- or 4-spored, often with clearly visible undeveloped spores. Ascospores colourless, 1-septate, the septum slightly submedian, with a finely warted perispore, (15–) 16–20 (–21) × 5.5–8.5 (–9) µm. **BLS 2320.**

In GBI, recorded from thalli of *Xanthoria parietina*, sometimes colonising galls caused by *Telogalla olivieri*; known from N. England (Westmorland) and Scotland (Unst, Shetland Is).

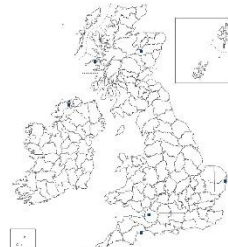
Z. coepulonus was considered by Grube & Hafellner (1990) to parasitize species from several genera of the Teloschistaceae. A collection on *Xanthocarpia fulva* (Harm.) Nav.-Ros. & Roux (2023) from Portland (Dorset) may belong here but appears to have aseptate ascospores (as does *Z. lecanorae*, q.v.). It may belong to an undescribed species.



Zwackhiomyces dispersus (J. Lahm ex Körb.) Triebel & Grube (1990) NE

Ascomata globose to pyriform, 100–130 µm diam., erumpent from the host thallus (often near the apothecia), part-emergent to sessile, black, the ostiole conspicuous. Exciple (peridium) chestnut brown, 15–25 (–40) µm thick, hardly thickened apically, composed of small irregular cells, pigment deposited on the outside of the cell walls, or in intercellular spaces. Asci cylindrical, 60–90 × 14–18 µm, (4-) 6- to 8-spored. Ascospores colourless to pale brown, 1-septate, the septum ± median, with a warted perispore, (17.5–) 18–22 × (6–) 7–7.5 (–8) µm, the upper cell broader than the lower one. **BLS 2275.**

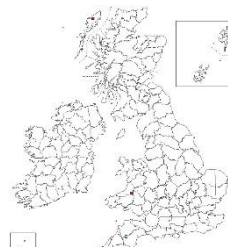
On thalli of *Protoblastenia rupestris*, scattered throughout Britain and Ireland; reported from England (Devon, Somerset), Wales (Carmarthenshire), Scotland (E. Aberdeenshire) and Ireland (Donegal).



Zwackhiomyces lacustris (Arnold) Orange (2002) NE

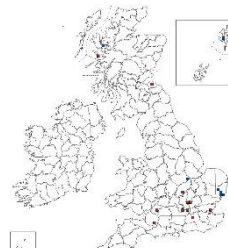
Ascomata ovoid, 150–200 µm diam., initially immersed in the host thallus but becoming erumpent and slightly protruding, black. Exciple (peridium) black above and paler below, ca 25 µm thick, hardly thickened apically, composed of small irregular cells, pigment deposited on the outside of the cell walls, or in intercellular spaces. Asci clavate, 8-spored. Ascospores ellipsoidal, slightly constricted at the septum, the upper cell slightly longer and wider than the lower cell, the perispore thick, smooth or finely roughened, eventually becoming brown and verrucose, 23–31 × 9–12 µm. **BLS 2378.**

On thalli of *Hymenelia lacustris*, Scotland (Outer Hebrides, Shetland), Wales (Caernarvon, Cardigan), England (Dartmoor).



Zwackhiomyces lecanorae (Stein) Nik. Hoffm. & Hafellner (2000) NE

Ascomata pyriform to globose, 90–170 µm diam., scattered or in small groups, usually erumpent, one third to half immersed, occasionally fully immersed, black, the ostiole conspicuous. Exciple (peridium) dark brown, 10–25 µm thick, hardly thickened apically, composed of small irregular cells, pigment deposited on the outside of the cell walls, or in intercellular spaces. Asci cylindrical, short-stalked, 50–100 × 12–21 µm, usually 8-spored. Ascospores colourless, ellipsoidal to ± clavate, almost all aseptate,



with a verruculose perispore, (11–) 12.5–19.5 (–20.5) \times (5.5–) 6–8.5 (–10) μm . **BLS 2152**.

On thalli and apothecia of *Myriolecis* spp., recorded in GBI on *M. albescens* and *M. dispersa*; S. and S.E. England and Scotland (E. Lothian, Inner Hebrides, Shetland).

Unusual in its aseptate ascospores (but see *Z. coepulonus* above).

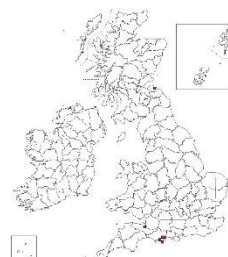
Zwackhiomyces lithoicaea (B. de Lesd.) Hafellner & Volk. John (2006)

Ascomata globose to hemispherical in surface view, 90–165 μm diam., scattered, erumpent and becoming sessile, black. Exciple (peridium) dark brown, 15–25 μm thick, composed of angular cells, pigment deposited on the outside of the cell walls, or in intercellular spaces. Asci clavate with an elongated stalk, (45–) 48–52 (–54) \times (14–) 15–22 (–25) μm , 4- to 6-spored, rarely 2-spored. Ascospores colourless, clavate, strongly constricted at the slightly suprmedian septum, the lower cell slightly longer and narrower than the upper cell, with a well-developed verruculose perispore, (17–) 18–20.5 (–24.5) \times (5.5–) 6.5–8 (–8.5) μm . **BLS 2688**.

On thalli of *Placopyrenium fuscillum* and *Verrucaria nigrescens*, England (Dorset, Somerset, MW Yorkshire) and Scotland (E. Lothian).

The description has been adapted from Darmostuk (2019), who also referred to an undescribed species on *Verrucaria nigrescens* with larger ascospores (21–) 25–30 (–35) \times 8.5–10.5 (–11.5) μm in size. Grube & Hafellner (1990) state that ascospores of *Z. lithoicaea* are smooth-spored; this may be a factor of maturation.

NE



Zwackhiomyces martinianus (Arnold) Triebel & Grube (1990)

Ascomata globose, 70–100 (–125) μm diam., scattered or clustered and sometimes gall-forming, immersed with barely visible ostioles. Exciple (peridium) chestnut brown, 10–15 μm thick, slightly thicker at the apex, composed of angular cells, pigment deposited on the outside of the cell walls, or in intercellular spaces. Asci cylindrical to cylindric-clavate, (45–) 50–70 \times ca 10 μm , 6- to 8-spored. Ascospores colourless, clavate, with a slightly suprmedian septum, 10–13.5 \times 3–5 μm , with a hardly warted perispore. **BLS 2658**.

On thalli of *Porpidia crustulata*, England (Devon) and Scotland (Moray, Mull).

Z. martinianus is unusual in the genus in being \pm gall-forming with immersed ascomata, and in having ascospores with an almost smooth perispore.

NE



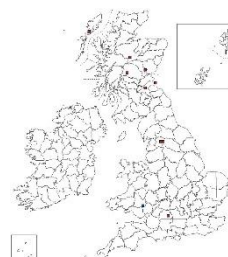
Zwackhiomyces physciicola Alstrup (1993)

Ascomata ca 150 μm diam., scattered or aggregated in rows along the margins of the host lobes, sessile, black. Exciple (peridium) ca 15 μm thick, of isodiametric cells with extracellular brown pigment. Asci \pm cylindrical, with a distinct stalk, 78–92 \times 11.5–13 μm , 4- to 6-spored. Ascospores colourless, 18–22 \times 5.5–6.5 μm , 1-septate, not constricted at the septum, smooth-walled, without a perispore. **BLS 2566**.

On thalli of *Physcia caesia*, England (Wiltshire, on sarsen stones, also from M.W. Yorkshire), Wales (Brecon), scattered throughout Scotland.

The original description of this species is rather short, and needs revision. The smooth-walled ascospores without a perispore reported by Alstrup (1993) are not typical of the genus. Diederich *et al.* (2014) reported that the ascospores of their collection were larger (ca 25 μm long), and Etayo (2010) reported larger perithecia in Peruvian material, 150–300 μm diam., and ascospores with 2–3 setulae, which are otherwise unknown for *Zwackhiomyces*. More than one species may be involved.

NE



Zwackhiomyces socialis (Körb.) Cl. Roux (2009)

Zwackhiomyces immersae (Arnold) Grube & Triebel (1990)

Ascomata globose to pyriform, 120–150 μm diam., in clusters, erumpent and half protruding from the host thallus, black. Exciple (peridium) dark chestnut brown, 10–15 μm thick, slightly thicker around the ostiole, composed of angular cells, pigment deposited on the outside of the cell walls, or in intercellular spaces. Asci cylindrical, 47–70 \times 11–13 μm , (4- to) 6- to 8-spored. Ascospores clavate, 1-septate, colourless, 14–17.5 (–20) \times (4–) 5–7 μm , the upper cell larger and more broadly rounded than the lower one, with a finely warted perispore.

On thalli of *Clauzadea metzleri* on a chalk pebble, England (Sussex, Lullington) and on limestone

NE

(Gloucestershire, Birdlip).

The Gloucestershire collection is not obviously lichenicolous, but the thallus of the host lichen might have deteriorated.

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