Some tips on how to study lichenicolous fungi (LFs)

Summary
Keys are a useful tool but won't always lead you to an appropriate name (there are other effective identification methods).

If this subject seems overwhelming at first, then consider getting to know some of the common and distinctive LFs to be found on *Physcia* and *Xanthoria* on twigs.

Don't expect to name every specimen.

If something doesn't comfortably 'fit', don't force it. Consider making a draft description of it.

We are now blessed with far better resources and means of communication than could have been dreamt of just a few decades ago. Make careful observations of any unknown specimens and consider discussing them on a forum.

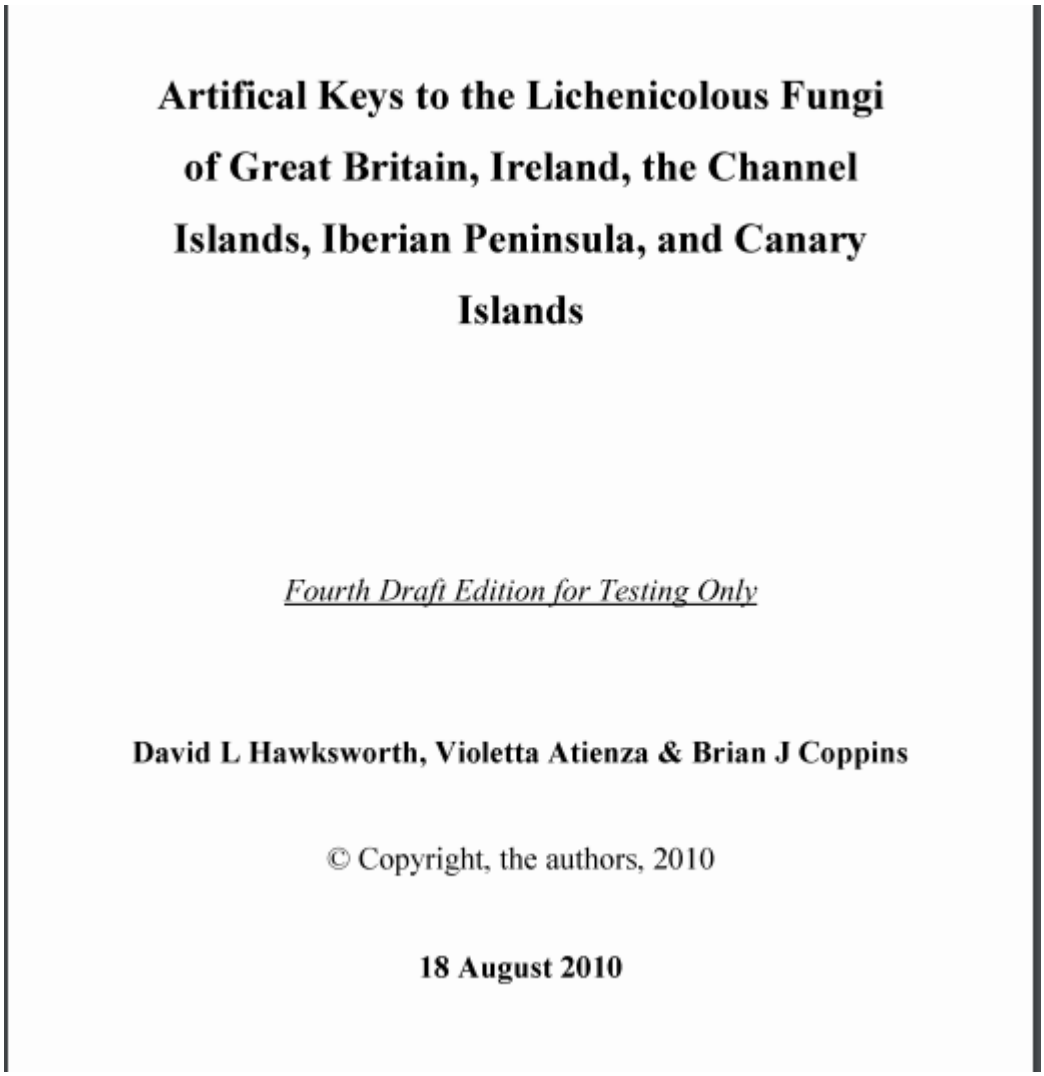
The British Lichen Society website now has a section devoted to lichenicolous fungi: https://www.britishlichensociety.org.uk/lichenicolous-fungi

Extracts from David Hawksworth's British Wildlife article (2004) seem as relevant as ever:

"The study of lichenicolous fungi has traditionally been the domain of the lichenologist. This is because it is necessary to be able to name the lichen hosts, but also to be able to avoid the repeated collection of healthy lichens with their normal pycnidial or ascomatal fruits, and also to spot galls and unusual discolorations. Naturalists who already have a knowledge of lichens will also have a grasp of much of the descriptive terminology of these fungi, though they are likely to find themselves in need of some introduction to the wider areas of fungal structures to be encountered… The pertinent literature itself is very dispersed, and much of it is not in English… However, perseverance will lead into a fascinating world of microscopic beauty and novelty. Here, it is possible for the amateur with keen powers of observation to discover species new to science or new to the country, and to add to our understanding of the biology and ecology of a hitherto hardly appreciated aspect of fungal diversity.

The most important resource for identification of LFs is the draft lichenicolous keys, a small set of pdf documents dated 2010 and which are passed around the community. As with all keys, they must be used with caution. It is not good enough to work diligently through the key and assume that you have arrived at the correct answer. There are plenty of ways to go wrong. Characters, terms and questions can all be misinterpreted. The keys are already out

of date with many species being added to the British list since 2010. There remain a considerable number of undescribed species which don't appear in any of the available resources. I hope that these notes will provide some hints about other resources available, and ways to make progress.



Artifical Keys to the Lichenicolous Fungi of Great Britain, Ireland, the Channel Islands, Iberian Peninsula, and Canary Islands

Fourth Draft Edition for Testing Only

David L Hawksworth, Violetta Atienza & Brian J Coppins

18 August 2010

The draft lichenicolous keys

Key 2B: ***Ascospores simple; ascomata not calicioid***

1 Ascomata whitish, pale brownish, yellowish to pale orange; on foliose lichens of *Peltigerales*.....2
Ascomata dark coloured, **or** if paler then not on *Peltigerales*.....4

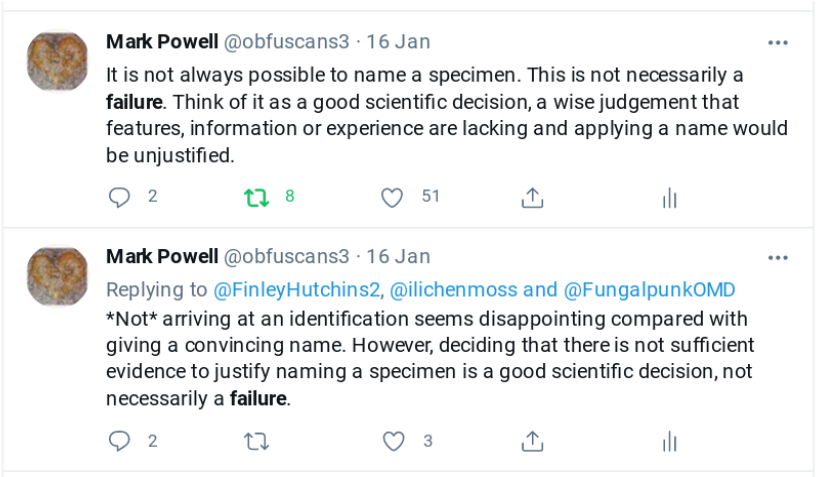
2(1) Ascus apex I– 2A
Ascus apex I+ blue 3

2A(2) Ascomata developing below the host surface, later innate or erumpent, immarginate, 0.3–0.7(–1) mm diam; ascospores (8.5–)10–12(–14) × 2.5–3.5(–5) µm; on thalli of *Peltigera* spp., especially *P. praetextata*. England, Wales, Scotland. See Hawksworth & Santesson (1988).
..... **Skyttella mulleri** (Willey) D. Hawksw. & R. Sant. 1988
Ascomata erumpent to superficial, to 0.33 mm diam, disc pale yellowish to pale brownish, exciple with whitish 0–2-septate glassy hairs with thickened tips to 140 × 1.5–4 µm; ascospores fusoid to leech-shaped, with somewhat attenuated ends, 8.5–16(–17.5) × 2.5–3 µm; on lower and upper surfaces of *Nephroma laevigatum* thalli; Scotland (E Inverness). See Huhtinen *et al.* (2008).
. **Protounguicularia nephromatis** (Zhurb. & Zavarzin) Huhtien *et al*. 2008

3(2) Ascus apex I+ blue with a darker blue axial tube; Ascomata 0.1–0.2 mm diam.; ascospores 10–14 × 3–4.5 µm. On thallus of cyanobacterial morph of *Sticta canariensis* ["*S. dufourii*"]. Canary Islands, W Scotland. See Wedin & Hafellner (1998).
..... **Corticiruptor abeloneae** (P.M. Jørg.) Wedin & Hafellner 1998
Ascus apex with an annular I+ blue ring; ascomata sessile, developing on host surface, marginate, 0.25–0.4 mm diam; ascospores (7–)8–10(–12) × 2.3–3(–3.5) µm. On thallus of *Peltigera* spp. England, Wales, Scotland. See Hawksworth (1980b).
..... **Pezizella epithallina** (W. Phillips & Plowr.) Sacc. 1889

A sample half page from the draft lichenicolous keys

Whichever way you arrive at a name, it is important that you make efforts to validate the identification by careful comparison with descriptions. If the features of your specimen do not comfortably fit any of the descriptions, it is best to keep an open mind.

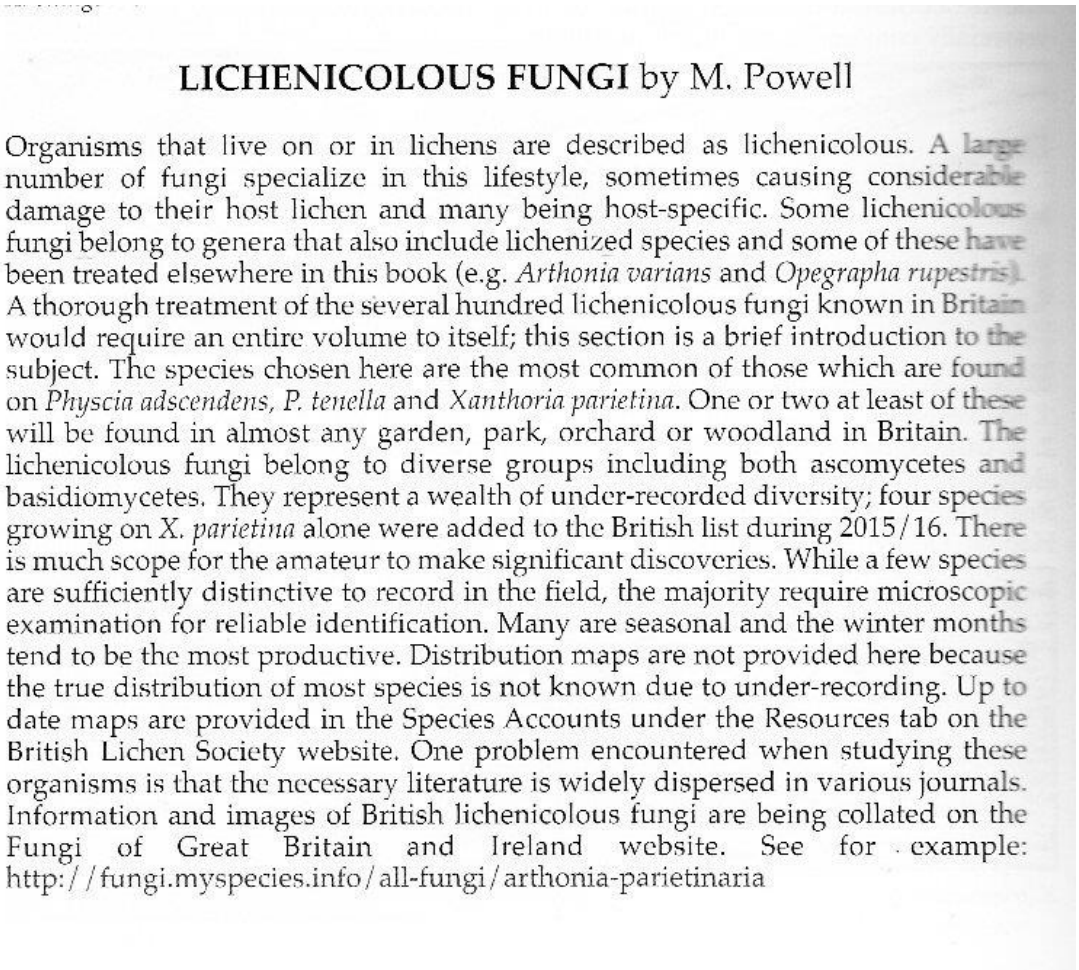


Anyone starting from scratch might be well advised to look at LFs growing on *Physcia adscendens*, *P. tenella* and *Xanthoria parietina* on twigs and branches. A good range of common LFs grow on these lichens, some of them so distinctive that they can be recorded on sight once they are known. Keys are available for the LFs on *Physcia* spp. and on *X. parietina* (see below). This narrower focus helps beginners to feel less overwhelmed. I took this approach when I wrote an introduction to LFs for the 2018 edition of 'Dobson' (see scans below).

This paper contains a key to lichenicolous fungi invading *Physcia* species:
https://www.researchgate.net/publication/270529980_A_Lichenicolous_Species_of_Pleospora_Ascomycota_and_a_Key_to_the_Fungi_Invading_Physcia_Species

Here are keys to LFs on *Xanthoria parietina*:
https://www.britishlichensociety.org.uk/sites/www.britishlichensociety.org.uk/files/Xanthoria%20-%20LF%20key.pdf

https://www.cambridge.org/core/journals/lichenologist/article/abs/capronia-suijae-herpotrichiellaceae-eurotiomycetes-a-new-fungus-on-xanthoria-parietina-from-belarus-with-a-key-to-the-lichenicolous-species-growing-on-xanthoria-s-str/0D04B6BEA7DD2FEE2E5B80EF899993F5



LICHENICOLOUS FUNGI by M. Powell

Organisms that live on or in lichens are described as lichenicolous. A large number of fungi specialize in this lifestyle, sometimes causing considerable damage to their host lichen and many being host-specific. Some lichenicolous fungi belong to genera that also include lichenized species and some of these have been treated elsewhere in this book (e.g. *Arthonia varians* and *Opegrapha rupestris*). A thorough treatment of the several hundred lichenicolous fungi known in Britain would require an entire volume to itself; this section is a brief introduction to the subject. The species chosen here are the most common of those which are found on *Physcia adscendens*, *P. tenella* and *Xanthoria parietina*. One or two at least of these will be found in almost any garden, park, orchard or woodland in Britain. The lichenicolous fungi belong to diverse groups including both ascomycetes and basidiomycetes. They represent a wealth of under-recorded diversity; four species growing on *X. parietina* alone were added to the British list during 2015/16. There is much scope for the amateur to make significant discoveries. While a few species are sufficiently distinctive to record in the field, the majority require microscopic examination for reliable identification. Many are seasonal and the winter months tend to be the most productive. Distribution maps are not provided here because the true distribution of most species is not known due to under-recording. Up to date maps are provided in the Species Accounts under the Resources tab on the British Lichen Society website. One problem encountered when studying these organisms is that the necessary literature is widely dispersed in various journals. Information and images of British lichenicolous fungi are being collated on the Fungi of Great Britain and Ireland website. See for example: http://fungi.myspecies.info/all-fungi/arthonia-parietinaria

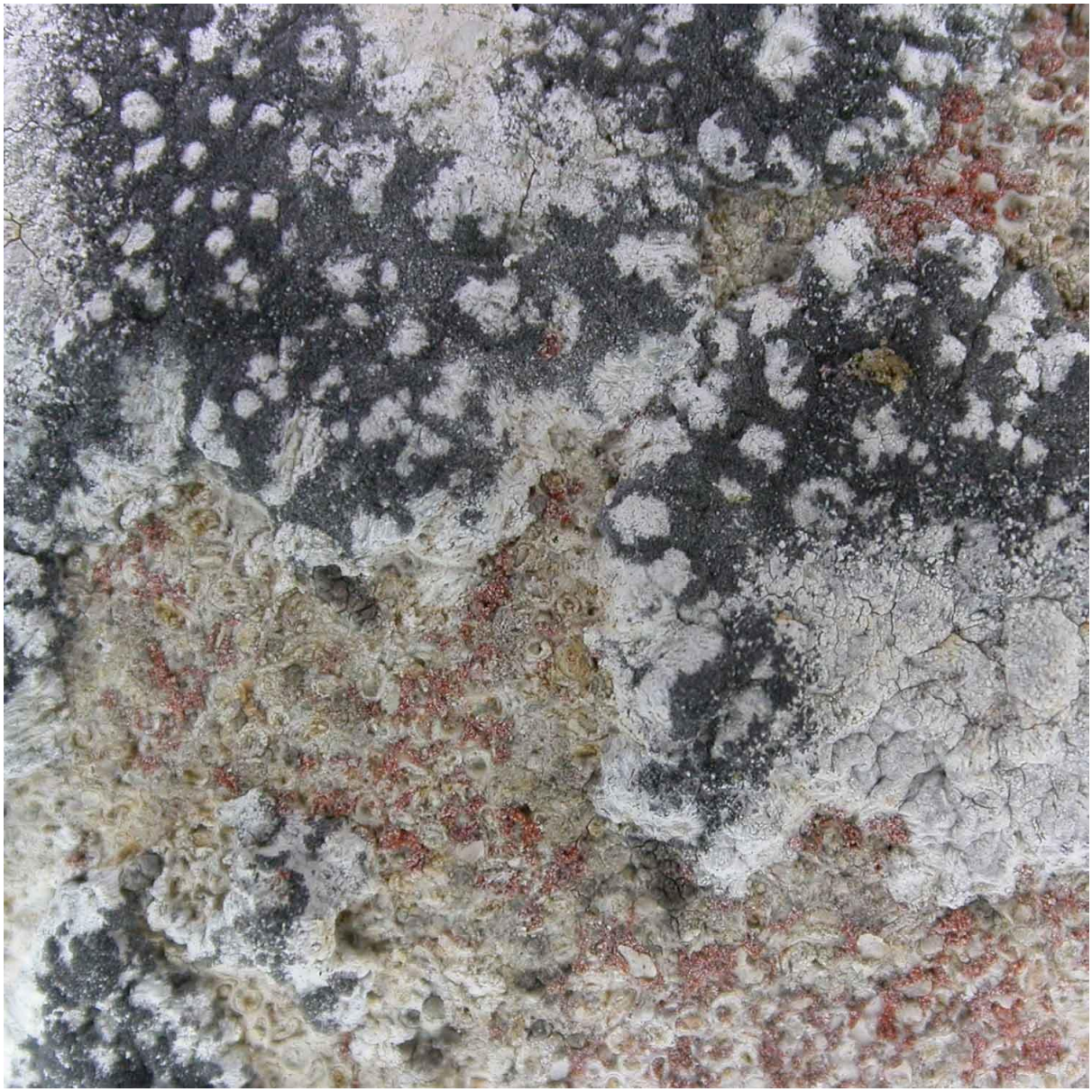
See the end of this document for the rest of my illustrated introduction to lichenicolous fungi.

The way that *Laetisaria lichenicola* was added to the British list is a useful illustration that keys do not provide the only (or even the best) way to put a name to a fungus. A relative novice from Essex found *L. lichenicola* on a nature reserve that he helped manage. Being curious to know what it might be, he made an internet search of images with keywords ‘pink lichenicolous Physcia’. Browsing through the results he concluded that his fungus looked most like images of *Laetisaria*. I was contacted via his local county recorder. A specimen was promptly sent to me, along with a reference to the type description. The novice had set the whole thing up and it was rather a simple matter to confirm his specimen as *L. lichenicola*, new to Britain.

Illosporiopsis christiansenii and *Laetisaria lichenicola* on a winter twig, forming a colourful community that can be found commonly throughout Britain.

Let me provide another example of the value of images for identification, and how they may lead you to a name more effectively than traditional keys. A member of the churchyard group

sent me photographs and a specimen of a lichenicolous fungus infecting *Dirina massiliensis* on a Wiltshire church. I examined the material carefully, tried to work meticulously through the draft keys but initially failed to work it out. Some days later, and by chance, I was looking through David Hawksworth's *British Wildlife* article which includes a plate of line drawings showing the range of spore and conidia forms in various LFs. One of the drawings caught my eye in an instant, and much to my satisfaction, I learnt that it belonged to *Milospium graphideorum*, an LF which grows on various *Trentepohlia*-containing LFs, including *Dirina*. Using the draft keys I had misinterpreted the intricately folded conidia as being multiseptate and led myself down a fruitless route through the keys.



Milospium graphideorum parasitising *Dirina massiliensis* on a church wall.

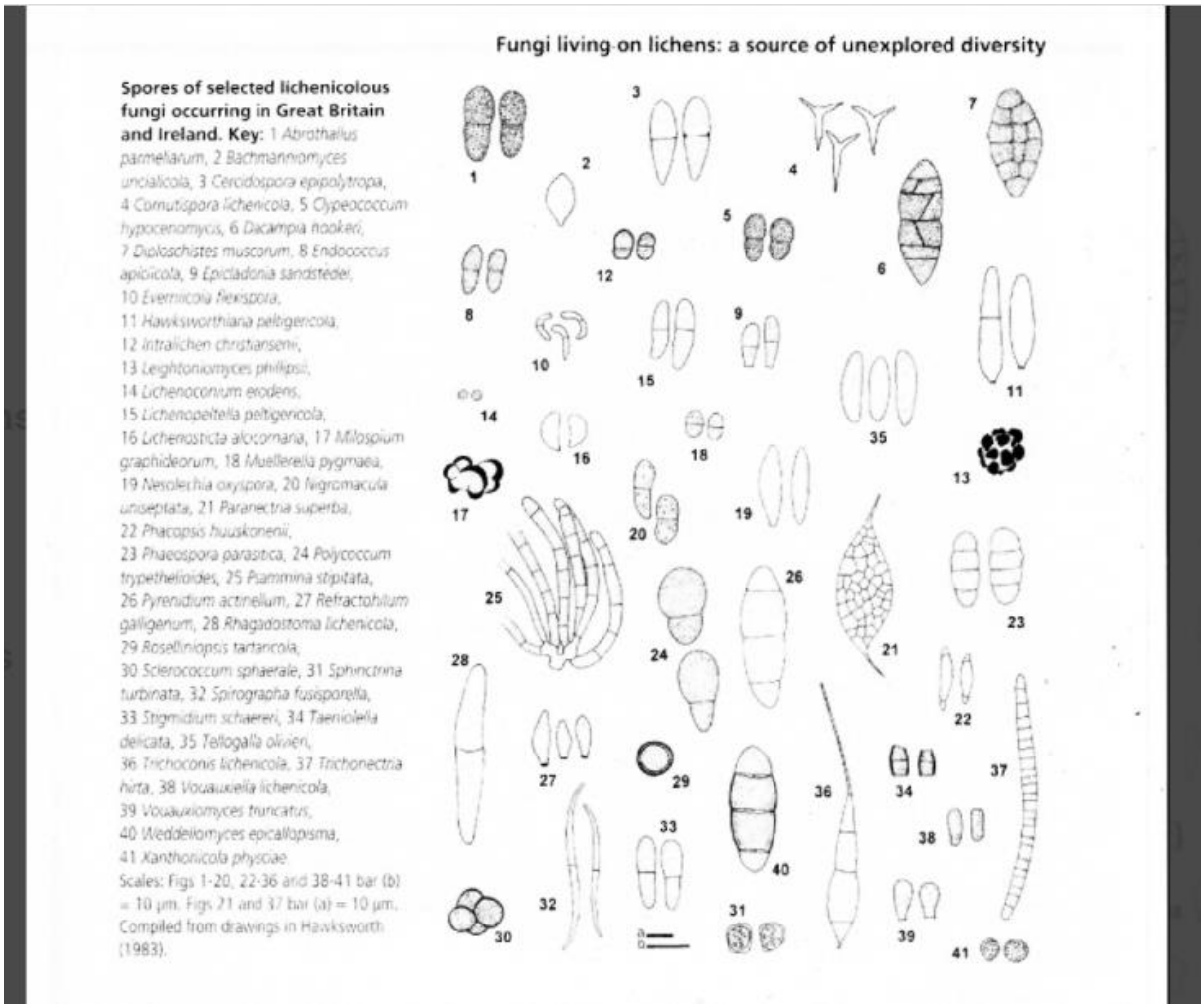


Plate from Hawksworth, D.L. (2004) Fungi living on lichens: a source of unexplored diversity. *British Wildlife*. 15 (February 2004): 192-199. It was a glance at this plate of line drawings that led me rather effortlessly to the identity of *Milospium graphideorum*.

Is it an LF or does it belong to the lichen?

Normandina pulchella provides a good example of the difficulty of knowing whether a fruiting body (or pycnidium) belongs to the lichen itself or is a separate lichenicolous fungus. From LGBI (2009):

“The perithecia [of *N. pulchella*] were for a century rightly believed to belong to the thallus, until some authors suggested that the thallus might be a Basidiomycete and the perithecia a lichenicolous fungus. However, careful morphological observations and phylogenetic work have proved the original opinion to be right.”

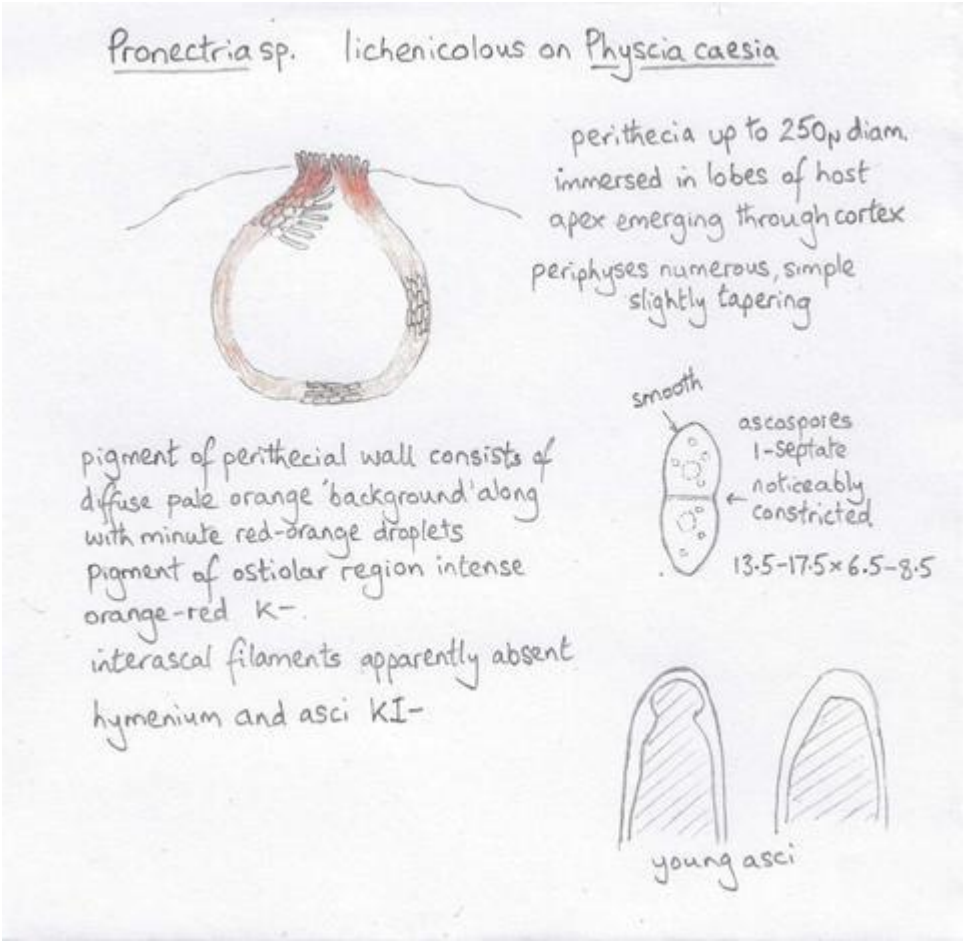
For more information and references to the relevant papers see this twitter thread:
https://twitter.com/obfuscans3/status/1087491194358243329

Some LFs are distinctly pathogenic and can be recognised as parasitic by the necrosis they induce in their hosts. In many other cases it is far less easy, perhaps impossible using simple microscopic inspection, to know for sure. One gets to know the most common sources of confusion. For example the conspicuous black dot-like pycnidia of *Hypogymnia physodes* and *Physcia adscendens*/*tenella* are often mistaken for LFs until one learns better. People who provide photos and micrographs of pycnidia belonging to various lichens provide good service.
http://fungi.myspecies.info/taxonomy/term/6087/media

A strategy for LFs that 'don't fit'

I am going to use the example of a lovely red-fruited fungus that infects *Physcia caesia*, a widespread LF that, rather surprisingly, is as yet undescribed. How do I know that it is undescribed? I have consulted fairly modern papers which claim to provide keys to all known *Pronectria* species and found no matches. I have searched the comprehensive Lichenicolous.net website for any *Pronectria* or related fungus growing on *Physcia* species and found that none of them are good matches. Here is the website:
http://www.lichenicolous.net/
On many browsers the three vertical dots near the top right of the screen will give an option of searching a whole website. Hence, the lichenicolous.net website can be searched for all mentions of host or genus of LF.

My next step was to make a detailed illustrated description and make it available online, in my case I uploaded the information and images to the fungi.myspecies website.
http://fungi.myspecies.info/all-fungi/pronectria-sp-mp3952
Finally I contacted Brian Coppins and Paul Diederich who agreed that my fungus was a species of *Pronectria* and that they knew of no described species that matched it. What now? There is nothing stopping anyone from going ahead and publishing a description of this fungus. I contemplated doing it myself as a stand-alone description but it was suggested to me that it would be more useful if it was described along with several other undescribed members of the genus. One day it will get described and in the meantime we can recognise it as an entity and have good online information available about it. Perhaps we should at least decide on an 'in ed.' name for it?



A drawing summarising the most important microscopic features of the undescribed *Pronectria*.

Some LFs occur in communities

It is not uncommon, especially when examining nutrient-enriched lichen communities on twigs, to find particular bushes or certain twigs to be little hotspots of LF diversity. I think this is because an initial fungus causes a deterioration of the host lichen and this is then exploited by others. Some people consider *Illosporiopsis christiansenii* to be quite pathogenic but I think this is a misreading of the situation. *I. christiansenii* often grows on thin algal crusts or even on apparently bare bark of twigs. When growing on degraded lichen thalli, I think it is taking advantage of the damage done by other LFs. *I. christiansenii* seems little more than a saprobe to me but it is appropriate to call it a lichenicolous fungus as lichenicolous merely implies growing on (or in) lichens.

Illosporiopsis christiansenii, growing apparently on almost bare bark in the first image, and taking advantage of the damage wrought by *Xanthoriicola physciae* in the second image.

Some LFs are good taxonomists, others turn out not to be

LFs range from general saprobes taking advantage of deteriorating lichen thalli to others which are strictly host specific. I had hoped that LFs would help us to distinguish between *Lecanora campestris* and its look-alike *L. horiza* but, after initial high hopes, these were dashed.

Up until 2012, almost all churchyard recorders were entirely ignorant about *L. horiza*. It was during the BLS autumn field meeting in Bedfordshire that a Dutch colleague started pointing at the vertical faces of gravestones and calling them *L. horiza*. Initially I was silently dismissive, especially because various well regarded British field lichenologists seemed similarly bemused. Over several subsequent weeks I spent time examining material in the field, collecting for microscopic examination and researching the published information about *L. horiza*. I gradually started to 'believe in' *L. horiza* and realised that its description in the 2009 'Flora' is incorrect about several important characters. Within a year Jiri Malicek had sequenced some of my collections from English churchyards, proving that we did indeed have both *L. campestris* and *L. horiza* as regular members of churchyard communities. At the extremes of their variability it is relatively easy to recognise these two species of *Lecanora*, but there are many intermediates which seem almost impossible to place. There are no simple chemical or microscopic differences. However I noticed that some of my initial collections of *L. horiza* were infected by *Vouauxiella verrucosa* while *Muellerella lichenicola* was a frequent fungus on *L. campestris*. I was really excited that these two LFs might be strictly host specific and hence provide an extra means of distinguishing them. As so often during scientific investigation, it is easy to get carried away with too few initial observations. It was with considerable disappointment that I started to find that either LF can grow on either host.

There follows a number of other interesting aspects relating to lichenicolous fungi; a screenshot from one of my twitter threads is accompanied by a link to the thread itself.

Mark Powell @obfuscans3 · 17 Jan 2019

Replying to @obfuscans3

In the 1960s there was little more than a cyclostyled key to macrolichens being passed around (all books at that time long out of date). No easily obtained images. Lichenologists communicated by post and only got together when meetings were organised.

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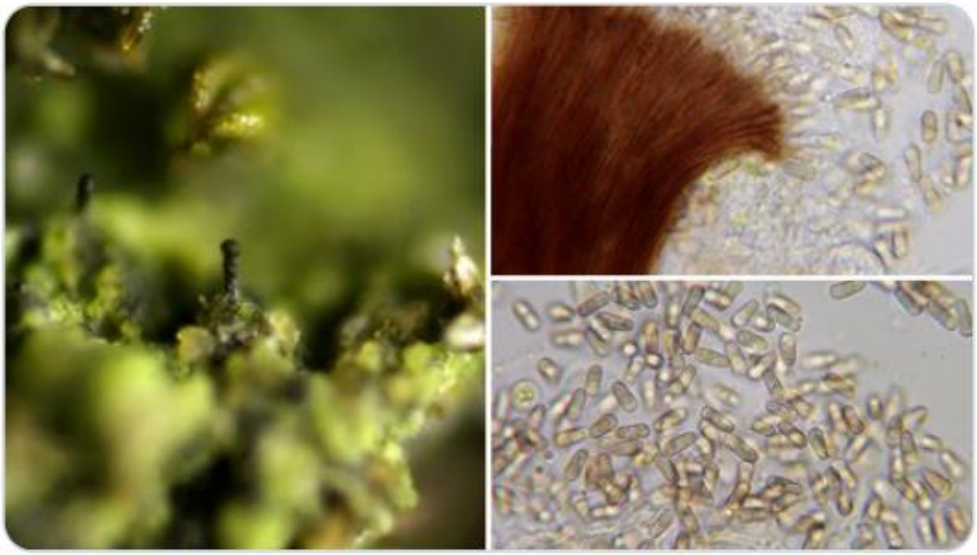
Mark Powell @obfuscans3 · 17 Jan 2019

What a difference? At the Malham workshop, someone found a minute fungus on Vezdaea. I took some micrographs that evening, sent email to Continental expert, and was able to give the collector a name (Graphium **apthosae**) at breakfast the next morning.



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https://twitter.com/obfuscans3/status/1085871393512644610

Mark Powell
@obfuscans3

Replying to @obfuscans3

Can we believe the supposed different fluorescence? This is what fertile L. lyncea looks like (the fruits of L. amylacea are rounded). Also shown is 'pseudo-lyncea' an unidentified lichenic. fungus which infects Schismatomma decolorans and whose infections mimic lirellae

8:47 pm · 23 May 2018 · Twitter Web Client

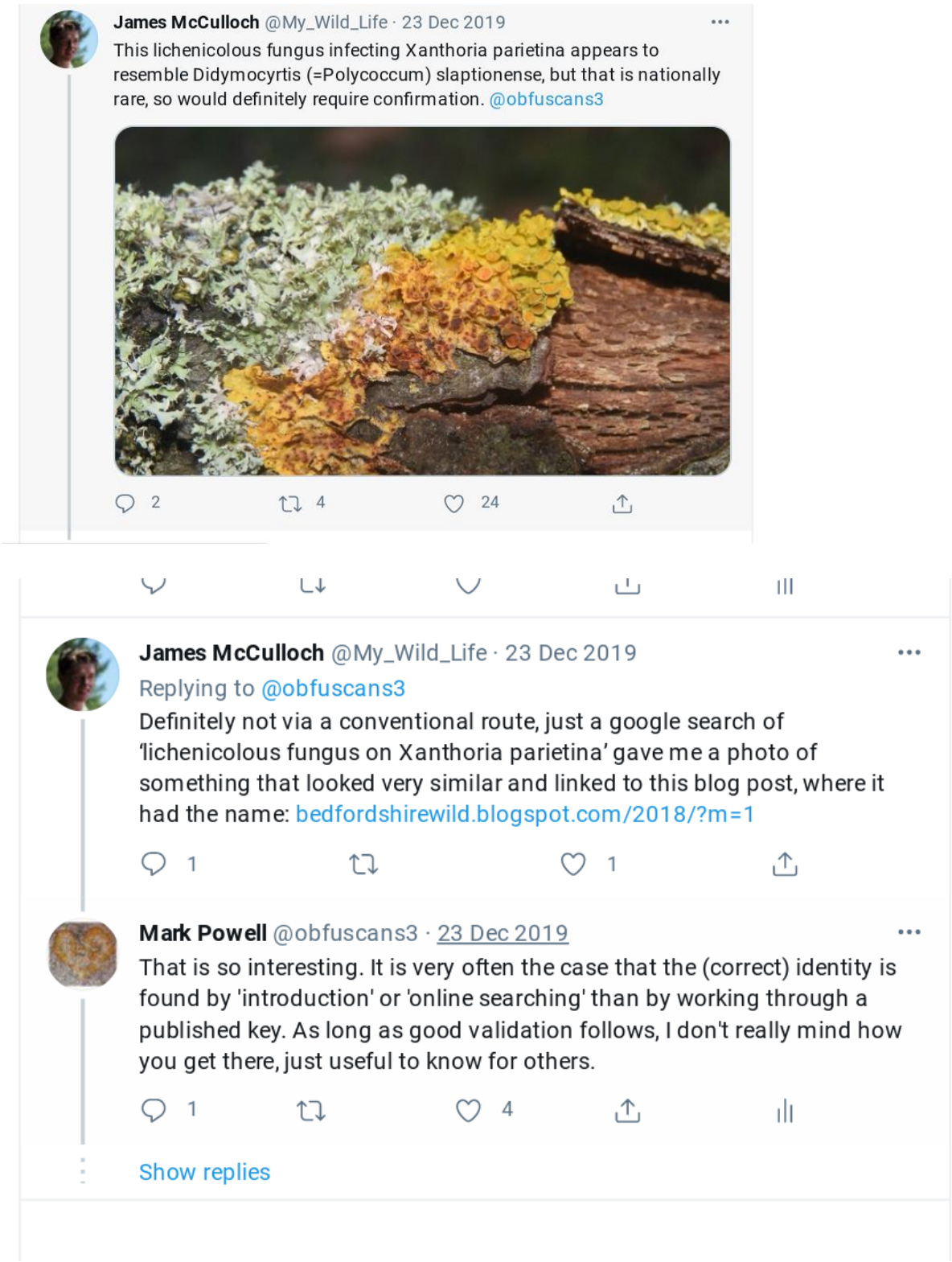
https://twitter.com/obfuscans3/status/999376170398441473

***Didymocyrtis slaptoniensis*, a case study of a published species which has plenty of interesting features not mentioned in the type description (or any other published sources)**

It was the interesting and distinctive pigmentation produced in its host that gave me confidence to record the anamorph of *Didymocyrtis slaptoniensis*. The anamorph was not known when this species was described.
https://twitter.com/obfuscans3/status/1087309854048440321

The hyphae of *D. slaptoniensis* appear to form haustoria adjacent to (perhaps attached to) the ascospores of its host.
https://twitter.com/obfuscans3/status/1216715876508033024

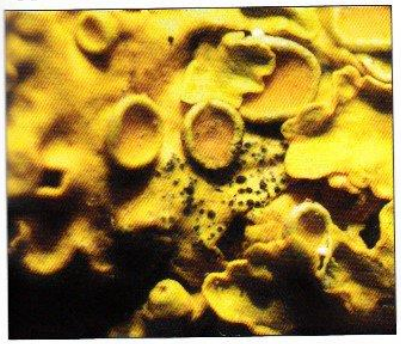
A twitter query about D. slaptoniensis, and the way that the correspondent had got to the (correct) identification

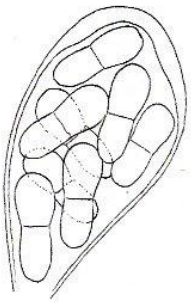


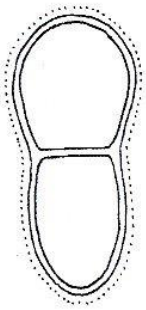
https://twitter.com/My_Wild_Life/status/1209138202851921921
https://twitter.com/obfuscans3/status/1209226194387902469

The descriptions of a range of lichenicolous fungi from my introduction to the subject in the 2018 edition of ‘Dobson’.

Arthonia parietinaria Described as recently as 2015, this common fungus was often previously recorded as *A. molendoi*. Infections consist of dense clusters of up to fifty immarginate, black apothecia but little damage is caused to its host, *X. parietina*. The ascospores are colourless, 10-12 × 4-5 μm, 1-septate with the upper cell somewhat broader.

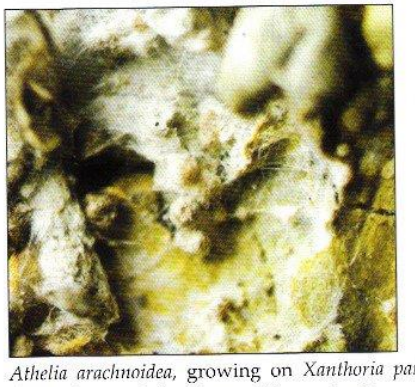


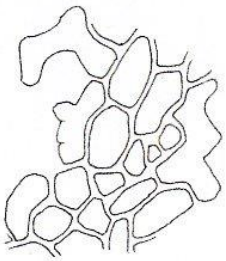




Arthonia parietinaria, numerous apothecia in an infection on *Xanthoria parietina*. The drawing shows an ascus and an ascospore.

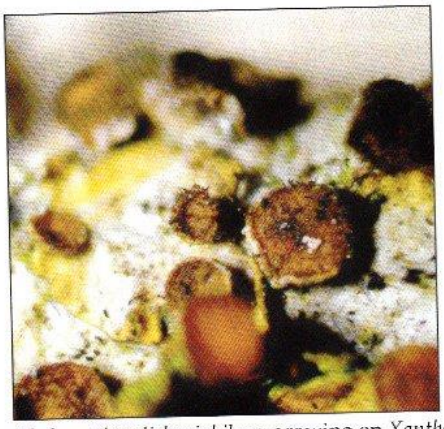
Athelia arachnoidea A common basidiomycete which produces wide-spreading cobweb-like colonies, often causing considerable damage to lichen communities. The infections can often be detected from a distance, for example when growing on nutrient-rich tree trunks, by the discolouration (darker orange) of X. *parietina*. Numerous sclerotia, small creamy or pale brown rounded masses of sterile hyphae, are produced periodically and serve as dormant propagules.

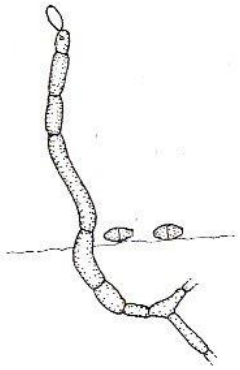




Athelia arachnoidea, growing on *Xanthoria parietina*, with pale brown sclerotia. The drawing shows the sterile hyphae within a sclerotium.

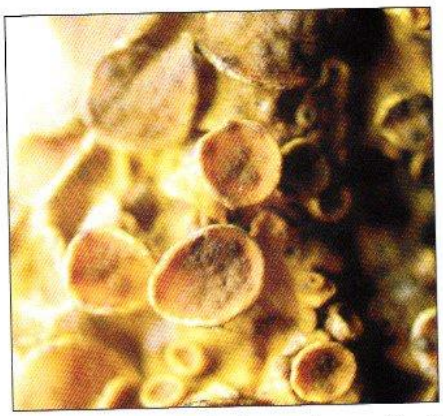
Cladosporium licheniphilum First recorded in Britain in 2015, but probably widespread, this fungus causes minutely furry brown infections on *X. parietina*. Being a hyphomycete its conidia are not produced in distinct structures. Instead the pale brown conidia develop on erect hyphae which are scattered across the infected lichen. The conidia are pale brown, ellipsoid, simple or 1-sepate, 5-13 × 3-7 μm.

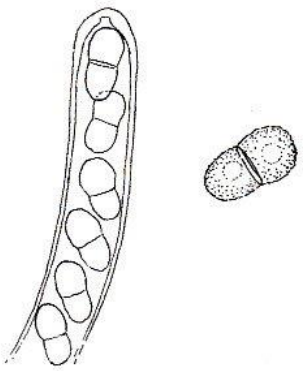




Cladosporium licheniphilum, growing on *Xanthoria parietina*. The drawing shows a conidium being formed at the tip of a hypha, and two conidia sitting on the host's surface.

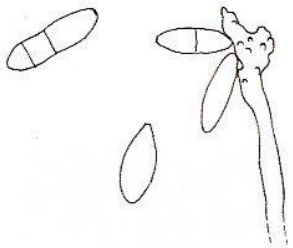
Didymocyrtis (Polycoccum) slaptoniensis Growing on *X. parietina*, and most frequently found in its apothecia, this fungus may produce either perithecia or pycnidia, both structures being black, globose structures semi-immersed in the host. The ascospores are brown, 1-septate, 13-14.5 × 5-6 μm while the conidia are colourless, simple and ellipsoid. In both forms, a curious phenomenon can often be seen whereby the ascospores of the host are turned red. *Sphaerellothecium parietinarius* also produces perithecia containing brown, 1-septate ascospores but that fungus lacks the interascal filaments which are present as branched and anastomosed hyphae in *D. slaptoniense*.





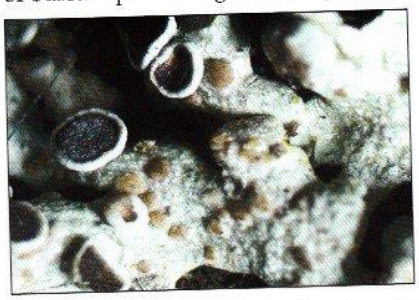
Didymocyrtis slaptoniensis, growing on *Xanthoria parietina*. The drawing shows an ascus and an ascospore.

Gonatophragmium lichenophilum Described as new to science in 2015, this fungus was first recorded in Britain the following year. The pale brown fuzzy infections are easily overlooked. The conidia are very pale brown, ellipsoid, mostly 1-septate, 9-15 × 3-4 μm. The conidia are produced on branched hyphae and leave conspicuous scars where they were formed, giving the hyphae a curious knobbly appearance.



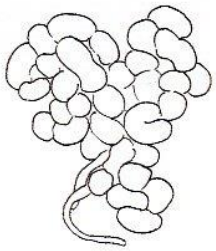
Gonatophragmium lichenophilum, growing on *Xanthoria parietina*. The drawing shows the production of conidia.

Heterocephalacria (Syzygospora) physciacearum This common basidiomycete forms pale to greyish brown, waxy galls on the lobes of *Physcia* species. It is usually recorded on sight but microscopic preparations often reveal the presence of basidia producing basidiospores (7.5-11 × 3.5-6.5 μm) on stalks (sterigmata).



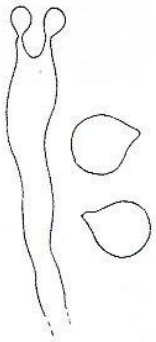
Heterocephalacria physciacearum, forming galls on *Physcia*. The drawing shows a basidium, one of the sterigmata still has a basidiospore attached.

Illosporiopsis christiansenii With experience the bright pink 'blobs' (masses containing helical, multi-celled conidia) can be recognised on sight but they are sometimes confused with the pink infections of *Laetisaria lichenicola* or the pale orange bulbils of *Marchandiobasidium aurantiacus*. The coiled conidia are 17-30 × 11-20 μm and form soft masses that gradually wash away in the rain. *I. christiansenii* does not appear to affect the lichens it grows upon and sometimes grows on bare bark.



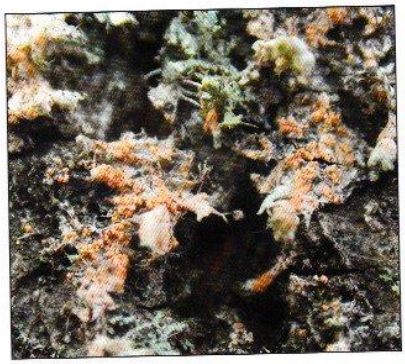
Illosporiopsis christiansenii, growing on *Physcia adscendens*. The drawing shows a helical, multi-celled conidium.

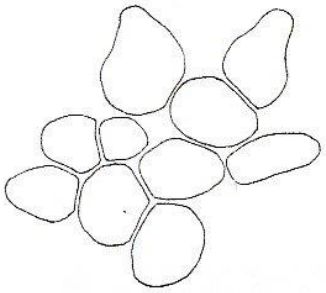
Laetisaria lichenicola The attractive pink infections appear to be common and widespread so it is surprising that this fungus was not recognised in Britain until 2015. The thalli of *Physcia adscendens* and *P. tenella* become minutely powdery in appearance due to the production of basidiospores and often appear partly 'dissolved' into a cellophane-like film. The basidiospores are produced on stalks (sterigmata) at the top of columnar basidia, and are 14.5-18 × 10.5-12.5 μm.



Laetisaria lichenicola, growing on *Physcia adscendens*. The drawing shows a basidium with two immature basidiospores attached. Two mature basidiospores are also shown.

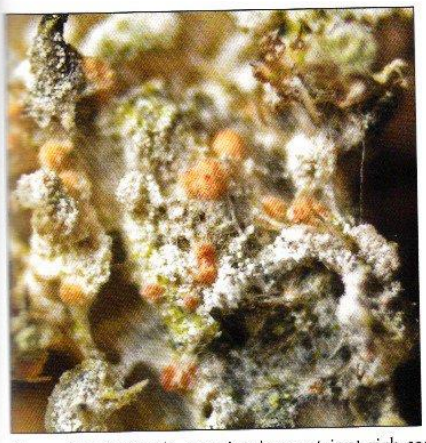
Marchandiobasidium (Marchandiomyces) aurantiacum A very common fungus producing attractive colonies of pastel orange bulbils (70-100 μm) on a range of host lichens. A microscope section through one of the bulbils reveals a mass of swollen sterile hyphal cells.

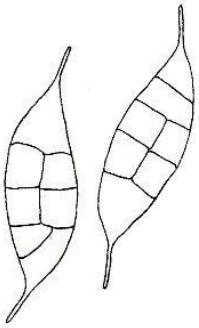




Marchandiobasidium aurantiacum, growing on the remains of *Physcia adscendens*. The drawing shows the sterile hyphal cells within the bulbils.

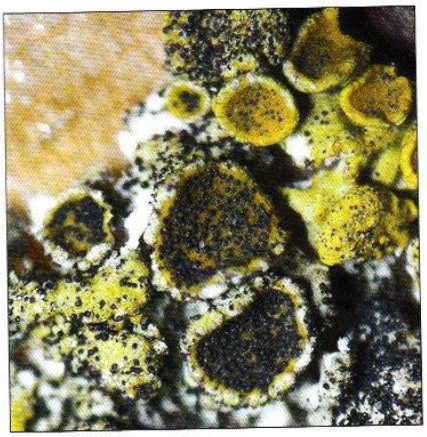
Paranectria oropensis The small pale, fluffy perithecia sit on a diffuse cobweb-like sheet of hyphae. The perithecia are often recognised by the bright orange ostiole and confirmation is provided by the large muriform ascospores with thread-like extensions at each end (25-32 × 11-14 μm with 12 μm 'tails'). *P. oropensis* grows on various lichen species in nutrient-rich communities.

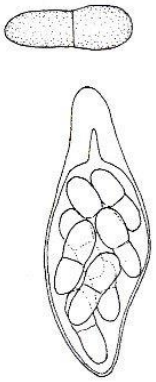




Paranectria oropensis, growing in a nutrient-rich community. The drawing shows two ascospores.

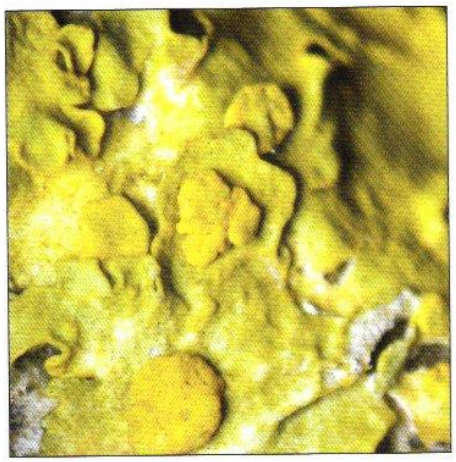
Sphaerellothecium parietinarius The abundant black perithecia (50-80 μm) are rather prominent and conspicuous on the apothecia (occasionally also on the thallus) of *X. parietina*. The ascospores are brown, 1-septate, 10.5-12 × 4-5.5 μm and interascal filaments are absent.

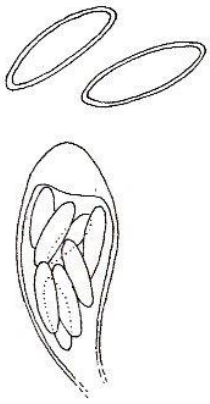




Sphaerellothecium parietinarius, growing on *Xanthoria parietina*. The drawing shows an ascospore and an ascus.

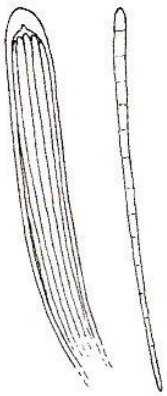
Telogalla olivieri This fungus forms curious galls shaped like a lobed cook's hat, usually when the host (*X. calcicola* or *X. parietina*) is saxicolous, but sometimes when growing on twigs. The walls of the immersed perithecia are colourless except around the ostiole. The ascospores are simple, colourless, 15-20 × 4-7 μm and interascal filaments are absent.





Telogalla olivieri, forming galls on *Xanthoria parietina*. The drawing shows two ascospores and an ascus.

Tubeufia heterodermiae Infections can sometimes be recognised before the minute perithecia are seen because the thalli of *P. adscendens* and *P. tenella* are discoloured a dingy off-white. The perithecia are globose, pale creamy brown, 150-220 μm, covered with hair-like hyphae and they sit sessile on the lobes of the host. The ascospores are thread-like, 145-165 × 2-2.5 μm with up to 25 septa.



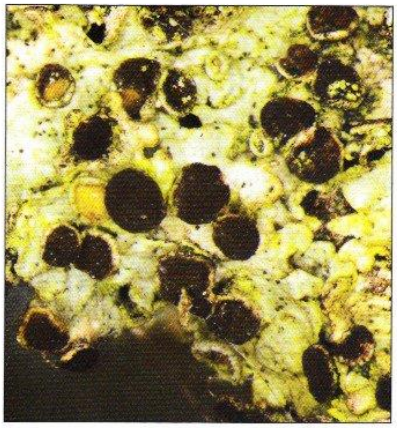
Tubeufia heterodermiae, growing on *Physcia adscendens*. The drawing shows an ascus and an ascospore.

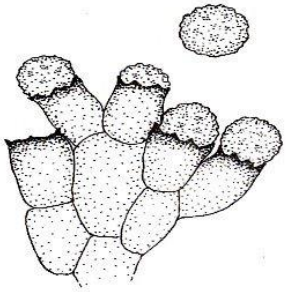
Xanthoriicola physciae Sometimes nicknamed '*Xanthoria* smut', this is a very common fungus, infecting *X. parietina* on which it produces large sooty colonies. The brown hyphae of this fungus produce conidia at the surface of the host tissue; the conidia are brown, globose, 3.5-6 μm in diameter with coarsely warted walls.

Xanthoriic
conidia.

Zwackh
immerse
16-20 ×
British
recorde

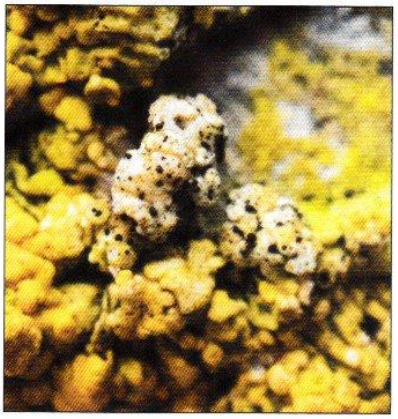
Zwackhi
ascospo

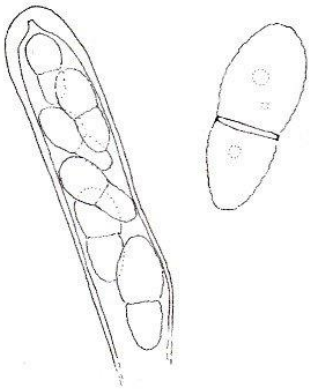




Xanthoriicola physciae, growing on *Xanthoria parietina*. The drawing shows the production of conidia.

Zwackhiomyces coepulonus The black perithecia (150-250 μm) are semi-immersed in the thallus of X. parietina. The ascospores are colourless, 1-septate, 16-20 × 5.5-8.5 μm. Interascal filaments are present. Currently there are very few British records but, like so many other lichenicolous fungi, it may be under-recorded.





Zwackhiomyces coepulonus, growing on *Xanthoria parietina*. The drawing shows an ascus and an ascospore.