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A survey of lichens on pine snags at Cors y Llyn National Nature Reserve

NG Bacciu & J McGill



Evidence Report No 761

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1. Crynodeb Gweithredol

Gwnaed arolwg yng Ngwarchodfa Natur Genedlaethol Cors y Llyn ym Mhowys ar gennau coed-drig ar foncyffion marw Pinwydd yr Alban (*Pinus sylvestris*) ar dri dyddiad ym mis Tachwedd 2023. Cofnodwyd cennau'n systematig ar 24 boncyff marw (snag) Pinwydd yr Alban (*Pinus sylvestris*) ac ar un boncyff marw bedwen (Betula), a gwnaed cofnodion achlysurol ychwanegol ar goed eraill Pinwydd yr Alban, bedw a grug (*Calluna vulgaris*).

Cofnodwyd 46 o rywogaethau o gen, 10 ffwng sy'n byw ar gennau a 2 ffwng nad ydynt yn ffurfio cen, yn ystod yr arolwg, ac roedd 33 o'r rhywogaethau hyn yn gofnodion newydd ar y safle. Mae gan ddeg rhywogaeth statws cadwraeth, gan gynnwys:

- **Dan Fygythiad (Cymru)** – cen *Cetraria sepincola*.
- **Cenedlaethol Brin** – cen *Fellhanera subtilis*, a'r ffyngau sy'n byw ar gennau, sef *Arthonia digitatae* a *Milospium lacoizquetae* .
- **Yn anfynych yn genedlaethol** – cennau *Caloplaca asserigena* a *Micarea coppinsii*, a'r ffyngau sy'n byw ar gennau - sef *Chaenothecopsis pusilla*, *Intralichen christiansenii*, *Lichenocodium xanthoriae* a *Spirographa fusisporella* .

Roedd sgôr mynegai'r pen pin yn 6, sef yn is na'r trothwy a awgrymwyd er mwyn ystyried y casgliad fel nodwedd SoDdGA ond yn dal i fod o arwyddocâd lleol. Cofnodwyd bod y ffwng *Lichenocodium xanthoriae* sy'n byw ar gennau yn newydd i Gymru, ac roedd pedair rhywogaeth o ffwng sy'n byw ar gennau yn newydd i Sir Faesyfed (VC43) – sef *Homostegia piggotii*, *Intralichen christiansenii*, *Lichenocodium erodens* a *Spirographa fusisporella* .

Roedd boncyffion marw yn amrywio mewn diamedr o 3 - 33 cm, mewn uchder o 57 - 850 cm, ac o ran eu hongl ogwydd o 71 - 90 gradd. O gymuned o 41 o gennau a ganfuwyd ar lignwm yn yr arolwg presennol, roedd cyfoeth rhywogaethau ar foncyffion marw unigol yn amrywio o 1 i 15. Y gwerth moddol oedd 7 (n=5). Roedd canran y boncyffion marw lle cofnodwyd rhywogaethau fel a ganlyn:

- Toreithrwydd (51-90%): 3 rhywogaeth.
- Amllder (21-50%): 9 rhywogaeth.
- Achlysurol (6-20%): 17 rhywogaeth.
- Prin (< 5%): 12 rhywogaeth

Yn seiliedig ar y data yn yr arolwg hwn, cofnodwyd cennau pen pin yn bennaf ar foncyffion marw â diamedr mwy, felly dylid creu o leiaf rhai o'r rhain o goed â diamedr boncyff mwy na 20 cm. Roedd yn ymddangos bod cyfoeth rhywogaethau'r cennau ar lignwm yn cael ei ysgogi gan gymhlethdod cynyddol yn adeiledd y boncyffion marw ac roedd llawer o rywogaethau naill ai'n achlysurol neu'n brin o ran eu presenoldeb ar nifer y boncyffion marw a gafodd eu samplu. Byddai parhau i greu boncyffion marw felly o fudd i ddatblygiad ac amrywiaeth y gymuned o gennau coed-drig.

2. Executive Summary

Cors y Llyn National Nature Reserve in Powys was surveyed for lignicolous lichens on dead Scots Pine *Pinus sylvestris* snags on three dates in November 2023. Lichens were systematically recorded on 24 Scots Pine *Pinus sylvestris* snags and on one birch *Betula* snag, with additional casual records made on other Scots Pines, birches, and Heather *Calluna vulgaris*.

Forty-six lichen species, 10 lichenicolous fungi and 2 non-lichenised fungi were recorded during the survey, of which 33 species were new site records. Ten species have conservation status, comprising:

- **Vulnerable (Wales)** – the lichen *Cetraria sepincola*.
- **Nationally Rare** – the lichen *Fellhanera subtilis*, and the lichenicolous fungi *Arthonia digitatae* and *Milospium lacoizquetae*.
- **Nationally Scarce** – the lichens *Caloplaca asserigena* and *Micarea coppinsii*, and the lichenicolous fungi *Chaenothecopsis pusilla*, *Intralichen christiansenii*, *Lichenocodium xanthoriae* and *Spirographa fusisporella*.

The Pinhead Index score was 6, below the threshold suggested for consideration of the assemblage as a SSSI feature but still of local significance. The lichenicolous fungus *Lichenocodium xanthoriae* was recorded as new to Wales, and four species of lichenicolous fungus were new to Radnorshire (VC43) – *Homostegia piggotii*, *Intralichen christiansenii*, *Lichenocodium erodens* and *Spirographa fusisporella*.

Snags ranged in diameter from 3 – 33 cm, in height from 57 – 850 cm, and in angle of lean from 71 – 90 degrees. From a community of 41 lichens found on lignum in the current survey, species richness on individual snags ranged from 1 to 15. The modal value was 7 (n=5). The percentage of snags where species were recorded was as follows:

- Abundant (51–90%): 3 species.
- Frequent (21-50%): 9 species.
- Occasional (6-20%): 17 species.
- Rare (< 5%): 12 species.

Based on the data in this survey, pinhead lichens were mostly recorded on larger diameter snags, so if ringbarking is used to create more snags at least some of these should be created from trees with a trunk diameter above 20 cm. Species richness of lichens on lignum seemed to be driven by increased complexity in the structure of snags, and many species were either occasional or rare in terms of occurrence on the number of snags sampled. Ongoing creation of snags would therefore benefit the development and diversity of the lignicolous lichen community.

3. Introduction

3.1 Background

This survey was commissioned by Natural Resources Wales (NRW) to gather data on the lichen assemblages present on Scots Pine *Pinus sylvestris* snags at Cors y Llyn National Nature Reserve in Powys (VC43, Radnorshire). These have developed since many pines were ring-barked in the 1990s, and appeared to be diverse and potentially of conservation interest when examined by a non-specialist in early 2023. In particular, assessment of the pine snag lichens against the SSSI Pinhead Lichen Assemblage criteria in Sanderson *et al.* (2018) was desired.

Cors y Llyn is an elliptical basin mire situated on a plateau to the east of the River Wye near Newbridge (Gilman, 1992). The mire occupies a small catchment on the Wenlock shales, which are generally impermeable and there is no evidence that it receives significant groundwater input. Peat profiles at the site suggest that peripheral birch carr has been a persistent feature, and at one time was more extensive, covering the northern basin. This has been modified by peat cutting, leading to colonisation of cut-over areas by *Sphagnum*. Pine woodland is a recent feature, and pine snags have been created where trees have been killed to keep parts of the bog from reverting to woodland.

3.2 Methodology

The survey involved systematic recording of lichens on a representative sample of Scots Pine snags, and casual recording of lichens on other pine snags, living pines, birch trees, and Heather *Calluna vulgaris*.

The diameter at breast height (dbh) of the snags sampled was measured using a 5 m diameter tape. The height of each snag was measured, or estimated if longer than 2 metres. The angle of lean for each snag was measured and the snags were also photographed. The frequency of each lignicolous lichen on the snags sampled was expressed on the DAFOR scale using the following classes: < 5% rare, 6–20% occasional, 21–50% frequent, 51–90% abundant, and 91–100% dominant (Hill *et al.*, 2005).

Some records of spiders were also made during the survey, and these are summarised in Appendix 3.

3.3 Survey area

Twenty-five snags were systematically surveyed for lichens within Cors y Llyn SSSI Unit 1 (The Bog). The location of these snags is shown on Figure 1.



Cors y Llyn SSSI Unit 1
 ○ Snag location

Figure 1. Map showing the locations of 25 snags surveyed for lichens at Cors y Llyn in November 2023. Contains OS data © Crown copyright and database rights 2024.

For each snag the tree species, grid reference, dbh, height, and angle of lean are provided in Table 1.

Table 1. The 25 snags systematically surveyed for lichens at Cors y Llyn National Nature Reserve in November 2023, including grid reference, snag diameter at breast height (dbh), snag height, and angle of snag from vertical.

Code	Tree species	Grid reference	Snag (cm)	dbh	Snag height (cm)	Snag angle of lean (degrees)
1	<i>Pinus sylvestris</i>	SO01643.55437	13.8		142	88
2	<i>Pinus sylvestris</i>	SO01671.55388	19.5		250	86
3	<i>Pinus sylvestris</i>	SO01649.55274	10.0		350	77
4	<i>Pinus sylvestris</i>	SO01594.55276	15.0		57	86
5	<i>Pinus sylvestris</i>	SO01576.55326	9.5		220	77
6	<i>Pinus sylvestris</i>	SO01581.55331	33.0		850	86
7	<i>Pinus sylvestris</i>	SO01579.55317	19.8		500	86
8	<i>Pinus sylvestris</i>	SO01582.55267	11.0		450	77
9	<i>Pinus sylvestris</i>	SO01606.55296	12.0		450	90
10	<i>Pinus sylvestris</i>	SO01672.55273	4.0		250	83
11	<i>Pinus sylvestris</i>	SO01663.55267	8.0		250	77
12	<i>Pinus sylvestris</i>	SO01669.55270	9.0		300	83
13	<i>Pinus sylvestris</i>	SO01675.55327	13.0		450	87
14	<i>Pinus sylvestris</i>	SO01664.55347	16.2		550	72
15	<i>Pinus sylvestris</i>	SO01660.55346	16.6		500	80
16	<i>Pinus sylvestris</i>	SO01675.55389	14.0		200	80
17	<i>Pinus sylvestris</i>	SO01655.55418	6.5		180	84
18	<i>Pinus sylvestris</i>	SO01661.55387	15.0		190	80
19	<i>Pinus sylvestris</i>	SO01682.55391	24.0		500	84
20	<i>Pinus sylvestris</i>	SO01639.55367	22.0		500	86
21	<i>Pinus sylvestris</i>	SO01671.55265	3.0		70	75
22	<i>Pinus sylvestris</i>	SO01632.55180	26.0		450	85
23	<i>Pinus sylvestris</i>	SO01648.55173	29.0		600	74
24	<i>Pinus sylvestris</i>	SO01667.55387	4.5		90	75
25	<i>Betula</i>	SO01660.55390	4.0		130	71

3.4 Field survey

The survey at Cors y Llyn was completed on three dates in November 2023. The locations and weather conditions for each day are summarised in Table 2.

Table 2. Weather conditions during the 2023 Powys twig lichen survey.

Date (2023)	Maximum temperature (°C)	Rainfall (mm)	Maximum wind speed (mph)
9 th November	6	2.3	SSW 10
10 th November	8	0	7 W
11 th November	9	0	E 5

3.5 Survey equipment

The survey equipment used is listed below:

- Lichen candelaris x10 magnification lens.
- Hammer, chisel, and knife.

- Sodium hypochlorite (C).
- Potassium hydroxide 10% solution (K).
- Paraphenylenediamine (Pd) as Steiner's solution.
- Alonefire SV003 10W 365nm UV Torch.
- Richter 5 m diameter tape.
- Compass.
- iPhone 12 with GPS OS Grid Reference App.
- Olympus TG5 camera.

Where possible lichens were identified macroscopically in the field, although some species were collected for subsequent identification by microscopy.

3.6 Species recording

Lichen locations were recorded using an iPhone 12 with the GPS OS Grid Reference App, accurate to approximately +/- 3 metres. These were checked against aerial photography during data entry. Lignicolous lichens were defined as those occurring on lignum, although some of these are not obligates on that substrate.

Taxonomic nomenclature follows the British Lichen Society (BLS) on-line Taxon Dictionary (British Lichen Society, 2024). The records from this survey have been submitted to the BLS National Database, which is uploaded to the National Biodiversity Network.

3.7 Site evaluation

Methods used for assessment of lichen assemblages follow guidelines published for selection of biological SSSIs (Sanderson *et al.*, 2018). The relevant method is the Pinhead Index. As a single survey is unlikely to record all the indicator species present, records from the last 25 years are pooled, unless the site has experienced habitat change during this period such that the species is unlikely to be extant, the autecology or distribution of the species suggest it was likely to be short-lived at the site, or recent taxonomic change makes it impossible to confirm the identification of the species recorded.

3.7.1 Pinhead Index

The Pinhead Index covers standing deadwood and large trees with dry bark crevices and is described by Sanderson *et al.* (2018) as follows:

“Deadwood and living trees large enough to provide crevices sheltered from much of the direct rainfall, support communities of lichens and microfungi that produce powdery spore masses on the tops of pin-shaped fruitbodies. The total number of recorded Pinhead species in the genera: Calicium, Chaenotheca, Chaenothecopsis, Microcalicium, Mycocalicium and Sclerophora is used as an index score. All sites scoring 10 or over on the Pinhead Index should be considered for notification.”

3.7.2 Species conservation status

The conservation evaluation of each species is based on criteria in Woods (2010), Woods & Coppins (2012) and Sanderson and others (2018), as follows:

- IUCN Red List Threat Categories, Abbreviations: **EX** – Extinct; **CR** – Critically Endangered (taxa that meet CR criteria and are at high risk of extinction in the wild); **EN** – Endangered (taxa that meet EN criteria and are at high risk of extinction in the wild); **VU** – Vulnerable (taxa that meet VU criteria and are at high risk of extinction in the wild); **DD** – Data Deficient (in most cases, species have recently been found in GB and there is insufficient data available for evaluation); **NT** – Near Threatened (when taxa do not qualify for CR, EN or VU status, but are close to qualifying least or is likely to qualify in the future); and, **LC** – Least Concern.
- Other abbreviations: **NE** – Not Evaluated (conservation status of the taxa has not yet been evaluated); **E** – Endemic (i.e. taxa recorded only from the British Isles), **IR** – International Responsibility (likely Britain supports 10% of the extant European and/or global population, however, further research is required); **NR** – Nationally Rare (taxa that are recorded from 1-15 hectads); **NS** – Nationally Scarce (taxa that are recorded from 16 – 100 hectads; and, **S8** – Schedule 8 (taxa listed on Schedule 8 of the Wildlife & Countryside Act 1981).
- Taxa on published lists of principal importance for the conservation of biodiversity: **Wa** – Wales (taxa listed under Section 7 of the Environment (Wales) Act 2016).

3.8 Constraints

There were at least 200 pine snags at Cors y Llyn. The time available only allowed for a representative sample of snags to be surveyed, although this is unlikely to have meaningfully affected the results. Nonetheless it is possible that some species occurring at low density could be present on snags that were not visited.

4. Results

4.1 Summary

46 lichen species, 10 lichenicolous fungi and 2 possibly non-lichenised fungi were recorded in the current survey. Thirty-three species were new site records, which now includes 81 lichen species, 10 lichenicolous fungi and 2 possibly non-lichenised fungi. The full species list based on data from the British Lichen Society database is provided in Appendix 2. Eight lichens and 6 lichenicolous fungi in the current survey are either relevant to the calculation of the Pinhead Index, or have conservation status, and these are summarised in Table 3.

Table 3. Lichen and lichenicolous fungi species with conservation status recorded at Cors y Llyn National Nature Reserve in 2023.

Taxon	Group	Pinhead Index	UK status Threat	Wales Status Threat	UK Conservation status
<i>Caloplaca asserigena</i>	L	No	LC	LC	NS
<i>Calicium glaucellum</i>	L	Pinhead	LC	LC	No
<i>Calicium viride</i>	L	Pinhead	LC	LC	No
<i>Cetraria sepincola</i>	L	No	LC	VU	No
<i>Chaenotheca brunneola</i>	L	Pinhead	LC	LC	No
<i>Chaenotheca ferruginea</i>	L	Pinhead	LC	LC	No
<i>Fellhanera subtilis</i>	L	No	LC	LC	NR
<i>Micarea coppinsii</i>	L	No	LC	LC	NS
<i>Arthonia digitatae</i>	LF	No	LC	n/a	NR
<i>Chaenothecopsis pusilla</i>	LF	Pinhead	LC	n/a	NS
<i>Chaenothecopsis</i> sp.	LF	Pinhead	n/a	n/a	n/a
<i>Intralichen christiansenii</i>	LF	No	LC	n/a	NS
<i>Lichenocodium xanthoriae</i>	LF	No	LC	n/a	NS
<i>Milospium lacoizquetae</i>	LF	No	LC	n/a	NR
<i>Spirographa fusisporella</i>	LF	No	LC	n/a	NS

Key – Group: L = Lichen; LF = Lichenicolous fungus. **Threat status:** LC = Least Concern; NE – Not Evaluated. **Conservation status:** NR = Nationally Rare; NS = Nationally Scarce; IR = International Responsibility.

4.2 Pinhead Index

The Pinhead Index score in the current survey was 6. This is below the threshold of 10 given for consideration of the lichen assemblage as a Notified Feature for SSSIs (Sanderson *et al.*, 2018) but is still of local significance.

4.3 New, rare, and interesting lichens

One species of lichenicolous fungus was newly recorded in Wales, *Lichenoconium xanthoriae*, and four other species of lichenicolous fungi were new for Radnorshire. These are summarised below, as well as some other records of interest.

***Imshaugia aleurites* (LC)**

Recorded for the first time at Cors y Llyn on the trunk of a pine snag, and on a dead branch of a living pine (see Photo A1.29). There are previous records of lignicolous lichens at Cors y Llyn and it is perhaps unlikely that this species would have been overlooked. It may be a recent colonist to the site.

***Arthonia digitatae* (NR)**

This lichenicolous fungus produces clusters of unmarginated black apothecia on discoloured *Cladonia* squamules and is usually associated with *Cladonia polydactyla* or *Cladonia digitata* in woodland. It appears to be dependent on large populations of the host, and in the current survey it was recorded on *Cladonia polydactyla*.

***Homostegia piggotii* (LC).**

This lichenicolous fungus forms conspicuous large black spots on the host thallus, and in the current survey it was found parasitising *Parmelia saxatilis*. This is the first record for Radnorshire.

***Intralichen christiansenii* (LC, NS)**

Noticeable as a blackish discolouration in the apothecia of the host lichen, *Intralichen christiansenii* was observed parasitising *Lecanora pulicaris*. This is the first record for Radnorshire.

***Lichenoconium erodens* (LC)**

Found twice in this survey, parasitising *Lecanora pulicaris* and *Lecanora symmicta*. It is conspicuous with numerous black pycnidia erupting through the thallus of the host lichen. This is the first record for Radnorshire.

***Lichenoconium xanthoriae* (LC, NS)**

The black pycnidia of this lichenicolous fungus are dispersed or clustered within the apothecia of the host lichen. At Cors y Llyn it was found parasitising *Cetraria sepicola* and is newly recorded to Wales. The association with *Cetraria sepicola* has been reported previously, and other hosts include *Xanthoria parietina* and *Xanthoria polycarpa* (Hawksworth *et al.*, 2010).

***Milospium lacoizquetae* (NR)**

This is a lichenicolous hyphomycete which forms sooty patches of conidia on the thalli of *Cladonia parasitica* and *Cladonia polydactyla*. In this survey it was recorded

parasitising *Cladonia polydactyla*. It is almost invariably associated with infections by *Arthonia digitatae* and is potentially the anamorph of this species. This is only the second record for Radnorshire and the first made this century.

***Spirographa fusisporella* (LC, NS)**

This parasite causes tiny, dark, circular to irregular eruptions within the surface of its host lichen, developing around the immersed fruit. At Cors y Llyn this species was recorded as new to Radnorshire.

***Skyttea gregaria* (LC)**

Recorded from a birch tree where it was parasitising *Violella fucata* (see Photo A1.30). It is apparently a host-specific lichenicolous fungus, with only two previous twentieth century records in Wales.

4.4 Summary of occurrence of lignicolous lichens on snags

Species richness of lignicolous lichens on snags ranged from 1 to 15. The modal value was 7 (n=6). These data are summarised in Figure 2.

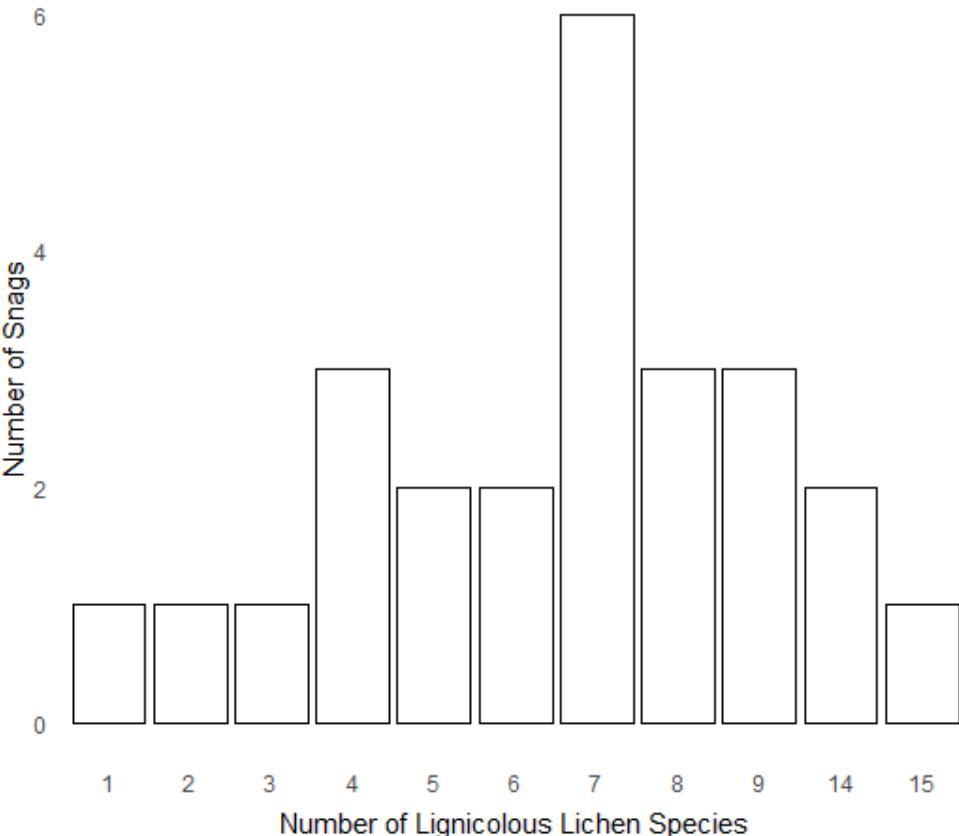


Figure 2. Summary of lignicolous lichen species richness on 25 snags at Cors y Llyn.

The number of snags where individual lignicolous lichen species were recorded during the current survey are summarised in Table 4, as well as the dbh range of snags where each species occurred.

Table 4. The number of snags where lignicolous lichens were recorded and the dbh range of snags where each species occurred.

Taxon	Number of snags	Min dbh	Max dbh
<i>Agyrium rufum</i>	2	14.0	15.0
<i>Buellia griseovirens</i>	4	4.0	15.0
<i>Calicium glaucellum</i>	14	9.0	33.0
<i>Calicium viride</i>	1	19.5	19.5
<i>Chaenotheca brunneola</i>	8	6.5	33.0
<i>Chaenotheca ferruginea</i>	3	13.8	19.5
<i>Chaenothecopsis pusilla</i>	1	19.5	19.5
<i>Chrysothrix flavovirens</i>	9	6.5	24.0
<i>Cladonia coniocraea</i>	1	33.0	33.0
<i>Cladonia polydactyla</i>	10	9.5	33.0
<i>Cladonia ramulosa</i>	1	33.0	33.0
<i>Cladonia squamosa</i>	1	29.0	29.0
<i>Evernia prunastri</i>	2	4.0	10.0
<i>Fuscidea lightfootii</i>	4	4.0	24.0
<i>Hypocenomyce scalaris</i>	7	6.5	26.0
<i>Hypogymnia physodes</i>	16	3.0	29.0
<i>Hypogymnia tubulosa</i>	2	10.0	11.0
<i>Imshaugia aleurites</i>	3	16.2	24.0
<i>Lecanora aitema</i>	5	8.0	19.8
<i>Lecanora conizaeoides</i>	1	6.5	6.5
<i>Lecanora pulicaris</i>	9	3.0	16.2
<i>Lecanora symmicta</i>	4	4.0	22.0
<i>Lepraria finkii</i>	2	10.0	19.5
<i>Melanelixia glabratula</i>	2	10.0	16.2
<i>Micarea coppinsii</i>	12	3.0	29.0
<i>Micarea denigrata</i>	1	13.8	13.8
<i>Micarea nitschkeana</i>	1	6.5	6.5
<i>Micarea prasina</i>	1	22.0	22.0
<i>Ochrolechia microstictoides</i>	15	4.0	26.0
<i>Parmelia saxatilis</i>	4	4.0	33.0
<i>Parmelia sulcata</i>	1	10.0	10.0
<i>Parmeliopsis ambigua</i>	1	24.0	24.0
<i>Placynthiella icmalea</i>	4	6.5	22.0
<i>Platismatia glauca</i>	6	4.0	33.0
<i>Pseudevernia furfuracea</i>	6	6.5	29.0
<i>Ramalina farinacea</i>	2	10.0	16.2
<i>Trapeliopsis flexuosa</i>	7	6.5	26.0
<i>Usnea cornuta</i>	2	6.5	22.0
<i>Usnea hirta</i>	1	10.0	10.0
<i>Usnea subfloridana</i>	2	4.0	13.0
<i>Xylographa vitiligo</i>	5	4.0	29.0

The frequency classification for the percentage of snags where each species was recorded is as follows:

- Abundant (51–90%): 3 species.
- Frequent (21-50%): 9 species.
- Occasional (6-20%): 17 species.

- Rare (< 5%): 13 species.

5. Discussion

5.1 Pinhead Index

The Pinhead Index was below the threshold suggested for consideration of the assemblage as a SSSI feature but it is still of local significance. The lignicolous lichen community has only developed on a significant number of standing dead pines since ring-barking was undertaken in the 1990s. The Pinhead Index could increase at Cors y Llyn if other species colonise, with *Chaenotheca chrysocephala* and *Chaenothecopsis nigra* as possibilities based on the distribution of these species in Wales. Future candidates include *Calicium parvum*, which is now found on live pines in the New Forest, having recently colonised from the near continent.

5.2 Occurrence of lichens on snags

Two trends are apparent from the data in this survey. Firstly, pinhead lichens were mostly recorded on larger diameter snags, so if ringbarking is used to create more snags in the future at least some of these should be created from trees with a trunk diameter above 20 cm. Secondly, most lichens on lignum were either occasional or rare in terms of occurrence on the number of snags sampled. Ongoing creation of snags would therefore benefit the development and diversity of the lignicolous lichen community, although this is a secondary consideration to maintaining the favourable hydrological status of the bog. Ring-barking to create snags may have the additional advantage that it causes minimal disturbance to the bog surface.

The three snags with the highest species richness of lichens on lignum were 3 and 17 (with 14 species), and 20 (with 15 species). Snag 3 was conspicuously leaning and Snag 17 had numerous remnant lateral branch stubs. Snag 20 was one of the largest trees in the survey and had longer remnant lateral branches. This suggests that greater complexity in the structure of the snag is the main driver of increasing species richness and supports the observation that most lichens on lignum were either occasional or rare in occurrence, as some species require specialist niches that are only found on a few trees. As an example, *Buellia griseovirens*, *Micarea nitschkeana* and *Xylographa vitiliigo* were all found on low diameter snags, or remnant lateral branches.

Lichens on dead branches of live pines were not recorded in detail, although *Imshaugia aleurites*, *Parmelia saxatilis*, *Pseudevernia furfuracea* and *Trapeliopsis flexuosa* were found in this situation. Nonetheless, attached dead branches only offer deadwood that is orientated horizontally and shaded by the tree canopy, and so will not support the full range of species found on standing dead snags.

5.3 Lignicolous lichen communities

Lichens associated with acid dry bark and decorticate wood in well-lit situations have been described as the *Calicium hyperelli* community (James *et al.*, 1977). These occur either in niches sheltered from direct rainfall, or in very exposed sites where the substrate dries out rapidly following rain (as is the case on the pine snags). The

Calicietum abietini association with stands of *Calicium glaucellum* is optimally developed on decorticate pine in the Scottish Highlands but is encountered occasionally in this habitat throughout the British Isles. The existence of distinct groupings within the *Calicietum abietini* has been recognised, although these were too poorly understood for description (James *et al.*, 1977).

The most frequent associates at Cors y Llyn were *Calicium glaucellum*, *Hypogymnia physodes* and *Micarea coppinsii*, and to a lesser extent *Chaenotheca brunneola*, *Chrysothrix flavovirens*, *Cladonia polydactyla*, *Hypocenomyce scalaris* and *Lecanora pulicaris*. This partly overlaps with the *Hypogymnia physodes* community described in the New Forest as occurring on naturally acid, rough-surfaced bark and decorticated wood (Rose & James, 1977). Species in this association recorded frequently at Cors y Llyn included *Hypogymnia physodes* and *Hypocenomyce scalaris*, as well as *Imshaugia aleurites*, *Parmelia saxatilis*, *Parmelia sulcata*, *Parmeliopsis ambigua*, *Platismatia glauca*, *Cladonia coniocraea*, *Cladonia macilenta* and *Cladonia squamosa*.

5.4 Management for the lignicolous lichen community

The only management issue noted for pine snags at Cors y Llyn was the presence of birch saplings around the base of a few snags. Birches in this situation should be removed as these will shade the snag, discouraging the development of a lignicolous lichen community. The only exception to this would be young birches with *Cetraria sepincola*, although in the current survey this species was only recorded on the west side of the bog, and not on birch adjacent to any pine snags.

6. Conclusions

This survey has documented a pinhead lichen assemblage at Cors y Llyn which has developed on pine snags created in the last 30 years during management work. It is possible that other species may colonise in the future, in addition to further development of a broader community of lichens on lignum. The snags are produced as a by-product of attempts to maintain areas of open bog, and the lignicolous lichen community can be seen as a secondary benefit of this work.

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Data Archive Appendix

Data outputs associated with this project are archived in DMS on server-based storage at Natural Resources Wales.

The data archive contains:

The final report in Microsoft Word and Adobe PDF formats.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue <https://libcat.naturalresources.wales> (English Version) and <https://catllyfr.cyfoethnaturiol.cymru> (Welsh Version) by searching 'Dataset Titles'.



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