



**Cyfoeth
Naturiol
Cymru**
**Natural
Resources
Wales**

Survey of upland rock lichens in Mynydd Preseli SSSI, Pembrokeshire



John Douglass

Evidence Report No 665

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1. Crynodeb Gweithredol

Comisiynwyd yr arolwg hwn gan Cyfoeth Naturiol Cymru er mwyn nodi'r rhywogaethau o gennau sydd i'w cael ar SoDdGA Mynydd Preseli a darparu gwybodaeth am reoli'r safle yn y dyfodol i gynnal ei boblogaethau o gennau.

Gwnaed gwerthusiad gan ddefnyddio mynegeion y Cyd-bwyllgor Cadwraeth Natur (JNCC) a ddatblygwyd yn ddiweddar ar gyfer dethol SoDdGAau biolegol (Sanderson *et al.* 2018). Mae sgôr y graig asidaidd anfynddigg (Cennau TNTN) yn 16, sy'n uwch na'r sgôr trothwy o 10 ar gyfer dynodiad SoDdGA posibl. Mae SoDdGA Mynydd Preseli yn safle 7o 15 o safleoedd cennau creigiau asidaidd y gwyddom amdanynt yng Nghymru. Mae'r sgôr hwn yn drawiadol o ystyried bod y rhan fwyaf o'r safleoedd eraill yn uwch ac yn llawer mwy o ran arwynebedd.

Roedd yr *Halecania spodomela* a oedd bron dan fygythiad (NR) yn rhyfeddol o niferus ym mhob un o'r pedwar safle. Ymhlith y rhywogaethau eraill a oedd yn niferus ar bob safle oedd *Candelariella coralliza* a *Lasallia pustulata*, y ddau ohonynt yn tyfu ar nifer fawr o greigiau. Roedd *Micarea subnigrata* (NS) hefyd i'w gael yn aml yn y rhan fwyaf o safleoedd.

Cofnodwyd pedair rhywogaeth fel rhai oedd yn newydd i Sir Benfro (VC 45): *Lecidea swartzioidea* (NS), *Miriquidica pycnocarpa* f. *pycnocarpa* (NS), *Stereocaulon vesuvianum* var. *nodulosum* (NS) ac *Umbilicaria deusta* (NS). Dyma rai o'r rhywogaethau nodedig eraill a ganfuwyd: *Caloplaca arenaria* (NS), *Catillaria atomarioides* (NS), *Clauzadeana macula* (NS), *Lecidea fuliginosa* (NS), *Lepra* (*Pertusaria*) *excludens* (NS), *Lepraria borealis* (NS) a *P. melinodes* (NS).

Mae'n ymddangos bod llygryddion nitrogenaidd (h.y. cyfansoddion NOx a/neu amonia a'u deilliadau) yn effeithio'n negyddol ar y safle hwn, o ganlyniad i ddyddodiad awyrol a charthion anifeiliaid sy'n pori (yn bennaf defaid a rhywfaint o ferlod). Mae gwefan y System Gwybodaeth Llygredd Aer (APIS 2022) yn rhoi darlleniadau ar gyfer lefelau dyddodiad amonia a nitrogen sydd bron deirgwaith yn uwch na lefelau llwyth critigol ar gyfer y safleoedd a arolygwyd. Adlewyrchir hyn yng nghyfansoddiad y fflora cennau a'r digonedd o algâu a cyanobacteria ar rai creigiau a thali cen.

Ymddengys fod pori yn atal llystyfiant rhag tyfu dros greigiau. Fodd bynnag, mae'n ymddangos bod gormodedd o borwyr (yn enwedig defaid), ac mae gollwng tail a throethi ar greigiau a'r llystyfiant oddi amgylch yn bryder. Argymhellir lleihau lefelau pori mewn ardaloedd creigiog o'r SoDdGA. Ymddengys hefyd fod nifer fach iawn o rywogaethau *Cladina terricolous*, gyda dim ond *Cladonia portentosa* a *C. ciliata* var. *tenuis* i'w cael yn anaml yn y safleoedd hyn.

Mae aildyfiant o gonwydd yn amlwg yng Ngharn Menyn a dylid ei symud cyn gynted ag y bo modd i atal cysgodi creigiau a brigiadau.

Mae'n bwysig bod rhaglen fonitro yn cael ei rhoi ar waith er mwyn helpu i gyfarwyddo penderfyniadau rheoli a chadw'r fflora cennau pwysig yn yr ardal hon.

Mae ffotograffau o rai lleoliadau yn manylu ar rai o'r rhywogaethau prinnaf a'u cynefinoedd cysylltiedig. Mae rhestr lawn o rywogaethau wedi'i darparu ar ffurf taenlen BLS a fydd yn cael ei dosbarthu i'r Canolfannau Cofnodion Amgylcheddol Lleol a'r Rhwydwaith Bioamrywiaeth Cenedlaethol.

2. Executive Summary

This survey was commissioned by Natural Resources Wales in order to identify the lichen species occurring in Mynydd Presili SSSI and provide information regarding future management of the site to support its lichen populations.

An evaluation was made using the recently developed JNCC (Joint Nature Conservation Committee) indices for the selection of biological SSSI's (Sanderson *et al.* 2018). The non-montane acid rock (Threatened Near Threatened and Notable Species) score is 16, above the threshold score of 10 for potential SSSI designation. Mynydd Presili SSSI ranks 7th out of 15 for known acid rock lichen sites in Wales. This score is impressive considering most of the other sites are higher in elevation and much greater in area.

The Near Threatened *Halecania spodomela* (NR) was surprisingly abundant at all four sites. Other species which were abundant at all sites include *Candelariella coralliza* and *Lasallia pustulata*, both occurring on a large number of rocks. *Micarea subnigrata* (NS) was also frequently encountered at most sites.

Four species were recorded as new to Pembrokeshire (VC 45): *Lecidea swartzioidea* (NS), *Miriquidica pycnocarpa* f. *pycnocarpa* (NS), *Stereocaulon vesuvianum* var. *nodulosum* (NS) and *Umbilicaria deusta* (NS). Other notable species found include: *Caloplaca arenaria* (NS), *Catillaria atomarioides* (NS), *Clauzadeana macula* (NS), *Lecidea fuliginosa* (NS), *Lepra* (*Pertusaria*) *excludens* (NS), *Lepraria borealis* (NS) and *P. melinodes* (NS).

Nitrogenous pollutants (i.e., NO_x and/or ammonia compounds and their derivatives) appear to be negatively affecting this site, from both airborne deposition

and from excreta from grazing animals (mostly sheep with some ponies). The Air Pollution Information System website (APIS 2022) gives readings for ammonia and nitrogen deposition levels nearly three times higher than critical load levels for the sites surveyed. This is reflected in the composition of the lichen flora and the abundance of algae and cyanobacteria on some rocks and lichen thalli.

Grazing appears to be keeping vegetation from growing over rocks. However, there does appear to be a superabundance of grazers (particularly sheep), and dunging and urination on rocks and the surrounding vegetation is a concern. It is recommended that grazing levels are reduced on the rocky areas of the SSSI. There also appears to be a very low occurrence of terricolous *Cladina* species, with only *Cladonia portentosa* and *C. ciliata* var. *tenuis* being rarely encountered at these sites.

Conifer regeneration is apparent at Carn Menyn and should be removed as soon as possible to prevent shading of rocks and outcrops.

It is important that a program of monitoring is initiated in order to help inform management decisions and conserve the important lichen flora in this area.

Illustrated target notes detail some of the rarer species and their associated habitats. A full species list has been provided in the form of a BLS spreadsheet which will be disseminated to the LeRCs and NBN.

3. Background

Within the Pembrokeshire Coast National Park, the Preseli Hills form a unique upland landscape, with heavily fractured outcrops and boulder fields at an altitudinal range of c.250 - 468m. The geology is Mudstones of the Aber Mawr Shale formation and Ordovician igneous intrusions composed of microgabbro (BGV 2022). The site is registered as 'common land'. The citation for Mynydd Preseli SSSI gives extremely scant mention to lichens: "The lichens of the tors and boulders are also of interest." (CCW 1995).

The BLS holds few records for the Preselis: e.g., the saxicolous *Cetraria aculeata*, *Lasallia pustulata*, *Parmelia omphalodes*, *Sphaerophorus fragilis* and *Stereocaulon evolutum* and the corticolous *Usnea articulata* (NT, P, NS, IR) recorded on hawthorn at Tafarn Y Bwlch. There are considerably more records for the high ground to the NW with Carningli supporting species including: *Cladonia peziziformis* (CR, NR, P, Wal), *Lecidea fuliginosa* (NS), *Porpidia contraponenda* (NS), *Ramalina polymorpha* (NT, NS), *Rhizocarpon viridiatrum* (NS) and *Stereocaulon leucophaeopsis* (NS, M).

The following is a description of the Preseli's taken from the NRW documents including the SAC Management Plan 2011.

"The Preseli Hills are an open, sparsely-settled upland landscape in North Pembrokeshire, much of which lies within the Pembrokeshire Coast National Park. Predominant hill grazing on open moorland results in a windswept, exposed landscape. Forestry plantations are limited to a few areas. Tree cover is much more evident in the lower valleys that dissect parts of the area and in the northern periphery, wherein small fields and thick hedgerows with trees provide much shelter. Though modest in elevation, the isolation of the Preseli Hills from other upland areas means

their profile is widely visible from adjacent lowland landscapes to the north and south and from the coast to the north-west. The area is commemorated in the Mabinogion folk legends and is rich in ancient archaeology from the Neolithic period onwards. It was from these hills that the bluestones for Stonehenge came. Remains of the once-important slate quarrying industry are also evident in places and there is a proud Welsh language tradition and way of life in this area, both in farming and ex-quarrying communities.”

“...The Ordovician rocks of north Pembrokeshire were formed 470 million years ago in a marine trough subject to numerous underwater volcanic eruptions. Subsequent earth movements have caused intense folding and faulting. Although rock exposures are fairly limited in the Preseli Hills, the complex of folds and faults and the topographical features relating to them have been picked out by geological mapping. The ridges and hill masses have resisted erosion because of the presence of hard igneous rocks, generally occurring as intrusions (sills) between the other rock layers, and having been folded with them.”

“Meltwater from the ice sheets present during the last Ice Age carved out the Gwaun valley, part of a widespread system of these channels. The melt water torrents also deposited sand and gravel, most extensively around the outflows of rivers that flowed underneath the ice. Elsewhere sediments, typically boulder clay, were deposited directly from melting ice.”

“There was much reworking of these sediments under the ensuing tundra-like conditions. Spring thaws of the surface of deeply-frozen ground (permafrost conditions) resulted in down slope movement of sediment (solifluction flows) causing alignment of any tabular stones, allowing these deposits to be easily distinguished.

The intensely cold conditions also caused frost-shattering of exposed rock and accumulation of scree, some of which was moved by solifluction to create extensive block-fields. These were generally cleared during creation of fields and used for stone walls, but many fine examples survive on the higher moorland.”

“...within this area there is a distinct contrast between the open heath and moorland of the uplands and the more enclosed, agricultural land of the lowlands. The latter are characterised by agriculturally improved livestock grassland bounded by hedgerows or hedge-banks. Arable farmland is relatively scarce. This agricultural land overlies relatively well-draining brown podsolic soils. There are also some noticeable areas of marshy grassland, associated with poorer draining surface-water gley soils. Along with the marshy grassland there are some small areas of deciduous woodland scattered throughout the farmed landscape, which provide areas of greater ecological interest. The most significant woodland areas however are the linear stands that follow the numerous watercourses that flow across the area. These watercourses have their origin in the higher ground of the Preseli Hills, but with their associated woodlands are only well developed on the lower ground and in the foothills, with notable deciduous woodland and to a lesser extent coniferous plantations along the Eastern Cleddau, a number of its tributaries to the south of the Preseli Hills and tributaries of the Western Cleddau to the west. The largest and most ecologically important woodland occurs in the Gwaun valley where there are considerable areas of sessile oak woodland and wet woodland, both of which are of high ecological value as well as supporting a number of protected species.”

“The upland area on the other hand, is largely grazed common land, and falls into two distinct areas divided by the Gwaun valley. The smaller area of Mynydd Carningli

to the north is largely dominated by dry heath with some significant areas of bracken on the northern slopes. The larger upland area of the Preseli Hills to the south contains a varied mosaic of heathland (both wet and dry) and acid grassland habitats. Large areas of blanket bog are also found across the area's upper slopes associated with poorly draining gley podsol soils; these areas support wet heath and cotton-grass communities with wet flushes on the slopes being another valuable ecological feature (NLC 2016)."

"The present-day vegetation cover is the product of many centuries of management; the heaths and commons have been an essential part of the local farming economy for centuries. Historically these sites have been grazed by larger animals like cattle and horses. Their grazing habits have helped to maintain the open nature of the site and produced varied, species-rich swards. In more recent times, sheep grazing has continued but cattle and pony grazing has declined dramatically. Sheep grazing will keep most of the vegetation short, but some of the special wetland features suffer without the trampling effect of heavier animals. Sheep are traditionally taken off the hills in winter, to coastal pastures at Castlemartin. Heather can be vulnerable to over-grazing at this time of year, so this movement helps conserve the heath. It also helps to prevent peat erosion scars from developing. Hefting or shepherding animals onto particular areas could become desirable if stock numbers are reduced."

"Traditionally, much of Mynydd Preseli has been managed by burning during the winter, to keep the coarser plants like heather, gorse and bracken in check and provide better quality grazing. Current advice is that burning should be used carefully and sparingly, ideally through a rotation of small, managed burns." (CMP 2011).

4. Methods

This survey focused on four areas of concentrated rock exposures chosen by Sam Bosanquet (NRW non-vascular plant specialist) who has explored these sections of the Preselis for bryological interest. Each area received one day of survey work.

Species lists were made in a notebook (100mg paper and/or waterproof paper) and photographs were taken using a Samsung 10 phone and an Olympus TG4. Some specimens were taken for further microscopic inspection using a small knife for wood/peatland habitats. For rock habitats a 1lb hammer and 9inch tungsten carbide tipped chisel were used.

A X 10 illuminated hand lens was used to aid identification. The following 'spot test' chemicals were also used to aid identification: Sodium hydroxide (10% caustic soda in water), Sodium hypochlorite (household bleach) and para-phenylenediamine.

The *Guidelines for Selection of Biological SSSIs* were revised recently, and a new chapter covering lichens was published (Sanderson *et al.* 2018). This includes a non-montane acid rock lichen assemblage for Threatened, Near Threatened and Notable species (TNTN), which is the main index used here. The Acid Watercourse Quality Index (AQUI) and Metalliferous Habitats Index (MHI) were also considered, but neither scored above the thresholds for potential SSSI designation.

Ten figure GPS readings were recorded for species of conservation importance. Location photographs for some species of conservation were taken. DAFOR abundance was recorded. A BLS spreadsheet was also produced of all lichens recorded in each of the 1km squares visited.

In some instances, specimens were collected to confirm identification.

Key to abbreviations

A = Abundant
APIS = Air Pollution Information System
AQUI = The Acid Watercourses Quality Index (Sanderson 2018)
BLS = British Lichen Society
DD = Data Deficient
DMP = Direct Monitoring Plot
EN = IUCN red list Endangered
F = Frequent
G = Graphidion community species
IR = Species for which the UK has an International Responsibility (Woods and Coppins 2012)
IUCN = International Union for the Conservation of Nature and natural resources
L = Lobarion community species
LF = Lichenicolous Fungus
MHI = Metalliferous Habitats Index (Sanderson 2018)
NBN = National Biodiversity Network
NR = Nationally Rare
NS = Nationally Scarce
NT = IUCN red list Near Threatened
O = Occasional
SOWI = Southern Oceanic Woodland index
TBC = Species ID to be confirmed by specialist
TLC = Thin Layer Chromatography
TNTN = Threatened, Near Threatened and Notable Species
VU = IUCN red list Vulnerable

DAFOR Codes

D = Dominant
A = Abundant
F = Frequent
O = Occasional
R = Rare
LF = Locally Frequent
LA = Locally Abundant

Nomenclature follows Smith *et al* (2009) and the BLS super dictionary (BLS website).

4.1. Timing and personnel

The surveys took place over four days between 17th and 20th September 2022.

4.2. Survey constraints

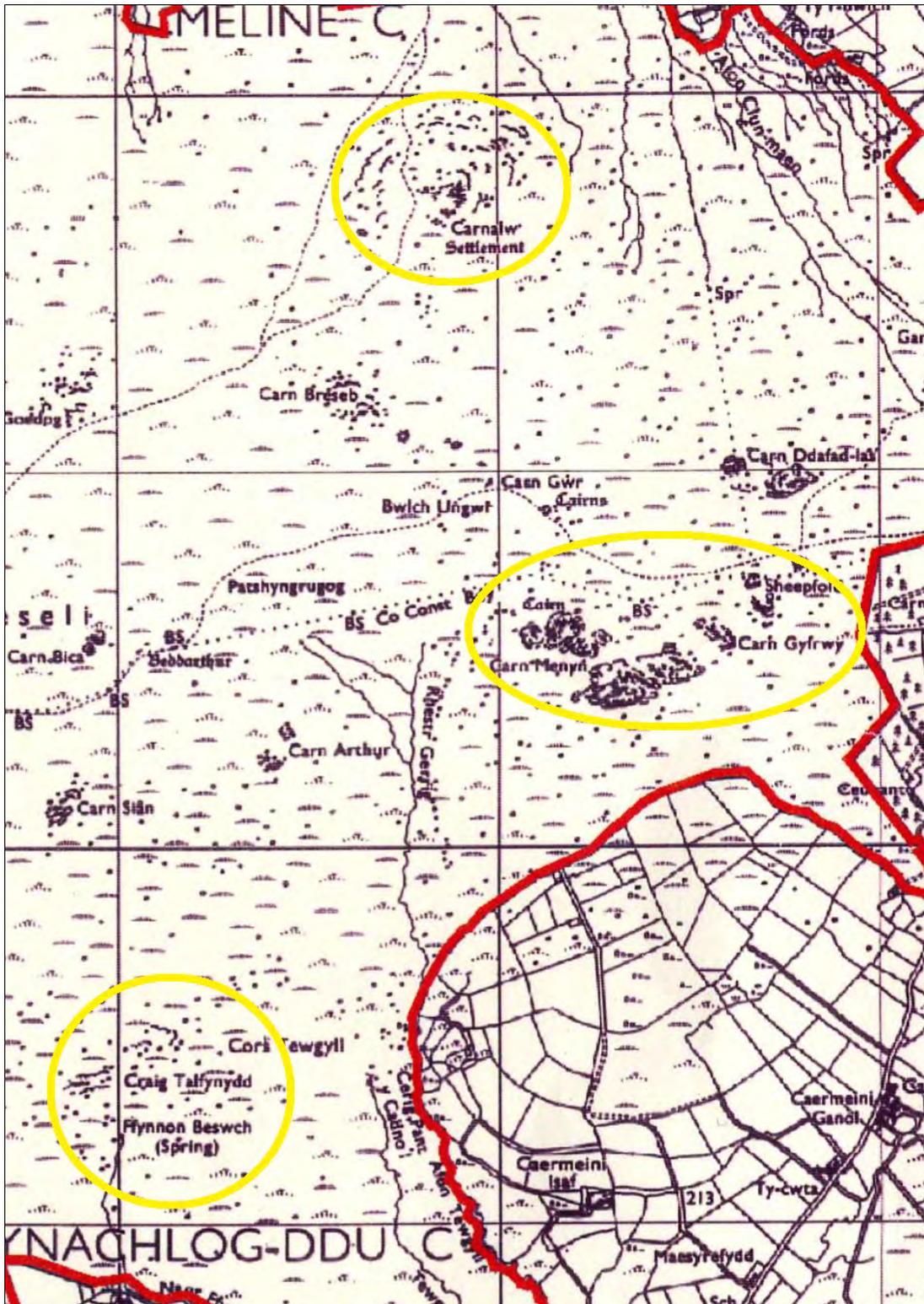
There was insufficient time to undertake a complete survey of the Preselis. Certain areas not surveyed may prove productive including the high ground at Cerrig Lladron

(SN0632) alt 467m Carn Sian (SN1232) alt 402m. These higher areas may support some of the more upland/montane species e.g., *Umbilicaria* spp.

5. Results

Maps below show the locations of the survey work. Table 1 shows notable species recorded. Table 2 shows comparisons with other similar lichen assemblages in Wales (compiled by Sam Bosanquet with updated results for Carn Owen and Cadair Idris). Illustrated target notes are detailed in Appendix I. Pollution concentrations from Air Pollution Information system website (APIS) are provided in Appendix II. A full species list is provided separately as a BLS spreadsheet (saved on the NRW DMS system), which will be disseminated to the NBN.

Map 1. Surveyed areas in the east of Mynydd Preseli outlined in yellow (Carnalw, Carn Menyn and Craig Talfynydd).



Map taken from CCW SSSI citation (CCW 1995).

Map 2. Surveyed area in the west: Carnau Ysfa and Carn Fach outlined in yellow.

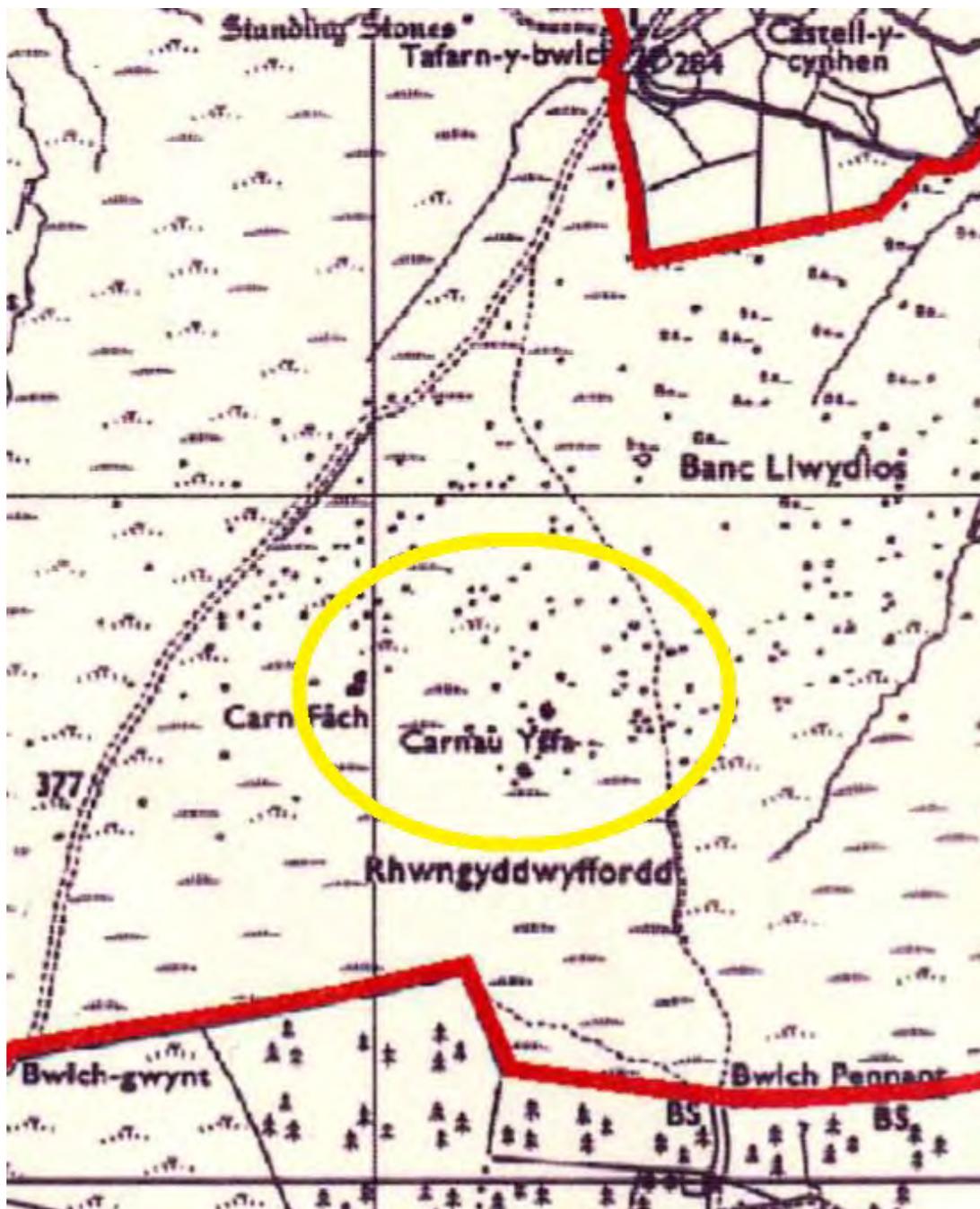


Table 1. Notable species recorded in Mynydd Preseli SSSI in 2022

Species name	UK Status	Index scores	Notes
<i>Caloplaca arenaria</i>	Nationally Scarce	TNTN 1	Rare: Carnau Ysfa and Craig Talfynydd.
<i>Catillaria atomarioides</i>	Nationally Scarce	TNTN 1	Rare.
<i>Clauzadeana macula</i>	Nationally Scarce	TNTN 1	Rare: Carnalw
<i>Endococcus propinquus</i> (LF)	Nationally Scarce	No score	Craig Talfynydd
<i>Endococcus verrucisporus</i> (LF)	Nationally Rare, Near Endemic	No score	On <i>R. lavatum</i> at Craig Talfynydd
<i>Halecania spodomela</i>	Nationally Rare (NT in Wales)	TNTN 2	Abundant: Carn Menyn, Craig Talfynydd, Carnau Ysfa, Carnalw.
<i>Lecidea fuliginosa</i>	Nationally Scarce	TNTN 1	Rare: Carnalw
<i>Lecidea swartzioidea</i>	Nationally Scarce	TNTN 1	Rare: Carnalw. New to VC 45.
<i>Lepra (Pertusaria) excludens</i>	Nationally Scarce	TNTN 1	Rare: Craig Talfynydd
<i>Lepraria borealis</i>	Nationally Scarce	TNTN 1	Craig Talfydd
<i>Micarea coppinsii</i>	Nationally Scarce	TNTN 1	Abundant: Carn Menyn, Craig Talfynydd, Carnau Ysfa, Carnalw
<i>Micarea subnigrata</i>	Nationally Scarce	TNTN 1	Frequent: Carn Menyn, Craig Talfynydd, Carnau Ysfa, Carnalw
<i>Miriquidica pycnocarpa</i> f. <i>pycnocarpa</i>	Nationally Scarce	TNTN 1	Rare: Craig Talfydd. New to VC 45.
<i>Placopsis lambii</i>	Not scarce	MHI 1 & AQUI 1	Rare: Craig Talfynydd
<i>Porina lectissima</i>	Not scarce	AQUI 1	Occasional: Craig Talfynydd & Carnalw
<i>Porpidia melinodes</i>	Nationally Scarce	TNTN 1 & MHI 1	Occasional: Carn Menyn, Craig Talfynydd & Carnalw
<i>Psilolechia clavulifera</i>	Nationally Scarce	TNTN 1	Carnau Ysfa
<i>Rhizocarpon lavatum</i>	Not scarce	AQUI 1	Occasional: Craig Talfynydd, Carnau Ysfa & Carnalw
<i>Rhizocarpon oederi</i>	Not scarce	MHI 1	Occasional: Carn Menyn, Craig Talfynydd, Carnau Ysfa
<i>Stereocaulon vesuvianum</i> var. <i>nodulosum</i>	Nationally Scarce	TNTN 1 & MHI	Frequent: Carn Menyn, Craig Talfynydd, Carnau Ysfa. New to VC 45.
<i>Umbilicaria deusta</i>	Nationally Scarce	TNTN 1	Occasional/rare: Carn Menyn, Craig Talfynydd, Carnau Ysfa. New to VC 45.

TNTN score for non-montane acid rocks = 16 (threshold = 10), Metalliferous Habitats Index (MHI) score = 4 (threshold = 10), Acid Watercourse Quality Index AQUI score = 3 (threshold = 11).

All of the notable species above are new for Mynydd Preseli SSSI.

Table 2. Updated comparison table of Non-montane Acid Rock TNTN scores for selected sites in Wales (modified from Bosanquet 2022)

Site	Area of Search	Non-montane Acid Rock TNTN
Eryri SSSI	West Gwynedd	111
Elenydd SSSI	Brecknock/Ceredigion	56
Marcheini Uplands, Gilfach Farm & Gamallt SSSI	Radnor	48
Carn Owen cSSSI	Ceredigion	40
Cadair Idris SSSI	East Gwynedd	38
Rhinog SSSI	East Gwynedd	20
Mynydd Preseli SSSI	Preseli & South Pembrokeshire	16
Carn Ingli SSSI	Preseli & South Pembrokeshire	12
Migneint - Arenig - Dduallt SSSI	East Gwynedd	12
Brecon Beacons SSSI	Brecknock	11
Berwyn SSSI	East Gwynedd/Montgomeryshire	10
Afon Eden - Cors Goch Trawsfynydd SSSI	East Gwynedd	9
Coedydd a Cheunant Rheidol (Rheidol Woods & Gorge) SSSI	Ceredigion	9
Black Mountains SSSI	Brecknock	8
Mynydd Du (Black Mountain) SSSI	Carmarthen & Dinefwr	7

6. Conclusions and Discussion

Despite its modest size Mynydd Preseli is of high conservation importance for lichens, with a score well above the threshold for SSSI site selection. It scores higher than Carn Ingli SSSI, which has long been considered the preeminent saxicolous lichen site of north Pembrokeshire. The SSSI citation for Mynydd Preseli SSSI should be updated to reflect this newly recognised interest.

Conifer regeneration is apparent at Carn Menyn and should be removed as soon as possible to prevent shading of rocks and outcrops.

There appears to be a superabundance of grazers (particularly sheep) and dunging and urination on rocks and the surrounding vegetation is a concern. It is recommended that grazing levels are reduced on the upper, rocky areas of the site to reduce the effects of hypereutrophication.

Large areas of the UK and Ireland have reactive nitrogen deposition levels above the Critical Loads that have been set to indicate when such nitrogen levels will have a damaging effect on habitats. The Air Pollution Information System website (APIS 2022) gives modelled ammonia concentrations and nitrogen deposition levels that are nearly three times higher than Critical Level for ammonia and Critical Load for N deposition for the sites surveyed (see Appendix 2). This is reflected in the composition of the lichen flora and the abundance of algae and cyanobacteria coating some rocks and lichen thalli.

Reactive nitrogen, which includes oxidised nitrogen (e.g., nitrogen dioxide) and reduced nitrogen (e.g., ammonia), is also known to acidify habitats (Plantlife 2017). These effects are most acute in areas of high rainfall in acid habitats e.g., siliceous rocks and soils in upland and montane situations which cannot buffer against the effects of increased acidity for rain, snow and occult precipitation.

Hormidiopsis (Klebsormidium) crenulata (a green alga) and other green alga and black/brown gunge from various cyanobacteria species were frequent to locally abundant on rocks and lichen thalli at the surveyed sites. Some of these algae/cyanobacteria are known to be associated with excess nitrogen input from both diffuse atmospheric sources and from point concentrated local sources e.g., sheep excretion & livestock licks. The green alga *Hormidiopsis crenulata* appears to be increasing, particularly in upland areas, in response to increased Nitrogen deposition (Douglass 2020a & b). Monitoring should be initiated at Mynydd Preseli on colonies of *Hormidiopsis crenulata* and other alga/cyanobacteria 'gunge' in particular, where they are impinging on notable lichens. This should form part of the management plan to help inform future management decisions at this site.

Interesting features of this site include the great abundance of three species: *Lasallia pustulata*, *Candelaria coralliza* and *Halecania spodomela* (NT, NR). In some areas these species appear to be on the majority of boulders. The former two are known to be ornithocoprophilous species: predominantly associated with bird perching sites. The latter is known to be a mainly coastal species of base enriched siliceous rocks and may also be responding to elevated nutrient levels. However, in some areas it was apparent that even these species were experiencing hypereutrophication and green alga were growing over thalli, particularly on damper sections of rocks. *Cladina* lichens were infrequently encountered, with *C. portentosa* only occasional to rare and *C. ciliata* var. *tenuis* rare and found only at Carnalw.

There was not enough time to undertake a complete survey of the site. Certain areas not surveyed, but which may prove productive include the higher ground at Cerrig Lladron (SN0632) alt 467m Carn Sian (SN1232) alt 402m.

7. Acknowledgements

Special thanks to: Sam Bosanquet, Ross Grisbrook and Mair Rees for their help and support.

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9. Appendix I. Illustrated Target Notes

The following photographs illustrate the survey area and its saxicolous lichen species. All have had their Alt-text set to 'decorative' because their captions provide sufficient information to interpret what the photographs show.

9.1. Carn Menyn



Figure 1. The large rocky prominences of Carn Menyn (far left) and Carnalw (right): two of the four target sites for this survey.



Figure 2. Summit area of Carn Menyn. The rocks here support a number of notable species including *Halecania spodomela* (NT, NR) and *Micarea subnigrata* (NS). SN1468 3271. View direction WSW.



Figure 3. Large boulder (left) supporting several cushions of *Sphaerophorus fragilis* among *Xanthoparmelia loxodes*. *Halecania spodomela* (NT, NR) was abundant in this area, with several thalli found on this boulder. SN 14574 32647. View direction NE.



Figure 4. Positions of colonies of *Umbilicaria deusta* (NS). SN 14545 32548. View direction NE.



Figure 5. Colonies of *Umbilicaria deusta* (NS) on furthest boulder in photo above.



Figure 6. Outcrops supporting species including *Halecania spodomela* (NT, NS.), *Micarea subnigrata* (NS) and *Porpidia melinodes* (NS). The semi mature Sitka spruce (left) and the small sapling adjacent should be removed before they colonise this area and shade out lichens on these rocks. The grazing sheep (right) are particularly numerous and the green alga *Hormidiopsis crenulata* is widespread in this area possibly as a result of the eutrophication by grazers.



Figure 7. Position of *Umbilicaria deusta* (NS). SN 14244 32559. View direction west.



Figure 8. Position of boulder supporting *Umbilicaria deusta* (NS) in photo above. View direction east.

9.2. Carnau Ysfa



Figure 9. Large low boulder supporting a colony of *Halecania spodomela* (NT, NS). The larger colonies are highlighted by yellow markers. This species occurs right across this boulder. SN 08241 32604. View direction SSW.



Figure 10. Fertile *Halecania spodomela* (NT, NS) on boulder above.



Figure 11. Position of colonies of *Caloplaca arenaria* (NS). SN 08246 32604. View direction SSW.



Figure 12. Colonies of *Caloplaca arenaria* (NS) either side of the bird dropping streak. SN 08246 32604. View direction SSW.



Figure 13. *Caloplaca arenaria* (NS) on boulder above.



Figure 14. Ponies grazing among the boulders. These grazers, along with the sheep are helping prevent the vegetation from growing over the boulders and smothering the lichens. SN 082 326. View direction SSE.



Figure 15. Large prominent boulder with jagged top supporting *Halecania spodomela* (NT, NS), *Miriquidica complanata* (RE, NS, S), *Micarea subnigrata* (NS).



Figure 16. Position of *Umbilicaria deusta*. SN 08345 32745. View direction SE.



Figure 17. Several scattered thalli of *Umbilicaria deusta* on the rock in the photo above.



Figure 18. *Umbilicaria deusta* on rock in photo above.



Figure 19. Position of *Micarea subnigrata* (NS) on prominent boulder. SN 08345 32733. View direction NNE.



Figure 20. *Micarea subnigrata* (NS) on the boulder above. Note the green patches of the green alga *Hormidiopsis crenulata*.



Figure 21. *Micarea subnigrata* (NS) on the boulder above. Note the green patches of the green alga *Hormidiopsis crenulata* thought to be associated with elevated nitrogen and acidity.



Figure 22. Heavy sheep and pony dunging is apparent across this site. The associated elevated levels of nitrogen appear to be stimulating the growth of *Hormidiopsis crenulata* and nitrophilous lichens. SN 083 327. View direction SE.

9.3. Craig Talfynydd



Figure 23. Boulders and outcrops on the SE facing slopes of Craig Talfynydd. SN 12724 31218. View direction NE.



Figure 24. Position of rock supporting *Micarea subnigrata* (NS) SN 12700 31181.



Figure 25. Positions of *Micarea subnigrata* (NS) on rock in photo above.



Figure 26. *Micarea subnigrata* (NS) on rock in photo above.



Figure 27. Heavy sheep dunging. The associated elevated levels of nitrogen appear to be stimulating the growth of *Hormidiopsis crenulata* and nitrophilous lichens. SN 127 313. View direction NE.



Figure 28. *Xanthoparmelia loxodes* (pale tan) and *X. verruculifera* (dark green) both foliose species are abundant at this site.



Figure 29. Ornithocrophilous/nitrophilous community *Candelaria coralliza*, *Lasallia pustulata* and *Xanthoria candelaria*. This community is abundant on the tops of rocks at this site. SN 12782 31314.



Figure 30. The ornithocoprophilous/nitrophilous *Candelaria coralliza* and *Xanthoria candelaria* are both frequent at this site.

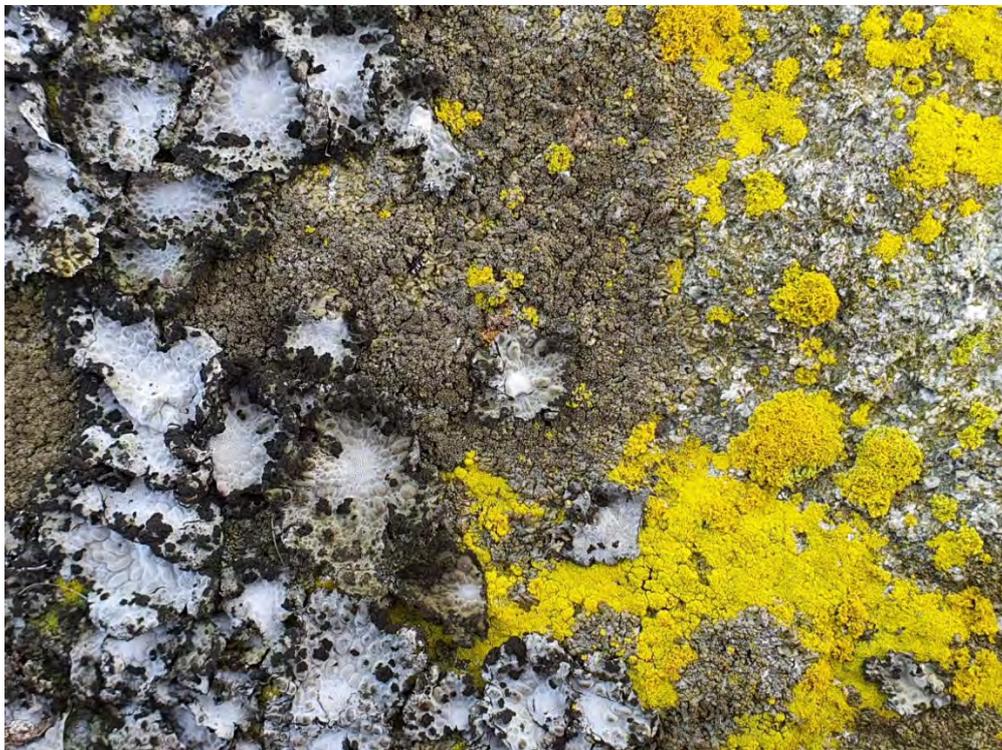


Figure 31. A typical ornithocoprophilous/nitrophilous community at Craig Talfynydd on the tops of a great number of rocks: *Candelariella coralliza*, *Lasallia pustulata*, *Xanthoparmelia loxodes* and *Xanthoria candelaria*.



Figure 32. The ornithocoprophilous/nitrophilous *Lasallia pustulata* in great abundance at many sites in the Preselis, particularly at Craig Talfynydd. Growing here with *Xanthoparmelia loxodes* and *Parmelia saxatilis*.



Figure 33. *Lasallia pustulata*. Abundant at Craig Talfynydd.



Figure 34. *Lasallia pustulata* 'rivers'. SN 12818 31314.



Figure 35. *Lasallia pustulata* on boulder above. These thalli are becoming coated in green algae, indicating hypereutrophication.



Figure 36. Boulder group with abundant *Hormidiopsis crenulata* colonies (green on the vertical faces) indicating high levels of reactive nitrogen causing eutrophication and acidification. This rock also supports species including: *Arthrorhaphis citrinella*, *Cladonia luteoalba*, *Fuscidea lygaea*, *Lasallia pustulata*, *Lecanora soralifera*, *Pertusaria aspergilla*, *P. pseudocorallina*, *Stereocaulon vesuvianum* var. *nodulosum* and *Halecania spodomela* (NT, NS) SN 12826 31340. View direction SE.



Figure 37. Low rock supporting large quantities of *Umbilicaria deusta* (NS) a species associated with flushed rocks in areas of relatively high rainfall. Most of the dark brown/blackish patches are this species. SN 12781 31426. View direction SW.



Figure 38. *Umbilicaria deusta* on low boulder. SN 12771 31506. View direction SW.



Figure 39. *Umbilicaria deusta* colony on boulder in photo above. Associated species include *Lasallia pustulata*, *Xanthoparmelia conspersa* and *X. loxodes*.



Figure 40. *Umbilicaria deusta* colony on boulder in photo above.



Figure 41. Colony of *Lasallia pustulata* forming a streak on outcrop. Notice the green tinge formed by a green alga growing among and on top of thalli, possibly the result of hypereutrophication.



Figure 42. *Lasallia pustulata* streak with a coating of green alga.



Figure 43. Lower section of *Lasallia* streak. The basal section supports a colony of *Umbilicaria deusta* (NS) mixed in with *Lasallia pustulata*.



Figure 44. Basal section supporting a colony of *Umbilicaria deusta* (NS) mixed in with *Lasallia pustulata*.



Figure 45. Low rock with large quantities of dunged by sheep dung. This rock supports a colony of *Umbilicaria deusta* (NS) and *Lasallia pustulata*. SN 12771 31506.



Figure 46. Large boulder (centre, right) supporting *Halecania spodomela* (NT, NR), *Lecidea fuliginosa* (NS) and *Micarea subnigrata* (NS). SN 13039 31652. View direction west.



Figure 47. Low slab jutting out of hillside supporting *Halecania spodomela* (NR, NT), *Lasallia pustulata*, *Micarea subnigrata* (NS), *Pertusaria excludes* (NS). SN 13009 31681. View direction west.



Figure 48. Boulder field supporting a wide variety of species including: *Arthrorhaphis citrinella*, *Aspicilia grisea*, *Caloplaca arenaria* (NS) (rare), *Candelariella coralliza* (frequent), *Cladonia borealis* (DD, NR) occasional, *Cladonia luteoalba* (rare), *Cladonia portentosa* (rare), *Enterographa hutchinsiae* (rare), *Fuscidea praeruptorum* (Occasional), *Halecania spodomela* (NT, NS, frequent to locally abundant), *Hypotrachyna britannica* (occasional), *Lasallia pustulata* (frequent), *Lepraria borealis* (NS), *Micarea coppinsii* (NS, occasional), *Ophioparma ventosa* (rare), *Placopsis lambii* (rare), *Porpidia melinodes* (NS, occasional), *Rinodina atrocinerea* (rare), *Sphaerophorus fragilis* (rare) and *Stereocaulon evolutum* (occasional). The green alga *Hormidiopsis crenulata* is frequent indicating elevated levels of nutrients and acidity. SN 130 314. View direction south.

9.4. Carnalw



Figure 49. Carnalw. SN 138 336. View direction NE.



Figure 50. Carnalw, showing the fractured nature of the rock. SN 139 338. View direction SW.



Figure 51. Low slab supporting several species including: *Haleciana spodomela* (NT, NS), *Micarea subnatrata* (NS), *Porpidia contraponenda* (NS), *Porpidia melinodes* (NS). View direction SN 14064 33424. View direction NW.



Figure 52. Low slab in photo above supporting *Haleciana spodomela* (NT, NS), *Micarea subnatrata* (NS), *Porpidia contraponenda* (NS), *Porpidia melinodes* (NS). View direction E.



Figure 53. Large slab supporting *Clauzadeana macula* (NS) and *Lecidea fuliginosa* (NS). SN 13883 33659. View direction NNE.



Figure 54. Large slab in photo above supporting several fertile thalli of *Clauzadeana macula* (NS) and a few squamules of *Lecidea fuliginosa* (NS). Several more thalli of *C. macula* were found on the main outcrop and boulders below, together with *Halecania spodomela* (NT, NS) which was frequent to locally abundant at Carnalw. SN 13883 33659. View direction WNW.



Figure 55. Large slab in photo above showing the position of the few squamules of *Lecidea fuliginosa* (NS) at yellow marker. SN 13883 33659. View direction NNW.



Figure 56. *Clauzadeana macula* (NS) on boulder above.

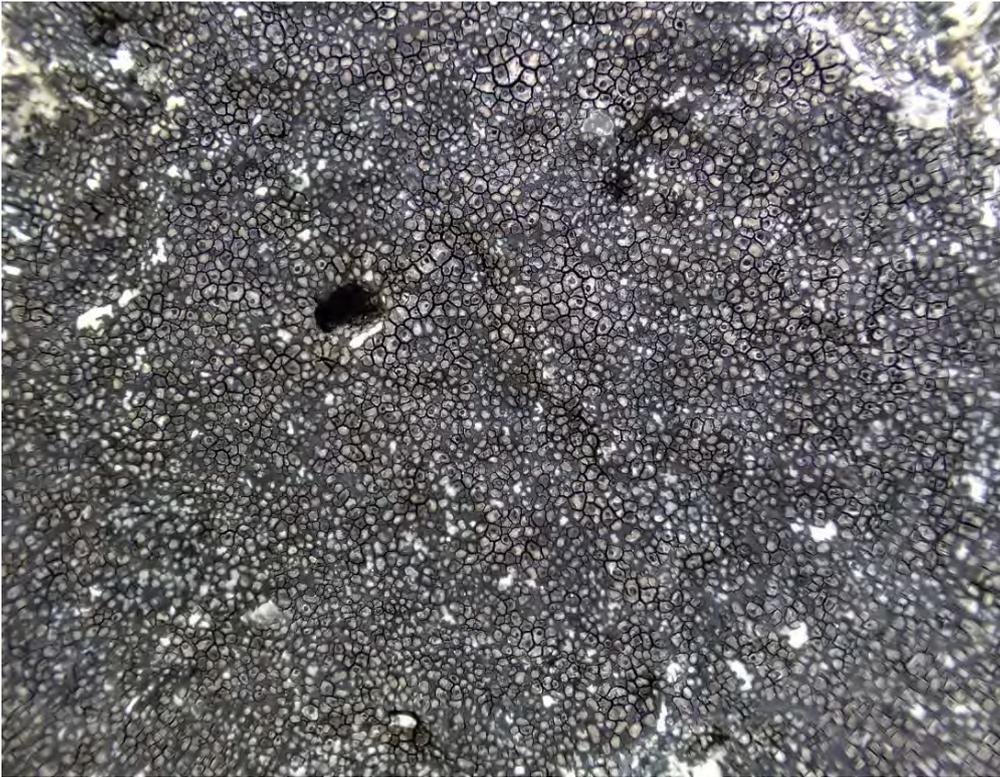


Figure 57. *Clauzadeana macula* (NS) on boulder above.



Figure 58. *Lecidea fuliginosa* (NS), small brown squamules with black apothecia on boulder in photo above.



Figure 59. Prominent end outcrop supporting a coastal community including *Anaptychia runcinata* and *Ramalina siliquosa*. A relatively rare feature occurring some 12km inland. SN 13961 33821. View direction NW to the sea.



Figure 60. Prominent end outcrop supporting a coastal community with *Anaptychia runcinata* and *Ramalina siliquosa*. SN 13961 33821. View direction N.



Figure 61. Top of prominent end outcrop supporting a coastal community with *Anaptychia runcinata* and *Ramalina siliquosa*. SN 13961 33821. View direction NNW.



Figure 62. The normally coastal *Ramalina siliquosa* on outcrop in photos above.



Figure 63. Outcrop just to the SW of Carnalw, supporting a number of species including *Halecania spodomela* (NT, NS, frequent) together with more coastal elements including *Anaptychia runcinata* and *Ramalina siliquosa*. SN 13649 33633. View direction SW.

9.5. Species portraits



Figure 64. The normally coastal *Anaptychia runcinata* found at Carnalw.



Figure 65. Fertile *Arthrorhaphis citrinella*. This common upland species was occasional in the Preselis.



Figure 66. *Aspicilia caesiocinerea*. Occasional to frequent in the Preselis on nutrient enriched, damp/flushed rocks, particularly bird perching areas.



Figure 67. *Brianaria (Micarea) sylvicola* (centre) on a boulder at Carnau Ysfa. Rarely encountered during this survey. Growing here with *Porpidia cinereoatra* (right) and *Parmelia saxatilis* (left).



Figure 68. *Caloplaca arenaria* (NS) rare and *Candelariella coralliza* abundant in the Preselis.



Figure 69. *Caloplaca arenaria* (NS) found at Craig Talfynydd and Carnau Ysfa.



Figure 70. *Candelariella coralliza* a species in great abundance in the Preselis. This ornithocoprophilous species is usually found on the upper parts of rocks around bird perching sites and is often associated with *Lasallia pustulata*, which also grows in great abundance in the Preseli Hills. This species is often seen as an ecotype of *C. vitellina* which has more flattened squamules/granules and was rarely encountered in the Preselis.



Figure 71. *Catillaria atomarioides* (NS) found at Carnau Ysfa. Rarely encountered during the survey.



Figure 72. *Enterographa hutchinsiae*. A species of damp shaded situations. Found at Craig Talfynydd.



Figure 73. *Halecania spodomela* (NR, NT) a rare species in great abundance in the Preselis. Usually coastal, this species occurs on the great majority of rocks in many of the localities surveyed. When sterile it is difficult to distinguish from other black 'crud'. Luckily it was frequently fertile in the Preselis.



Figure 74. *Halecania spodomela* (NR, NT). Note the granular thalline margin. A striking character of this species.



Figure 75. *Hormidiopsis crenulata* seen here again growing with *Micarea lignaria* var. *lignaria*. This green alga appears to be on the increase due to increasing reactive nitrogen levels and acidity.



Figure 76. *Hypotrachyna britannica*, occasional in the Preselis.

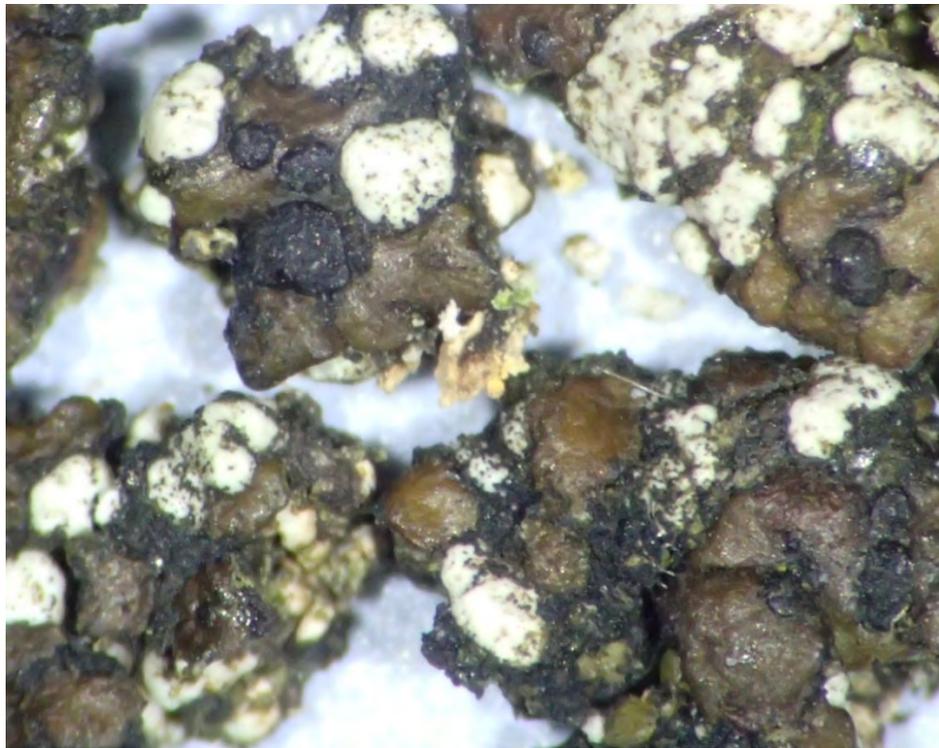


Figure 77. *Lecidea fuliginosa* (NS). Rarely recorded during this survey. Found only at Carnalw.



Figure 78. *Micarea subnigrata* (NS). Frequently encountered in the Preselis.



Figure 79. Close up of *Micarea subnigrata* (NS).



Figure 80. *Trapelia obtegens* (above) growing with the dark brown moss *Andreaea rothii falcata* and a pale, shaded form of *Lecidea fuliginosa* (bottom, right) in a crevice of a boulder at Carnalw.

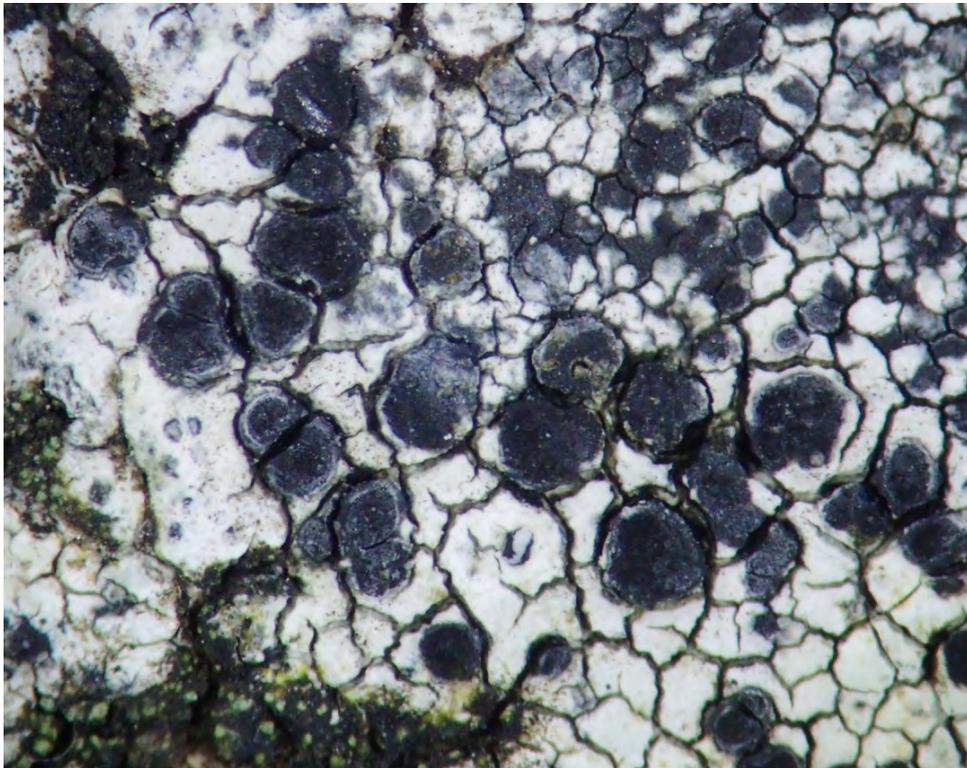


Figure 81. *Lecidea swartzioidea* (NS). New to VC 45 and found only at Carnalw during this survey.



Figure 82. *Pertusaria corallina* (left) and *P. pseudocorallina* (right). Both common upland species frequent in the Preselis.



Figure 83. The common upland species *Parmelia omphalodes*, *Lecanora intricata* and *Miriquidica leucophaea*, frequent in the Preselis.

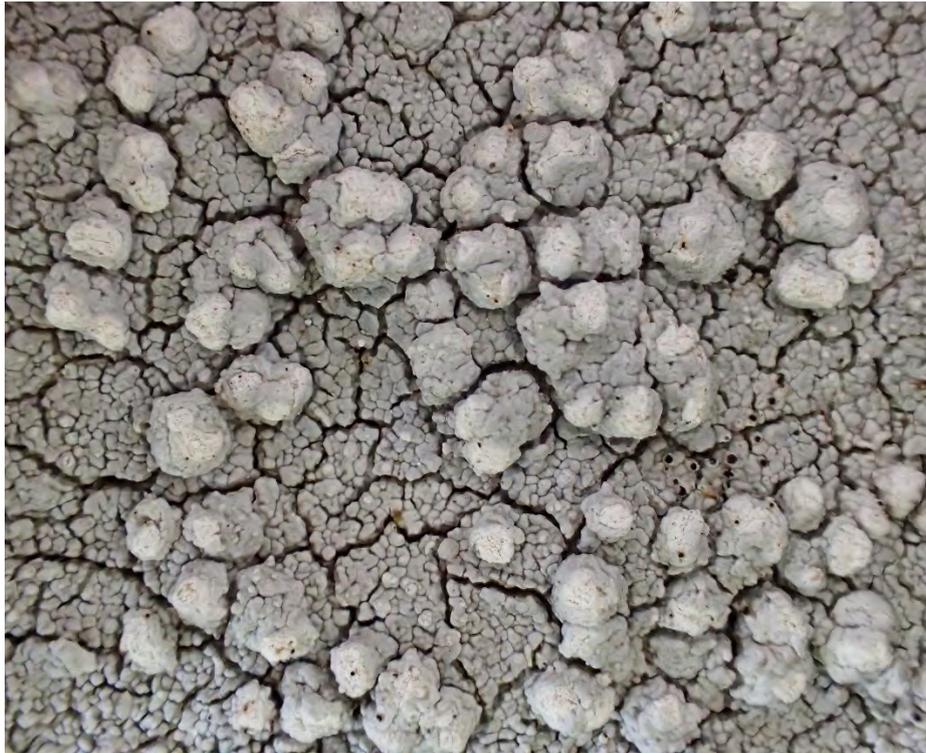


Figure 84. Fertile *Pertusaria corallina* with the lichenicolous fungus *Sclerococcum sphaerale*.



Figure 85. *Ramalina subfarinacea* with speckled blue/grey soredia. A species normally found on coastal rocks. Occasionally found in the Preselis indicating that this site is influenced by the coastal climate and salt laden westerly winds which penetrate some distance inland.



Figure 86. The cushion forming *Sphaerophorus fragilis*, occasional in the Preselis.

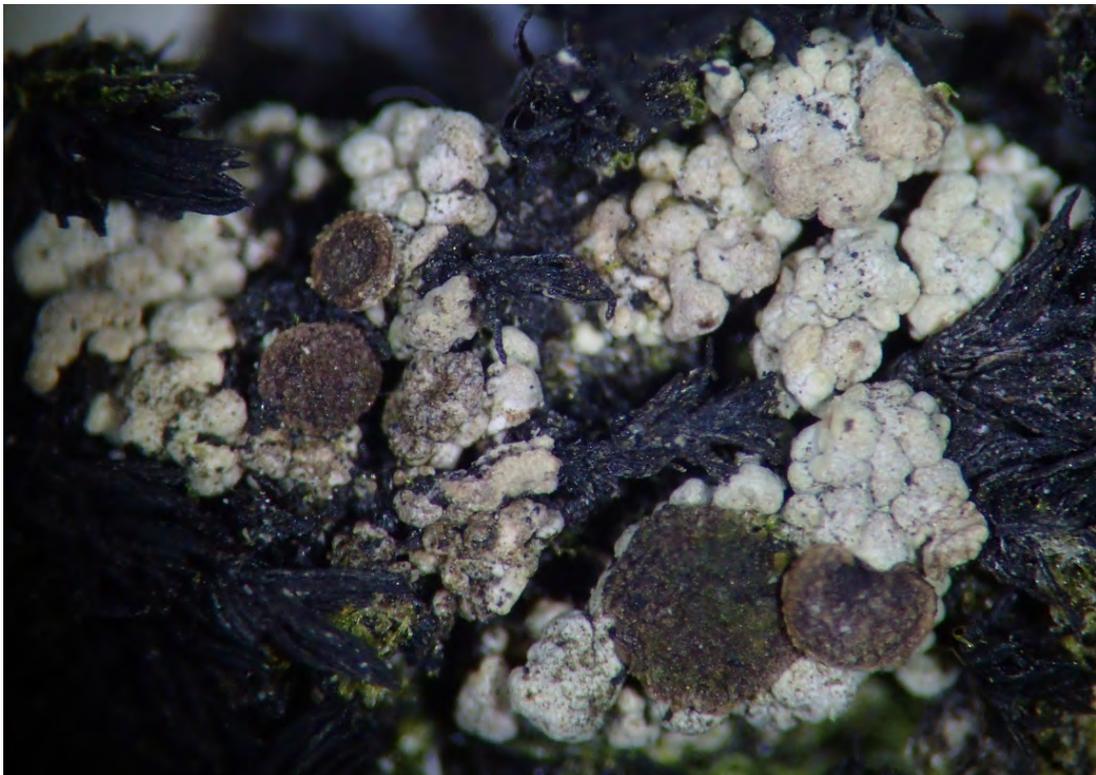


Figure 87. *Trapelia obtegens*. Found on a boulder growing among *Andreaea* moss at Carnalw. Occasionally seen during this survey.



Figure 88. *Umbilicaria deusta* (NS) occasional to locally abundant in the Preselis and new to Pembrokeshire. This upland species is usually found close to water and/or flushed rocks.



Figure 89. *Usnea* sp. growing on a large outcrop at Carnau Ysfa. This species has the appearance of *Usnea cornuta* but the medulla is K-.



Figure 90. *Xanthoparmelia loxodes* and *X. verruculifera* growing together at Craig talfynydd.

10. Appendix II. Pollution concentrations for each site surveyed.

Table 3. Pollution concentrations for each site (taken from APIS Air Pollution Information system website 2022)

Site name	Grid Ref	Ammonia $\mu\text{g}/\text{m}^3$ Critical Level = 1	N Deposition $\text{kg}/\text{ha}/\text{yr}$ Critical Load = 10	Acid Deposition (N) ($\text{keq}/\text{ha}/\text{yr}$) Critical Load = 0.816	Acid Deposition (S) ($\text{keq}/\text{ha}/\text{yr}$) Critical Load = 0.45	Nitrogen Oxides (NOx as NO_2) $\mu\text{g}/\text{m}^3$ Critical Level = 30
Carn Menyn	SN 144 324	2.72	28.42	2.10	0.20	3.90
Carnau Ysfa	SN 082 326	2.72	29.54	2.11	0.20	3.89
Craig Talfynydd	SN 127 312	2.72	28.42	2.03	0.20	3.89
Carnalw	SN 138 336	2.72	28.42	2.03	0.20	3.88

Ammonia concentrations and N deposition are nearly three times higher than their respective Critical Level and Critical Load.

Data Archive Appendix

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

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] A spreadsheet of records in Microsoft Excel format.

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