



Smut and Allied Fungi of Wales

**A Guide, Red Data List and
Census Catalogue**

**Y Gwir-Barddu a Ffyngau Perthynol
Cymru Arweiniad, Rhestr Ddata Coch a
Chatalog Cyfrifiad**

**Ray G. Woods, Arthur O. Chater,
Paul A. Smith, R. Nigel Stringer & Debbie A. Evans**

Summary

The smut fungi and their allies are a group of specialist plant pathogens. Eighty-one species are recorded from Wales, sixty-six on native plants. Twenty-nine species on native hosts are either considered to be extinct or threatened with extinction. Amounting to 44% of the total, the percentage lost or threatened is over twice as high as for any other studied plant or fungus group in Wales. Over 130 host/fungus interactions are recorded from the 13 Welsh Vice-counties. With little detailed long term recording to establish population trends the threats identified stem almost exclusively from known small population sizes. Whilst superficially some might consider the extinction of parasitic species to be no great loss, the smut fungi are proving to possess useful biochemical pathways. Their selection pressure on plants may have led to the evolution of many genes for resistance that may be of value in crop protection.

Crynodeb

Mae'r gwir-barddu a'u perthnasau yn grwp o bathogenau planhigion arbenigol. Cofnodwyd 81 o rywogaethau o Gymru, gyda 66 yn byw ar blanhigion cynhenid. Ystyrir 29 o rywogaethau sydd ar blanhigion cynhaliol cynhenid i fod yn ddiflanedig neu o dan fygythiad o fynd i ddifodiant. Yn cyfrif am 44% o'r cyfanswm, mae'r canran sydd wedi ei golli neu dan fygythiad dros ddwywaith yn fwy nac unrhyw grwp o blanhigion neu ffwng a astudiwyd yng Nghymru. Cofnodwyd 130 o ryngweithiadau planhigion cynhaliol/ffwng o'r 13 Is-sir (Vice-county) yng Nghymru. Gyda ychydig o gofnodi hir-dymor manwl i sefydlu tueddiadau poblogaethau, mae'r bygythiadau a ganfuwyd yn deillio bron yn gyfangwbl o boblogaethau o nifer bychain a wyddir amdanynt. Efallai nad yw rhai yn ystyried difodiant y rhywogaethau parasitig yn golled enfawr ond profwyd fod ffyngau parddu yn meddu ar lwybrau biogemegol defnyddiol. O bosib fod y gwasgedd detholus maent yn osod ar blanhigion wedi arwain at esblygiad nifer o'r genynnau ar gyfer ymwrthedd a all fod o werth ar gyfer amddiffyn cynydau.

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Y Gwir-Barddu a Ffyngau Perthynol Cymru
Arweiniad, Rhestr Ddata Coch
a Chatalog Cyfrifiad

“The Dark and Secretive Smuts and Bunts”

Chapter title from Ingram & Robertson (1999)

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Paul A. Smith, R. Nigel Stringer & Debbie A. Evans

2018

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A selection of smuts: left *Exobasidium vaccinii* Cowberry Redleaf on Cowberry *Vaccinium vitis-idaea*; centre *Ustilago avenae* Loose Smut on False Oatgrass *Arrhenatherum elatius*; right *Microbotryum saponariae*, an anther smut on Soapwort *Saponaria officinalis*.

Preface

In 2002 in The Hague, Netherlands, Britain adopted the *Global Strategy for Plant Conservation*. Sixteen global targets were set, two of which involved the cataloguing of all plants and fungi and then assessing their conservation status. In 2016 Natural Resources Wales published *An Assessment of the Sustainable Management of Natural Resources*. It recognised as one of the evidence gaps that despite the long history of observing and recording animals, plants and fungi in the UK and Wales, there are many significant gaps in the breadth and quality of our knowledge of the distribution, condition and trend data with respect to many Welsh species.

This report is the fifth in a series of Welsh Red Data Books that have sought to catalogue and identify the threats facing the plants and fungi of Wales. Over 3700 taxa (nearly 1500 of which are fungi) have now been catalogued and evaluated. It is hoped this information will assist Wales and its Government in meeting its aspiration to become one of the first nations to effectively plan and utilise its natural resources sustainably.

In addition, this report aims to be an introduction to the smut fungi and a basic guide to their identification in the hope that more attention will be given to them in future in Wales.

Acknowledgements

This report is only possible thanks to the hard work identifying and cataloguing the fungi carried out by a small but dedicated group of largely amateur mycologists in Wales who have been willing to share their data. It also draws on specimens held at the Royal Botanic Gardens, Kew and in the National Museum and Galleries of Wales, Cardiff, and on the records in the British Mycological Society's Fungus Records Database of Britain and Ireland. We are grateful for permission to reproduce a number of images, the donors of which are acknowledged in the text. The remaining photographs are almost all by the authors.

The authors are also grateful for the help received in determining and confirming specimens. Such help is acknowledged in the species descriptions below. We are indebted to Eilir Evans for the Welsh translations. We would also like to thank Plantlife and the Welsh Government for support and for assisting in the financing of this publication.

1 Introduction

The smut fungi, so called because many produce masses of black, sooty spores, as understood and described by Ainsworth & Sampson in their classic *The British Smut Fungi* (Ustilaginales) of 1950 have proved through modern genetic studies to comprise fungi now placed in three different Classes, the Exobasidiomycetes, Ustilaginomycetes and Microbotryomycetes, and further split into seven different Orders (Klenke & Scholler, 2015). This account seeks to draw together distributional information to provide presence and absence data for 81 species of plant parasitic fungi in the above Classes for each of the 13 Welsh Vice-counties (Watson, 1883) and tentatively offer a conservation evaluation based on the IUCN recommended criteria (IUCN, 2001 & 2003).

Why do we need a Red Data List and Census Catalogue such as this for Wales? The Environment (Wales) Act 2016 sets out Wales' approach to planning and managing natural resources at a national and local level, enshrining in statute the principles of sustainable management of natural resources. It contains two key sections.

Section 6 - Biodiversity and resilience of ecosystems duty

Section 6 of the Act places a duty on public authorities to “seek to maintain and enhance biodiversity” so far as it is consistent with the proper exercise of those functions. In so doing public authorities must also seek to “promote the resilience of ecosystems”. The duty replaces in Wales the section 40 duty in the Natural Environment and Rural Communities Act 2006 (NERC Act 2006).

Public authorities will be required to report on the actions they are taking to improve biodiversity and promote ecosystem resilience.

Section 7 - Biodiversity lists and duty to take steps to maintain and enhance biodiversity

This section replaces the duty in section 42 of the NERC Act 2006. The Welsh Ministers will publish, review and revise lists of living organisms and types of habitat in Wales, which they consider are of key significance to sustain and improve biodiversity in relation to Wales.

The Welsh Ministers must also take all reasonable steps to maintain and enhance the living organisms and types of habitat included in any list published under this section and encourage others to take such steps. Without Red Data Books such lists could not be produced nor could conservation priorities be established or the success of measures to ensure Wales develops sustainably be established.

No smut species are specially protected under the Wildlife and Countryside Act 1981 but a single smut species (*Urocystis colchici*) found on Autumn Crocus (*Colchicum autumnale*) is listed on Section 7 of the Environment (Wales) Act 2013 as being “a living organism of principal importance for the purpose of maintaining and enhancing biodiversity in relation to Wales”. Action has been taken by the Brecon Beacons National Park Authority, Natural Resources Wales and commoners to put in place appropriate management of the most important site for this smut fungus on Henallt Common near Hay on Wye.



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Welsh Government, the Brecon Beacons National Park Authority and graziers have come together on Henallt Common near Hay on Wye to restore favourable management to ensure the long-term survival of *Colchicum autumnale* and its smut fungus.

The Well-being of Future Generations (Wales) Act 2015 seeks to improve the social, economic, environmental and cultural well-being of Wales. One of its seven well-being goals aspires to “A nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change (for example climate change).” The maintenance and enhancement of nature and its biodiversity requires a detailed knowledge of the distribution of even microfungi.

The main sources of records have been the specimens held in the fungaria of the Royal Botanic Gardens at Kew and in the National Museum and Galleries of Wales, Cardiff; the records in the British Mycological Society’s Fungus Records Database of Britain and Ireland (FRDBI) and the Association of British Fungus Groups (ABFG) CATE2 database; and Charles Aron’s *Fungi of Northwest Wales* (2005). Bruce Ing has collected regularly in Wales. Tom Preece has been active in central eastern Wales, RGW and Graham Motley have worked in central Wales, whilst AOC has made numerous collections from Cardiganshire and adjacent VCs. Without the latter’s contribution this account would not have been possible. Carmarthenshire has seen active recording by RNS who has also checked numerous records from elsewhere in Wales. PAS has collected in both Monmouthshire and Glamorgan and DAE and Andrew Graham in NW Wales.

Pembrokeshire has been surveyed by visiting mycologists and now has an active fungus recording group.

Still being largely dependent on the discovery of fruiting bodies for detection and identification, these fungi present unique problems for anyone seeking to document their distribution or evaluate the threats posed to them in a world ever more dominated by humans, due to their very low detection rate. Of the more than 1100 species described from the world, Vánky (2012) notes that over a quarter of them have never been found again following their initial discovery and description. A large proportion of the 151 species reported from Britain and the 81 from Wales have been found less than a dozen times. The experience of the authors who have spent many hours searching for these fungi is that most are genuinely very rare.

We are not all as fortunate as the Rev Wolley Dod from whose garden W.G. Smith pens the following report that appeared in the *Gardeners' Chronicle* of the 30th Aug 1884 p. 268 "The Rev. Wolley Dod is to be envied for his productive garden. Not long since it gave rise to a new species of putrescent mildew on lilies...Mr. Berkeley there told that Mr. Dod possessed "an abundant supply of diseased lilies". Edge Hill has now produced a destructive parasite of primulas which has not hitherto been described as British (*Uromyces* [now *Urocystis*] *primulicola*) (on *Primula farinosa*)...although handsome smuts decidedly belong to the lower orders of fungi they are always ready to imbibe beer. The spores of *U. primulicola* will germinate sluggishly in water but if placed in diluted beer...they germinate...and a vast colony of colourless yeast-like cells is deposited all over the surface of the diluted beer". A ready supply of beer is clearly a prerequisite of anyone intending seriously to study the smut fungi!



Corn Smut *Ustilago maydis* galls the cobs of Maize and can lead to substantial crop losses.

They infect a wide range of hosts, though over half are found on species within the grass Poaceae and sedge Cyperaceae families. Until recently smut fungi caused major losses to our cereal crops, often halving yields and tainting good grain with fish-smelling spores. Before control became effective spores could be so abundant as to cause explosions in combine harvesters. Care in seed production, the use of fungicidal seed dressings and the selection of resistant cereal varieties have much diminished the losses, though constant vigilance is required. Maize can also be badly affected in the Americas by the corn smut *Ustilago maydis*. On the positive side the galls formed by this fungus are considered by some to be edible and are sold as a delicacy in Mexico. In culture the fungus is also a source of a number of useful compounds such as ustilagic acid. As a biosurfactant and natural detergent it can be used in pharmaceutical, cosmetic and

food applications and is known paradoxically for its strong fungicidal activity. Unlike rust fungi, smut fungi are not obligate parasites but can be grown separately from their host and require only a single host species to complete their life cycle. Easy to grow in liquid culture, the yeast-like phase of the corn smut has become a model organism following the complete elucidation of its genome. This has led to a better understanding of the repair mechanisms of DNA and the role genes play in the development of breast cancer. A useful introductory account to these fungi can be found in the New Naturalist book *Plant Disease* (Ingram & Robertson 1999).

As we place ever more pressure on land, the area of species-rich semi-natural habitats capable of supporting fungi declines in Wales. For example it is believed that 98% of dry lowland flower-rich grassland has been lost in the last 50 years (Stevens *et al.* 2010), mostly to agricultural intensification. With a decline in available host plants there will have been a decline in their associated fungi.

In considering conservation evaluations, smut fungi confined to cultivated non-native plants in Wales have been omitted but are listed in the Census Catalogue. Species names for the fungi mostly follow those used in the Kew *Checklist of the British and Irish Basidiomycota* (Legon & Henrici 2005) updated in Spooner & Legon (2006) and online at www.BasidioChecklist.info. Occasionally where a very recent revision has been adopted *Index Fungorum* has been followed. The taxonomy of the host plants follows Stace (2010) and where English names for fungi have been used they follow the recommendations of the British Mycological Society (see www.britmycolsoc.org.uk/library/english-names).

The aim of this report is to encourage recording of these fungi to better assess the level of threat facing these fungi in Wales so that priorities can be identified for conservation action. Some might question the desirability of conserving plant pathogenic fungi. We understand little as to why some are rare and others common. Only a very small selection of crop pathogens has been studied in detail. Resistance genes and mechanisms, currently unknown to us, may be present in wild plants. An understanding of their functioning may improve our ability to protect important crops. Smut fungi can be cultured, many in a single-celled state making them easy to handle. Already one species (*Pseudozyma tsukubaensis*) is used in the commercial production of erythritol, a widely employed food sweetener. Geiser *et al.* (2014) have recently demonstrated the ability of smut fungi to produce in culture products such as itaconate used in the production of resins, plastics and biofuels, malate which is used as an acidulant for foods, lipids used in pharmaceuticals and cosmetics, erythritol used as a non-calorific food sweetener and even substances used to create fungicides. Differing strains of the fungi produced widely different quantities of the compounds. It is clearly desirable to appreciate and conserve such potentially useful organisms (see also Helfer (1993)).

2 Putting the Red Data List to Use

Whilst Sites of Special Scientific Interest and nature reserves provide refugia for potential host plants, fungi have rarely featured in their selection and have hardly ever been taken into account in framing management strategies. This RDL is intended to help with the selection and management of sites with a view to ensuring the conservation of a fuller spectrum of the living world. It is also hoped that the Welsh Government, in its aspiration to develop Wales sustainably, will now be able to take into account this group of fungi.

Any taxon that is threatened (Critically Endangered, Endangered, Vulnerable) or Near Threatened in Britain (Evans *et al.* 2006) should also be regarded as a priority for conservation in Wales, regardless of its threat status in Wales. If a taxon is less threatened in Wales than it is in Britain or is even classified as Least Concern in Wales, the Welsh population must still be regarded as a critically important component of the British population and deserves full protection in Wales with appropriate conservation measures. Should the British population outside Wales continue to decline, the Welsh population will become increasingly important again regardless of its status within Wales. Should the Welsh population begin to decline, the species will be regarded as even more threatened in Britain as a whole.

3 Application of IUCN Criteria

The standard IUCN Red Data List Categories (IUCN 2001) are used with minor modifications to take account of the regional nature of this analysis. Taxa extinct within Wales but extant in other parts of Britain are classified as Regionally Extinct (RE). A taxon is RE when there is no reasonable doubt that the last individual in the region has died or a species has not been seen for more than 50 years. In this report, taxa not only extinct in Wales but extinct in Britain as a whole are classified as EX. The list of extinctions for Wales therefore includes both EX and RE taxa.

Considerable guidance is given by IUCN (2003) regarding the application of standard IUCN criteria and categories (IUCN 2001) to a region (defined as any sub-global geographically defined area, such as a continent, country, state, or province). Provided that the regional population being assessed is isolated by, for example, unsuitable habitat or a lack of susceptible host material from conspecific populations of the smut fungi outside the region, the IUCN Red Data List Criteria (IUCN 2001) can be used without modification within any geographically defined area.

However, when the criteria are applied to part of a population defined by a geopolitical border, as in the case of Wales sharing a border with England, the threshold values listed under each criterion may be inappropriate because the unit being assessed is not the same as the whole population or subpopulation. As a result, the estimate of extinction risk may be inaccurate.

In order to take this into account, we need to ask whether the Welsh population experiences any significant immigration of viable propagules from England. If not (or it is unknown), there is no change in the IUCN category assessed from a Welsh perspective. If, however, it is known or appears likely that viable propagules are entering Wales from England, the Welsh

IUCN category is downgraded by one level provided that the British population is stable or increasing. If the British population is decreasing the Welsh IUCN category remains the same. The level of propagule immigration is, however, almost impossible to assess but an attempt has been made to determine how likely immigration is by a consideration of the proximity of threatened Welsh taxa to English populations.

The threat category of Welsh taxa where the entire population is close to English populations may therefore be downgraded by one category if the British population is Least Concern. If, however, the British population is threatened the Welsh IUCN category remains unaltered.

Historic records of smut fungi in Wales are sparse and reside in a few old collections in national institutions, whilst a few published accounts e.g. Vize (1882) provide tantalizing hints of a one-time much richer mycota. This lack of any detailed information concerning the long term changes in population sizes permits only a very limited number of IUCN criteria to be employed. For most species only presence/absence data is available and population sizes can at best only be estimated.

Fluctuations from year to year in the number of “mature individuals” also form part of the criteria. Whilst such fluctuations may threaten the existence of, for example, birds or mammals, many fungi, including smuts, appear to vary naturally in abundance from year to year as measured by their visible fruit bodies. Until more is understood of these variations they have not formed a significant element of the evaluation process.

These fungi also pose some unique problems in assessing threats to populations. Issues include the selection of a threat status for populations of native smut species that appear clearly threatened on wild hosts, but that have, of late, appeared on cultivated plants in the horticultural trade. Such problems are highlighted in the species notes below.

Any direct measure of decline based on records over different time periods is problematic due to a substantial increase in recording effort in recent years. Instead, indirect methods have had to be adopted using known loss of habitat and changes in abundance of host species. All the fungi considered here are plant parasites. Their success is therefore intimately linked to the success and conservation status of their host plant or plants. For a fungus species confined to a red data listed host the threat to the fungus has been taken to be no lower than that of its host. Vascular plant red listings follow Cheffings *et al.* (2005) and Dines (2008).

Following in part Evans *et al.* (2006), the criteria listed below have been employed.

Extinct (EX and RE):

A taxon is listed as Extinct (EX) when there have been no records from Britain for more than 50 years or Regionally Extinct (RE) if there have been no records from Wales for more than 50 years.

Critically Endangered (CR):

D2: Where the total population in Wales numbers fewer than 50 individuals*.

Endangered (EN):

B: Found in 2-5 hectads and there is evidence of decline or a clear threat to host or habitat is identified.

D: Where the population in Wales numbers more than 50 but fewer than 250 individuals*.

Vulnerable (VU):

D: Where the population in Wales is small and estimated to number fewer than 1000 individuals*.

D1: Found in 1-5 hectads in Wales with no evidence of decline of host or habitat.

D2: Found in 5 or fewer locations within Wales (where a location is a “Wells” site i.e. a moveable 1km square) and as a result is rendered liable to extinction through human activities or stochastic events.

Near Threatened (NT):

Found in 6-10 hectads within Wales with no evidence of decline of host or habitat or 11-20 hectads with a threat to host or habitat identified.

Data Deficient (DD):

Where there is insufficient information to place a probably threatened species in one of the categories above.

Not Evaluated (NE):

Fungi confined to non-native species or plants in cultivation have not been given a threat status.

In the Census Catalogue, where a host is labeled (H), the fungus has only been found in a man-made habitat such as a garden or in a cultivated field crop and there is no evidence of the existence of the fungus in the wild in Wales. Those marked with (A) are not considered to be native species.

* IUCN uses the number of “mature individuals” as a measure of population size. This may be straightforward for elephants, but for fungi it is often unclear how many individuals might be present. A “mature individual” has here been taken to be a single infected plant. For some plants such as extensive stands of rhizomatous species e.g. great pond-sedge (*Carex riparia*) it is not clear where one individual host plant ends and another begins. A single discrete stand has been taken to be an individual.

4 Analysis of the Red Data List and Census Catalogue

4.1 Red Data List

Of the 151 plant pathogenic fungi species reported on the FRDBI as occurring in Britain in the three classes of the fungal kingdom under consideration, 81 have been reported from Wales, 15 of which were reported only on introduced plant species. At 54% of the British total, this is a lower proportion than reported for the bryophytes (almost 75% of the British bryophyte flora (Bosanquet & Dines 2011)), the rust fungi (79% of the British total (Woods *et al.* 2015)) and the lichens (68% of the British total (Woods 2010)). But since Wales makes up only 11% of the total British mainland surface area this percentage further emphasises the exceptional biodiversity of the principality.

Four species are considered to be regionally (Welsh) or nationally (UK) extinct and 15 species have only been reported from Wales on non-native plants or those under cultivation. The remaining 66 species (which include archaeophytes) have been subject to an evaluation process and categorised into one of six statuses. 20 species are considered not to be threatened and have been placed in the Least Concern category. 6 are considered to be Near Threatened whilst 25 have been given a threat status. Of particular note is the high number of species (13) considered to be Critically Endangered in Wales.

The numbers in each category are recorded in the table below.

Threat Category	No of Taxa	% of Total
Extinct in GB and/or Wales	4	6
Critically Endangered	13	20
Endangered	5	8
Vulnerable	7	11
Near Threatened	6	10
Data Deficient	11	17
Least Concern	20	30

Discounting the species that are probably extinct and those in the near threatened category, 42% of the extant Welsh smut taxa on native hosts are considered to be under threat. This compares with 19% of the rust taxa (Woods *et al.* 2015), 16% of the lichens (Woods 2010), 18% of the bryophytes (Bosanquet 2011) and 17% of the vascular plants (Dines 2008).

In the following tables, fungi are arranged by category of threat. An indication of the most likely habitat the fungus and its host was found in is appended based either on information provided in the original record or deduced from the host and site details. Vice-county names in square brackets indicate that the latest record(s) was made more than 50 years ago. Records from plants in cultivation are omitted.

Extinct Taxa

Smut Taxon	Host	Wales Red List	Date Last Seen	VC Last Seen	Habitat
<i>Doassansiopsis hydrophila</i>	<i>Potamogeton polygonifolius</i>	RE	1931	Monts	Mountain bog
<i>Melanotaenium cingens</i>	<i>Linaria vulgaris</i>	EX	1931	Flints	Roadside?
<i>Melanotaenium endogenum</i>	<i>Galium verum</i>	RE	20 th cent.	Cards	Shingle at edge of dunes
<i>Tilletia holci</i>	<i>Holcus mollis</i>	RE	1930's?	Cards	Not known

Critically Endangered Taxa

Smut Taxon	Host	Wales Red List	Vice-County(ies)	Habitat
<i>Anthracoidea subinclusa</i>	<i>Carex riparia</i>	CR D2	Carms	Reed swamp
<i>Entyloma chrysosplenii</i>	<i>Chrysosplenium alternifolium</i>	CR D2	Rads	Wet flush
	<i>C. oppositifolium</i>		Cards	
<i>Entyloma henningsianum</i>	<i>Samolus valerandi</i>	CR D2	Cards	Unimproved wet pasture
<i>Haradaea duriaeana</i>	<i>Cerastium glomeratum</i>	CR D2	Cards & Monts	Dry grassland
<i>Microbotryum scorzonerae</i>	<i>Scorzonera humilis</i>	CR D2	Glams	Rhos pasture
<i>Microbotryum stygium</i>	<i>Rumex acetosa</i>	CR D2	Carms	Grassland?
<i>Schizonella melanogramma</i>	<i>Carex caryophyllea</i>	CR D2	Rads	Dry grassland
<i>Tilletia menieri</i>	<i>Phalaris arundinacea</i>	CR D2	Cards	River bank
<i>Tranzscheliella hypodites</i>	<i>Elytrigia juncea</i> ssp. <i>boreo-atlantica</i>	CR D2	Carms	Yellow dunes
	unknown		[Monts] & Angl	
<i>Urocystis agropyri</i>	<i>Elytrigia repens</i>	CR D2	Rads	Garden
<i>Urocystis trollii</i>	<i>Trollius europaeus</i>	CR D2	Brecs	Rhos pasture
<i>Urocystis ulmariae</i>	<i>Filipendula ulmaria</i>	CR D2	Cards	Road verge
<i>Vankya ornithogali</i>	<i>Gagea bohemica</i>	CR D2	Rads	Rock outcrop

Endangered Taxa

Smut Taxon	Host	Wales Red List	Vice-County(ies)	Habitat
<i>Anthracoidea paniceae</i>	<i>Carex panicea</i>	EN D	Cards & Denbs	Damp unimproved grassland
<i>Entyloma eryngii</i> s.l.	<i>Eryngium maritimum</i>	EN D	Glams, Carms, Pembs, Mers, [Caerns]	Sand dunes
<i>Exobasidium arescens</i>	<i>Vaccinium myrtillus</i>	EN D	Mers & [Denbs]	Upland heath
<i>Urocystis colchici</i>	<i>Colchicum autumnale</i>	EN B	Breccs	Unimproved grassland and scrub
<i>Ustilago serpens</i>	<i>Elytrigia juncea</i> ssp. <i>boreo-atlantica</i> & <i>Elytrigia repens</i>	EN D	Cards	Sand dunes

Vulnerable Taxa

Smut Taxon	Host	Wales Red List	Vice-County(ies)	Habitat
<i>Microbotryum coronariae</i>	<i>Silene flos-cuculi</i>	VU D	Rads, Carms, Cards, Monts & Angl	Mires and fens
<i>Microbotryum reticulatum</i>	<i>Persicaria lapathifolia</i>	VU D1	Glams, Breccs, Rads, Cards & Angl	Arable fields and grass leys
<i>Microbotryum succisae</i>	<i>Succisa pratensis</i>	VU D	Glams, Rads, Pembs & Cards	Rhos pasture and unimproved grassland
<i>Microbotryum tragopogonis-pratensis</i>	<i>Tragopogon pratensis</i>	VU D2	[Mons], Glams, Rads, [Monts] & Angl	Unimproved grassland and dunes
<i>Thecaphora seminis-convolvuli</i>	<i>Calystegia sepium</i> & <i>Convolvulus arvensis</i>	VU D	Glams, Cards, Monts & Caerns	Waste ground
<i>Urocystis primulae</i>	<i>Primula vulgaris</i>	VU D	Cards	Hedgebanks and broadleaved woodland
<i>Ustilago grandis</i>	<i>Phragmites australis</i>	VU D2	Glams, Carms & Cards	Reed swamp

The causes of extinction are not readily apparent. All host species are still of widespread occurrence in Wales. The *Melanotaenium* species are particularly obvious when they infect plants and are not likely to be overlooked. The smut on the leaves of *Potamogeton* may have been overlooked but the ovary smut of *Holcus* has rarely been found anywhere in Britain and may be of casual occurrence. An examination of the habitats occupied by threatened taxa shows that the largest number occur in agriculturally unimproved grasslands, followed closely by sand dunes, wet flushes and reed swamp. Few threatened species are confined to woodland, unlike the rust fungi (Woods *et al.* 2015), and only two species are confined to hosts that are themselves considered threatened in Wales. Yet the widely acknowledged post Second World War losses of wild plants and the fragmentation of the few surviving areas due to modern intensive agricultural and forestry methods (Stevens *et al.* 2010) must place at risk the survival of many of these fungi even when they use apparently widespread hosts

Rising carbon dioxide levels appear to have led to a recent reduction in numbers of stomata in many plants (Woodward 1987). Reductions can be in the order of 40% and since stomata provide a means of entry to the plant for some of the fungi considered here and others rely on the release of spores via stomata, these changes may also have reduced their colonisation and/or reproductive efficiency. There are also major changes reported in the nutrient quality of plants with carbohydrates up by as much as 75% and mineral content reduced by up to 20% (Teng *et al.* 2006). Such changes may well have had an impact on the survival success of parasitic fungi.

4.2 Census Catalogue

81 species of fungi are recorded, 14 of which were only located on non-native hosts, from the 13 Vice-counties of Wales. The native host species, of which there were 73, occurred within 46 genera. Plant species supporting these fungi accounted for only 5% of the total Welsh flora. There were 18 native host species/fungus species interactions with members of the grass family (Poaceae), followed by 10 in both the buttercup (Ranunculaceae) and sedge (Cyperaceae) families.

The following table summarizes the total number of smuts and smut allies per Vice-county and compares it to the total number of rust species (Woods *et al.* 2015) and vascular plants (BSBI records database April 2018).

Vice-county	Smut Species	Rust Species	Vascular Plant Taxa	Vice-county	Smut Species	Rust Species	Vascular Plant Taxa
Mons 35	19	114	1464	Monts 47	33	106	1141
Glams 41	24	137	1573	Mers 48	23	116	1249
Brechs 42	24	131	1374	Caerns49	20	161	1454
Rads 43	34	115	1095	Denbs 50	14	94	1501
Carms 44	29	164	1480	Flints 51	5	69	1434
Pembs45	14	107	1191	Angl 52	20	143	1243
Cards 46	59	155	1307				

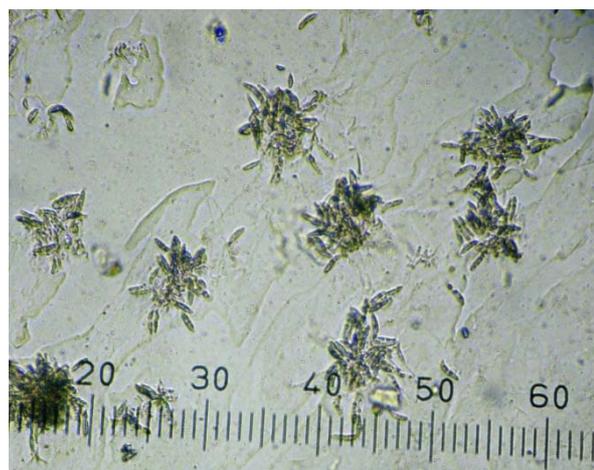
There is no clear relationship between total smut fungi number and vascular plant diversity. Smut fungi totals probably reflect more on the recording effort of the few mycologists. This is evidenced by the high number of smut fungi recorded from Cardiganshire, a Vice-county that has received more recording effort than any other. The low number recorded from Pembrokeshire almost certainly also reflects the low recording effort expended rather than a natural paucity of these fungi.

The above smut fungi totals can also be compared with the following totals of 40 for Surrey, 18 for West Sussex, 17 for East Sussex, 18 for Kent (Dennis 1995), 19 for Warwickshire (Clark 1980) and 24 for the Hebrides (Dennis 1986).

5 Species Accounts

Through brief descriptions and illustrations we hope that, once the identity of the host has been established, almost all known Welsh smut fungi can be identified from this guide. Unlike the rust fungi, smut fungi complete their life cycle on only a single host species and produce only two spore stages. The resting and probably mainly over wintering ustilospore or teliospore stage may be black and sooty, hence the name smut fungi, and may be found in pustules that are sometimes described as sori in the leaves (see *Urocystis* spp.) or filling the ovary or flowers (see *Antherospora* spp.). Occasionally they are located in small tubers on the roots (see *Entorrhiza* spp.) or the spores may replace the pollen in the stamens as in some species of *Microbotryum*. Other smuts (see *Entyloma* spp.) produce ustilospores immersed in the plant tissue without obvious distortion of the leaf, though recognisable as the leaf in these areas may become chlorotic. The spores are then only visible under the microscope.

The ustilospores germinate to produce bacilliform or sickle-shaped conidia (otherwise known as sporidia) and known as the anamorph stage which can infect new plants. This stage has been little studied so we have tried to illustrate as many examples here as we can. The full life cycle of most smut species is imperfectly known. Ingram and Robertson (1999) in their book on plant pathogens not without good cause head their chapter on these fungi “The dark and secretive smuts and bunts”. We frequently find both spore stages in the same part of a leaf and occasionally only find conidia. A few species produce the two spore stages in completely different parts of the plant. In *Urocystis primulae* the conidia are formed as a white powder in the anthers of the stamens whilst the black ustilospores form in the ovaries. Applying transparent adhesive tape to the leaf surface and then mounting the tape on a microscope slide often reveals the conidia to occur in groups associated with the stomata via which they escape from the host plant.



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Conidia of the Lesser Celandine smut *Entyloma ficariae* clustered around the stomata.

Details of locality and recorder are given only for the more notable species. If the recorder is one of the authors of this publication their name is reduced to initials. Almost all the images below are of material that originated in Wales. The images of spores are mostly taken through a student's microscope, a deliberate choice since this is how most users of this publication are likely to view them. The taxonomy mostly follows Legon & Henrici (2005). Synonymy to this checklist is provided where a more recent nomenclature has been adopted.

Antherospora

Sori form in the flowers, mostly in the anthers of Asparagaceae, producing blackish ustilospore masses. Placed within the Ustilaginomycetes.

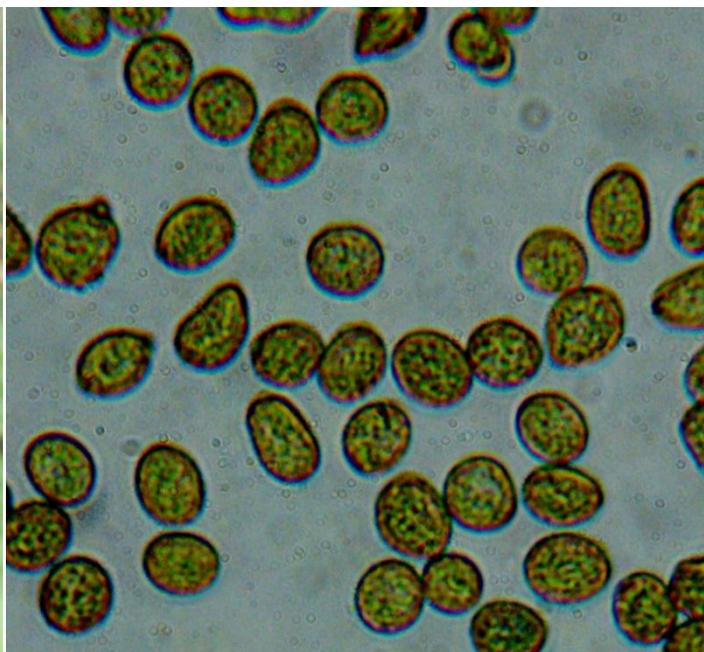
Antherospora hortensis M. Piątek & M. Lutz

Not Evaluated

Probably widespread on the cultivated and naturalised Grape Hyacinth *Muscari armeniacum* throughout Wales, with almost 50 records from five Vice-counties (VCs). The masses of dark-coloured ustilospores spilling from the anthers in the globose corollas are often only visible if the corolla is torn apart or the inflorescence tapped over a hand. This is doubtless why the smut was overlooked until 2010, when material from Aberystwyth was sent by AOC to Marcin Piątek and Matthias Lutz who confirmed it as a new species (Piątek *et al.* 2013). The holotype is from the Llanbadarn campus of the University of Aberystwyth, Cardiganshire. The smut is systemic, and the same plants are infected from year to year. It is not given a conservation status as it has not been found on a native or archaeophyte plant.



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Antherospora tractemae M. Piątek & M. Lutz

Least Concern

Probably present in most of the colonies of Spring Squill *Scilla verna* (= *Tractema verna*) along the coast of Wales with records from four VCs stretching from Glamorgan to Anglesey. It is conspicuous since dark spore masses fill and distort the corollas of the flowers so that they mostly do not open fully and the whole inflorescence becomes mis-shapen (see left

image below) and differs markedly from uninfected inflorescences. Ustilospores are shed through gaps between the corolla lobes as the inflorescence is rocked in the wind (see below left), resembling the spore dispersal mechanism of the capsules of the Rockmoss *Andreaea* spp. When infected flowers do occasionally open (as below right), spores may be spread by pollinators. This fungus was formerly considered to belong to *A. vaillantii*, but was



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recognised as a distinct species only in 2011 (Piaątek *et al.* 2011) when material from Cardiganshire and the Outer Hebrides was investigated by microscopy and rDNA analysis. The holotype is from Llangranog Head, Cardiganshire (see inside rear cover).

The extent of infection varies greatly from year to year, suggesting that the smut may be only weakly systemic in the host, though in spring 2018 at Manorbier, Pembrokeshire and Mwnt, Cardiganshire all early flowering inflorescences were found to be infected. A later visit when more plants are in flower may well have missed these early appearing infected inflorescences. Its distribution outside Britain is not yet known. In view of its widespread occurrence in mostly well-protected sites in Wales its conservation status is considered to be of **Least Concern**, though Welsh populations may be of international significance.



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[*Antherospora vaillantii* see *A. tractemae*]

Anthracoidea

Sori in or around the ovaries of Cyperaceae, producing brown or blackish masses of spores. Placed within the Ustilaginomycetes. The following three species form part of the *Anthracoidea caricis* group. See Taylor & Smith (2017) for information on recent British records of *Anthracoidea*.

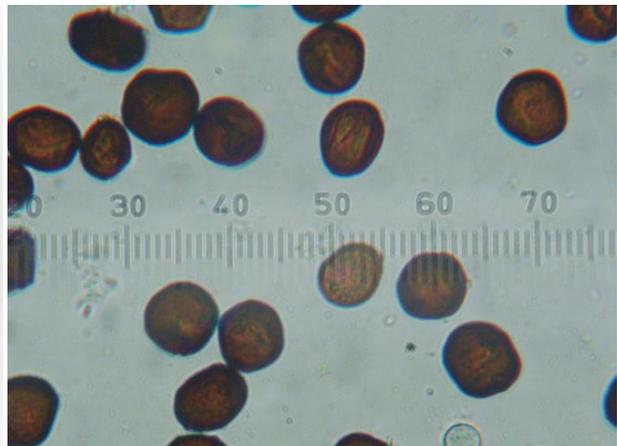
Anthracoidea arenaria (Syd.) Nannf.

Near Threatened

The FRDBI reports records from little more than a dozen sites on mainland Britain post 1960, all on Sand Sedge *Carex arenaria* and ranging from the South Coast of England to Northern Scotland. In Wales it has been reported recently from Tywyn Point, Pembrey and Ginst Point in Carmarthenshire; in 1940 at Freshwater East in Pembrokeshire and recently at Morfa Gwylt, Tywyn in Merionethshire and Rhosneigr and Red Wharf Bay on Anglesey (Aron 2005). The spore masses are black and very conspicuous. As it occurs in fewer than 10 hectads in Wales in the last fifty years it is considered to be **Near Threatened**.



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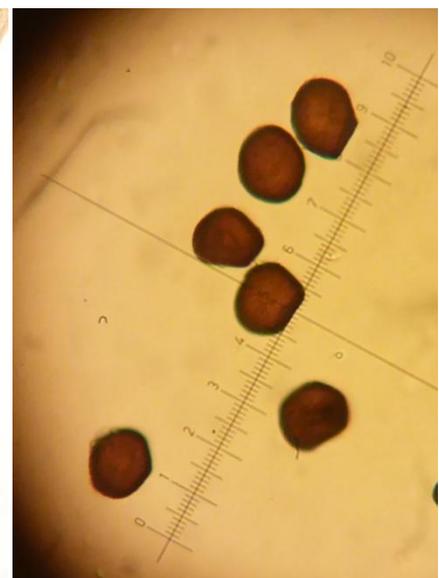
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Anthracoidea paniceae Kukkonen

Endangered D

Recorded only twice from Wales, on Carnation Sedge *Carex panicea* on Cors Fochno, Cardiganshire in 2001 by RGW and in some quantity in Minera Quarry, Denbighshire by Andrew Graham in 2016. The spore masses form hard, blackish spore bodies in the swollen utricles that are quite distinctive.

It has been recorded elsewhere in Britain from scattered sites throughout



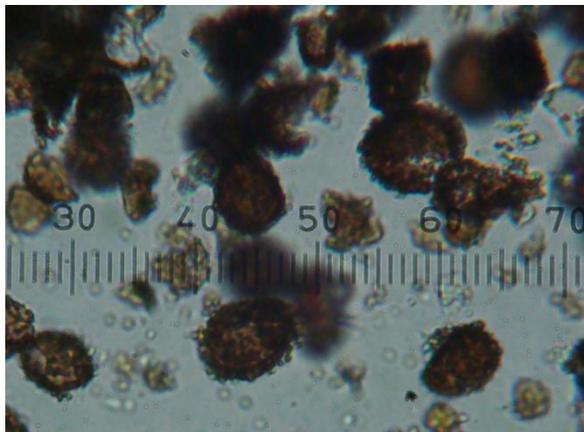
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Scotland and Northern England. In view of the small and discontinuous population in Wales it is considered to be **Endangered D**.

Anthracoidea subinclusa (Körn.) Bref.

Critically Endangered D2

Reported recently from around a score of sites on mainland Britain mostly on Greater Pond-sedge *Carex riparia*. It forms small, hard, blackish bodies in the utricles, not very conspicuous until they break out. Within Wales it has been recorded once on this host in Carmarthenshire at Pendine Burrows by AOC. Since it occurs as a single isolated population in Wales it is considered to be **Critically Endangered D2**.



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Doassansiopsis

Sori as spots or swellings in the leaves of aquatic hosts, producing spore balls (central sterile cells surrounded by colourless spores and a sterile cortex). Placed within the Ustilaginomycetes.

Doassansiopsis hydrophila (A. Dietr.) Lavrov (= *Doassansia martianoffiana*)

Regionally Extinct

Reported just once in Wales on Common Pondweed *Potamogeton polygonifolius* in a mountain bog at Foel near Llanfair Caereinion, Montgomeryshire by PGM Rhodes in 1931. It has possibly been overlooked elsewhere though most recent records are either from southern England or Scotland with the notable exception of a record from Moccas Park, Herefordshire in 1951 (FRDBI). In the absence of records for over 80 years it is considered **Regionally Extinct** in Wales.

Entorrhiza

Sori as globose, elongated or branched whitish galls terminal on the roots of Cyperaceae and Juncaceae, darkening as they ripen from the proximal end. Spores are globose to ellipsoid, smooth or variously ornamented. The galls on perennial hosts appear to develop throughout the year. See Chater & Smith (2018a, b) for more detailed information.

Entorrhiza is placed within the Ustilaginomycetes.

Entorrhiza aschersoniana (Magnus) Lagerh.

Data Deficient

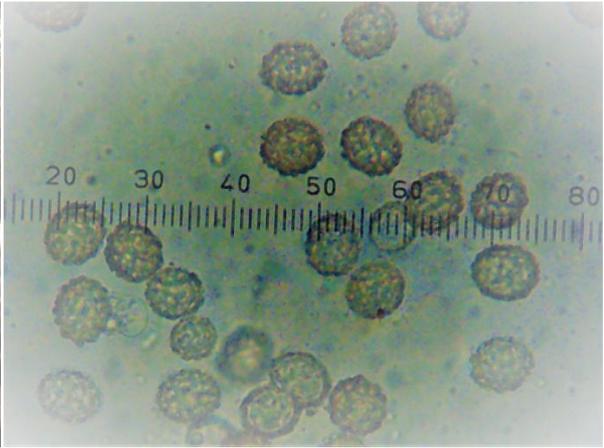
Discovered new to Wales by AOC in 2017, this elusive smut forms subglobose to fusiform galls on the roots of Toad Rush (*Juncus bufonius*). Discovered first on plants in a garden at Ynyshir, Cardiganshire, further colonies were quickly located in 31 more tetrads, mostly on plants growing in flushed roadside gravelly soil in the uplands of Cardiganshire, but also extending into Carmarthenshire, Montgomeryshire and Merionethshire. Two populations have been found in Radnorshire, one in the gateway to Rhosgoch Common by RGW and one at the edge of a mud-bottomed pool near Llandeilo Graban by Andy Shaw. It has been looked for, but not found, on its other European hosts, Minute Rush (*Juncus minutulus*) and Frog Rush (*J. ranarius*). Elsewhere in Britain there is only a single 20th century record of this fungus from the Isle of Mull on the FRDBI, and more recent records from the Outer Hebrides (PAS in 2016 and 2017), and from Surrey. Whilst it appears likely this smut is widespread but overlooked and is in consequence of least concern, further targeted searches in other parts of especially upland Wales are required before a conservation evaluation can be confidently applied. It is currently considered to be **Data Deficient**.



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***Entorrhiza caricicola* Ferd. & Winge**

Data Deficient

Found in 2017 by AOC on Bog-sedge (*Carex limosa*) in a small basin mire on Banc Ty-llwyd, above Llanfarian, Cardiganshire, and frequent on the abundant Bog-sedge in the lagg vegetation at the west side of the Cors Caron raised mire complex. The root galls tend to be rather elongated and widened towards the apex. Although previously unrecorded in Britain, it is likely to prove to be widespread and so is considered **Data Deficient**. Its other host in Europe that is a British species, Thread Rush (*Juncus filiformis*), occurs at one site in Caernarvonshire, Coedty Reservoir and should be examined for this smut.



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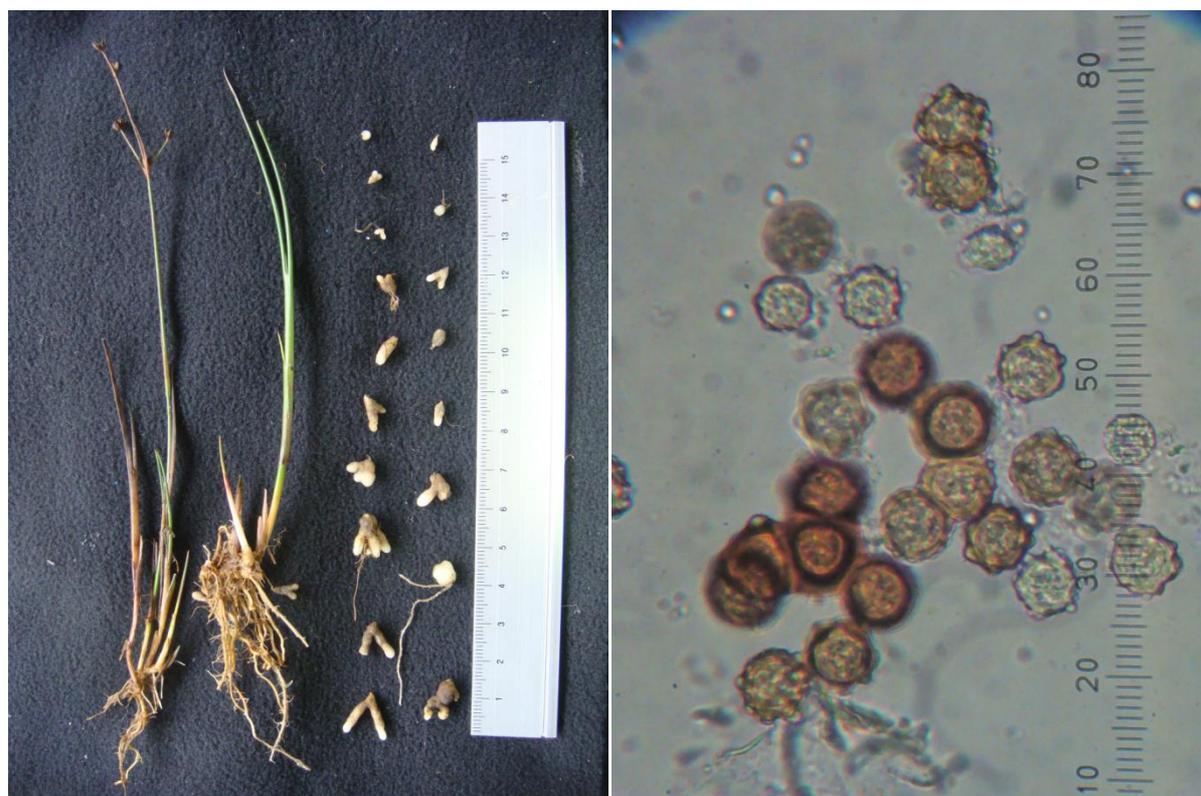


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Entorrhiza casparyana (Magnus) Lagerh.

Data Deficient

Prior to the commencement of this project this smut on Jointed Rush roots had been reported from only a handful sites in the north and west of Scotland within Britain (FRDBI). A wide scatter of records from Western Europe suggested it might be more widespread in Britain. Taking up the challenge it was not long before AOC located it in 25 tetrads on the roots of Jointed Rush (*J. articulatus* var. *articulatus*, var. *littorale* and var. *nigritellus*) in Cardiganshire and single sites in Breconshire, Radnorshire, Montgomeryshire and Merionethshire. He also found it on *Juncus bulbosus* subsp. *kochii*, a new host for the species in Britain, at two sites in Cardiganshire. Again it may be assumed to be widespread throughout Wales, but meanwhile it should be considered to be **Data Deficient**.



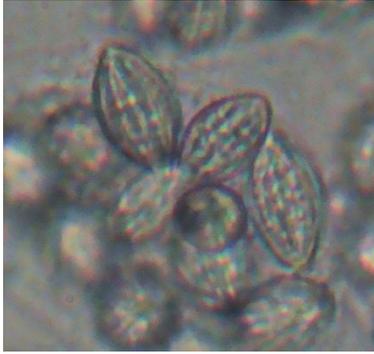
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Entorrhiza raunkiaeriana Ferd. & Winge

Data Deficient

The first collection ever of this smut was made in October 1912 on the island of Fano off the west coast of Denmark (data from GBIF) where it formed small, whitish, pea-like galls on the roots of Floating Club-rush *Eleogiton* (= *Scirpus*) *fluitans*. There appear to be no other documented records anywhere in the world until 105 years later when in autumn 2017 AOC took up the challenge to find it in Britain and in the first site searched in Cardiganshire, a shallow pool in the Aberleri Fields, Cors Fochno NNR, discovered it in quantity! Mud-bottomed pools with Floating Club-rush are something of a Radnorshire specialty so it was not surprising that the first site searched in this VC by RGW and Liz Fleming-Williams the following week on the Begwns near Llowes should reveal a second Welsh and third world locality. Andy Shaw subsequently discovered another population nearby in the Monk's Pool.



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Further populations in pools in a basin mire to the east of Pant y Llyn Pool, Llanddewi'r Cwm, Breconshire and at the south-west end of Rhosgoch Common National Nature Reserve, Radnorshire were then discovered by RGW. In the former site the host occurred in c20cm of water.



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The root galls were noted floating to the surface as the club-rush roots were disturbed, suggesting a possible dispersal mechanism. AOC has also found it in four more sites in Cardiganshire, in Ffynnon Geredig, Mynydd Llanybydder in Carmarthenshire, in Llyn Ebyr, Montgomeryshire and Llynnoedd Cregennen, Merionethshire. Doubtless widespread elsewhere in Wales, it is meanwhile considered **Data Deficient**.

Entorrhiza scirpicola (Correns) Sacc. & P. Syd.

Data Deficient

Recorded by AOC in 2018 from a dune slack in the Ynys-las Dunes, Cardiganshire, this smut forms inconspicuous elongated galls up to only 3 x 20mm on the roots of Few-flowered Spike-rush *Eleocharis quinqueflora*. In spite of extensive searching only a single gall was found (image overleaf), and sampling at six other sites in the county and at several in Carmarthenshire failed to produce further records. Elsewhere in Britain since 1900 it has been found only in a handful of sites in Scotland and one each in Norfolk and Hampshire. Searches have yet to be undertaken in North and South Wales for this smut. It is currently considered to be **Data Deficient**.



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Entorrhiza scirpicola

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Entyloma

Sori forming spots or more rarely pustules in the leaves and stems of dicotyledons. The spots may show up initially as paler green areas, becoming more yellow as the season progresses, with many eventually becoming brown as the leaf tissue dies. Spores are mostly smooth and often thick-walled. Anamorph, with conidiophores protruding from the stomata, often present. Placed within the Exobasidiomycetes.

Entyloma bellidis Willi Krieg. (= *E. calendulae* f. *bellidis*) Data Deficient

The FRDBI lists only a single record of this fungus, causing small circular yellowish or brownish spots on the leaves of Daisy *Bellis perennis*, from Aberdeenshire in 1932 until in 1995 Tom Preece discovered cultivated daisies with this fungus in gardens in the

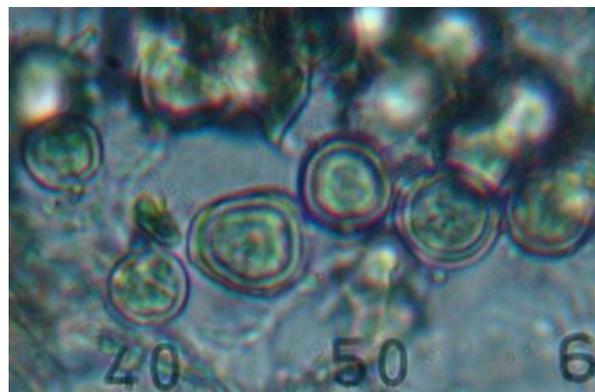
Llanymynach/Oswestry area of Shropshire (Preece & Clement 1997). He then went on to find it in wild Daisy populations in the area and on visits to Hampshire and London. One visit took him to Wales where he made the only Welsh record of this smut from Daisy near Water-break-its-neck, New Radnor, Radnorshire. Given its apparent abundance in west Shropshire we conclude that it must have been overlooked in Wales and in consequence is considered to be **Data Deficient**.

Entyloma calendulae (Oudem.) de Bary

Not Evaluated

This smut is probably locally common but under-recorded on the annual Garden Marigold *Calendula officinalis* where it forms pale yellowish-green spots on the leaves. No anamorph has been seen. There is a single record by PAS from a garden in Bargoed, Glamorgan-shire whilst AOC has recorded it from 6 sites in Cardiganshire and a single site nearby in Montgomeryshire, these being the milder parts of Wales where Pot Marigolds frequently overwinter successfully.

Searches in Mid Wales where the plant is a strict annual have failed to locate the fungus. It is not given a conservation status as it has not been found on a native or archaeophyte plant.



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Entyloma chrysosplenii (Berk. & Broome) J. Schröt.

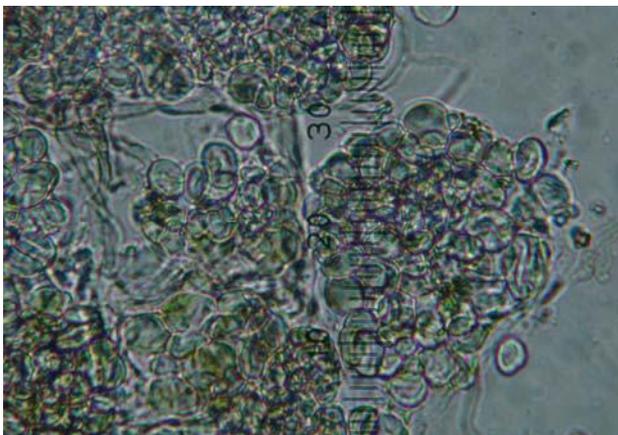
Critically Endangered D2

The FRDBI lists only 8 recent records of this smut on both Common and Alternate-leaved Golden-saxifrage *Chrysosplenium oppositifolium* and *C. alternifolium* from Britain. Despite the abundance of the host genus in Wales, it has been found only three times. Once by a stream in the Allt Ffwrn-du woodland 2km NE of Cwm Cou, Cardiganshire in June 2010 by AOC on Opposite-leaved Golden-saxifrage (below left) and twice by RGW on Alternate-leaved Golden-saxifrage in damp woodland in central Radnorshire (overleaf). There is only one other recent record on Common Golden-saxifrage in Britain with 6 other records on the

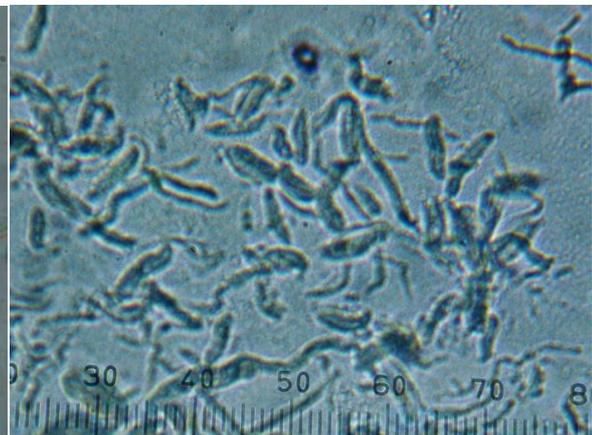


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scarcer Alternate-leaved Golden-saxifrage (the nearest being close to the Welsh border in Brillley Green Dingle, Herefordshire). In the Radnorshire sites this fungus was frequent on Alternate-leaved Golden-saxifrage but could not be found on adjacent patches of Common Golden-saxifrage. In spite of several return visits by AOC to the Cardiganshire site, it has not been found there again. It causes pale yellowish-green spots on the leaves and does genuinely appear to be scarce rather than overlooked.



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The ustulosores are illustrated bottom left on the preceding page, and the conidia bottom right. Evans *et al.* (2006) report it to be Vulnerable D2 in Britain. In Wales its known populations are so small it is considered to be **Critically Endangered D2**.

Entyloma eryngii (Corda) de Bary *sens. lat.*

Endangered D

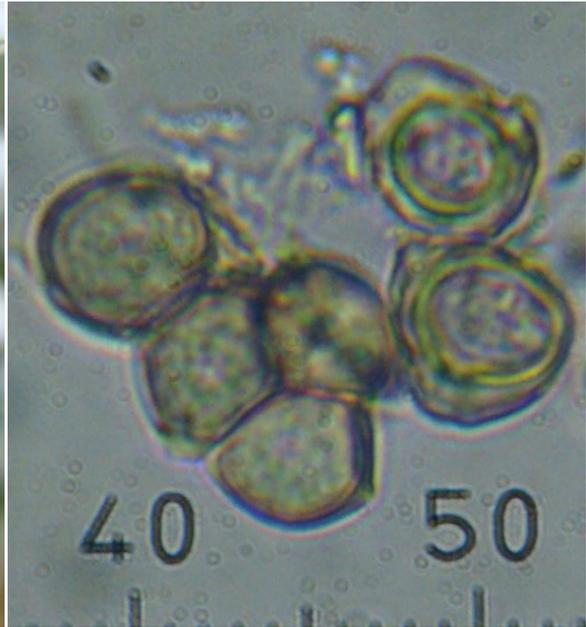
On Sea Holly *Eryngium maritimum*, forming brownish pustules on the leaves, it is considered by Evans *et al.* (2006) to be Endangered B in Britain. In Wales it occurs on the extensive



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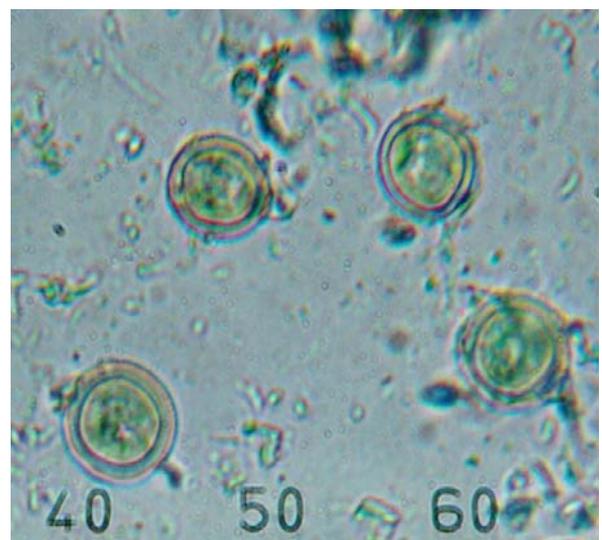
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dune systems of South and West Wales with recent records from Oxwich, Crymlyn Burrows and Baglan in Glamorganshire; Pembrey in Carmarthenshire; Freshwater West in Pembrokeshire; and Aberdyfi in Merionethshire. There is a record made in 1932 from Pwllheli in Caernarvonshire. Savchenko *et al.* (2014) consider the smut fungus on Sea Holly with spores 6-9 x 7-10 μ and walls 1-2 μ thick to be *Entyloma eryngii-maritimi*. Material collected by AOC from Pembrey Harbour and Aberdyfi, and by Barry Stewart from Baglan Burrows however had spores 10-16 x 8-12 μ and walls unevenly 1-5 μ thick, better matching *Entyloma eryngii* reported by Savchenko *et al.* to occur only on *Eryngium campestre*. However this issue is resolved, with sea level rising and continued offshore sand removal from the Bristol Channel, fore dune habitat is increasingly threatened in parts of Wales and this smut is categorized as **Endangered D** in Wales.

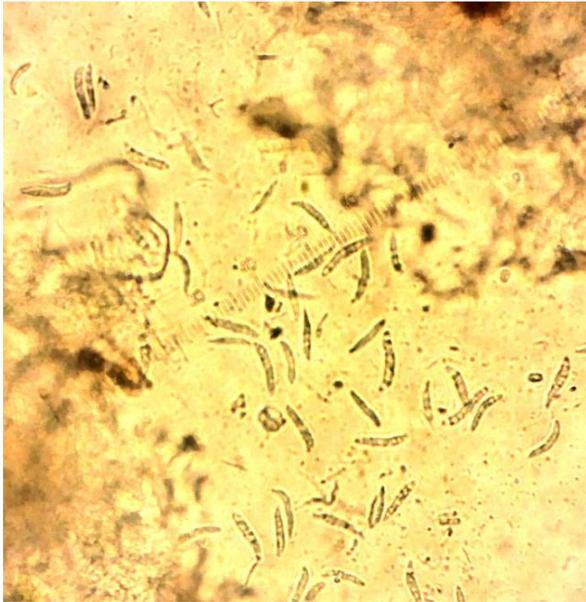
Entyloma ficariae Thüm. & A. A. Fisch

Least Concern

The Lesser Celandine smut is probably the commonest smut in Wales, with some 175 records in 123 tetrads from Cardiganshire alone and records from all but one Welsh VC. Pale yellowish or whitish spots are formed on the leaves. In Cardiganshire 70% of the records are on *Ficaria verna* subsp. *fertilis*, and 30% on subsp. *verna*. The spots are conspicuous and whitish or yellowish-brown. Conidiophores and conidia (see overleaf top left) of the anamorph are quite frequently present. In view of its widespread occurrence it is considered to be of **Least Concern**.



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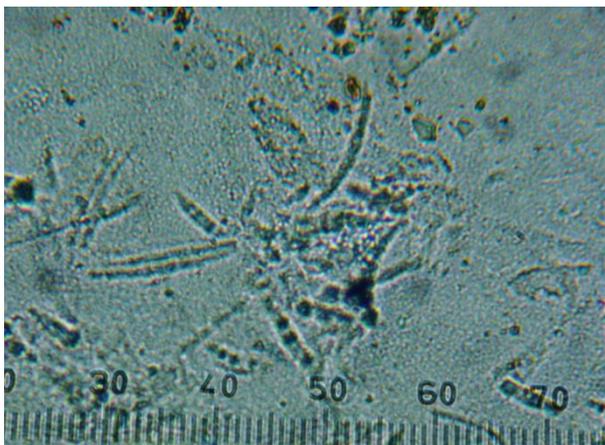


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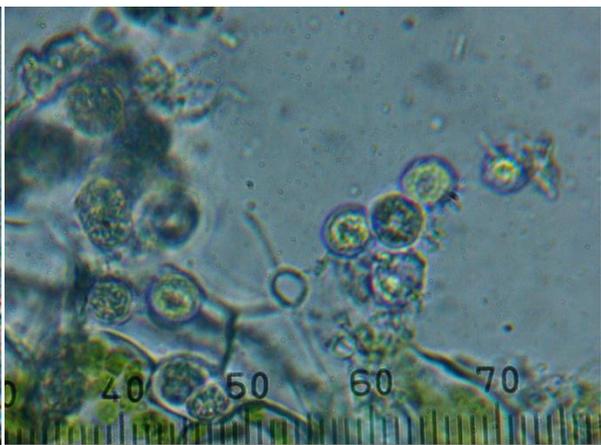
***Entyloma helosciadii* Magnus**

Least Concern

Recorded in Wales on Hemlock Water-dropwort *Oenanthe crocata* and Fool's-water-cress *Apium nodiflorum* where it forms small whitish or brownish spots on the leaves. It was first found in Wales by AOC on *O. crocata* and determined by RNS on the bank of the Cletwr at Craigypenrhyn, Tre'r-ddol, Cardiganshire in late May 2011. In 2018 it was found on *O. crocata* in 3 tetrads in Breconshire, 9 in Radnorshire, 1 each in Carmarthenshire, Monmouthshire and Pembrokeshire, 11 in Cardiganshire and 2 each in Montgomeryshire and Merionethshire. On *A. nodiflorum* it has been found in one tetrad in Breconshire and 2 in Cardiganshire. In consequence of these recent records it is considered to most likely be widely distributed in Wales, as it is in Southern and South West England, and therefore to be of **Least Concern**. The conidia, both bacilliform and longer sickle-shaped ones, are shown upper left below and ustilospores upper right below. The image bottom left shows the typical mottling of the upper surface of infected leaves and the under surface bottom right. It is most profitably searched for amongst the lower, older leaves particularly where they overhang streams. As the leaves senesce the areas colonised by the fungus become brown and in damp weather the conidia are clearly visible under a lens as a grey felt on the lower leaf surface.



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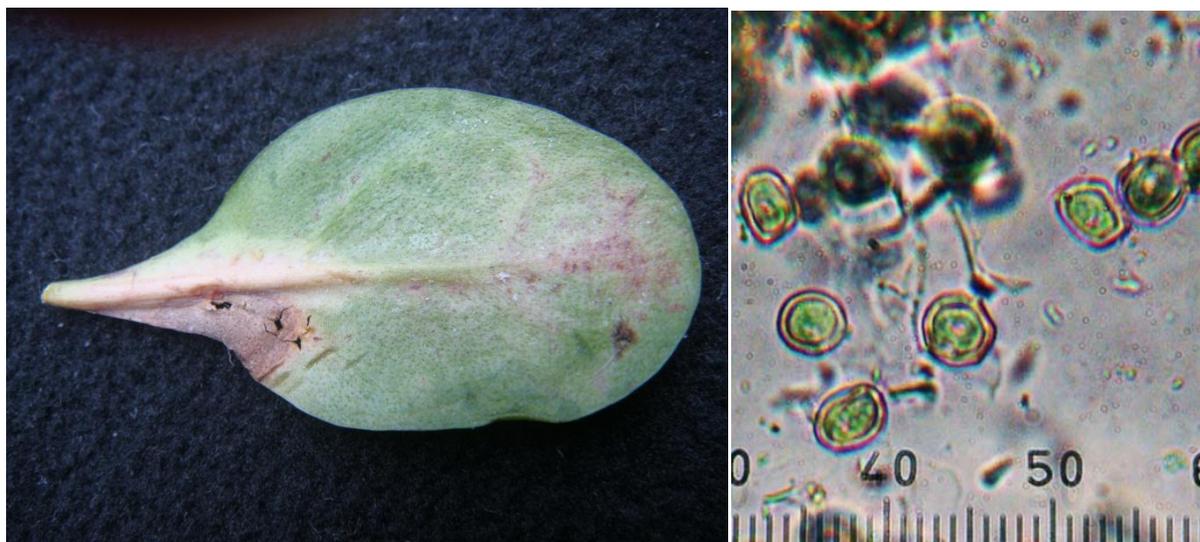


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***Entyloma henningsianum* Syd.**

Critically Endangered D2

Considered by Evans *et al.* (2006) to be extinct in Britain, it has subsequently been reported from four sites in Britain on the FRDBI. All were on Brookweed *Samolus valerandi*, with three sites in Somerset and Dorset and one in Wales, where it was discovered by AOC in 2004 and again in 2018 in the marshy pasture of Aberleri Fields near Ynys-las, Cardiganshire and determined by RNS. It forms sizeable yellowish or brownish spots on the leaves. In view of great rarity and small population size it is considered to be **Critically Endangered D2**.



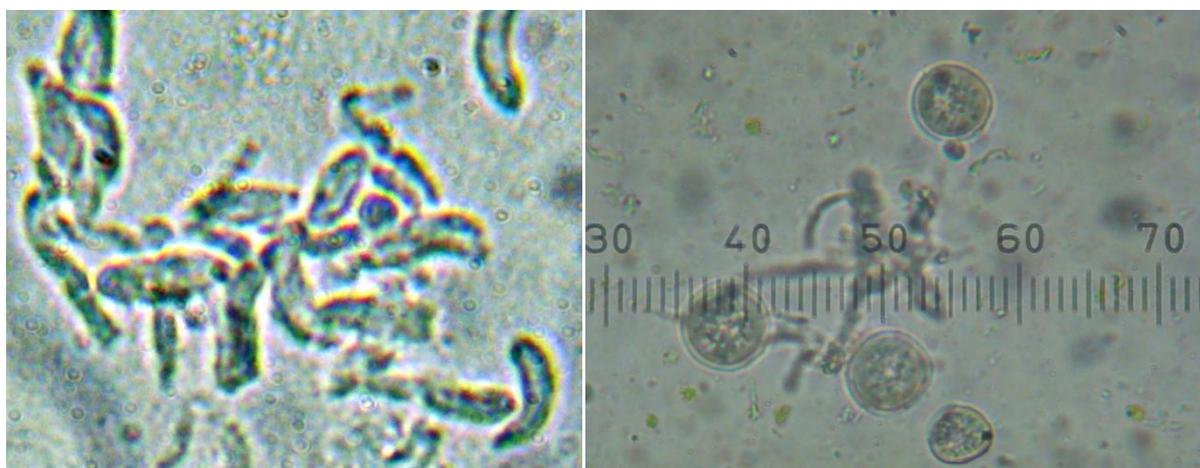
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***Entyloma linariae* J. Schröt.**

Data Deficient

Of the records reported on the FRDBI of this smut on Common Toadflax *Linaria vulgaris*, only four records, all in Devon, lie outside Cardiganshire. AOC has, however, found this smut from 19 sites in Cardiganshire, mostly near the coast. It forms very small, inconspicuous white or yellowish spots on the leaves. On Pendinas near Aberystwyth the host seems entirely free of it some years. The anamorph is illustrated, possibly for the first time, below left and the ustilospores below right. In view of the inconspicuousness and in consequence probable under-recording of this smut, its status is considered for the present to be **Data Deficient**.



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Entyloma microsporum (Unger) J. Schröt.

Least Concern

Recorded from 9 VCs in Wales on buttercup *Ranunculus* species. It is most frequent on Creeping Buttercup *Ranunculus repens*, with two records from Celery-leaved Buttercup *R. sceleratus* and a single old record on Meadow Buttercup *R. acris*. It is conspicuous, creating whitish to brown wart-like pustules and the spore walls are uneven and 1-9 microns thick. *E. ranunculi-repentis* on living leaves is less wart-like and has smooth spores with walls 1-2 microns thick and in *Urocystis ranunculi* the fungus develops into soot-coloured irregular masses of spore balls. In view of its relative frequency it is considered to be of **Least Concern**.



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***Entyloma ranunculi-repentis* Sternon**

Data Deficient

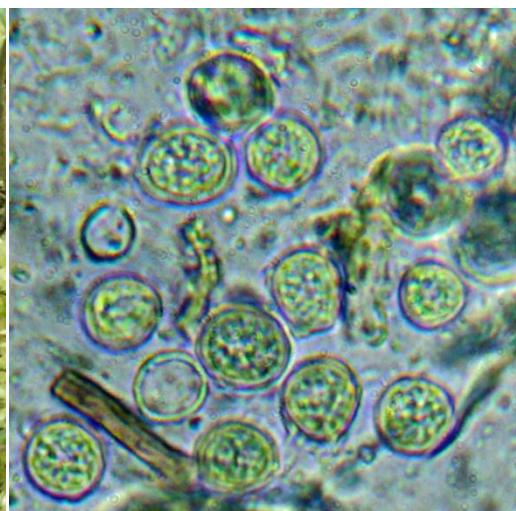
Separated recently from *E. ficariae*, despite the abundance of the host-buttercups in the genus *Ranunculus*, the pale-green to whitish unraised to slightly raised spots on the leaves have been rarely recorded in Wales, with all but one record made recently by AOC in West Wales. It was found from early February to mid-April, twice on Goldilocks *Ranunculus auricomus* (Burfa Camp, Radnorshire (RGW) – see image below left – and near Llechryd Bridge, Cardiganshire (AOC)), once on Meadow Buttercup *R. acris* and twice on Creeping Buttercup *R. repens* (overleaf) in Cardiganshire and once on Creeping Buttercup in Montgomeryshire. At all these sites conidia (right) were present. The ustilospores (below right) are pale brown with an evenly thickened wall 1-2 microns thick. It appears from the FRDBI to be widespread but rarely recorded in the rest of Britain. With a record on Goldilocks from close to the Welsh border in Herefordshire and a number of records from Celery-leaved Buttercup *R. sceleratus* outside Wales this smut appears likely to have been overlooked and pending further surveys is placed in the **Data Deficient** category.



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Entyloma serotinum

Not Evaluated

It is recorded on Borage *Borago officinalis* in a plant nursery in Meifod, Montgomeryshire by Tom Preece in 1996 and in Llandegai, Bangor, Caernarvonshire (recorder unknown) in 1993. In England there is a scatter of records on Comfrey *Symphytum* species and it should be sought on this more widely occurring host in Wales. It forms small yellowish or brownish circular spots. As it has not been recorded on a native host in Wales its conservation status has not been evaluated.

Exobasidium

Lacking sori, the spores are formed mostly on the lower surface of the leaves of Ericaceae and *Camellia*, forming a dense covering and usually causing reddening, swelling and distortion, sometimes of the whole shoot. Placed within the Exobasidiomycetes, see Ing (1998) and Nannfeldt (1981) for further information.

***Exobasidium arescens* Nannf.**

Endangered D

Reported by Bruce Ing on the leaf of Bilberry *Vaccinium myrtillus* in an oakwood at Coed Camlllyn, Merionethshire in 1998 and in SJ16 and SJ25 in Denbighshire in 1961. Small, scarcely thickened yellow or red spots are formed on the leaves. The FRDBI lists only three

other records from Britain, all in Highland Scotland. In view of the small population this fungus is categorized as **Endangered D**.

Exobasidium camelliae Shirai Not Evaluated

Reported rarely from Wales on the Garden Camellia *Camellia japonica* where it produces conspicuous fleshy swellings on the leaves and flower parts (right). As it has not been recorded in the wild in Wales its conservation status has not been evaluated.



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Exobasidium japonicum Shirai Not Evaluated

Reported only rarely on introduced Azalea group taxa of Rhododendron, in gardens in Wales. It causes pale fleshy galls up to 3cm across on the leaves (below). As it has not been recorded in the wild in Wales its conservation status has not been evaluated.



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Exobasidium juelianum Nannf. Dwarfing Redleaf

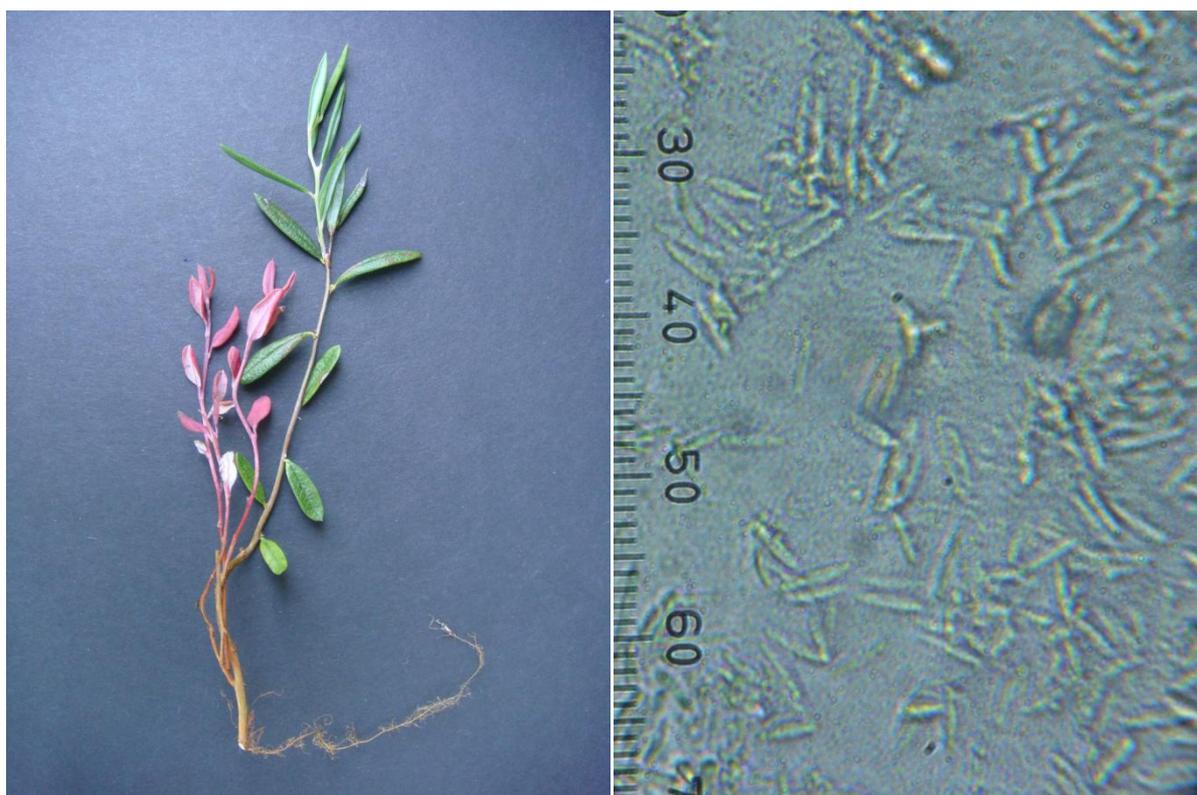
Data Deficient

Deforming and dwarfing whole shoots and leaves and sometimes even the flowers of Cowberry *Vaccinium vitis-idaea* and turning them pink, this fungus has only been reported once from Wales by Bruce Ing in Denbighshire in 1961. Very rare in the North of England, almost all other British records are from Scotland. Its current status and population size in Wales is unknown so consequently it is placed in the **Data Deficient** category.

Exobasidium karstenii Sacc. & Trotter

Least Concern

Widespread on Bog-rosemary *Andromeda polifolia* in Mid Wales causing whole shoots, arising from underground, to become thickened and pink, with the leaves broadened and usually flattened, later becoming blackish. In Cardiganshire AOC also notes that it can be found at the same sites each year, but it seems absent from many of the host sites. Bog-rosemary is nowhere common and some sites have been lost by coniferous afforestation such as on Llanbrynmair Moors. Unfortunately no early records of this fungus have been traced from Wales so losses cannot be measured. With Bruce Ing's records (FRDBI) from the 1950's and 60's this fungus is reported from 11 hectads in Wales and is therefore placed in the **Least Concern** category pending a resurvey to update records.



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Exobasidium myrtilli Siegm. (= *E. vaccinii-myrtilli*) Blaeberry Redleaf

Least Concern

The leaves of whole shoots of Bilberry *Vaccinium myrtillus* become enlarged, slightly thickened and pale yellowish or reddish on the upper surface and white with the spores beneath. It appears to occur in well-lit situations such as on banks and in this survey has

never been seen on tall Bilberry within woodlands. There are recent records from 18 hectads and 7 VCs in Wales and in consequence this fungus is considered to be of **Least Concern**.



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Exobasidium oxycocci Rostr. ex Shear

Near Threatened

This highly conspicuous fungus, recorded from eight sites in Wales in four VCs (Cardiganshire, Merionethshire, Caernarvonshire and Denbighshire) and little more than a score of sites recently in the rest of Britain, causes the shoots of Cranberry *Vaccinium oxycoccos* to become swollen and pink and grow upright. Not easy to overlook, it must in consequence be genuinely rare. Had it been better recorded in the past it is certain a decline would have been noted since large areas of habitat formerly occupied by Cranberry-dominated bogs were drained and planted with conifers in the latter half of the 20th century in Wales. In the absence of such evidence and with records from fewer than 10 hectads (5 of which are in Cardiganshire) it is placed in the **Near Threatened** category.



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Exobasidium rhododendri (Fuckel) C.E. Cramer

Not Evaluated

Reported widely in South and West Wales from *Rhododendron* species, hybrids and cultivars (but not the *Azalea* group taxa), mostly in gardens. It distorts the leaves into reddish apple-galls. This introduced species of smut is placed in the **Not Evaluated** category.



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Exobasidium rostrupii Nannf.

Least Concern

Recorded from at least 20 hectads in Wales and 6 VCs on Cranberry *Vaccinium oxycoccos*, mostly in valley mires. The fungus causes scattered leaves on the creeping stems of the host to develop bright red blotches or become entirely red (right). In view of its widespread occurrence it is considered to be of **Least Concern**.

Exobasidium vaccinii (Fuckel) Woronin Cowberry Redleaf

Near Threatened

This conspicuous fungus thickens and reddens the leaves of Cowberry *Vaccinium vitis-idaea*, which also become pouch-shaped. Rarely the shoot tips are affected, but never the whole shoot as in *E. julianum*. It has been reported from 6 VCs in Wales. Cowberry has a very patchy distribution in Wales and this fungus appears to be rare. It could be placed in the Vulnerable D2 threat category but with numerous recent records from the Shropshire Hills close to the Welsh Border it is downgraded to **Near Threatened**.



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Farysia

Sori in the flowers of Cyperaceae, producing masses of brown or blackish, variously ornamented spores mixed with fascicles of elaters. Placed within the Ustilaginomycetes.

Farysia thuemenii (A.A. Fisch. Waldh.) Nannf.

Near Threatened

This smut may prove to be widespread on the Greater Pond-sedge *Carex riparia* in coastal fens in southern Wales. There are currently records from Penclacwydd Wetland Centre, Pendine Burrows and Whitehill Down near Laugharne in Carmarthenshire and on Pendulous Sedge *Carex pendula* at Marros in the same VC and on a single plant in a large population of the sedge in damp woodland by Llanina Bridge, at New Quay and on the Teifi Marshes (see below left), Cardiganshire. A population on Lesser Pond-sedge *Carex acutiformis* at Plas Bodafon, Anglesey is the only known North Wales record. The masses of brown spores and elaters conspicuously spilling from the female spikes make this one of the more



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easily detectable smut fungi. Though widespread in Britain on several species of sedge, it appears genuinely rare in Wales. Occurring in fewer than 10 hectads in Wales it is placed in the **Near Threatened** category.



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Haradaea

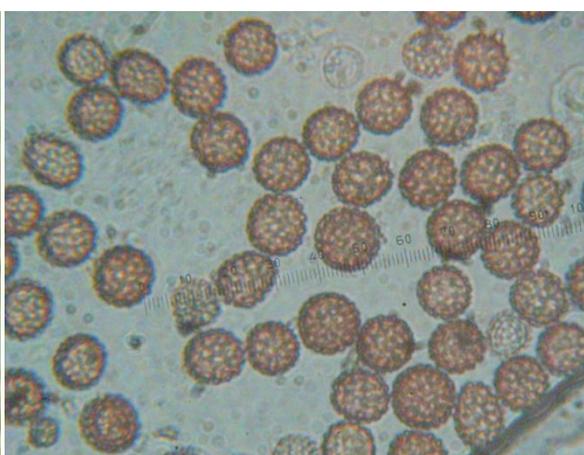
There do not appear to be any easily observable morphological characteristics that separate this genus from *Microbotryum*. The split is justified on differences in DNA. Further work is required on the following two species which may prove to be conspecific. The genus is placed within the Microbotryomycetes.

Haradaea duriaeana (Tul. & C. Tul.) Denchev & H.D. Shin (= *Microbotryum duriaeenum* & *Ustilago duriaeana*) Critically Endangered D2

A rare smut of Sticky Mouse-ear *Cerastium glomeratum*. Of the three British records two are from Wales. It was first recorded by Andy Jones from under grazed gorse at Ffridd Faldwyn, Montgomery, Montgomeryshire in 2013 (Denchev *et al.* 2010). AOC found a second record on a sloping, heavily poached pasture on the coast north of Llanrhystud, Cardiganshire in mid-June 2016. Many plants in the population were infected, the brown spores conspicuously spilling out of the capsules. A search of this latter site in 2017 failed to re-find this fungus and the host was much diminished. It was, however, re-found in May 2018 when the host was abundant again. The only other British record is from Essex in 1902. As fewer than 50 plants have been found infected in Wales this smut is considered to be **Critically Endangered D2**.



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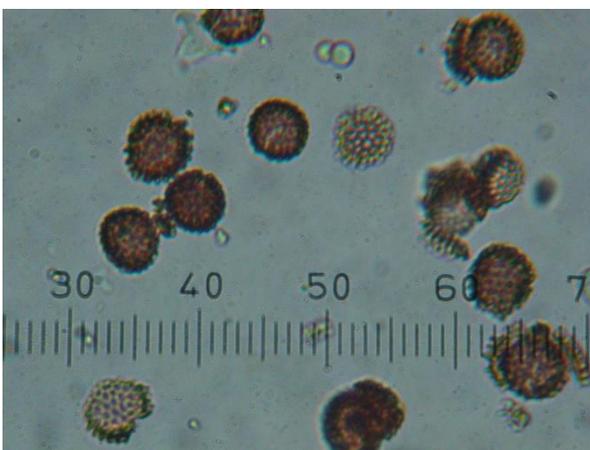
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Haradaea moenchieae-manticae (Lindtner) Denchev & H.D. Shin (= *Microbotryum moenchieae-manticae*) Data Deficient

With possibly four records from Britain on the FRDBI this is clearly a scarce smut. Its spores are produced inconspicuously in the ovaries of Upright Chickweed, *Moenchia erecta*, itself a somewhat uncommon plant. There are three Welsh records. Two were made by Andy Jones at Ffridd Faldwyn, Montgomery, Montgomeryshire in 1997 and 1998. Subsequent



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searches have failed to relocate it but in 2013 revealed the presence of *H. duriaeana* on Sticky Mouse-ear (see above) nearby. This coincidence of discovering two extremely rare fungi so close together has prompted a re-examination of the differences between these two taxa (Spooner & Legon, 2006). A result is still awaited. The FRDBI also records the presence of this smut on Upright Chickweed in Radnorshire. The collection was made in 1997 by Tom Preece at "Newtown". There does not appear to be a place of this name in Radnorshire though it is of course the largest conurbation in nearby Montgomeryshire. The two other records were made from Hampshire and Sussex in 2015. In view of the uncertainty concerning the current status of this fungus in Wales it is placed in the **Data Deficient** category.

Melanotaenium

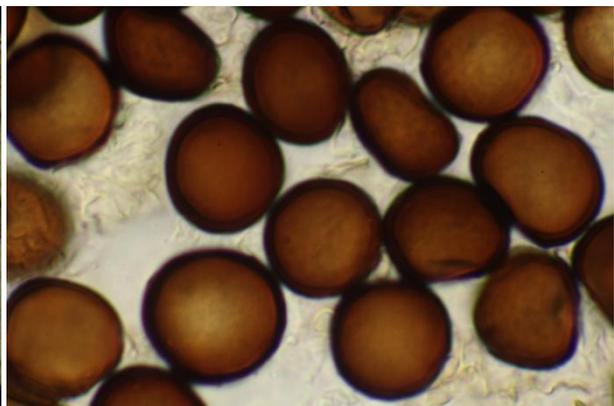
Sori in the leaves and stems of dicotyledons, often distorting the host and producing smooth, dark, thick-walled spores. The genus is placed within the Ustilaginomycetes.

Melanotaenium cingens (Beck) Magnus Yellow Toadflax Smut Extinct

Noted by Evans *et al.* (2006) as extinct in Britain. Almost all British records of this very distinctive smut that develops as slate-grey streaks in stem and leaves and later blackens the upper parts of the whole plant of Common Toadflax *Linaria vulgaris* were from NE Wales. The first detailed record traced is from Glyndyfrdwy, Llangollen in Denbighshire by CT Green (Anon 1902, pp6-7). It was then recorded from Corwen in Merionethshire in 1908 also by CT Green. Glyndyfrdwy lies mid-way between Corwen and Llangollen and the village is in Merionethshire. It is possible that these records represent a single site and the Denbighshire record could be doubtful. It was last recorded in Wales at Prestatyn in Flintshire in 1931 by L Nicholls. Ainsworth & Samson (1950) also note a record from Cambridgeshire, though no details can be traced. The nearest known colonies may now be in France. The illustrations below, provided by Paul Cannon are from Welsh material held at Kew. In the absence of any more recent records this fungus is considered to be **Extinct** both in Britain and Wales.



© PF Cannon



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Melanotaenium endogenum (Unger) de Bary Bedstraw Smut

Regionally Extinct

Considered Vulnerable D2 in Britain by Evans *et al.* (2006), the only Welsh record was made on Lady's Bedstraw *Galium verum* growing in shingle at Borth, Cardiganshire by J. Bayliss-Elliott at some time in the 20th century. In the absence of any recent records in Wales it is considered **Regionally Extinct**.

Microbotryum

Sori in the floral parts of various dicotyledons, producing light to blackish spore masses, the spores being variously ornamented (usually reticulately). The genus is placed in the Microbotryomycetes.

Microbotryum cordae (Liro) G. Deml & Prillinger (= *Ustilago cordae*)

Least Concern

Probably frequent on Water Pepper *Persicaria hydropiper*, but it is inconspicuous as the brownish-violet spore masses remain long inside the perianth. An infected plant is



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shown on the right of the image on the previous page. To the left is Water-pepper infected with *Sphacelotheca hydropiperis* with black spore masses protruding from the perianth. The reticulated spores of *M. cordae* (previous page) differ from the smooth spores of *S. hydropiperis* which are developed around a prominent columella in the latter species. There are records from 5 vice-counties and over 30 sites scattered through Wales. It is less frequent on Redshank *P. maculosa*, with records from Cardiganshire (5 sites) and Montgomeryshire and with a single record on the var. *dumosa* from Cardiganshire. It is considered to be of **Least Concern**.

Microbotryum coronariae (Liro) Denchev & T. Denchev (= p.p. *Ustilago violacea*)

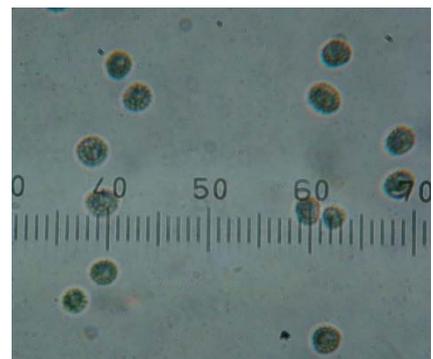
Vulnerable D

The anther smut of Ragged-Robin *Silene flos-cuculi* has only recently been treated as a separate species from that of Red Campion *Silene dioica* and so unless host information was collected with the record some records cannot be separated. Notwithstanding that limitation this smut appears to be genuinely rare in Wales with recent records traced only from Penfrosfa Mire, Llandrindod Wells, Radnorshire, near Llanybydder in Carmarthenshire, from

near Llyn Fanod in Cardiganshire, near Dovey Junction Station in Montgomeryshire and from Cors Bodeilio and Porth Diana on Anglesey. Given that the population certainly numbers fewer than 1000 individuals it is considered to be **Vulnerable D**.



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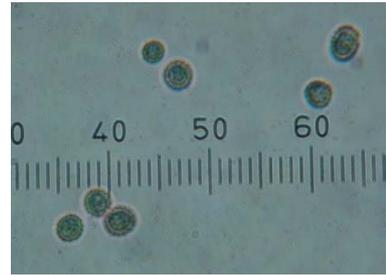
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Microbotryum lychnidis-dioicae (Liro) G. Deml & Oberw. (= p.p. *Ustilago violacea*)

Campion Anther Smut

Least Concern

Common and highly visible by the fungus producing purple-black spore masses in the anthers of the stamens in flowers of Red Campion *Silene dioica* (below left) throughout Wales and recorded from over 100 sites. It is much rarer on White Campion *Silene latifolia* subsp. *alba* (below right) with records only from Carmarthenshire, Cardiganshire and Flintshire. It is considered to be of **Least Concern**.



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Microbotryum pinguiculae Rostr. & Vánky

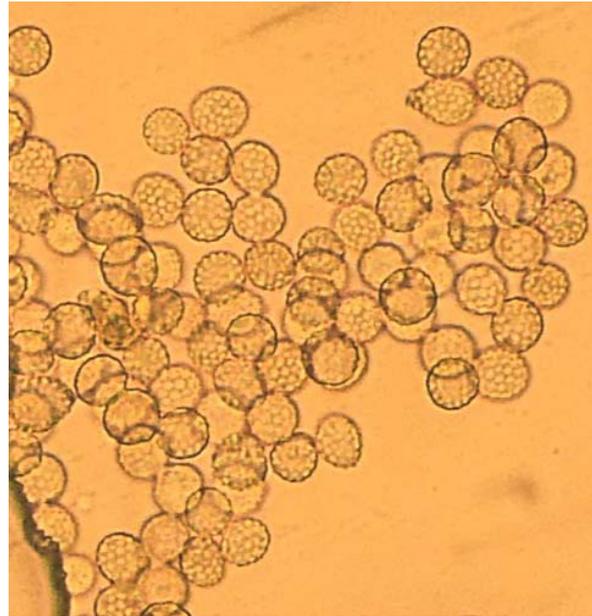
Least Concern

Ziegler *et al.* (2018) published a review of the smut species sporulating in the anthers of *Pinguicula* (Butterwort) species. There were no records from the British Isles of this complex. This paper, however spurred a search and RGW discovered this smut in the first population of Common Butterwort *P. vulgaris* examined. About a quarter of the flowers in a



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large population on Pentrosfa Mire, Llandrindod Wells, Radnorshire instead of having pure white pollen grains within the two stamens were found instead to have produced buff-coloured smut spores. Some infected flowers also tended to have the upper corolla lip somewhat contorted so as to narrow the entrance to the flower. Further populations of this smut were quickly discovered by RGW, AOC, Julian Woodman and Gethin Elias. It is now known from two sites in Radnorshire three sites in Breconshire, seven sites in Cardiganshire and two sites in Merionethshire. The success rate in locating infected plants in Breconshire and Radnorshire was 100% with over 50% of the flowers examined containing the smut. In Cardiganshire AOC found 7 out of 12 populations of butterwort with the smut (226 flowers inspected, 81 with the smut) and infection rates in excess of 30% were noted in all the infected sites. It appears highly likely that this smut, widely recorded from Western Europe, has been overlooked in Wales and it is considered appropriate to place it in the **Least Concern** category. The image on the preceding page shows the flower with the corolla tube sliced open to expose the stamens on the left which instead of producing white pollen grains are buff-brown from the production of ustilospores. The reticulated ustilospores are shown above right.

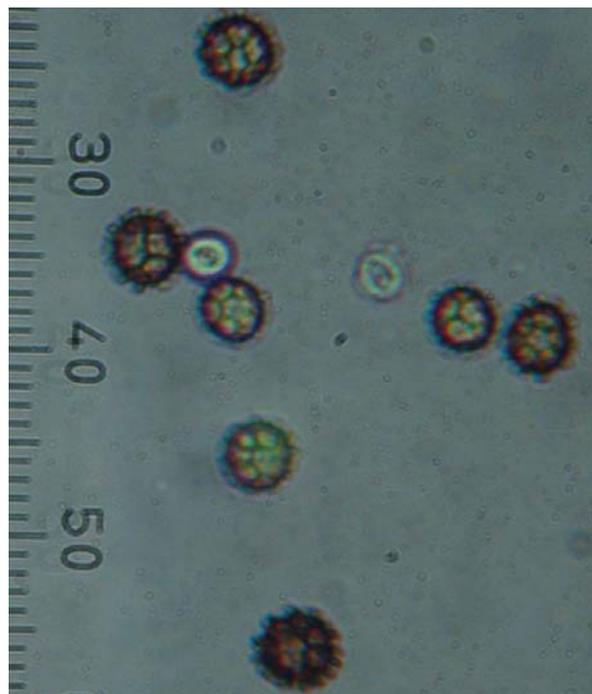


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Microbotryum reticulatum (Liro) R. Bauer & Oberw (= *Ustilago utriculosa*)

Vulnerable D1

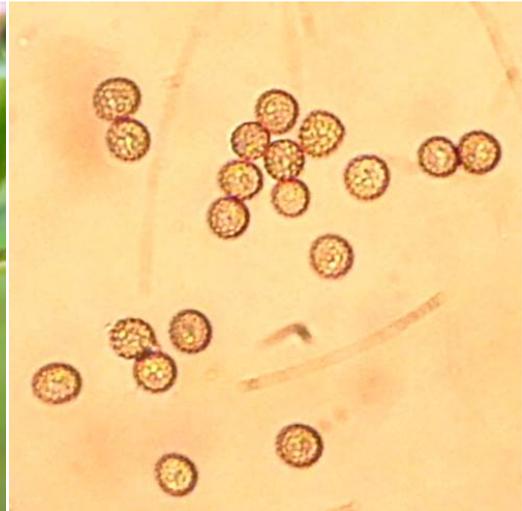
Uncommon or overlooked and differing from *M. cordae* in the much coarser reticulations on the spores. In the ovaries of Pale *Persicaria Persicaria lapathifolia*, (including the subsp. *pallida*) (image overleaf left) with single records from Glamorganshire (Ty-du, Capel Llanilltern, coll. Julian Woodman, det. AOC), Breconshire (in a recently reseeded grass ley, Llanfihangel Brynpabuan, RGW) Radnorshire (in a birdseed crop, Gilfach Farm, Rhayader, RGW) and Anglesey (Llyn Alaw, coll Martyn Stead, det DAE), and 3 records by AOC from Cardiganshire in arable fields and on a roadside. Occurring in only 6 hectads it is considered to be **Vulnerable D1**. The widespread use of pre-emergence weed killers on arable crops in recent years has greatly reduced the abundance of the host plant.



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M. reticulatum



© DA Evans *M. saponariae*

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Microbotryum saponariae M. Lutz, Göker, Piatek, Kemler, Begerow & Oberw.

(= p.p. *Ustilago violacea*)

Data Deficient

Considered to have been erroneously reported from Britain by Legon & Henrici (2005), this smut, widespread on the Continent, had been found in 1998 in Cambridgeshire and more recently in Devon, Cornwall and Lancashire and in two sites in Wales. It turns the anthers of the flowers of *Saponaria*

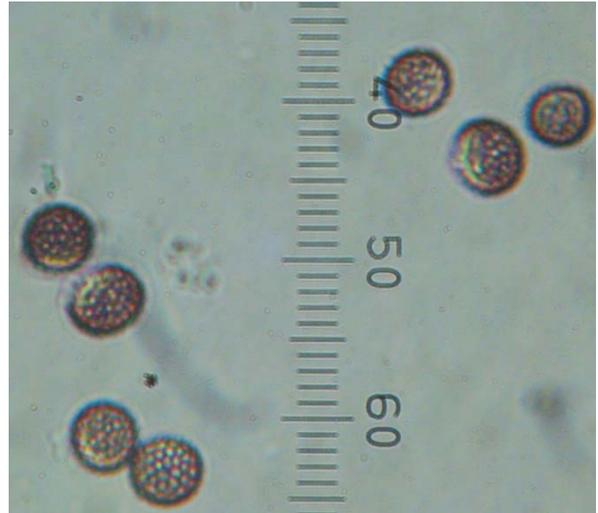
officinalis Soapwort conspicuously purple-black, being found in all the flowers of a particular plant and often causing the flowering cymes to become more compressed. Seeds do not appear to be set in infected plants. In Wales it was reported by Graham Watkeys at Pwll Waun Cynon Nature Reserve, Mountain Ash, Glamorganshire and by RGW on the banks of the River Usk above and below Llanfoist Bridge, Abergavenny, Monmouthshire. As probably a recent colonist of Britain, a **Data Deficient** categorization is proposed.



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Microbotryum scorzonerae (Alb. & Schwein.) G. Deml & Prillinger
Critically Endangered D2

This smut fungus systemically infects populations of Viper's-grass *Scorzonera humilis*, transforming the florets into a conspicuous mass of blackish violet spores. It is known from a single site in Glamorgan where it was first found by Julian Woodman in early April 2014 (see image below). Infected plants flower earlier than normal and tend to be smaller and so may have been missed previously. Cheffings *et al.* (2005) list the host plant as a British national RDB Vulnerable species, as it is in Wales (Dines, 2008). This smut was recorded on the same host in Dorset in 2017 by Brian Gale and others. The smut is entirely dependent on this host which is unknown elsewhere in Britain. The Glamorgan population is at the very edge of the European range of both fungus and host, and is protected to some extent by a SSSI designation. Given the small size of the single Welsh population it is considered to be **Critically Endangered D2**.



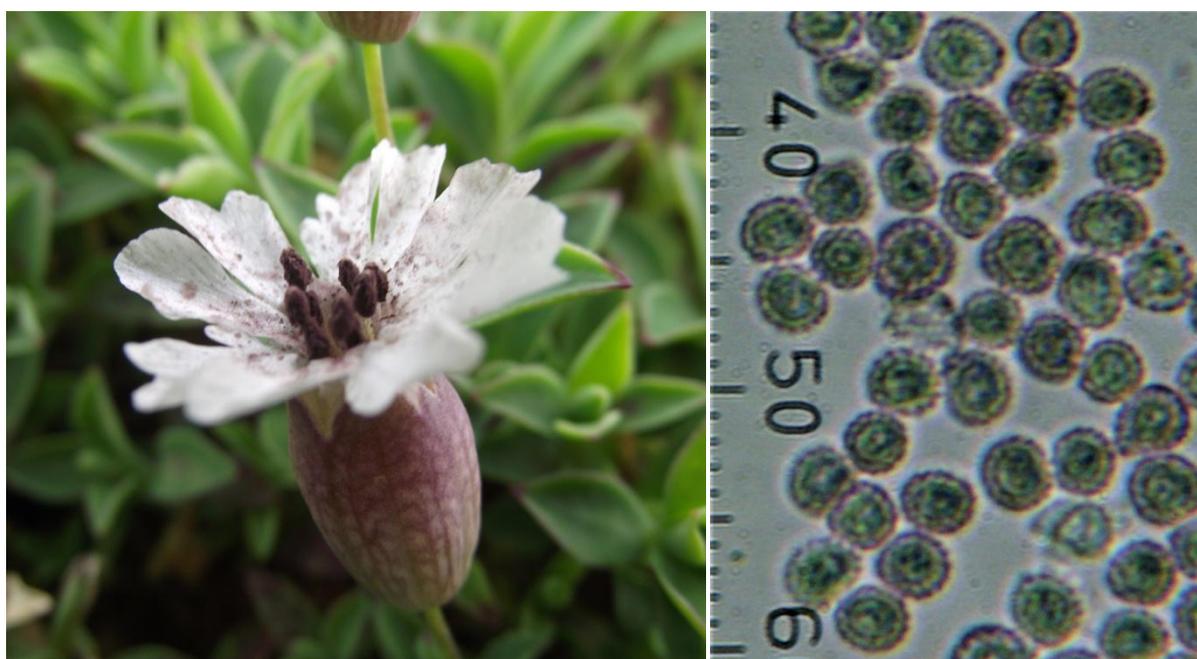
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© JP Woodman

Microbotryum silenes-inflatae (Liro) G. Deml & Oberw. (= p.p. *Ustilago violacea*)
Least Concern

Widespread and distinctive where its purple-black spores spill out from the anthers of Sea Campion *Silene uniflora* around the Welsh coast and occasionally on inland populations on cliffs and old lead mines. There is one record on *S. uniflora* × *vulgaris* at Esgair Fraith lead mine in Cardiganshire. Chung *et al.* (2012), using DNA methods, recognised an additional very similar species in southern England, *M. lagerheimii*, but the three populations they investigated in Wales, in Cardiganshire and Pembrokeshire, were *M. silenes-inflatae*, and the spore colour (there seems to be no other visible character) of several other Cardiganshire populations suggested to PAS that they were also this species. The VC distribution is incomplete since the recent major revision of anther smuts in the Caryophyllaceae. It is considered to be of **Least Concern**.

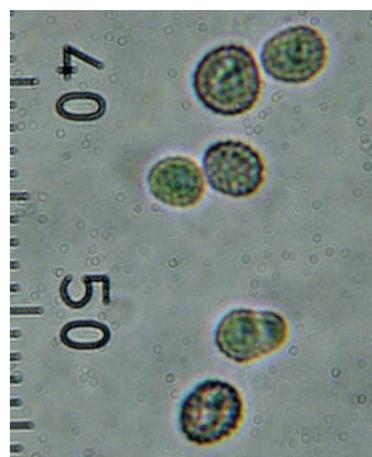


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Microbotryum stellariae (Sowerby) G. Deml & Oberw.
(= p.p. *Ustilago violacea*) Least Concern

One of the commonest smuts in Wales, conspicuously infecting the anthers of Lesser Stitchwort *Stellaria graminea* with blackish-violet spore masses (see image overleaf). With records from over 30 hectads and from 8 VCs, it is considered to be of **Least Concern**.



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Microbotryum stygium (Liro) Vánky
Critically Endangered D2

Filling the flowers of Common Sorrel *Rumex acetosa* with blackish-purple spores, this smut was recorded only once in Wales, at Castle Hill, Llansteffan, Carmarthenshire by R. W. G. Dennis in 1971 (Spooner & Legon, 2006). There are only four other British records, from Suffolk, Derbyshire and Peeblesshire. With only a single record from Wales and four other British records this smut is considered to be **Critically Endangered D2**.

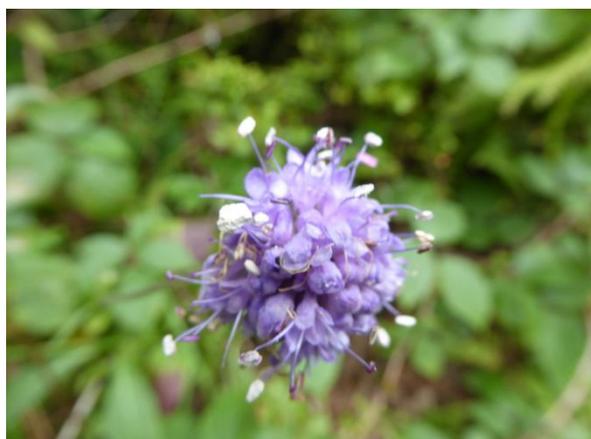


M. stellariae

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Microbotryum succisae (Magnus) R. Bauer & Oberw. (= *Ustilago succisae*)
Vulnerable D

Infected anthers of Devil's-bit Scabious *Succisa pratensis* flowers become enlarged and white rendering this smut relatively easy to find. There are, however only 10 records from 4 VCs in Wales. Despite extensive searches it has not been found in most of central SW Wales where its host plant is most abundant. At Abercamlo Bog near Crossgates, Radnorshire the same plant has hosted this smut over three successive years. As fewer than a thousand plants support this smut it is placed in the **Vulnerable D** category.



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Microbotryum tragopogonis-pratensis (Pers.) R. Bauer & Oberw. (= *Ustilago tragopogonis-pratensis*)
Vulnerable D2

This fungus infects the inflorescence of Goat's-beard *Tragopogon pratensis*, replacing the inflorescence with a sooty mass of spores set amongst some chaffy scales. It is in consequence difficult to overlook. Recent records have been traced from only three VCs viz. Glamorgan, Radnorshire and Anglesey and it might be considered to be Endangered. The

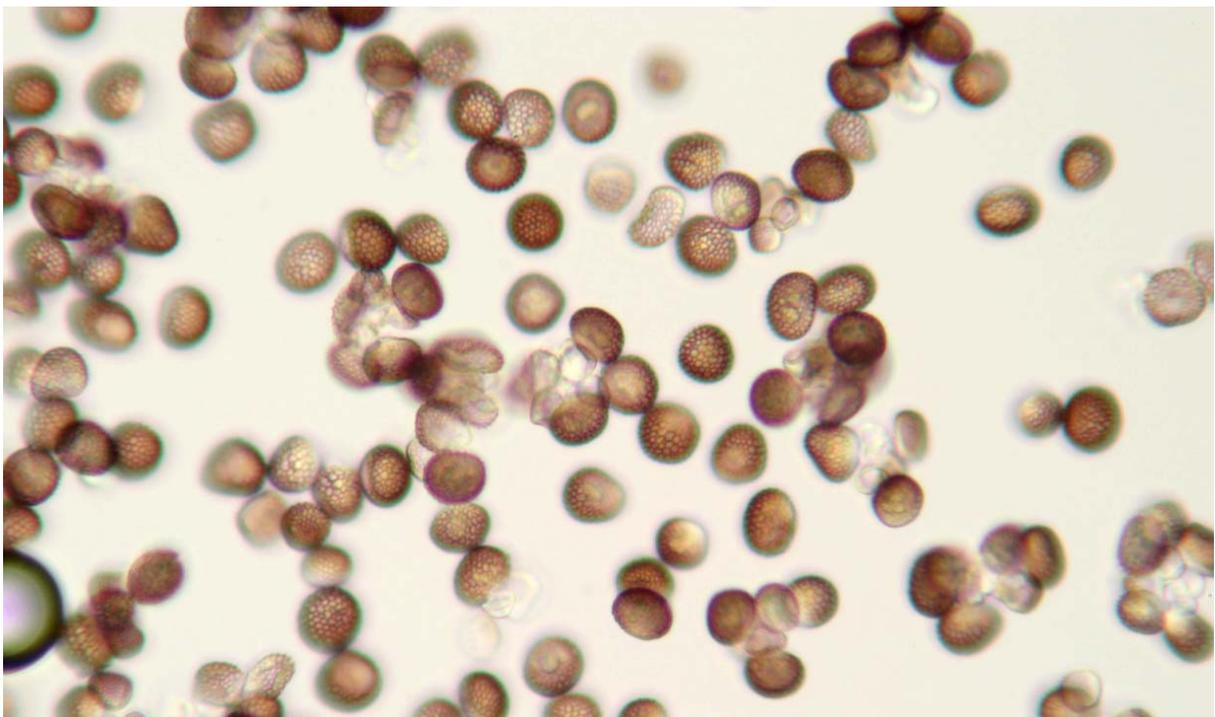
FRDBI however lists a number of records from the Welsh Marches in England where the host plant is more widespread. In consequence the threat status is dropped by a category and this fungus is placed in **Vulnerable D2**. The distinctive blackening of the Goat's-beard inflorescence is shown in the upper images below and the ustilospores in the lower image.



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[*Microbotryum violaceum*, the cause of anther smuts in the Caryophyllaceae has been split into the following species:-*M. coronariae* is the anther smut of Ragged-Robin *Silene flos-cuculi*. *M. lychnidis-dioicae* occurs on Red Campion *Silene dioica* and White Campion *S. latifolia* subsp. *alba*. *M. saponariae* occurs on Soapwort *Saponaria officinalis*. *M. silenens-inflatae* occurs on Sea Campion *S. uniflora* and its hybrids, whilst *M. stellariae* is found on Lesser Stitchwort *Stellaria graminis*.]

Microstroma

Lacking sori, the whitish spores are produced by clusters of conidiophores emerging from stomata on the lower surface of the leaves of various trees; pale or yellowish spots are visible above, but with no distortion. The genus is placed in the Exobasidiomycetes.

Microstroma album (Desm.) Sacc.

Least Concern

For what at times can be a very conspicuous fungus on the underside of Oak leaves, creating chalk-white powdery patches, there were few records from both Wales and the rest of Britain at the commencement of this study. First noted in Wales by JE Vize at Forden in Montgomeryshire in the nineteenth century, it was next recorded in the VC in 2014 by AOC on Pedunculate Oak *Quercus robur* in Machynlleth. He has also made six records on this host, two on the hybrid *Q. × rosacea* and one on Sessile Oak *Q. petraea* in Cardiganshire along with a record on Turkey Oak *Quercus cerris* in Aberystwyth. There are twelve additional recent records from Pedunculate Oak: one each in Monmouthshire and



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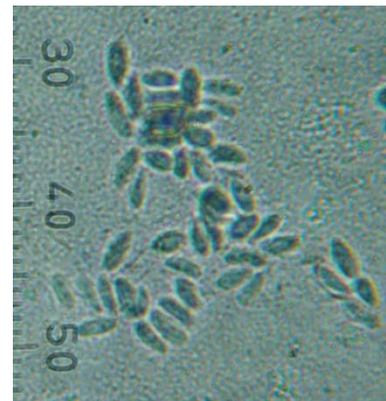
Glamorganshire and five each from Carmarthenshire and Radnorshire. There is a further single record from Bute Park, Glamorganshire on Turkey Oak and two further Welsh records from the hybrid *Q. × rosacea*, one in Breconshire and one in Radnorshire. As there have been fewer records in Wales from Sessile Oak *Q. petraea* the fungus may be genuinely less frequent on this host. At the Abercamllo site in Radnorshire referred to above, despite Pedunculate Oak supporting numerous colonies of this fungus only traces were found on an intertwining Sessile Oak. In the same VC it was found in small quantity on Sessile Oak on the Gilfach Radnorshire Wildlife Trust nature reserve north of Rhayader. This widespread scatter of records from a range of hosts suggests this smut is widespread but overlooked and it is accordingly considered to be of **Least Concern**.



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Microstroma juglandis (Bérenger) Sacc. Not Evaluated

There are only six records from Wales, all on the leaves of planted Walnut *Juglans regia* trees, but it is probably widespread wherever walnuts are grown. Noted on a tree in the appropriately named Walnut Tree Cottage, Llanigon, Breconshire by David Mitchel in 2014, in the same year it was collected by Matt Sutton from a recently planted sapling at Windrush Pastures, Redberth, Pembrokeshire. In July 2016 was noted by AOC in the garden of Ynys Edwin, Eglwys Fach, Cardiganshire. In 2017 it was noted at Glynhir, Llandybie, Carmarthenshire by AOC and in the garden of Boughrood Castle, Radnorshire and in the grounds of Plas Dolmelynlyn at Ganllwyd, Merionethshire by RGW. With no records from a native or archaeophyte host this fungus has not been evaluated.



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Rhamphospora

A monotypic genus, the sori forming spots on the leaves of Nymphaeaceae. The pale, smooth spores, embedded in the host tissues, bear a papilla at one end and a short hyphal appendage at the other. The genus is placed in the Exobasidiomycetes.

Rhamphospora nymphaeae D.D. Cunn.

Not Evaluated

There are two recent records from Wales both made by AOC on the leaves of White Waterlily *Nymphaea alba* in ornamental ponds at Llwyncelyn, Glandyfi, Cardiganshire and nearby at Derwen-las in Montgomeryshire. A search of the only nearby native population of *N. alba* on Llyn Fanod failed to locate this smut, though infection lesions resemble many other forms of leaf discolouration. As it has yet to be recorded in the wild in Wales the status of this smut fungus is **Not Evaluated**. It is not described by Ainsworth & Samson (1950) and the first British records on the FRDBI are from ornamental parklands in 1963 in SE England. It may be a recent introduction.



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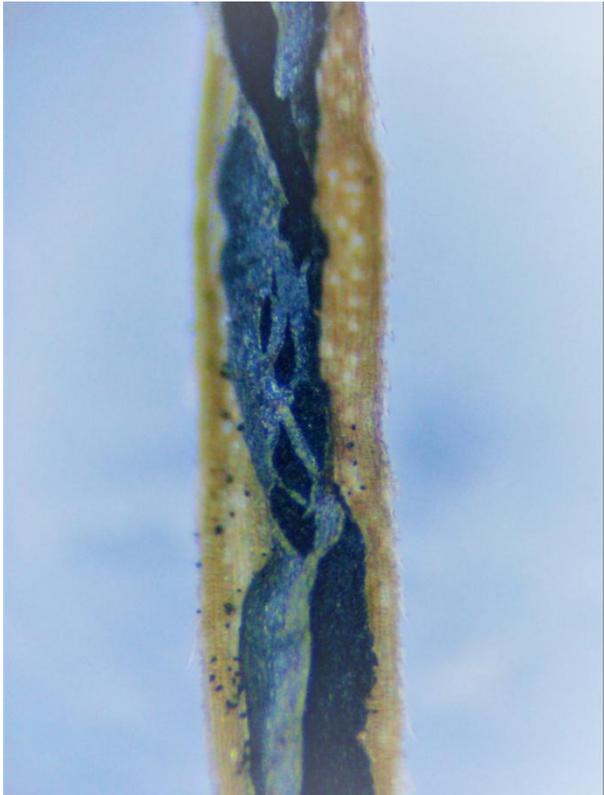
Schizonella

Sori forming streaks in the leaves of Cyperaceae, releasing blackish, usually paired and sometimes agglutinated spores. The genus is placed within the Ustilaginomycetes.

Schizonella melanogramma (DC.) J. Schröt.

Critically Endangered D2

Considered by Evans *et al.* (2006) to be extinct in Britain. It was re-discovered in the leaves of a Spring Sedge *Carex caryophyllea* plant in summer-droughted turf on a well-drained slope at Hirllwyn Bank, Hundred House, Radnorshire by Steve Chambers in May 1999. When young the agglutinated spore masses form black striae along the leaf blades. Previous British mainland records had been from the Rare Spring-sedge *C. ericetorum* in West Suffolk and from the Glaucous Sedge *C. flacca* in South Aberdeenshire, both in the 1950's. In view of the single record it is placed in the **Critically Endangered D2** category.



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Sphacelotheca

Sori in the ovaries of Polygonaceae, bursting out with a conspicuous columella as a blackish-violet structure. The genus is placed within the Ustilaginomycetes.

Sphacelotheca hydropiperis (Schumach.) de Bary

Least Concern

Widespread on Water-pepper *Persicaria hydropiper*, mostly on river and stream banks, in fens and marshy pastures, in most Welsh VCs and in over 30 hectads and more rarely on Redshank *Persicaria maculosa*. Infected flowers are very conspicuous on account of the black spore masses and columellae issuing from the perianths as seen in the images overleaf and bottom of p38 (specimen on the left). The spore walls lack the reticulations of *Microbotryum cordae*, the spores of the latter being also long concealed in the ovaries of its hosts. In view of its widespread occurrence it is placed in the **Least Concern** category.



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Thecaphora

Sori mostly in the flowers of various dicotyledons, producing spore balls consisting entirely of agglutinated fertile, brownish spores. The genus is placed within the Ustilaginomycetes.

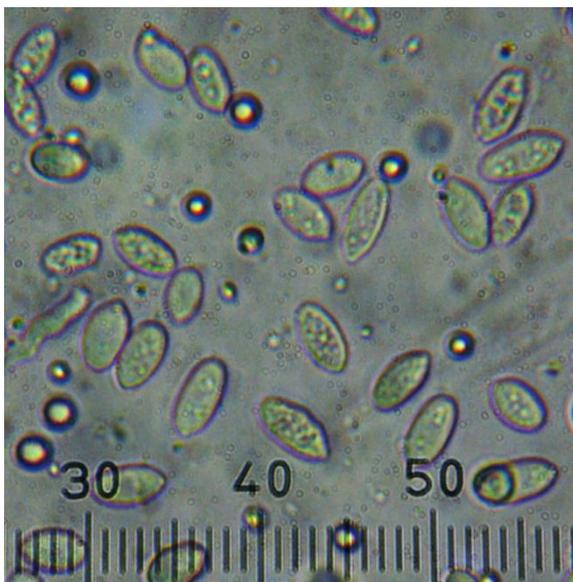
Thecaphora seminis-convolvuli (Desm.) S. Ito

Vulnerable D

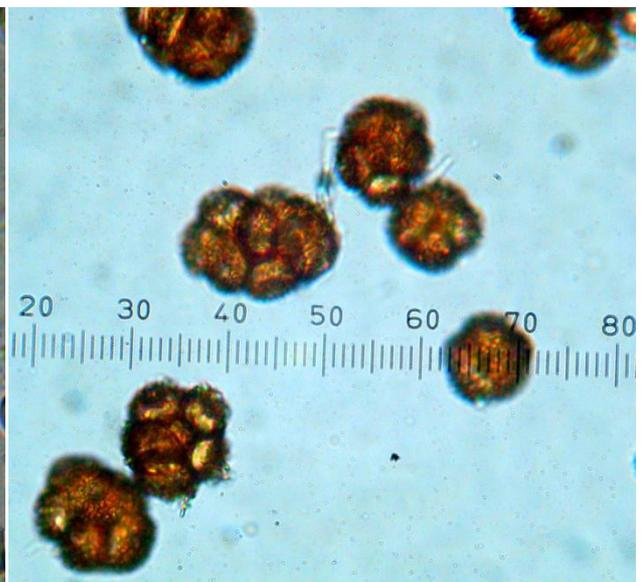
This inconspicuous smut develops spore balls (bottom right) within the seed capsules of Bindweed species and the anamorph produces spores that discolour and dwarf the stamens (see image below and bottom left). Infected flowers may also be reduced in size. Extensive searches have failed to locate it inland in the central part of Wales and its British distribution from the FRDBI appears to be mostly southern and eastern. In Wales it has been found on



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twelve occasions, all the sites being close to the sea. It was reported from Field Bindweed *Convolvulus arvensis* once on Worms Head, Glamorgan and by AOC in a large population at Llan-non, Cardiganshire, where it was found in three flower colour morphs, and in Aberystwyth in the grounds of the Castle and on a verge overlooking the harbour. It is recorded on Large Bindweed *Calystegia silvaticum* near St Mellons and Hedge Bindweed *C. sepium* at Pontardawe, both in Glamorgan. This latter host accounts for all the remaining Welsh records with most ascribed to the subsp. *sepium*. It has been seen at six sites in Cardiganshire, four in Aberystwyth (though subsequently lost from two) and one each at Aberaeron and on the Teifi Marshes. It is also reported from Trefriw in Caernarvonshire. Given the small size of the Welsh population and isolation from English populations it is placed in the **Vulnerable D** category.

Tilletia

Sori in Poaceae, mostly in the ovaries, producing variously ornamented and variously coloured spores mixed with sterile cells. The genus is placed within the Exobasidiomycetes.

Tilletia caries (DC.) Tul. & C. Tul. Wheat Bunt or Stinking Smut Not Evaluated

Reported only on Wheat *Triticum* cultivars from Glamorganshire in 1943, Cardiganshire sometime in the 20th century and Montgomeryshire in 1873. With no records on native hosts this fungus is **Not Evaluated**.

Tilletia holci (Westend.) J. Schröt. Regionally Extinct

There is a single undated 20th century record (probably from the 1930s) for Wales on the FRDBI from the ovaries of Creeping Soft-grass *Holcus mollis* at Aberystwyth, Cardiganshire made by K. Sampson. Despite the abundance of its host there are few records from the rest of Britain and it must be considered to be **Regionally Extinct**.

Tilletia lolii Auersw. ex G. Winter Not Evaluated

Included for the sake of completeness since this smut fungus probably never occurred outside of a greenhouse in Wales or anywhere else in Britain. Mordue & Ainsworth (1984) report that it was introduced to the Welsh Plant Breeding Station, Aberystwyth, Cardiganshire around 1937 in seed of Darnel *Lolium temulentum* from Portugal, infecting in pots not only this species but also Perennial Rye-grass *L. perenne*, *L. remotum* and Italian Ryegrass *L. multiflorum*. Its conservation status is **Not Evaluated**.

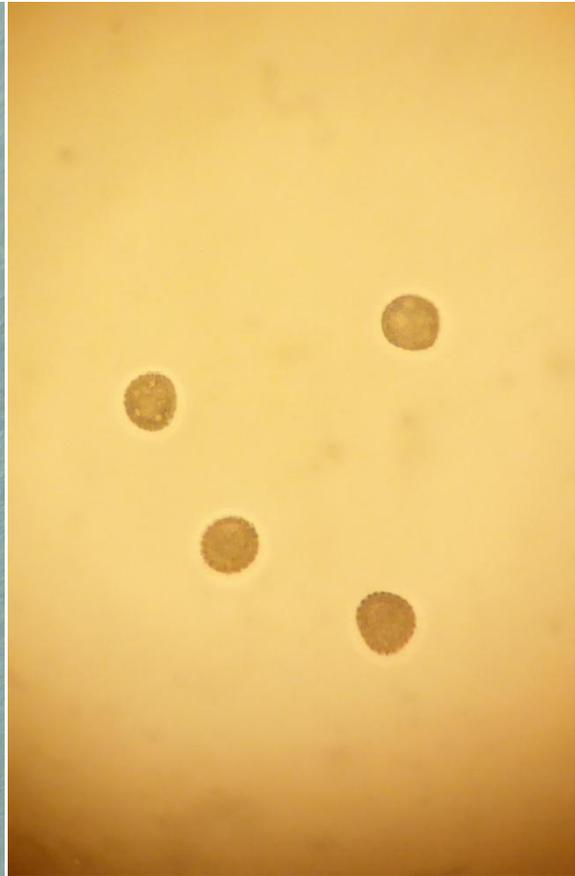
Tilletia menieri Har. & Pat.

Critically Endangered D2

Noted by RGW in the ovaries of Reed Canary-grass *Phalaris arundinacea* on Cors Caron, Cardiganshire in July 2002, there are only four other records on the FRDBI post 1950 from Britain on this host and no others from Wales. On account of the single small population it is considered to be **Critically Endangered D2**.



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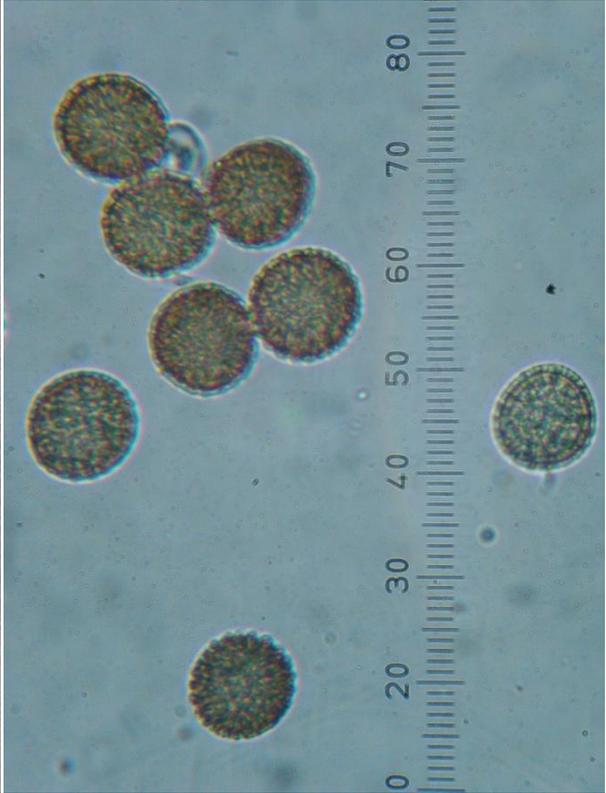
Tilletia sphaerococca (Rabenh.) A.A. Fisch. Waldh.

Least Concern

Widespread in upland Wales with over a hundred records on Common Bent *Agrostis capillaris*. The systemic infection dwarfs the host plant and causes it to flower a month or more earlier than uninfected plants. The resulting appearance of the plants deceived Linnaeus into describing them as a separate species, *Agrostis pumila*. Two infected plants are illustrated top left opposite, showing the rather variable degree of dwarfing that can be found. Most records are from open ground such as rough tracks and their verges, especially forestry tracks, bare ground and road verges. There is one record on Creeping Bent *A. stolonifera* from a disused quarry at 440m above Llanddewi-Brefi in Cardiganshire. In view of its relative abundance, this smut is considered to be of **Least Concern**.



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Tranzscheliella

Sori in the stems or inflorescence branches, often concealed by the leaf sheaths and usually stunting the stems and aborting the inflorescences of Poaceae. The spores are brown or blackish and finely ornamented. The genus is placed within the Ustilaginomycetes.

Tranzscheliella hypodites (Schltldl.) Vánky & McKenzie (= *Ustilago hypodites*)

Critically Endangered D2

In Wales it has been recorded from only two sites. It was found on Sand Couch *Elytrigia juncea* subsp. *boreoatlantica*, at Llanelli Docks, Carmarthenshire by Dic Davies and determined by RNS in 1996 and on a probable Couch-grass on the beach at Red Wharf Bay, Anglesey by Charles Aron in 1999. J.E. Vize also notes its presence in the Parish of Forden, Montgomeryshire in a list of cryptogamic plants published in 1882 (host unspecified). Surviving as two small populations in Wales remote from populations in England it is categorised as **Critically Endangered D2**.

Urocystis

Sori can be in any part of a wide range of hosts, producing spore balls consisting of one or more fertile spores surrounded by smaller sterile cells. Sori can form streaks, swellings or spots in leaves or stems, or be in the ovaries. The genus is placed within the Ustilaginomycetes. We have adopted a narrow circumscription of the smuts on Ranunculaceae, separating *U. ranunculi* and *U. trollii* from *U. anemones*.

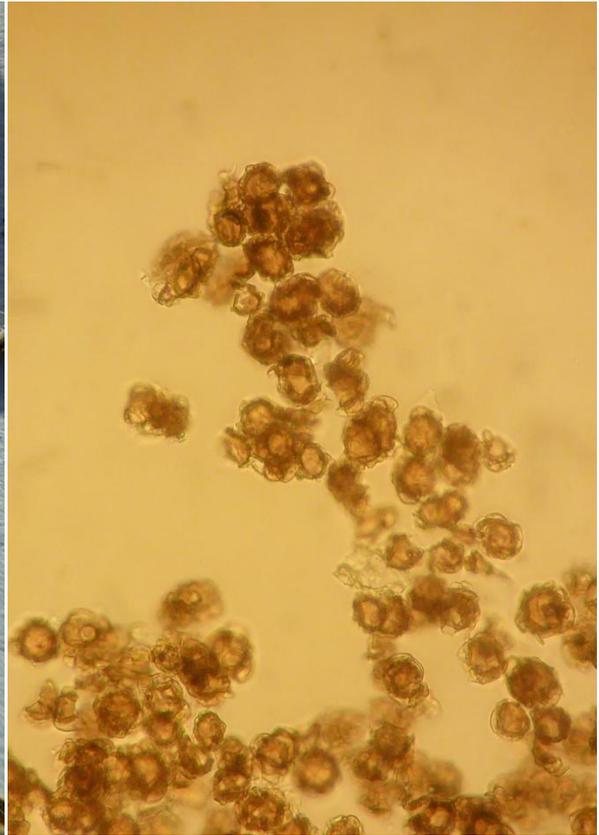
Urocystis agropyri (Preuss) J. Schröt.

Critically Endangered D2

There is but a single Welsh record of this smut fungus, which forms dark streaks on leaves, sheaths and culms. It was noted on Common Couch *Elytrigia repens* in a garden at Howey, near Llandrindod Wells, Radnorshire in 2005 by RGW. It differs from *Ustilago serpens*, also found on this host in that its spores are surrounded by sterile cells. With little more than a score of records from the rest of Britain since 1960 this smut is unaccountably rare given the widespread distribution of its host grasses. As a single small population, remote from populations in England, it is categorised as **Critically Endangered D2**.



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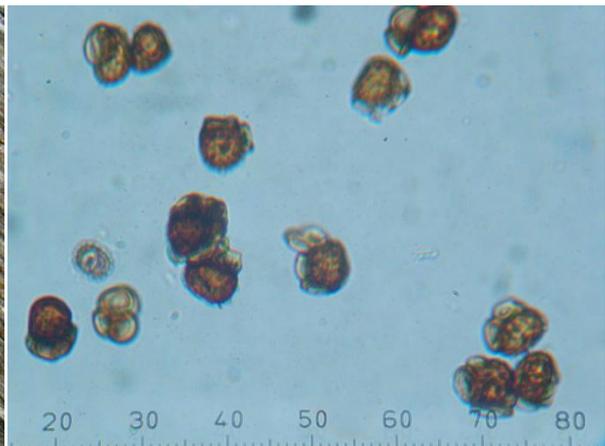
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***Urocystis anemones* (Pers.) G. Winter** Anemone Smut Least Concern

Widespread but never common on Wood Anemone *Anemone nemorosa* causing conspicuous pustules to form on the leaves and petioles that later release blackish spore balls. All records on Creeping Buttercup *Ranunculus repens* are now considered to be *U. ranunculii*. The Anemone Smut is sufficiently abundant to be of **Least Concern**.



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Considered by Evans *et al.* (2006) to be Critically Endangered D in Britain, this smut fungus of Autumn Crocus *Colchicum autumnale* has also been placed on the UK and Welsh Biodiversity Action Plan Lists. Before World War 2 it seems to have been quite widespread with records from Yorkshire, Warwickshire, Somerset, Sussex and Wiltshire. During the war its host plants were widely dug up to supply a pharmaceutical to relieve the pain of gout since previous sources of this drug from the Mediterranean had become unavailable. Permanent pastures were ploughed up to grow crops and the change from hay to silage post war greatly diminished the abundance of its host. The smut was considered extinct until its rediscovery in two meadows near Hay on Wye, Breconshire in 1984 by RGW. It has subsequently been lost from at least one of these sites as the host is no longer present and may have been lost from both. It was, however, subsequently discovered at a third site on Henallt Common nearby where appropriate management of this SSSI has been put in place by the Brecon Beacons National Park and Natural Resources Wales in cooperation with a commoner. Over 100 infected plants were counted in 2016. In 2002 another small population was discovered at Moccas in Herefordshire and in 2013 a new population was found at Westonbirt Arboretum, Wiltshire. The source of the record from Glamorgan in Mordue & Ainsworth (1984) has not been traced. Pustular streaks on the leaves and petioles release masses of blackish spore balls. As it occurs only in a single hectad in Wales and has declined, and as the adjacent English population is isolated and small it is placed in the **Endangered B** category.



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Urocystis eranthisis (Pass.) Ainsw. & Sampson

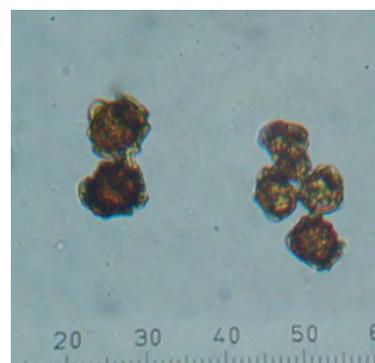
Not Evaluated

Confined to Winter Aconite *Eranthis hyemalis*, on which it forms small pustule on the leaves releasing blackish spore balls, it is known from only two sites in Wales, both in gardens. It



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was found at Llanynys, Breconshire in 2015 by Andy Shaw and in the garden of Felindre, Aberarth, Cardiganshire, where it has been seen by AOC in several years from 2010 on an old cultivar of *Eranthis hyemalis*. Since neither population is naturalised this smut is **Not Evaluated**.



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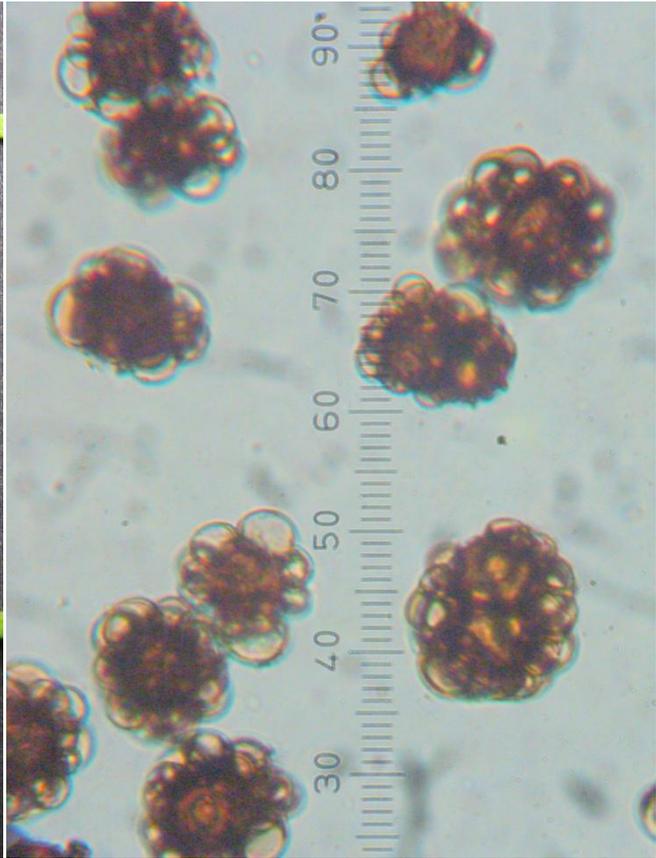
Urocystis ficariae (Liro) Moesz

Near Threatened

Given the abundance of its host, Lesser Celandine *Ficaria verna* subsp. *fertilis*, this smut appears to be rare. The few Welsh records have all been made recently and are almost all by AOC after intensive searches. He recorded it once in Carmarthenshire at Penllan, Cenarth and six times in Cardiganshire, always in the lowlands. At all except one site he found only a single infected leaf and at one site it was on the same leaf as the rust *Uromyces ficariae*. He notes that the conspicuous pustules usually distort the leaf lamina and especially the petiole, and release blackish spore balls so if it were abundant more records would seem likely. The one other record is by PAS from Cwm Crach, Monmouthshire. In the rest of mainland Britain there have been little more than a dozen records (FRDBI). Given the number of Welsh records it is considered to be **Near Threatened**.



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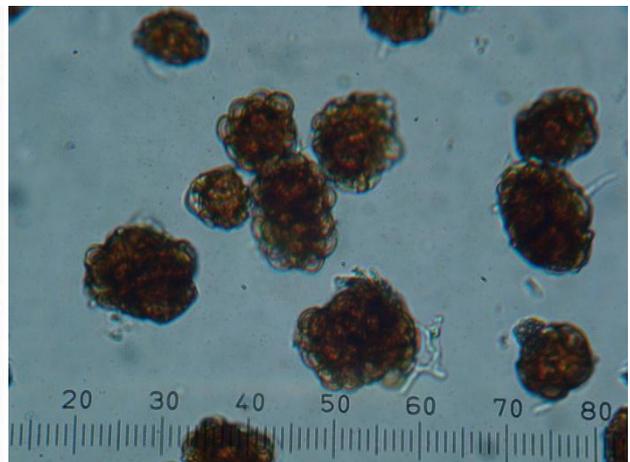
***Urocystis fischeri* Körn.**

Near Threatened

Six records have been made of this smut fungus in Wales, all on Glaucous Sedge *Carex flacca*. In Carmarthenshire AOC noted it in calcareous grassland 2km ESE of Carreg Cennen. In Cardiganshire he has found it in four sites along the coast two of which were in turf on coastal slopes near Cwm Cilfforch, one in the splash zone in short turf near the mouth of the Afon Soden, and one on the Ynys-las sand dunes. In North Wales it was collected from the Great Orme in Caernarvonshire by Kathryn Birch (det. DAE) and found by DAE on Cors Bodellio on Anglesey. Creating black streaks in the leaves, it can easily be overlooked. Notwithstanding this latter possibility, there are only a score of other records



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from Britain on the FRDBI so the Welsh population assumes some significance and it is considered to be **Near Threatened**.

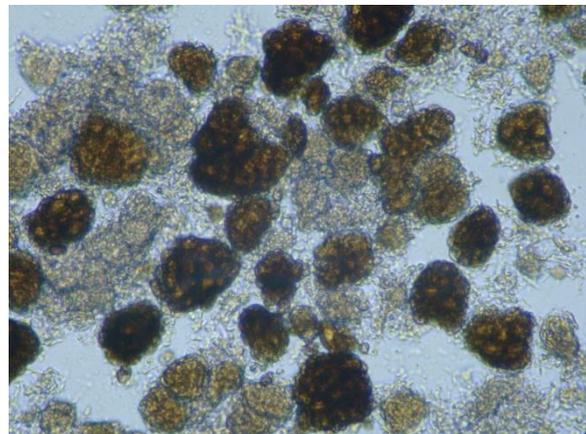
Urocystis primulae (Rostr.) Vánky

Vulnerable D

This is perhaps one smut where dedicated and careful checking of Primrose *Primula vulgaris* flowers is required to spot the rather obscure white sporidia in the anthers of the flowers, particularly in pin-eyed flowers where the stamens lie concealed in the flower's corolla tube. Later in the year masses of spore balls might be detected in the ovaries but many Primrose sites are in deep shade by summer. Dedicated searching paid dividends for AOC who has recently detected this smut in ten sites in Cardiganshire. Most sites are at low altitude and near the coast where Primroses are frequently abundant. Despite careful searching in Mid Wales where Primroses are generally scarce no trace of this fungus has been found. It is placed in the **Vulnerable D** category in Wales since it seems highly unlikely that there are in excess of a 1000 infected Primrose plants in Wales. Detailed searches of the coastal belt of Pembrokeshire, Carmarthenshire and Glamorgan should be a high priority to add confidence to this grading.

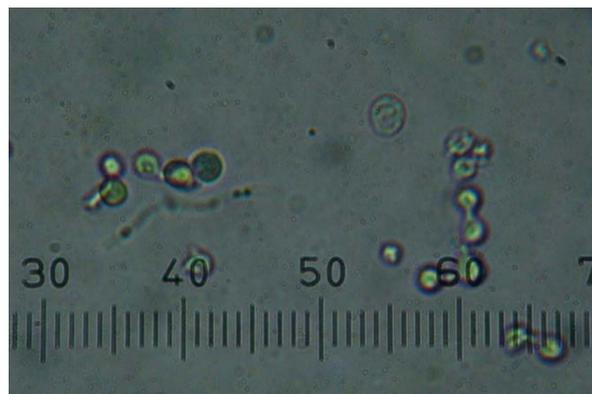


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Spore balls

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Sporidia

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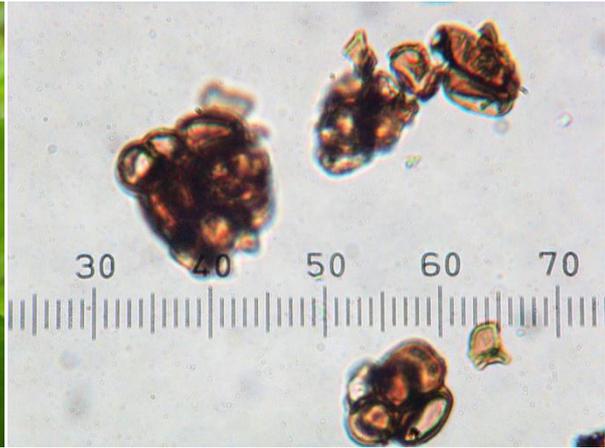
Urocystis ranunculi (Lib.) Moesz

Least Concern

Widespread and common on Creeping Buttercup *Ranunculus repens* and recorded from over 50 sites in 10 VCs in Wales. Blackish spore ball masses ultimately spill out of large pustules on the leaves. In *Entyloma microsporum* the spore mass is golden brown and the spores are thick-walled and simple. This smut is often frequent, especially where the host grows in damp and shaded places. It is sufficiently abundant to be of **Least Concern**.



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Urocystis trollii Nannf.

Critically Endangered D2

In 1998 Graham Motley collected a smut from the leaves of Globeflower *Trollius europaeus*, in Cwm Cadlan National Nature Reserve, Breconshire (not Glamorganshire as stated in the FRDBI) that was subsequently determined as *Urocystis trollii* by Tom Preece. The FRDBI only lists records from the Isle of Arran in 1927 and two from non-native *Trollius* species in cultivation (Spooner & Legon, 2006). The Welsh record is the only recent record of this smut on a native Globeflower in Britain. Its host has greatly diminished in abundance in Wales due to changing agricultural practices and as a northern species it is close to the southernmost edge of its range and is possibly threatened by a warming climate. Blister-like swellings on the leaves rupture to disperse blackish spore ball masses. The possibility



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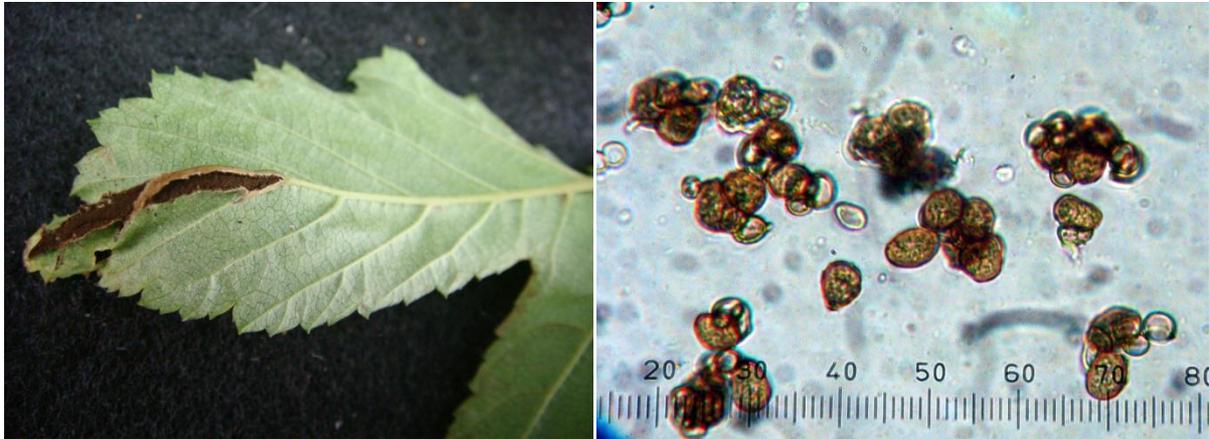
must exist that this smut was recently introduced to this country through the horticultural trade and in 2017 Graham Motley noted three plants of an orange-flowered Globeflower in Bute Park, Cardiff, Glamorganshire infected with it (see image left). Cwm Cadlan is, however, remote from any habitation and garden and for now this smut on wild Globeflower is considered to be native and to be **Critically Endangered D2**.

Urocystis ulmariae (Liro) Vánky

Critically Endangered D2

Reported only once from Wales when AOC noted three elongated pustules, releasing masses of dark brown spore balls, on one plant of Meadowsweet *Filipendula ulmaria* in a

dense population on a road verge near Pont Llanfair, Cardiganshire in 2016. It could not be re-found in 2017. Only three other records are listed on the FRDBI from a riverside walk near Yeovil, Somerset, in Lathkilldale near Bakewell, Derbyshire and from Stewarton, Kintyre. In view of the tiny size, lack of protection and isolation of the Welsh population it is placed in the **Critically Endangered D2** category.



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Urocystis violae (Sowerby) A.A. Fisch. Waldh.

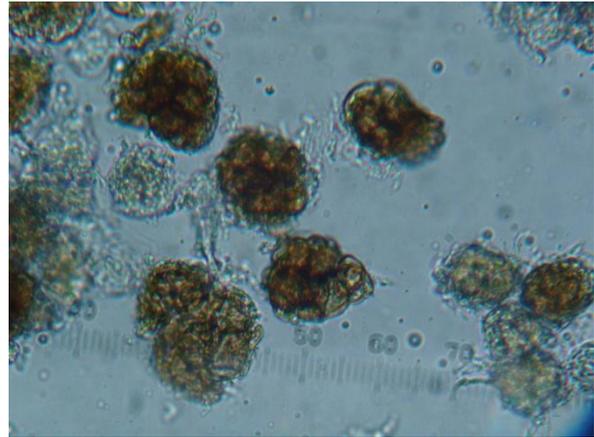
Least Concern

This smut causes elongated swellings on the petioles and leaves of Common Dog-violet *Viola riviniana* and very rarely on the hybrid between this and Pale Dog-violet *V. lactea*,



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usually strongly distorting them and releasing masses of blackish brown spore balls (right). It is recorded from over 15 hectads and in 3 VCs on a host that is not itself threatened, so this smut is considered to be of **Least Concern**.



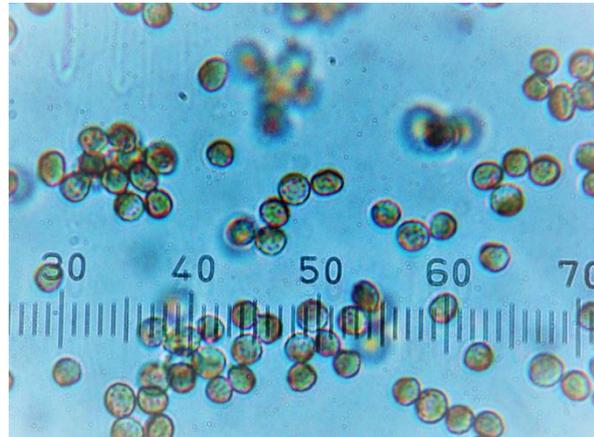
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Ustilago

Sori in the stems, ovaries or other parts of Poaceae, producing brown or blackish spore masses, the spores variously ornamented and single. The genus is placed within the Ustilaginomycetes.

Ustilago avenae (Pers.) Rostr. Loose Smut of Oats and False Oat-grass Least Concern

Reported from at least 10 VCs in Wales, this is one of the most widespread of smut species, filling the ovaries of False Oat-grass *Arrhenatherum elatius* var. *elatius* with black spores. The image overleaf shows several infected inflorescences (see also p i) with an uninfected one on the right. Records on the var. *bulbosum* are much rarer and whilst the smut on False Oat-grass is widespread, it is never particularly common. Nevertheless its ubiquity ensures it must be placed in the Least Concern category.



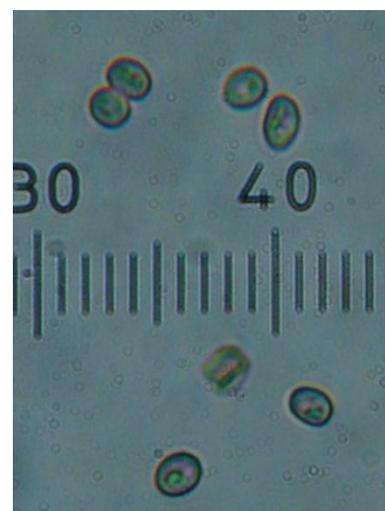
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[*Ustilago cordae* see *Microbotryum cordae*]

[*Ustilago duriaeana* see *Haradaea duriaeana*]

Ustilago filiformis (Schrank) Rostr. (= *U. longissima*)

Frequent and forming conspicuous black streaks in the leaves (see image overleaf) almost wherever Reed Sweet-grass *Glyceria maxima* occurs in Wales, even in isolated populations. Less common on other species in this genus with records from Floating Sweet-grass *G. fluitans* and Small Sweet-grass *G. declinata* from a scatter of VCs. It is sufficiently abundant to be of **Least Concern**.



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Ustilago avenae

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Ustilago filiformis

© RG Woods



Ustilago grandis

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Ustilago grandis Fr. Reed Smut

Vulnerable D2

This conspicuous smut of Reed *Phragmites australis* is recorded from Pant y Sais Fen in Glamorganshire, Pembrey Forest in Carmarthenshire and from the Teifi Marshes and at Ynys-hir in Cardiganshire. On the Teifi Marshes it was first noticed by AOC in 2001; by 2003 it covered 0.4ha, infecting every stem and by 2011 it had at least doubled in area. The image below is of a short length of infected culm dried in a herbarium packet illustrating the copious quantities of spores produced between the stem and sheathing leaves. The FRDBI lists only 4 other recent British records from Norfolk, Devon and Cornwall. As it is found in only four sites in Wales it is placed in the **Vulnerable D2** category.



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Ustilago hordei (Pers.) Lagerh. Covered Smut of Barley and Oats

Not Evaluated

There are no recent records of this smut on Oat *Avena* and Barley *Hordeum* cultivars in Wales. The most recent record traced was on Bristle Oat *Avena strigosa* at Aberystwyth, Cardiganshire in 1950. Ainsworth & Sampson (1950) note that it was “not uncommon” on varieties of this latter host in mid-Wales. Whilst considered to be Vulnerable B by Evans *et al.* (2006), since there are no Welsh records on native species its conservation status in Wales is **Not Evaluated**.

[*Ustilago hypodites* see *Transcheliella hypodites*]

[*Ustilago longissima* see *U. filiformis*]

Ustilago maydis (DC.) Corda Maize Smut

Not Evaluated

Reported only once on cultivated Maize *Zea mays* in Caernarvonshire (Aron 2005), this smut is **Not Evaluated**.

[*Ustilago ornithogali* see *Vankya ornithogali*]

[*Ustilago reticulatum* see *Microbotryum reticulatum*]

Ustilago serpens (P. Karst.) B. Lindeb.

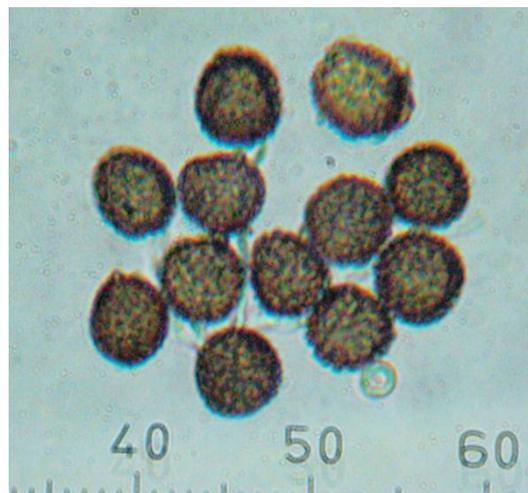
Endangered D

Reported only twice from Wales with records from Cardiganshire on Common Couch *Elytrigia repens* in a pasture at Ynys-las, and on Sand Couch *Elytrigia juncea* subsp. *boreo-atlantica* on the sandy seaward slope of Tan-y-bwlch beach, Aberystwyth. It forms dark, often confluent streaks in the leaves and is widespread but rare in Britain with a handful of



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recent records from Somerset, Surrey and Yorkshire on a variety of grass hosts. It is possibly somewhat overlooked but nevertheless appears to be sparsely distributed. Tan-y-bwlch beach has suffered significant erosion in recent storms and its survival there is uncertain. First found there in 2010 it was, however, still present in 2018. It differs from *Urocystis agropyri* that also occurs on *Elytrigia* spp. in that the spores of *U. agropyri* are surrounded by sterile cells. It is considered to be **Endangered D**.



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Ustilago striiformis (Westend.) Niessl Stripe Smut

Least Concern

Widespread in Wales and most frequently recorded on Creeping Soft-grass *Holcus mollis*, (below left) particularly on dry shaded banks where the stunted growth and distinctive dark ribbons of the smut in the leaves render it conspicuous. There are fewer records on Yorkshire Fog *H. lanatus* and even fewer on Black Bent *Agrostis gigantea*, Reed Canary-grass *Phalaris arundinacea* and Red Fescue *Festuca rubra*. In view of its widespread occurrence it is considered to be of **Least Concern**.



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[*Ustilago succisae* see *Microbotryum succisae*]

[*Ustilago tragopogonis-pratensis* see *Microbotryum tragopogonis-pratensis*]

***Ustilago tritici* (Pers.) Rostr.** Loose Smut of Wheat and Barley

Not Evaluated

There are two recent Welsh records. One was from a Wheat cultivar *Triticum* cult. on Anglesey and the other on two varieties of Naked Barley *Hordeum vulgare* ssp. *nudum* on Bangor University's Henfaes Farm in Caernarvonshire in 2007. This smut, unknown on native plant species, is **Not Evaluated**.



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[*Ustilago vaillantii* see *Antherospora tractemae*]

[*Ustilago violacea* see *Microbotryum violaceum*]

Vankya

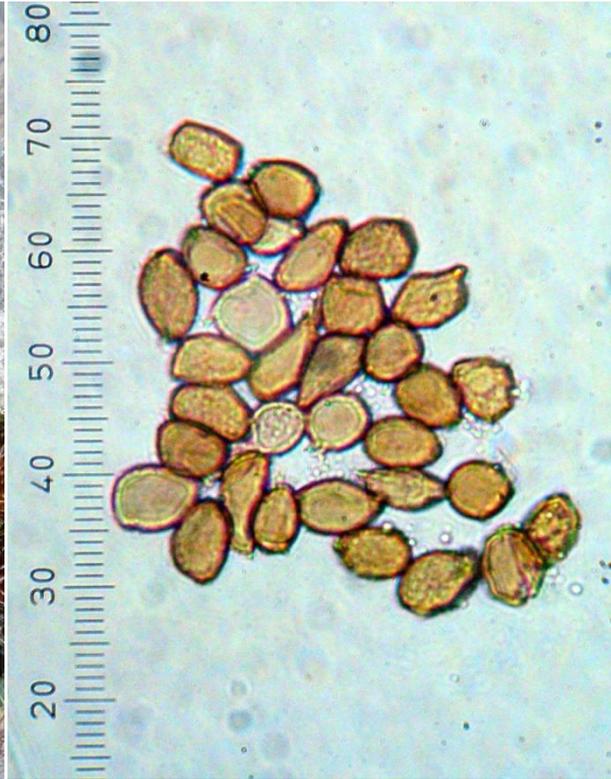
Sori forming pustules or short streaks on the leaves of Liliaceae, producing smooth, brown spores mixed with sterile cells. The genus is placed within the Ustilaginomycetes.

Vankya ornithogali (J.C. Schmidt & Kunze) Ershad Star-of-Bethlehem Smut (= *U. ornithogali*) Critically Endangered D2

Discovered as small black lesions on the leaves of the Radnor Lily *Gagea bohemica* on Stanner Rocks National Nature Reserve, Radnorshire in 2015 by Andy Shaw and identified by AOC. A search in 2016 failed to relocate it but the lesions on the small leaves of this plant are easy to overlook. It was re-found in 2017 in its original location on the quarry floor and in another host population above the quarry and then only on the quarry floor in 2018. There are no other Welsh records and the nearest known population reported on its other host, the Yellow Star-of-Bethlehem *G. lutea*, is in Oxfordshire. With only half a dozen recent records of this smut from all of Britain and a host that is conservation dependent and considered to be Vulnerable in Britain and Wales (Dines 2008), this smut, considered Vulnerable D2 in Britain by Evans *et al.* (2006), is, in view of its single site and tiny population, categorised as **Critically Endangered D2** in Wales. In view of the discovery of this smut on both native species of *Gagea* in Britain we have chosen to omit the word "yellow" from the English name.



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6 Wales Red Data List and Census Catalogue Tables

Two tables are provided. Table 1 is ordered alphabetically by fungus names, whilst Table 2 is ordered by host species names.

Species Names

Where a host plant name is followed by (A) this indicates it is considered to be an archaeophyte (naturalised before AD 1500); by (N) a neophyte (naturalised post AD 1500) and by (H) a non-naturalised cultivated plant (including forestry and agricultural crops as well as ornamental plantings). These definitions largely follow Preston *et al.* (2002). Where more than one category is applied it indicates that the status of this species varies from place to place in Wales.

Taxonomy of the hosts largely follows Stace (2010) whilst that of the fungi follows the FRDBI of the British Mycological Society.

Wales Red List Threat Status and Criteria

EX indicates a taxon extinct in Britain; RE extinct in Wales but not Britain; CR indicates Critically Endangered; EN Endangered; VU Vulnerable; NT Near Threatened; DD Data Deficient and NE Not Evaluated. This last criterion is largely reserved for fungi confined to cultivated plants.

Vice-county

Under the heading of “Vice-county” are listed the Welsh vice-counties from which each fungus and its host has been recorded. Vice-county numbers in square brackets indicate that no record has been traced in the last fifty years. The vice-county numbers equate to the vice-counties as follows:-

35 Monmouthshire; 41 Glamorgan; 42 Breconshire; 43 Radnorshire; 44 Carmarthenshire; 45 Pembrokeshire; 46 Cardiganshire; 47 Montgomeryshire; 48 Merionethshire; 49 Caernarvonshire; 50 Denbighshire; 51 Flintshire; 52 Anglesey. See Watson (1883) for details.

Table 1: Smuts and allied fungi recorded in Wales.

Fungus Taxon	Host Taxon	Cons. Eval.	Vice-county
Antherospora hortensis	Muscari armeniacum (H)	NE	42, 43, 45-47
Antherospora tractemae	Scilla verna	LC	41, 45, 46, 52
Anthracoidea arenariae	Carex arenaria	NT	44, [45], 48, 52
Anthracoidea paniceae	Carex panicea	EN D	46, 50
Anthracoidea subinclusa	Carex riparia	CR D2	44
Doassansiopsis hydrophila	Potamogeton polygonifolius	RE	[47]
Entorrhiza aschersoniana	Juncus bufonius	DD	42-44, 46-48
Entorrhiza caricicola	Carex limosa	DD	46
Entorrhiza casparyana	Juncus articulatus var. articulatus	DD	46-48
Entorrhiza casparyana	Juncus articulatus var. littorale	DD	46
Entorrhiza casparyana	Juncus articulatus var. nigrifolius	DD	42-44, 46
Entorrhiza casparyana	Juncus bulbosus ssp. kochii	DD	46
Entorrhiza raunkiaeriana	Eleogiton fluitans	DD	42-44, 46-48
Entorrhiza scirpicola	Eleocharis quinqueflora	DD	46
Entyloma bellidis	Bellis perennis	DD	43
Entyloma calendulae	Calendula officinalis (H)	NE	41, 46, 47
Entyloma chrysosplenii	Chrysosplenium alternifolium	CR D2	43
Entyloma chrysosplenii	Chrysosplenium oppositifolium	CR D2	46
Entyloma eryngii s.l.	Eryngium maritimum	EN D	41, 44, 45, 48, [49]
Entyloma ficariae	Ficaria verna agg.	LC	35, 41-49, 51, 52
Entyloma ficariae	Ficaria verna ssp. fertilis	LC	35, 41-48
Entyloma ficariae	Ficaria verna ssp. verna	LC	41, 43, 45-47
Entyloma helosciadii	Apium nodiflorum	LC	42, 46
Entyloma helosciadii	Oenanthe crocata	LC	35, 42-47
Entyloma henningsianum	Samolus valerandi	CR D2	46
Entyloma linariae	Linaria vulgaris	DD	46, 47
Entyloma microsporum	Ranunculus acris	LC	[49]
Entyloma microsporum	Ranunculus repens	LC	35, 41, 42, 44-46, 48, 49, 52
Entyloma microsporum	Ranunculus sceleratus	LC	46, 47
Entyloma microsporum	Ranunculus sp.	LC	50, 52
Entyloma ranunculi-repentis	Ranunculus acris	DD	46
Entyloma ranunculi-repentis	Ranunculus auricomus	DD	43, 46
Entyloma ranunculi-repentis	Ranunculus repens	DD	35, 41, 45-47

Fungus Taxon	Host Taxon	Cons. Eval.	Vice-county
Entyloma serotinum	Borago officinalis (A)	NE	47, 49
Exobasidium arescens	Vaccinium myrtillus	EN D	48, [50]
Exobasidium camelliae	Camellia japonica (H)	NE	46
Exobasidium camelliae	Camellia sinensis (H)	NE	41
Exobasidium camelliae	Camellia sp. (H)	NE	44, 52
Exobasidium japonicum	Rhododendron (Azalea) (H)	NE	46, 49
Exobasidium juelianum	Vaccinium vitis-idaea	DD	[50]
Exobasidium karstenii	Andromeda polifolia	LC	43, 46, [47]
Exobasidium myrtilli	Vaccinium myrtillus	LC	35, 42, 43, [44], 46-49, [50]
Exobasidium oxycocci	Vaccinium oxycoccos	NT	46, 48-50
Exobasidium rhododendri	Rhododendron ferrugineum (H)	NE	[52]
Exobasidium rhododendri	Rhododendron Sect. Pentanthera (H)	NE	41, 44, 46, 48, 49
Exobasidium rostrupii	Vaccinium oxycoccos	LC	42, 43, 46, 48, 49, [50]
Exobasidium vaccinii	Vaccinium vitis-idaea	NT	43, 46-48, 50
Farysia thuemenii	Carex acutiformis	NT	52
Farysia thuemenii	Carex pendula	NT	44, 46
Farysia thuemenii	Carex riparia	NT	44
Haradaea duriaeana	Cerastium glomeratum	CR D2	46, 47
Haradaea moenchiae-manticae	Moenchia erecta	DD	47
Melanotaenium cingens	Linaria vulgaris	EX	[48], [50], [51]
Melanotaenium endogenum	Galium verum	RE	[46]
Microbotryum cordae	Persicaria hydropiper	LC	35, 44, 46, 47, 49
Microbotryum cordae	Persicaria maculosa	LC	46, 47
Microbotryum cordae	Persicaria maculosa var. dumosa	LC	46
Microbotryum coronariae	Silene flos-cuculi	VU D	43, 44, 46, 47, 52
Microbotryum lychnidis-dioicae	Silene dioica	LC	35, 42-49, 51, 52
Microbotryum lychnidis-dioicae	Silene latifolia subsp. alba	LC	44, 51
Microbotryum pinguiculae	Pinguicula vulgaris	LC	42, 43, 46, 48
Microbotryum reticulatum	Persicaria lapathifolia	VU D1	41-43, 46, 52
Microbotryum reticulatum	Persicaria lapathifolia ssp. pallida	VU D1	46
Microbotryum saponariae	Saponaria officinalis (A)	DD	35, 41
Microbotryum scorzonerae	Scorzonera humilis	CR D2	41
Microbotryum silenes-inflatae	Silene uniflora	LC	42, 44, 46, 51
Microbotryum silenes-inflatae	Silene uniflora × vulgaris	LC	46
Microbotryum stellariae	Stellaria graminea	LC	35, 41-44, 46, 48-50, 52
Microbotryum stygium	Rumex acetosa	CR D2	44
Microbotryum succisae	Succisa pratensis	VU D	41, 43, 45, 46
Microbotryum tragopogonis-pratensis	Tragopogon pratensis	VU D2	[35], 41, 43, [47], 52
Microstroma album	Quercus cerris (H)	LC	35, 41, 46
Microstroma album	Quercus petraea	LC	42, 43
Microstroma album	Quercus robur	LC	35, 41-44, 46-48
Microstroma album	Quercus sp.	LC	[47]

Fungus Taxon	Host Taxon	Cons. Eval.	Vice-county
Microstroma album	Quercus × rosacea	LC	42, 43, 46
Microstroma juglandis	Juglans regia (H)	NE	43-45, 46, 48
Rhamphospora nymphaeae	Nymphaea alba (H)	NE	46, 47
Schizonella melanogramma	Carex caryophylla	CR D2	43
Sphacelotheca hydropiperis	Persicaria hydropiper	LC	35, 42-44, 46-49, 52
Sphacelotheca hydropiperis	Persicaria maculosa	LC	42, 46
Sphacelotheca hydropiperis	Unknown	LC	[41], [47], [49]
Thecaphora seminis-convolvuli	Calystegia sepium	VU D	41, 46, 49
Thecaphora seminis-convolvuli	Calystegia sepium ssp. sepium	VU D	46, 47
Thecaphora seminis-convolvuli	Calystegia silvatica	VU D	41
Thecaphora seminis-convolvuli	Convolvulus arvensis	VU D	41, 46
Tilletia caries	Triticum sp. (H)	NE	[41], [46], [47]
Tilletia holci	Holcus mollis	RE	[46]
Tilletia lolii	Lolium multiflorum (H)	NE	[46]
Tilletia lolii	Lolium perenne (H)	NE	[46]
Tilletia lolii	Lolium remotum (H)	NE	[46]
Tilletia lolii	Lolium temulentum (H)	NE	[46]
Tilletia menieri	Phalaris arundinacea	CR D2	46
Tilletia sphaerococca	Agrostis capillaris	LC	35, 42-44, 46, 47, 52
Tilletia sphaerococca	Agrostis stolonifera	LC	46
Tranzscheliella hypodites	Elytrigia juncea ssp. boreo-atlantica	CR D2	44
Tranzscheliella hypodites	Unknown	CR D2	[47], 52
Urocystis agropyri	Elytrigia repens	CR D2	43
Urocystis anemones	Anemone nemorosa	LC	35, 42, 43, 45-50, [51], 52
Urocystis colchici	Colchichum autumnale	EN B	42
Urocystis eranthidis	Eranthus hyemalis (H)	NE	42, 46
Urocystis ficariae	Ficaria verna ssp. fertilis	NT	35, 44, 46
Urocystis fischeri	Carex flacca	NT	44, 46, 49, 52
Urocystis primulae	Primula vulgaris	VU D	46
Urocystis ranunculi	Ranunculus repens	LC	35, 41-44, 46, 47, 49, 50, 52
Urocystis ranunculi	Ranunculus sp.	LC	[41], [47], [48]
Urocystis trollii	Trollius cultivar (H)	CR D2	41
Urocystis trollii	Trollius europaeus	CR D2	42
Urocystis ulmariae	Filipendula ulmaria	CR D2	46
Urocystis violae	Viola riviniana	LC	43, 45, 46
Urocystis violae	Viola sp.	LC	[47]
Ustilago avenae	Arrhenatherum elatius	LC	35, [41], 42-44, 46-52
Ustilago avenae	Arrhenatherum elatius var. bulbosum	LC	44, 46
Ustilago avenae	Arrhenatherum elatius var. elatius	LC	42-48, 51, 52
Ustilago avenae	Avena strigosa "S. 75" (H)	LC	43
Ustilago filiformis	Glyceria declinata	LC	44, 46
Ustilago filiformis	Glyceria fluitans	LC	46
Ustilago filiformis	Glyceria maxima	LC	35, 41-44, 46, 47, 52

Fungus Taxon	Host Taxon	Cons. Eval.	Vice-county
Ustilago filiformis	Glyceria sp.	LC	43
Ustilago grandis	Phragmites australis	VU D2	41, 44, 46
Ustilago hordei	Avena brevis (H)	NE	[46]
Ustilago hordei	Avena sativa (H)	NE	[46], [49]
Ustilago hordei	Avena strigosa (H)	NE	[46]
Ustilago hordei	Hordeum sp. (H)	NE	[50]
Ustilago hordei	Unknown	NE	[47], [49]
Ustilago maydis	Zea mays (H)	NE	49
Ustilago serpens	Elytrigia juncea ssp. boreo-atlantica	EN D	46
Ustilago serpens	Elytrigia repens	EN D	46
Ustilago striiformis	Agrostis gigantea	LC	46
Ustilago striiformis	Festuca rubra	LC	[46]
Ustilago striiformis	Holcus lanatus	LC	35, 41, 46, [49]
Ustilago striiformis	Holcus mollis	LC	35, 41-47
Ustilago striiformis	Phalaris arundinacea	LC	44
Ustilago tritici	Hordeum vulgare ssp. nudum (H)	NE	49
Ustilago tritici	Triticum sp. (H)	NE	49, 52
Vankya ornithogali	Gagea bohemica	CR D2	43

Table 2: Hosts of smut fungi recorded in Wales

Host taxon	Fungus taxon
Agrostis capillaris	Tilletia sphaerococca
Agrostis gigantea	Ustilago striiformis
Agrostis stolonifera	Tilletia sphaerococca
Andromeda polifolia	Exobasidium karstenii
Anemone nemorosa	Urocystis anemones
Apium nodiflorum	Entyloma helosciadii
Arrhenatherum elatius	Ustilago avenae
Arrhenatherum elatius var. bulbosum	Ustilago avenae
Arrhenatherum elatius var. elatius	Ustilago avenae
Avena brevis (H)	Ustilago hordei
Avena sativa (H)	Ustilago hordei
Avena strigosa (H)	Ustilago avenae
	Ustilago hordei
Bellis perennis	Entyloma bellidis
Borago officinalis (A)	Entyloma serotinum
Calendula officinalis (H)	Entyloma calendulae
Calystegia sepium	Thecaphora seminis-convolvuli
Calystegia sepium ssp. sepium	Thecaphora seminis-convolvuli
Calystegia silvatica	Thecaphora seminis-convolvuli
Camellia japonica (H)	Exobasidium camelliae
Camellia sinensis (H)	Exobasidium camelliae
Camellia sp. (H)	Exobasidium camelliae
Carex acutiformis	Farysia thuemenii
Carex arenaria	Anthracoidea arenariae
Carex caryophyllea	Schizonella melanogramma

Host taxon	Fungus taxon
Carex pendula	Farysia thuemenii
Carex flacca	Urocystis fischeri
Carex limosa	Entorrhiza caricicola
Carex panicea	Anthracoidea paniceae
Carex riparia	Anthracoidea subinclusa
	Farysia thuemenii
Cerastium glomeratum	Haradaea duriaeana
Chrysosplenium alternifolium	Entyloma chrysosplenii
Chrysosplenium oppositifolium	Entyloma chrysosplenii
Colchichum autumnale	Urocystis colchici
Convolvulus arvensis	Thecaphora seminis-convolvuli
Eleogiton fluitans	Entorrhiza raunkiaeriana
Elytrigia juncea ssp. boreo-atlantica	Tranzscheliella hypodites
	Ustilago serpens
Elytrigia repens	Urocystis agropyri
	Ustilago serpens
Eranthis hyemalis (H)	Urocystis eranthidis
Eryngium maritimum	Entyloma eryngii s.l.
Festuca rubra	Ustilago striiformis
Ficaria verna agg.	Entyloma ficariae
Ficaria verna ssp. fertilis	Entyloma ficariae
	Urocystis ficariae
Ficaria verna ssp. verna	Entyloma ficariae
Filipendula ulmaria	Urocystis ulmariae
Gagea bohemica	Vankya ornithogali
Galium verum	Melanotaenium endogenum
Glyceria declinata	Ustilago filiformis
Glyceria fluitans	Ustilago filiformis
Glyceria maxima	Ustilago filiformis
Glyceria sp.	Ustilago filiformis
Holcus lanatus	Ustilago striiformis
Holcus mollis	Tilletia holci
	Ustilago striiformis
Hordeum sp. (H)	Ustilago hordei
Hordeum vulgare ssp. nudum (H)	Ustilago tritici
Juglans regia (H)	Microstroma juglandis
Juncus articulatus var. articulatus	Entorrhiza casparyana
Juncus articulatus var. littorale	Entorrhiza casparyana
Juncus articulatus var. nigrifolius	Entorrhiza casparyana
Juncus bufonius	Entorrhiza aschersoniana
Juncus bulbosus ssp. kochii	Entorrhiza casparyana
Linaria vulgaris	Entyloma linariae
	Melanotaenium cingens
Lolium multiflorum (H)	Tilletia lolii
Lolium perenne (H)	Tilletia lolii
Lolium remotum (H)	Tilletia lolii
Lolium temulentum (H)	Tilletia lolii
Moenchia erecta	Haradaea moenchieae-manticae
Muscari armeniacum (H)	Antherospora hortensis
Nymphaea alba (H)	Rhamphospora nymphaeae

Host taxon	Fungus taxon
Persicaria maculosa	Microbotryum cordae
Oenanthe crocata	Sphacelotheca hydropiperis
Persicaria hydropiper	Entyloma helosciadii
	Microbotryum cordae
Persicaria lapathifolia	Sphacelotheca hydropiperis
Persicaria lapathifolia ssp. pallida	Microbotryum reticulatum
Persicaria maculosa var. dumosa	Microbotryum reticulatum
Phalaris arundinacea	Microbotryum cordae
	Tilletia menieri
Phragmites communis	Ustilago striiformis
Pinguicula vulgaris	Ustilago grandis
Potamogeton polygonifolius	Microbotryum pinguiculae
Primula vulgaris	Doassansiopsis hydrophila
Quercus cerris (H)	Urocystis primulae
Quercus petraea	Microstroma album
Quercus robur	Microstroma album
Quercus sp.	Microstroma album
Quercus × rosacea	Microstroma album
Ranunculus acris	Microstroma album
	Entyloma microsporum
Ranunculus auricomus	Entyloma ranunculi-repentis
Ranunculus repens	Entyloma microsporum
	Entyloma microsporum
Ranunculus sceleratus	Entyloma ranunculi-repentis
Ranunculus sp.	Urocystis ranunculi
	Entyloma microsporum
Rhododendron (Azalea) (H)	Entyloma microsporum
Rhododendron ferrugineum (H)	Urocystis ranunculi
Rhododendron Sect. Pentanthera (H)	Exobasidium japonicum
Rumex acetosa	Exobasidium rhododendri
Samolus valerandi	Exobasidium rhododendri
Saponaria officinalis	Microbotryum stygium
Scilla verna	Entyloma henningsianum
Scorzonera humilis	Microbotryum saponariae
Silene dioica	Antherospora tractemae
Silene flos-cuculi	Microbotryum scorzonerae
Silene latifolia subsp. alba	Microbotryum lychnidis-dioicae
Silene uniflora	Microbotryum coronariae
Silene uniflora × vulgaris	Microbotryum lychnidis-dioicae
Stellaria graminea	Microbotryum silenes-inflatae
Succisa pratensis	Microbotryum silenes-inflatae
Tragopogon pratensis	Microbotryum stellariae
Triticum sp. (H)	Microbotryum succisae
	Microbotryum tragopogonis-pratensis
Trollius cultivar (H)	Tilletia caries
Trollius europaeus	Ustilago tritici
Vaccinium myrtillus	Urocystis trollii
	Urocystis trollii
	Exobasidium arescens
	Exobasidium myrtilli

Host taxon	Fungus taxon
Vaccinium oxycoccos	Exobasidium oxycocci Exobasidium rostrupii
Vaccinium vitis-idaea	Exobasidium juelianum Exobasidium vaccinii
Viola riviniana	Urocystis violae
Viola sp.	Urocystis violae
Zea mays (H)	Ustilago maydis



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Top left: *Microbotryum lychnidis-dioicae* on *Silene dioica*; top right: *Microbotryum stellariae* on *Stellaria graminea*; above: *Farysia thuemenii* on *Carex riparia*.

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Appendix 1

Smut and allied fungi recorded from areas adjacent to Wales that might be expected to occur in Wales

The following taxa have been recorded in the last 60 years from Vice-counties adjacent to Wales with hosts present in Wales and might be expected to be found in the principality.

Entyloma dahliae Syd. & P. Syd. (= *E. calendulae* f. *dahlia*) Noted on cultivated Dahlias close to the Welsh Border at Pant and Llanymynach, Shropshire in 2000. It causes pale spots to form on the leaves that later turn brown.

Jamesdicksonia dactylidis (Pass.) R. Bauer, Begerow, A. Nagler & Oberw. (= *Entyloma dactylidis*) Noted in 1965 on *Agrostis* sp., a bent grass, at Thornbury, West Gloucestershire (FRDBI) and in Herefordshire (Mordue & Ainsworth 1984). It forms dark flecks on the leaves.

Microbotryum kuehneanum (R. Wolff) Vánky (= *Ustilago kuehneana*). Causes pinkish-purple spore masses to form in blisters on the stem and in the ovaries of docks and sorrels *Rumex* spp. Reported recently from Haugh Wood and Durslow Common in Herefordshire.

Urocystis magica Pass. (= *U. cepulae*). The Onion Smut, causing black blisters on leaves and stems, was reported from Shropshire in 2001. The host was not specified but it infects cultivated Onions and Leeks, Wild Onion *Allium vineale* and rarely Ramsons *A. ursinum*.

Appendix 2

Pursuing an interest in Smut Fungi

Should you wish to carry the study further the following sources may prove to be helpful.

Introducing the Smuts

David Ingram and Noel Robertson provide one of the most readable introductions to this group of fungi, in chapter 10 of HarperCollins New Naturalist Volume 84 *Plant Disease*, published in 1999.

Identification Guides

There is no up to date, well-illustrated guide to British smut fungi in print. Neither Ainsworth & Sampson's *The British Smut Fungi* published in 1950 nor Mordue & Ainsworth's *Ustilaginales of the British Isles* published in 1984 are in print and second hand copies are near impossible to find.

However Martin B. Ellis and J. Pamela Ellis in their magnificent *Microfungi on Land Plants. An Identification Handbook* published as a new enlarged edition by The Richmond Publishing Co. Ltd. in 1997, whilst expensive, is an invaluable guide to all fungi found on land (and a few aquatic) plants in Britain. The fungi are described by each host genus. So if you know the host you have immediately eliminated most species from consideration and most smut fungi are readily identifiable. The Bibliography above lists in addition a number of advanced and expensive books should you wish to carry the study further.

Bruce Ing's article on the genus *Exobasidium* published in the *Mycologist* in 1998 provides an excellent introduction to this genus.

Many smut fungi are illustrated on the web, including Malcolm Storey's Bioimages site on www.bioimages.org.uk.

Featured Species

Following the collection of specimens to determine the distribution of smut fungi in Wales, materials were made available to assist European studies, resulting in the description of two species new to science. A knowledge of species reported from Europe but not the British Isles also led to the targeted search for and discovery of three smut species new to Britain.



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Material of *Antherospora tractemae*, the anther smut of Spring Squill (*Scilla verna*) (above) collected from Llangrannog Head (right), became the type specimen and this Cardiganshire coastal headland the type locality (Piaątek *et al.* 2011).



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The Aberystwyth University campus became the type locality for the holotype of *Antherospora hortensis*, anther smut of Grape Hyacinth (*Muscari armeniacum*) (Piaątek *et al.* 2013).

The anther smut *Microbotryum pinguiculae*, of Common Butterwort (*Pinguicula vulgaris*) was confirmed as British for the first time in Wales. Henallt Common, Breconshire (see right) has a large population of the smut.



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Also new to Britain were two root smut fungi – *Entorrhiza caricicola* on Bog Sedge (*Carex limosa*) and *E. raunkiaeriana* on Floating Club-rush (*Eleogiton fluitans*) (Chater & Smith 2018a, b).

Rear cover images (left to right): *Microbotryum silenes-inflatae* on *Silene uniflora* © CD Preston, *M. coronariae* on *Silene flos-cuculi* © RG Woods and *Thecaphora seminis-convolvuli* on *Convolvulus arvensis* © AO Chater.



This publication builds on and is complementary to the Red Data lists produced by Plantlife Cymru of Welsh vascular plants, bryophytes and lichens and that produced by the Welsh Rust Group on rust fungi. The authors are pleased that the following organisations wish to be associated with this publication:



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