DIVERSITY AND DISTRIBUTION OF MUSHROOM-FORMING FUNGI (AGARICOMYCETES) IN IRELAND

R. O'Hanlon and T.J. Harrington

ABSTRACT

The diversity and distribution of Agaricomycete species in the Republic of Ireland (ROI) is examined and the records are compared with similar records from Northern Ireland, England, Scotland and Wales. The number of Agaricomycete species recorded from Ireland is much lower than in the other countries examined. The ROI has 100, 700, 1300 and 2200 fewer species than Northern Ireland, Wales, Scotland and England respectively. When species records according to major taxonomic clades are examined, it is evident that under-recording of Agaricomycete species from the ROI is common throughout all of the clades. Estimates of potential Agaricomycete diversity in the ROI indicate that 25 of the 26 counties have less than half of their likely Agaricomycete diversity recorded. Agaricomycete clades that have been reasonably well recorded and those that suffer from severe under-recording in Ireland have been identified, and preliminary lists of the 50 most common Agaricomycete and of possibly threatened Agaricomycetes in the ROI have been created. One of the main reasons for the low number of species recorded in the ROI is the lack of both professional and amateur mycologists conducting periodic surveys. This paper makes recommendations as to how the true Agaricomycete diversity of Ireland can be discovered.

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INTRODUCTION

Fungi constitute one of the most diverse groups of organisms. There are approximately 75,000 described species of fungi, but this is regarded as significantly fewer than the actual number of species. There has been a good deal of controversy about estimates of true fungal diversity. However, a figure of 1.5 million species has been proposed as a working hypothesis (Hawksworth 1991) and has been accepted by most mycologists as an estimate, although some consider it too low (O'Brien *et al.* 2005). This figure is based largely on field data from the tropics, which have, from the available evidence, considerably greater fungal diversity than temperate regions, although most of it is not described (Lodge *et al.* 1995).

The most advanced group of fungi are the club fungi or phylum Basidiomycota, containing about 30,000 described species, or 37% of the described species of true fungi (Kirk *et al.* 2001). The extrapolated global diversity of the Basidiomycota is estimated to be in the region of 180,000 species (Rossman 1994). The largest subphylum of the Basidiomycota are the Agaricomycotina, the most familiar and conspicuous of all the fungi, because they mostly produce large fruiting bodies. Included in the group are the gilled mushrooms (agarics), puffballs, bracket fungi (polypores), corticoid fungi, chanterelles, coral fungi, cyphelloid fungi and many others. Included are many edible species, although not truffles or morels, which belong to the related fungal phylum Ascomycotina or sac fungi. We have confined this review to the Agaricomycetes because they are the most conspicuous group of fungi and are very important in terms of ecosystem functions, and because there is much more data available on the diversity and distributions of this group than other fungal groups in Ireland and other European countries.

This review uses the modern interpretation of the Agaricomycotina (Hibbett 2007) comprising three classes: the Agaricomycetes, Dacrymycetes and Tremellomycetes. The Agaricomycetes comprise 16,000 described species (98% of the Agaricomycotina) (Kirk *et al.* 2001), but the true figure is probably nearer 80,000 (Rossman 1994). Recent molecular evidence (Binder and Hibbett 2002; Matheny *et al.* 2007) indicate that the Agaricomycetes comprise a monophyletic group of fourteen clades. The gill-fungi are the most conspicuous members, but other members include groups such as the Aphyllophorales or non-gilled Basidiomycetes (e.g. bracket, coral, corticoid and hedgehog fungi), phalloid fungi and puffballs,

which in pre-molecular studies of Basidiomycete phylogeny based on fruiting body morphology were considered to be distinct groups within the Basidiomycota. Agaricomycetes function as decayers, pathogens, parasites and mutualistic symbionts of both plants and animals. They make their broadest ecological impacts through their activities as wood-decayers and ectomycorrhizal symbionts of forest trees (such as pines, oaks, dipterocarps and eucalypts (Rayner and Boddy 1988; Smith and Read 2008)).

The aims of this review are to assess the status of Agaricomycete recording in the Republic of Ireland (ROI), to examine patterns of Agaricomycete abundance in the ROI and recent changes, to identify important areas of Agaricomycete diversity in the ROI, and to examine conservation issues in relation to Agaricomycetes.

SOURCES OF INFORMATION

The first published record of fungi in Ireland was published by Caleb Threlkeld in 1726 (Threlkeld 1726 as cited in Muskett 1976). In this work the author recorded and described five species of fungi. Since the publication of Threlkeld's records, few other scientific studies have examined fungal diversity in Ireland (for a review see Hassell 1957). However, the information available was synthesised into the first census catalogue of fungi by Adams and Pethybridge (1910), which identified over 800 species of basidiomycetes. Muskett and Malone, in *Catalogue of Irish Fungi* (Muskett and Malone 1978; 1980), listed a total of 1203 basidiomycetes in Ireland. The work of Muskett and Malone set a baseline for Irish basidiomycete diversity studies, and it forms a large portion of the records for fungi in Ireland in the *Checklist of British and Irish Basidiomycetes* (Legon and Henrici 2005). Excursions by the British Mycological Society (BMS) to Ireland (south and north) have been a significant source of fungal records in the ROI and Northern Ireland (NI). The BMS visited Dublin and Wicklow in 1898, 1925 and 1957 (Pim 1898; Wakefield 1926; Francis 1958), Killarney in 1936 (Ramsbottom 1936), Roscrea and the midlands in 1989 (Ing and Feehan 1990) and the Burren in 1993 (British Mycological Society 1993). In Northern Ireland they visited Belfast in 1931 (Wakefield 1932) and 1948 (Ainsworth 1950). Their latest visit was to Fermanagh in 2000. Participants have included not only Irish mycologists, but also professional and amateur mycologists from Britain and other European countries.

Recent information on the distribution of basidiomycetes in Ireland has been gleaned from five main sources:

- the British Mycological Society's *Checklist of Basidiomycetes for Britain and Ireland* (Legon and Henrici 2005);
- the Fungal Records Database of Britain and Ireland (FRDBI) (British Mycological Society 2009);
- the database of the Northern Ireland Fungus Groups (NIFG 2009);
- the fungal records database in the National Biodiversity Data Centre (National Biodiversity Data Centre 2008);
- published records from journals such as *Irish Naturalists' Journal*, *Field Mycology* and *Proceedings of the Royal Irish Academy*.

Records for basidiomycetes found in the Republic of Ireland (ROI) and Northern Ireland (NI) have been collected and synthesised by N.W. Legon and A. Henrici as part of the *Checklist of British and Irish Basidiomycetes* (Legon and Henrici 2005). The *Checklist* records are derived from both confirmed records that have voucher specimens deposited in an established herbarium and from some anecdotal records. It rates the distribution of the fungus based on how many verified specimens have been deposited in the Herbarium at the Royal Botanical Gardens at Kew. If no voucher specimen is supplied then the record is purely anecdotal and the justification for its use in further analyses or species lists is questionable (Ammirati 1979). If a voucher has been supplied and the fungus has been listed from a number of areas then it can be classed as common, occasional or rare. The *Checklist* contains 1204 records for basidiomycetes in the ROI, of which 1012 are members of the Agaricomycotina. Since the publication of the original list by Muskett and Malone there have been 551 name changes, 539 of which relate to the Agaricomycotina. The Northern Ireland Fungus Group (NIFG) was established in 1996 and through forays and surveys has compiled an extensive database of fungal distribution in NI, including many new records of basidiomycetes and ascomycetes. The NIFG database contains 1347 records for basidiomycetes (NIFG 2009).

The FRDBI gives the number of records for many types of fungi, e.g. ascomycetes, basidiomycetes and chytridiomycetes, recorded in Britain and Ireland. It is useful in that it contains information on the number of species of fungi recorded in all the vice-counties of Britain and Ireland and is used to identify areas where

little mycological recording has taken place. A significant recent development for the study of biodiversity in general in Ireland has been the establishment of The National Biodiversity Data Centre in 2007 (http://www.biodiversityireland.ie), which has collated information on records of basidiomycetes in Ireland from the FRDBI and has plotted records on maps to highlight distribution data for certain common species (National Biodiversity Data Centre 2008).

Fifteen papers and reports dealing directly with Agaricomycete diversity in Ireland have been published since 1898 (Table 1). Some other short communications relating to new records from Ireland have been published in journals such as the *Irish Naturalists' Journal* and *Field Mycology*. For many of the records cited in these publications, voucher specimens have been sent to the Royal Botanical Gardens at Kew and have been included in the *Checklist of British and Irish Basidiomycetes*.

In addition to published records, there are a number of unpublished record collections held by lifelong fungal collectors in Ireland. Accessing and analysing the data in these collections was beyond the scope of this article, but it is likely that the information contained therein, if channelled through a formal recording system, would add considerably to the tally of Agaricomycete records in individual vice-counties and the ROI in total. An important repository for fungal specimens and records is the herbarium at the National Botanical Gardens in Glasnevin, Dublin. The Glasnevin collection contains over 39,000 fungal records, including 7500 fungal records from Ireland, many of which are represented in the FRDBI and NDBC databases.

NUMBERS OF RECORDS

In the *Checklist of British and Irish Basidiomycetes*, 1204 species of Agaricomycetes are recorded for the ROI, compared to 1303 for NI, 1936 for Wales, 2507 for Scotland and 3482 for England. This number is much less than would be expected on a comparative land area basis; for example, NI and Wales have only 22% and 30% of the land area of the ROI respectively but have greater numbers of fungal records (over 1.6 times as many in the case of Wales). It is estimated that the *Checklist* only contains up to one-third of the total species richness for Agaricomycetes in Ireland (Senn-Irlet *et al.* 2007). Ireland also has the lowest mean number of basidiomycete species recorded per vice-county, compared to the other countries listed in Table 2. Vice-counties (or Watsonian vice-counties) were first introduced by H.C. Watson (Watson 1859) as a basic biogeographical unit for plant records. The vice-counties of Ireland and Northern Ireland range from H1 to H40 and those of Great Britain

Table 1—Published papers or reports dealing with Agaricomycete diversity in the Republic of Ireland.

Theme of publication	*No. of Agaricomycete species*	*Reference*
Fungi of Co. Dublin and Co. Wicklow	–	Pim 1898
Fungi of Co. Kerry	214	Gill 1948
Fungi of Co. Dublin	–	Hassell 1953
Fungi of the Burren	86	Harrington 1996
		Harrington 2003
Fungi of Ireland	11	O'Connor 1936
	15	O'Connor 1949
	900	Adams and Pethybridge 1910
Grassland fungi	60	Carter 1998
	111	Mc Hugh *et al.* 2001
	25	Mitchel 2006
	101	Mitchel 2007
	44	Mitchel 2008
	158	Mitchel 2009
Basidiomycetes of Ireland	1097	Muskett and Malone 1978
		Muskett and Malone 1980

Table 2—Basidiomycete records per vice-county from the fungal records database for Britain and Ireland (FRBDI) (British Mycological Society 2009).

Country	*No. vice-counties*	*Mean no. records pervice-county*	*Minimum no. records*	*Maximum no. records*
Ireland	26	289	9	1064
Northern Ireland	6	906	549	1469
England	66	1742	213	3653
Scotland	30	970	186	2351
Wales	13	1096	477	1734

range from 1 to 112. Disparity in the frequency of basidiomycete records is very evident for the average numbers of records per vice-county: in the 36 vice-counties in Ireland, the average number of species records is 289 species. The six vice-counties of Northern Ireland average 906 species, and the 13 vice-counties of Wales average 1096 species. A number of the ROI vice-counties (8) have below 100 records, the lowest being Longford (H24). The lowest average in the UK is 186 for Renfrewshire, in Scotland, which has a smaller area than Longford.

The comparatively low mean number of records per vice-county in the ROI is a consequence of a lack of formal and informal surveys and recording of species rather than an inherent paucity of species; the disparity in records between the ROI and the vice counties of the geographically similar NI illustrate this. A scarcity of personnel is only one of the reasons for the scarcity of records. Historically, macrofungal studies and surveys have not received as much attention in Ireland as studies and surveys of vegetation or invertebrates. The absence of a national platform for reception of records, standard protocols for record submission and a national database into which records could be submitted have all hindered recording of fungal species in the ROI. The establishment of the NBDC will help to address the deficit in fungal records, but only if a database of fungal biodiversity, similar to that which exists in NI, can be established. The NBDC has launched a number of initiatives to collect distribution data on a number of organisms, including higher and lower plants (National Vegetation Data Project), invasive species (National Invasive Species Database), water beetles (Water Beetles of Ireland Initiative) and freshwater fishes (Freshwater Fish Database), and a similar initiative for fungi would be welcome.

Records of basidiomycetes and fungi in general in the ROI tend to be highly clustered and localised. Areas close to County Dublin, for example, have greater numbers of records. Many of the macrofungal records for County Dublin can be attributed to the work of mycologists in universities in Dublin and members of the Dublin Naturalists' Field Club (Pim 1898; Hassell 1953; Carter 1998; McHugh *et al.* 2001). Species lists generated by excursions by the British Mycological Society (BMS) to Ireland have formed the core of records in vice-counties visited, and it is no coincidence that those counties visited are among those with the greatest number of records. Past forays have visited eight counties in total and have revealed much information about records new to Ireland and about the distribution of common fungi. Localities that have interesting or unique ecological attributes have attracted more interest from professional and amateur mycologists than less well known areas. County Wicklow, which has the largest area of native and non-native forest cover relative to county size, has also the largest number of basidiomycete records (1064) (this may also reflect its proximity to Dublin). The vice-county of Kerry comes in at second overall with fungal records (978), most of which come from the Killarney Valley, which has attracted the attention of mycologists principally interested in the stands of Atlantic oak woods. Many of the records from here are attributable to the BMS visit in 1936 (Ramsbottom 1936) and to increased surveying in the aftermath of the BMS foray (Gill *et al.* 1948). The vice-county of Offaly has 690 records for fungi, which puts it third overall for the number of records in Ireland. The BMS annual foray visited Offaly in 1991, and their recording effort concentrated on woodland areas including the species-rich pedunculate oak woodland of Charleville demesne near Tullamore, Co. Offaly. County Clare has also received the attention of mycologists, but most macrofungal records have come from the Burren in the north of the county, which has a unique vegetation and a number of macrofungi with otherwise very restricted distributions (Harrington 2003). In total the vice-county of Clare (which includes the Aran Islands) is fourth with regard to the number of

fungal records. Another of Ireland's unique areas is the grassland of the Curragh, Co. Kildare, which has a well-documented diversity of grassland macrofungi (Carter 1998; Mc Hugh *et al.* 2001).

ANOMALIES IN AGARICOMYCETE RECORDS

A comparison of fungal records between the ROI, NI, England (E), Scotland (S) and Wales (W) is shown (Table 3) for the fourteen main clades of the Agaricomycotina (Hibbett 2007), based on records in the *Checklist of British and Irish Basidiomycetes* (Legon and Henrici 2005). Genera have been assigned to clades according to Hibbet (2007).

CLADE AGARICALES

The largest apparent disparity in the profile of fungal genera in the ROI compared to the other countries is the relatively low numbers of species recorded in the Agaricales, the most biodiverse clade, which comprises 109 genera in the ROI, marginally more than in NI, but significantly fewer than E (43 fewer), S (27) and W (22). Genera absent from Ireland that have been found in E, S, W and NI are *Ampulloclitocybe, Camarophyllopsis, Cellypha, Chrysomphalina, Fayodia, Hydropus, Macrotyphula, Myxomphalia, Phaeolepiota, Phyllotopsis, Rimbachia, Simocybe* and *Squamanita*. Three of these genera (*Camarophyllopsis, Simocybe* and *Hydropus*) have five or more species recorded from E, S, W or NI, so it may be expected that at least one representative of each genus would be found in Ireland.

Compared to E, over 1000 species of Agaricales are not recorded in the ROI. Fifty-nine species recorded in NI are not recorded in the ROI. Some genera are relatively poorly recorded in the ROI. Hypogeous genera (*Hymenogaster*, *Hysterangium* and *Rhizopogon*) are poorly represented in the ROI. Some large and taxonomically difficult genera such as *Cortinarius, Inocybe, Hebeloma, Entoloma, Mycena, Coprinopsis* and *Tricholoma* are under-recorded in the ROI relative to E, S, W and NI (Fig. 1). *Entoloma* is the most diverse genus in the ROI list with 63 species, but this represents only 60% of the average number of *Entoloma* species recorded for E, S, W and NI. Some genera are comparatively well-represented in Ireland: for example in the ROI the genera *Hygrocybe, Lycoperdon, Mycena, Clitocybe* and *Stropharia* contain at least 70% of the mean number of species recorded for these genera across E, S, W and NI. In the ROI, 45 species of *Hygrocybe* have been recorded, or 89% of the average number of *Hygrocybe* species found in E, S, W and NI, reflecting the availability of suitable habitat for *Hygrocybe* and the greater attention they have received from mycologists (Carter 1998; McHugh *et al.* 2001; Mitchel 2006; 2007; 2008; 2009).

CLADE BOLETALES

Sixteen genera have not been found in the ROI, and two of these (*Phylloporus* and *Strobilomyces*) are found in every other country except the ROI. The most striking disparity in the clade Boletales is the genus *Boletus*; in the ROI there are only 13 species of *Boletus* recorded, compared to 40, 23, 21 and 20 from E, S, W and NI respectively.

CLADE POLYPORALES

Species of *Antrodia*, *Athelopsis*, *Burgoa*, *Corticium*, *Cotylidia*, *Junghuhnia*, *Phlebiella*, *Phlebiopsis, Sistotremastrum* and *Terana* have all been found in all of the other countries except the ROI. Of these, two (*Antrodia* and *Phlebiella*) have five or more species described in the *Checklist* and it is quite possible that their existence in the ROI has yet to be discovered. Members of this clade are relatively poorly recorded in the ROI; some, for example *Inonotus* and *Phellinus*, which are tree parasites, have restricted host ranges and the shortage of suitable forest habitat may be a factor in their poor representation in the ROI.

CLADE RUSSULALES

Species of *Celatogloea*, *Dentipellis*, *Dichostereum*, *Vesiculomyces*, *Zelleromyces*, *Boidinia*, *Clavicorona*, *Gymnomyces*, *Laxitextum*, *Lentinus*, *Scytinostroma*, *Stephanospora*, *Vararia*, *Megalocystidium* and *Mucronella* are absent from the ROI. None of these have been found in all of the other countries and only two (*Megalocystidium* and *Mucronella*) have been found in three of the other countries. One of the most obvious differences concerns *Russula*, where only 42 species have been recorded in Ireland compared to 133, 113, 79 and 80 species from E, S, W and NI respectively. *Lactarius* appears to be also under-represented in the ROI, although not to the same extent as *Russula* (Fig. 1).

Fungal species, and in some cases whole genera, can be assigned to functional groups that are based on mode of nutrient acquisition. Ferris *et al.* (2000) designated four functional groups: ectomycorrhizal fungi, wood decomposers, litter decomposers and parasitic fungi. The ROI is

Table 3—Total number of genera and species in each clade of the Agaricomycotina in the Republic of Ireland (ROI), England, Scotland, Wales and Northern Ireland (NI).

Clade		*ROI*	*England*	*Scotland*	*Wales*	*NI*
Agaricales	Genera	109	152	136	131	106
	Species	652	1820	1344	1016	710
Atheliales	Genera	5	12	12	11	7
	Species	7	43	33	22	10
Auriculariales	Genera	14	30	20	17	13
	Species	26	89	59	40	27
Boletales	Genera	21	37	27	25	20
	Species	56	136	92	77	68
Cantharellales	Genera	7	10	8	8	8
	Species	17	48	40	30	16
Corticiales	Genera	5	7	3	3	2
	Species	7	17	6	4	5
Gloeophyllales	Genera	0	1	1	1	0
	Species	0	2	3	2	0
Hymenochaetales	Genera	9	10	9	10	9
	Species	18	57	43	32	20
Phallomycetidae	Genera	9	19	10	8	9
	Species	17	66	37	36	20
Polyporales	Genera	48	109	80	73	58
	Species	75	299	186	168	99
Russulales	Genera	15	30	20	19	15
	Species	106	279	233	168	153
Sebacinales	Genera	1	3	1	2	1
	Species	2	6	2	3	2
Thelephorales	Genera	5	8	8	5	5
	Species	25	57	38	31	19
Trechisporales	Genera	1	1	1	1	1
	Species	4	22	12	9	6
	Total Genera	249	429	336	314	254
	Total species	1012	2941	2128	1638	1155

under-recorded compared to E, S, W and NI in respect of each of these groups, but particularly in respect of mycorrhizal and timber-decomposing basidiomycetes of woodland habitats (Fig. 2).

Are the relatively low percentage of woodland cover in the ROI and the low levels of high-quality coarse woody debris in some woodlands (Sweeney *et al.* 2010) contributory factors in this under representation and if so, to what extent? Timber and woodland litter decomposers and ectomycorrhizal species would be expected to be more diverse in areas with extensive forest cover, in particular with old forests. This relationship was assessed for England using linear regression (SPSS version 16 SPSS, Chicago, Illinois) of the number of fungal species recorded in each forest region (Forestry Commission 2003) as the dependant variable and the area of the regions under forest cover (deciduous, coniferous and total forest cover) of the region as independent

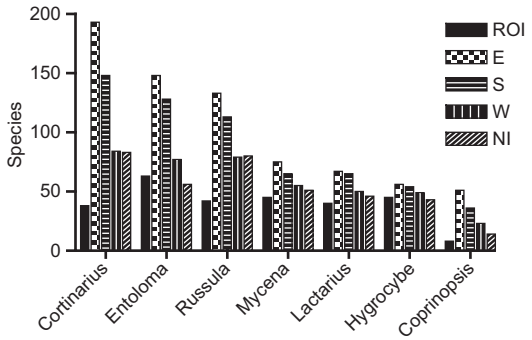

Fig. 1—Number of species per genus in the countries Republic of Ireland (ROI), England (E), Scotland (S), Wales (W) and Northern Ireland (NI).

variables. The amount of deciduous forest cover was the most significant and influential independent variable ($F_{1,38}$ = 17.805, P = 0.0001, R^2 = 0.319) (Fig. 3). The regression model is Y = 0.072X + 1383 (Fig. 3). The extreme outlier at the top of Fig. 3, which has values of 5314 species per 19,962 hectacres of deciduous forest, corresponds to the region of Surrey, probably the most comprehensively surveyed mycological region in the UK. This strong and significant relationship is not surprising considering that past studies have shown a strong relationship between the area of forest (Peay *et al.* 2007), the number of tree species present (Ferris *et al.* 2000; Schmit *et al.* 2005) and the diversity of fungal species, suggesting that fungal species distribution is directly related to the area of forest being surveyed (Peay *et al.* 2007).

An identical analysis conducted for fungal records from the ROI vice-counties also showed that the amount of deciduous woodland was the most significant variable ($F_{1,24}$ = 5.654, P = 0.05, R^2 = 0.191). However, it is evident from the relatively low R^2 value that the relationship between deciduous forest cover and Agaricomycete diversity in the ROI is not nearly as strong as in the UK, probably because of the paucity of information on Agaricomycete diversity in most ROI vice-counties. Substituting deciduous forest cover data from the ROI vice-counties into the UK species, the forest area relationship indicates that all ROI vice-counties could have between 1400 and 2400 species of fungi. Twenty-five ROI vice-counties have realised less than 50% of their potential species richness, with only one vice-county having more than half its estimated species richness (Wicklow 55%).

AGARICOMYCETE SPECIES FREQUENCY IN THE ROI

The distribution and frequency of recordings of species can provide useful information about the abundance of species in different geographical areas

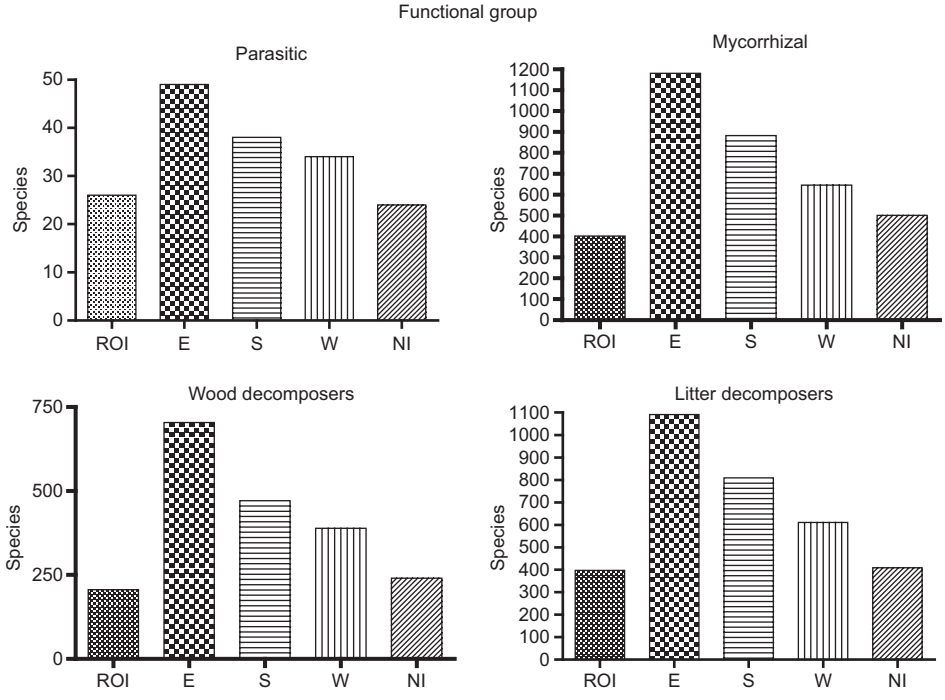

Fig. 2—Comparison of mean species per functional group in Republic of Ireland (ROI), England (E), Scotland (S), Wales (W) and Northern Ireland (NI).

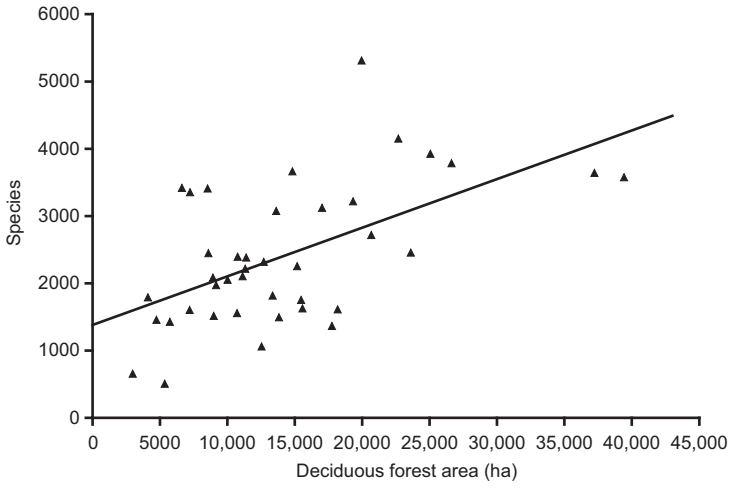

Fig. 3—Regression of the number of fungal species per region versus the area of deciduous forest cover in hectares in the forest regions in England.

and can also give insights into species' ecology. The FRDBI database provides information on the frequency of recording of Agaricomycetes in the ROI, the UK and NI. In the ROI, waxcaps (*Hygrocybe* species) are among the most frequently recorded of Agaricomycetes. These colourful fungi are commonly found on unimproved grasslands. *Hygrocybe conica* is the most recorded species in the ROI (209 records) and NI (527 records), in contrast to E, where it is ranked 32nd (Table 4). The highest ranking *Hygrocybe* sp. in England is *H. virginea* (26). In Ireland, five of the ten most frequently recorded Agaricomycetes are mainly grassland species, principally *Hygrocybe conica, H. virginea, H. chlorophana, H. psittacina* and *H. insipida.* In England, all top ten are woodland species; some of these are also highly ranked in the ROI and NI. For example, the wood-rotter *Hypholoma fasciculare* is ranked 1, 2 and 14, and the ectomycorrhizal *Laccaria laccata* is ranked 5, 6 and 11 in E, the ROI and NI respectively. Two other wood-rotters, *Trametes versicolor* and *Stereum hirsutum*, are ranked 2 and 3 in UK, and 7 and 9 in NI, but are ranked much lower in the ROI (50 and 68 respectively).

Woodland species are in the majority in the 50 top-ranked species in both countries, and many common woodland species have similar rankings in both countries. For example, *Hypholoma fasciculare, Russula ochroleuca, R. cyanoxantha, Paxillus involutus, Phallus impudicus, Laccaria laccata, Lycoperdon perlatum, L. pyriforme* and *Collybia dryophila* are all within ten ranks of each other in both countries. However, there are significant differences in the rankings of some woodland species in both countries. For example, *Laccaria amethystina, Cantharellus tubaeformis, Inocybe geophylla, Russula nobilis, Clavulina coralloides, Clitopilus prunulus, Suillus bovinus, S. luteus, Lactarius deterrimus* and *L. deliciosus* are at least 70 places higher in the ROI rankings than the E rankings.

Conversely, some highly ranked UK species are less-recorded in the ROI. Species that are found in the top 50 British species and not in the top 50 ROI list include *Auricularia auricula-judae, Bjerkandera adusta, Clitocybe nebularis, Coprinus micaceus, Dacrymyces stillatus, Daedaleopsis confragosa, Lactarius turpis, Leccinum scabrum, Lepista nuda, Mycena galericulata, Mycena galopus* and *Piptoporus betulinus.*

What do these differences in rankings reflect, if anything? To a large extent they may simply reflect anomalies in recording effort, for example, greater discrimination and recording of less common and less easily identifiable species in the UK compared to the ROI—the higher ranking of easily identifiable species (e.g. *Laccaria amethystina* and *Lycoperdon nigrescens*) would suggest that this is an important contribution to the differences. Rankings, in the ROI at least, are probably a poor indicator of abundance for most species. For example, there is only one record for *Auricularia auricula-judae,* but this actually is a common species in the ROI although late in the season. Grassland species are probably more highly ranked in the ROI because of the proportionally greater recording effort in grassland versus woodland habitats in the ROI compared to the UK. The study of grassland fungi has received much attention in Ireland, with many projects focusing on grassland species as an indicator of grassland habitat status (Carter 1998; McHugh *et al.* 2001; Mitchel 2006; 2007; 2008; 2009).

Table 4—Ranking of the top 50 of agaricomycetes in the Republic of Ireland (ROI) based on frequency of records (number of records in brackets), corresponding to rankings for the UK and Northern Ireland (NI). ROI data from the NBDC database. UK rankings based on FRDBI top 50 list (British Mycological Society 2009) and NI rankings based on NIFG top 50 list (NIFG 2009).

Species	*ROI rank*	*UK rank*	*NI rank*	*Habitat*
Hygrocybe conica	1 (209)	32	1	G
Hypholoma fasciculare	2 (157)	1	14	W
Hygrocybe virginea	3 (154)	26	2	G
Hygrocybe chlorophana	4 (140)	65	13	G
Laccaria amethystina	5 (135)	28	46	W
Laccaria laccata	6 (135)	5	11	W
Hygrocybe psittacina	7 (111)	42	3	G
Lycoperdon perlatum	8 (100)	12	30	W
Hygrocybe insipida	9 (90)	[a]	6	G
Mycena pura	10 (88)	48	31	W
Phallus impudicus	11 (85)	9	66	W
Hygrocybe coccinea	12 (83)	70	5	G
Lycoperdon pyriforme	13 (83)	13	33	W
Stropharia semiglobata	14 (83)	54	12	C
Paxillus involutus	15 (82)	6	19	W
Clavulinopsis helvola	16 (81)	114	29	W
Hygrocybe pratensis	17 (77)	45	8	G
Collybia dryophila	18 (74)	21	[b]	W
Panaeolus papilionaceus	19 (71)	145	36	C
Russula ochroleuca	20 (70)	7	22	W
Entoloma conferendum	21 (68)	96	46	G
Tricholomopsis rutilans	22 (66)	55	62	W
Coprinus comatus	23 (65)	56	55	G, W
Hygrophoropsis aurantiaca	24 (65)	37	84	W
Hygrocybe persistens	25 (64)	[b]	[b]	G
Hygrocybe russocoriacea	26 (63)	[a]	16	G
Amanita rubescens	27 (60)	11	46	W
Pluteus cervinus	28 (60)	15	32	W
Scleroderma citrinum	29 (60)	17	81	W
Panaeolus acuminatus	30 (58)	[a]	[b]	G
Lycoperdon pratense	31 (57)	130	93	G
Calocera viscosa	32 (56)	49	77	W
Psilocybe semilanceata	33 (56)	157	84	G
Hygrocybe miniata	34 (55)	[b]	96	G
Hygrocybe quieta	35 (54)	[a]	19	G
Russula nigricans	36 (54)	40	41	W
Clavulinopsis corniculata	37 (53)	[a]	41	W
Lycoperdon foetidum	38 (52)	98	77	W
Lycoperdon nigrescens	39 (52)	98	77	W
Hygrocybe reidii	40 (51)	[a]	15	G
Boletus chrysenteron	41 (50)	14	36	W
Hygrocybe punicea	42 (50)	[b]	46	G
Clitopilus prunulus	43 (48)	121	82	W
Russula cyanoxantha	44 (48)	36	43	W
Amanita muscaria	45 (47)	19	84	W
Armillaria mellea	46 (47)	34	16	W
Bolbitius titubans	47 (47)	87	62	C
Cystoderma amianthinum	48 (47)	104	10	W
Lactarius blennius	49 (46)	79	24	W
Rhodocollybia butyracea	50 (45)	24	18	W

[a] =common; [b] =occasional; habitat preferences: W = woodland species; G = grassland species; C = coprophilic.

Differences in rankings between the ROI and the UK may, for some species (e.g. *Lactarius turpis*, *Boletus edulis*, *Bjerkandera adusta Cantharellus cibarius*, *Clavulina coralloides*, *Clitopilus prunulus*, *Stropharia semiglobata*, *Suillus luteus* and *Lactarius deterrimus*) reflect real differences in distribution and ecology of these species between both regions.

CHANGES IN AGARICOMYCETE FREQUENCY IN THE ROI

Anecdotal evidence suggests that there have been declines in the abundance of grassland fungi such as the common field mushroom (*Agaricus campestris*) in Ireland as in other European countries since the mid-twentieth century at least. Other grassland fungi such as waxcaps have probably also declined in overall abundance as a consequence of loss of unimproved grassland. Other species appear to be on the increase. *Agaricus bernardii,* a coastal species, is said to be spreading in the UK and possibly in the ROI due to the spreading of salt to de-ice roads (Legon and Henrici 2005). This species was not listed in Muskett and Malone's *Catalogue* (Muskett and Malone 1980), but it has since been recorded by Carter (1998) in a meadow in County Limerick and by Mitchel (2008) in a field in County Mayo. *Agrocybe arvalis* and the threatened *Agrocybe pediades* can often be found on wood chips and mulch spread to inhibit weed growth. *Agrocybe pediades* was reported in the original catalogue by Muskett and Malone. The deadly webcap, *Cortinarius rubellus* (syn. *Cortinarius speciosissimus*), is a highly toxic member of the genus *Cortinarius* that has been responsible for a number of poisonings in Scotland. Originally it was thought to occur only in native pine forests as an ectomycorrhizal associate of pine (Watling 1982), but it now appears to be much more widely distributed in conifer plantations, particularly of Sitka spruce, with which it appears to form ectomycorrhizas. Muskett and Malone (1980) did not report *C. rubellus* as occurring in the ROI or NI, and the first published record was from a Sitka spruce stand in County Mayo in 1994 (Harrington 1994). It is likely to have been in the ROI well before that date, but overlooked, and it is now common in Sitka spruce and other conifer stands in the ROI (T. Harrington, unpublished data). It is also recorded with both *Betula* and *Picea* in Northern Ireland (NIFG 2010). The root-rot fungus, *Heterobasidion annosum,* is a common parasite of commercial coniferous forest that causes large financial losses. It has been identified as the most serious disease of Sitka spruce in Ireland (Joyce and O'Carroll 2002). The fungus infects trees through freshly cut stumps and then invades the root systems, from where it can spread to adjacent trees. Single species plantings of Sitka spruce and other conifers has encouraged the spread of *H. annosum*. It was reported from ten of the sites by Muskett and Malone (1980) but is now found in most conifer stands. Other Agaricomycete species that have increased in abundance as result of commercial conifer forestry include *Lactarius deterrimus, Lactarius turpis, Entoloma cetratum, Entoloma conferendum, Cortinarius obtusus* and *Clitocybe vibecina* (R. O'Hanlon, unpublished data).

IMPORTANT AREAS IN IRELAND FOR AGARICOMYCETE DIVERSITY

In the UK, the report *Important Fungus Areas* (Plantlife 2001) identified over 500 areas that have unique collections of fungi and may be in need of protection. The criteria for designation of an Important Fungus Area are as follows:

- The site should have significant populations (of at least five species) of rare fungi that have been identified as threatened in a Red Data List.
- The site should have an exceptionally rich and well-recorded fungal flora with over 500 different species of fungi.
- The site should be an exceptional example of a habitat of known mycological importance.
- The site should be a nominated site that is considered important but needs more research.

Such areas in Ireland have not yet been formally identified or designated, but the basis exists for identifying such areas based on existing fungal records or the presence of unique plant communities that are known from other regions to be rich in fungi.

Using the above criteria, the areas that could be considered mycologically unique in Ireland include certain woodland areas, grassland areas, the Burren heaths and some sand dune areas.

WOODLAND

Woodland habitats support the greatest fungal diversity and Agaricomycete diversity in particular. The area of surviving native woodland cover in Ireland is very low by European standards, and fungal recording in these surviving woodland areas is patchy and intermittent due to the scarcity of recording expertise available. Nevertheless, there are some unique woodland habitats in Ireland, albeit small in area, that are

known or are suspected of being mycologically rich (Ramsbottom 1936). Foremost are the surviving oligotrophic woodlands, which includes bryophyte-rich Atlantic (acidophilus) oak woods (Kelly 1981) in west Cork, Kerry, Galway, Mayo and Donegal, which include the annexed WN1 oak woodlands that correspond with the annexed habitat, 'old sessile' oak woods with *Ilex* and *Blechnum* in the British Isles (EUROPA 2009) and acidophilus oak woodland in the south and east. Other woodland types that are likely, from the limited information available, to be mycologically rich include pedunculate oak stands in the midlands on limestone or limestone drift and oligotrophic birch woodland on raised bog margins.

GRASSLAND

Traditionally managed meadows and pastures or semi-natural grasslands are typically rich in specialised saprotrophic fungi, particularly species of *Hygrocybe, Entoloma,* Geoglossaceae and clavarioids (such grasslands are also known as 'Hygrocybe grasslands'). Such grasslands are in sharp decline all over Europe as a result of improvement arising from agricultural intensification, afforestation and abandonment followed by scrub invasion. The decline in Ireland, however, does not seem to be as severe as that in the UK and other northern European countries, where the loss of semi-natural and unimproved grassland has been more marked. The Curragh in County Kildare is the most species-rich of all the grassland sites examined in the ROI (Carter 1998; McHugh *et al*. 2001). To date there are 350 records for fungi from the Kildare region. The work by Mitchel has greatly expanded knowledge of grassland fungi in western counties (Mitchel 2006; 2007; 2008; 2009).

THE BURREN

The Burren is an area of karst landscape in the county of Clare. Its climate is markedly Atlantic and characterised by high rainfall, relative humidity and wind exposure and a small annual temperature range. Much of the higher parts of the Burren are covered by grass-heath dominated by blue grass (*Sesleria albicans*) and dwarf shrubs such as mountain avens (*Dryas octopetala*) and bearberry (*Vaccinium uva-ursi*). The Burren population of mountains avens is well outside its normal alpine arctic range, where it supports a wide range of arctic–alpine fungi, both saprophytic and ectomycorrhizal. These fungi are not found with mountain avens in the Burren, but it is host to a diverse range of ectomycorrhizal fungi including many uncommon *Cortinarius* species such as *C. odorifer, C. mussivus* and others (Ing and Feehan 1990; British Mycological Society 1993; Harrington 1996; 2003; Harrington and Mitchell 2002). Some of these species are probably relicts of a larger fungal biota associated with Scots pine forest, which is known from palynological evidence to have persisted in the Burren until the Bronze Age (Harrington 1996). The Burren also has a rich representation of *Hygrocybe* and other grassland fungi.

SAND DUNES

Ireland has extensive areas of sand dune around its coast. Sand dunes have a distinctive Agaricomycete biota (Rotheroe 1992), but apart from work on the fungi of the sand dunes on the North Bull Island, in Dublin Bay (Hassell 1953; Landy 2001), there is little information on Agaricomycete diversity in Irish sand dune systems. These systems, particularly along the west and south costs, are rarely decalcified, in contrast to many systems in Britain and mainland Europe. They also contain extensive areas of slack vegetation and dune grassland or machair (particularly in counties Galway, Mayo and Donegal), which are likely to add significantly to the variety of species present.

Table 5—Data from Senn-Irlet *et al*. (2007) showing the fungal conservation ratings of Ireland and five other European countries. 1 = best rating, 2 = middle rating and 3 = worst possible rating.

Country	*Checklist*	*Professional mycologists*	*Amateur mycologists*	*Red list*	*Conservation consideration*
Ireland	1	3	–	3	3
UK	1	3	2	2	2
France	2	2	1	2	3
Switzerland	1	3	1	1	2
Poland	1	1	3	2	2
Finland	2	1	1	1	2

CONSERVATION ISSUES

Habitat modification and loss, climate change, introductions and the ecological processes of colonisation and extinction have led to changes in our Agaricomycete biota in the past and will continue to do so in the future, although perhaps at an accelerating pace. Many countries, realising the importance of fungi in ecosystem processes, take fungi into account in habitat management plans, collect data on fungal distribution and devise conservation measures for rare or threatened species. A recent report (Senn-Irlet *et al.* 2007) rated 44 European countries on a 1 to 3 scale in relation to five performance indicators for fungal conservation. Ireland received top marks for having a fungal checklist, but fared poorly in the four remaining indicators, namely the number of professional mycologists and amateurs working with fungal diversity, the existence of a Red Data List for the country and the consideration given to fungal conservation in official planning schemes. It is noteworthy that amateur mycologists in Ireland could not be rated due to insufficient information and the lack of an official fungus group. When all of the ratings are accumulated, Ireland is rated in joint 33rd place of 44.

The first step in conservation of endangered fungi is deciding which fungi are in danger of extinction and the current threat level and compiling a Red List of species. Currently, 31 European countries have compiled Red Lists for threatened macrofungi with over 5500 species red-listed in at least one European country (Senn-Irlet 2007). Some countries have statutory legal protection for endangered species. Slovakia has listed 52 species of fungi as having a 'special legal status,' which enables the prevention of damage to habitats where these fungi are found (Lizon 1999). The United Kingdom (British Mycological Society 1998) and Switzerland (Egli *et al.* 1995) have also taken steps to halt the loss of fungal diversity by creating codes of practice and recommendations to achieve fungal conservation. In contrast, Ireland has no fungi listed as protected in the most recent *Checklist of Protected and Rare Species in Ireland* (NPWS 2009).

Neither the ROI nor NI currently has a Red Data List of fungi. However, a preliminary Red Data List has been compiled for the UK (England, Scotland, Wales and Isle of Man) (Ing 1992; Evans *et al.* 2003). At least 55 species of Agaricomycetes in that list are also recorded in Ireland, although the status of many records is doubtful and needs to be clarified (Table 6). Some species on the list are possibly more abundant locally in the ROI than in the UK, for example grassland species such as *Hygrocybe calyptriformis* and *Entoloma bloxamii* and woodland species such as *Marasmius hudsonii* and *Cantharellus aurora*. Conversely, there are probably some common UK species that are rare in the ROI and would merit inclusion in an ROI Red Data List.

CONSERVATION STRATEGIES FOR PROTECTING FUNGAL DIVERSITY IN IRELAND

Until more comprehensive information is available about the diversity and distributions of Agaricomycetes in the ROI it will be difficult to identify all the vulnerable species and devise conservation strategies. In the UK, the recent report *Saving the Forgotten Kingdom: A Strategy for the Conservation of the UK's Fungi 2008–2015* (Fungus Conservation Forum 2008) set out guidelines on approaches to conservation of fungal diversity. We have adopted some of the guidelines and adapted others from this report.

(i) There is a need to create a greater public awareness of the importance of fungi, in ecosystems and in relation to human use, their biology and ecology and the need for conservation. This can be done by the establishment of a field mycology society on the lines of the Northern Ireland Fungus Group, the establishment of educational websites, organisation of forays by local environmental groups, and the inclusion of information about fungi in promotional and education materials for forest parks and nature reserves that are frequented by the public. Foresters in particular need to be aware of the great hidden diversity of Agaricomycetes in forests, including edible species. The NBDC is eager to work towards a better understanding of Ireland's fungal diversity. As part of the 2010 year of biodiversity, the data centre's annual event, 'Biodiversity Knowledge Quest', has focused on the current state of knowledge of different groups of organisms (including fungi) in Ireland and also on the identification of significant knowledge gaps and steps that the data centre can take to fill these gaps (Liam Lysaght, Director NBDC, pers. comm.).

(ii) The *Checklist*: The current checklist of Agaricomycetes in the ROI could not, for reasons outlined already, be regarded as comprehensive. More field mycologists need to contribute vouched records, particularly from areas that have had limited recording in the past. Existing records from the herbarium of the National Botanic Gardens need to be sorted by a fungal taxonomist, and newly submitted records need to be confirmed and stored as reference material. It should be the norm that Irish Agaricomycete specimens are sent for identification and storage

Table 6—Distribution and threat level to agaricomycetes in the Republic of Ireland (ROI) and England.

Species name	*Distribution in ROI*	*Distribution in England*	*Threat level*	*Habitat*
Boletus ferrugineus	U	U	V	WC
Buchwaldoboletus lignicola	D	U	V	WC
Cantharellus aurora	U	U	V	WC
Cantharellus cinereus	U	U	V	WD
Clavaria incarnata	U	U	NT	G
Clavaria straminea	U	U	NT	B
Clavulinopsis umbrinella	U	O	V	G
Collybia acervata	U	U	V	WC
Coprinus sterquilinus	U	U	V	G
Cortinarius largus	U	O	V	WD
Cortinarius olearioides	U	U	V	WD
Cortinarius violaceus	U	U	NT	WD
Cystoderma cinnabarinum	U	U	NT	WC
Entoloma aethiops	U	U	V	WD
Entoloma bloxamii	U	U	E	G
Entoloma excentricum	U	U	V	G
Entoloma roseum	U	U	V	G
Entoloma tjallingiorum	U	U	V	WD
Eocronartium muscicola	U	U	V	WC
Flammulaster muricatus	U	U	V	WD
Geastrum fornicatum	D	O	V	WC
Gomphus clavatus	U	U	EX	WD
Gyrodon lividus	U	U	NT	WD
Hohenbuehelia culmicola	U	U	V	S
Hydnellum concrescens	U	O	V	WD
Hydnellum ferrugineum	U	U	EX	WC
Hygrocybe calciphila	U	U	NT	G
Hygrocybe calyptriformis	O	O	V	G
Hygrocybe xanthochroa	U	U	NT	G
Hygrophorus penarius	U	U	V	WD
Hydnellum scrobiculatum	U	O	R	WC
Hydnellum spongiosipes	U	O	R	WD
Inocybe calospora	U	U	V	WD
Inocybe vulpinella	D	U	V	S
Lyophyllum favrei	R	U	E	WD
Marasmius hudsonii	U	O	R	WD
Melanoleuca cinereifolia	U	U	V	S
Mycena rosella	U	U	V	WC
Mycena rubromarginata	U	U	V	WC
Omphalina galericolor	U	U	V	S
Phellinus torulosus	D	U	NT	WD
Phellodon melaleucus	O	O	V	WD
Phellodon niger	U	U	EN	WD
Phellodon tomentosus	U	O	EX	WC
Pleuroflammula ragazziana	U	U	V	WD
Pluteus pellitus	U	U	V	WD
Porpoloma metapodium	U	U	R	G
Pseudocraterellus undulatus	U	O	V	WD
Ramaria stricta	O	C	V	WD
Ripartites tricholoma	U	U	R	WC
Russula intermedia	U	D	NT	WD
Sarcodon squamosus	U	U	E	WC
Tricholoma acerbum	U	O	V	WD

Table 6 (*Continued*)

Species name	*Distribution in ROI*	*Distribution in England*	*Threat level*	*Habitat*
Tricholoma atrosquamosum var. atrosquamosum	U	O	V	WD
Tricholoma inamoenum	U	U	EX	WC

Distribution: R = rare, O = occasional, C = common, U = frequency unknown, D = doubtful record.
Threat level: Ex = extinct, E = endangered, V = vulnerable, NT = Near threatened.
Habitat: G = grassland, WC = woodland coniferous, WD = woodland deciduous, B = bog, S = sand dunes.

to this herbarium. The private records of many collectors also need examination for inclusion in a revised checklist for Irish fungi.

(iii) Agaricomycete distribution data needs be compiled and regularly updated through a formal mapping programme. Initially this might only involve common species, but eventually could be extended to less common and potential Red Data List species.

(iv) Important areas for fungal diversity should be identified and designated, for example, as Important Fungus Areas similar to those in the UK. It has been proposed that the simplest and most effective way to conserve fungal diversity in an area is to conserve the habitat in which that fungus is found (Watling 2005). Luckily, this approach ensures that many fungi are already being protected, because habitats with rare protected plants and animals often also harbour rare and threatened fungi. Bodies and individuals with responsibility for habitat assessment, management and conservation need to have greater awareness of the importance of fungal biodiversity and conservation and to incorporate such considerations into habitat management plans. In assessing the status of sites for Agaricomycete diversity other indicators of biodiversity such as higher plant diversity may often be a good guide, but this is not always the case. For example, Agaricomycete-rich grassland is often relatively poor in plant species. Ecological restoration efforts to restore mixed forest sites to native-tree-only status may have negative impacts on fungal diversity if non-native species such as beech or Scots pine are removed prior to replanting. Such non-native trees can support many mycorrhizal fungi that have a wide host range and may have survived on non-native trees after modification of the original woodland habitat. Retained mature trees are a key source of ectomycorrhizal inoculum for new establishing trees (Jones *et al.* 2003) and also promote heterogeneity by allowing the new trees to tap into an existing mycorrhizal network.

(v) Managers of plantation conifer forests need to be aware of simple measures to promote Agaricomycete diversity. There are already rules in place to ensure that biological diversity is maintained in Irish woodlands through the creation and implementation of the *Forest Biodiversity Guidelines* (Forestry Commission 2000). These guidelines stipulate that at minimum a plantation must (i) have at least two tree species, with the primary species not accounting for more than 80% of the forest (ii) have at least 15% of the forest area as biodiversity enhancement areas, which includes open spaces and retained mature trees; and (iii) retention of at least $2m^3\ ha^{-1}$ of dead wood of good quality and size. These guidelines are all beneficial to Agaricomycete diversity provided native ectomycorrhizal broadleaves such as oak and birch are planted. The establishment of 'broadleaf corridors' (Orton 1987) will enhance the spread of Agaricomycetes within and between conifer plantations.

(vi) Priority species and groups need to be identified and conservation action plans need to be initiated for them. Considerable work has been done in relation to rare grassland Agaricomycetes (Mitchel 2006; 2007; 2008, 2009), which face threats from fertilisation (Griffith *et al.* 2010), reseeding, overgrazing (Marren 2001), undergrazing (which allows scrub colonisation) and plantation forestry. Protocols need to be developed to monitor the on-going status of these species.

CONCLUSIONS

The *Checklist* under-represents the real Agaricomycete diversity in the ROI. The ROI has many fewer Agaricomycete species recorded on an area basis than NI or UK. The distribution of records is very uneven, with big disparities between vice-counties; many vice-counties, particularly in the midlands and north-west, have many fewer Agaricomycete records than the national average. Twenty-five of the 26 counties

in the ROI have less than 50% of their potential Agaricomycete diversity documented. The comparatively low mean number of records per vice-county in the ROI is a consequence of a lack of formal and informal surveys and recording of species rather than an inherent paucity of species. An initiative to address this deficiency is required. Based on records, some mainly woodland genera, including *Russula, Cortinarius, Inocybe, Tricholoma, Lepiota, Pholiota, Boletus* and *Polyporus*, appear to be less well represented in Ireland compared to NI and the UK. Much of this difference is probably due to the poorer representation of areas of continuous old growth forest cover in the ROI compared to the other regions. This is also reflected in the under-representation of ectomycorrhizal and wood-decomposing Agaricomycetes in the ROI species list. Under-recording is also a factor, but until a more comprehensive overview of the ROI Agaricomycete biota is available, it is not possible to assess the true impact of the ROI's impoverished woodland cover on Agaricomycete diversity.

There are striking differences between the ROI and neighbouring regions in respect of the ranking of the most commonly recorded species; grassland Agaricomycetes are the most frequently recorded in the ROI, whereas woodland species are the most commonly recorded in the UK. Most of these differences are due to differences in recording effort, but they may to some extent reflect real differences in the ecology of certain species in the ROI compared to the UK. Such differences in Agaricomycete ecology and diversity may also become evident with a closer examination of unique habitat types in Ireland. Work by a number of researchers has already shown this to be the case for grassland and the Burren heaths, and further work on other unique Irish habitats such as Atlantic oak wood, raised bog, bog forest and machair may bring other species to light.

There are areas in the ROI that are important for Agaricomycete diversity and some harbour species that have restricted distributions. Some of these need to be designated along the lines of the Important Fungal Areas in the UK, and this needs to be considered when management plans are compiled for these areas. There is no Red Data List for Agaricomycetes or fungi in general in the ROI, and fungi are not in the official list of protected species in Ireland. In this we compare poorly with neighbouring countries. The compilation of a Red Data List is hampered by the lack of adequate distribution data and the doubtful status of many species in the ROI. A start needs to be made by compiling a preliminary list in conjunction with mycologists in Northern Ireland for those species for which reliable information is available.

Finally, there is a need, through education and promotion, for a greater public awareness of the importance of fungi. Consideration should be given to the potential impacts, beneficial or otherwise, of fungal diversity in development of habitat management and restoration plans.

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