THE MACROFUNGI OF LUNDY

by

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ABSTRACT

The chapter reviews the biodiversity and ecology of fungi on Lundy island, the chief focus being on the 'mushrooms and toadstools' or macrofungi, but some of the microfungi, especially plant pathogens, are included. The information used in the paper is derived from records published in the Annual Report of the Lundy Field Society from 1970 onwards, together with the results of brief surveys carried out by the authors between 2003-06. It is concluded that, although Lundy is predictably depauperate in species of fungi associated with woodland, the high diversity of fungi characteristic of unimproved grassland and heathland indicates that Lundy may be a site of national and even international importance. Suggestions are made for further work to confirm this status and for management strategies to maintain it.

Keywords: *Lundy, fungi, ecology, biodiversity*

INTRODUCTION

The History of Fungi on Lundy

The annual crop of edible macrofungi must have always been a welcome addition to the limited diet of the Lundy island community since its settlement by man. Some must have been put to additional uses, for example Bronze Age use as tinder for fire from some of the bracket fungi (Polyporaceae), although there is no archaeological record to substantiate this statement. No doubt both the Marisco and Heaven families enjoyed their mushroom feasts in the right season during their suzerainties, and, in more recent history, Diana Keast (personal communication 2005) remembers with pleasure dishes of 'field mushrooms' (*Agaricus campestris*) and 'wood blewitts' (*Lepista nuda*) when she lived on the island. Some of the current inhabitants still continue to enjoy this annual bounty, especially the large 'parasol mushroom' (*Macrolepiota procera*) (Plate 1).

Plate 1: *Macrolepiota procera* (parasol mushroom) with the Old Light in the background. October 2003. *(Photo: John Hedger)*

More formal records of fungi on Lundy only began with reports of sightings, usually of the macrofungi by interested visiting members of the Lundy Field Society and these have appeared at irregular intervals in the Annual Reports of the Lundy Field Society. The accumulated list for the period 1970-1995, abstracted from the Annual Reports, was summarised in Hedger & George (2004) and stood at some ninety-five species, to which they were able to make seventy-five additions from a week long survey in October 2003. Since then we have carried out further short surveys, in November 2004, April 2005 and January 2006 (Hedger, George, Griffith & Deacon unpublished data). In these surveys the field of search was extended to the microfungi on living plants, dead wood and plant litter, and 188 additional records were made, bringing the total to 358 species. It is planned to continue to publish these data in the Annual Reports.

The object of these studies was to start a more systematic inventory of the diversity of fungi on Lundy, and the habitats they occupy on the island, and to begin a database of Lundy fungi for entry in the British Mycological Society U.K. recording scheme. As with most mycological surveys, we have used the identification of fruit bodies of the fungi to establish the records, a practical approach, which can also be used to study the ecology of different species, but with some reservations, because the active mycelium remains hidden in the soil, wood or litter. Ecological surveying in this way is equivalent to using the flowers to map plant distribution, and has its predictable defects, especially in studies of the larger fungi. In some years fungi may not fruit, in others be abundant, which, combined with the shortness of study visits to the island, means that there is a high degree of serendipity to the process. In addition, the many microfungi are much more diffÆult to survey in this way, although determination of their fruiting structures with hand lens and microscope on particular plants or litter indicates their ecological preferences. However, despite these problems, even brief surveys can give useful information on the ecology of fungi on Lundy, especially their association with particular habitats and plants, and this is explored in more detail in this review.

The Lundy Climate and Fungi

There have been very few mycological studies of isolated British islands such as Lundy, one exception being the Hebrides from which Dennis (1986) recorded 2,905 species, although these have a much greater land area, and a different climate and soil to Lundy. Better parallels are, perhaps, the nearby Welsh islands of Skomer and Skokholm, but these are also little known mycologically. As with other aspects of island biology, there are intriguing contrasts to the mainland. The ameliorating influence of a maritime climate makes winter frost a comparative rarity, so that the macrofungi of autumn may continue to fruit for far longer on Lundy than the mainland, and on our visit in January 2006 we found quite a number of autumnal grassland species, long gone from the pastures of Devon. On the other hand, the strong winds on Lundy, the lack of shelter, and the thin granitic soils, may create very dry conditions in summer and early autumn, which reduce the fruiting of the fungi. Visits in September and October to search for macrofungi may be disappointing when compared to the mainland (Hedger & George, 2004). Our own experience indicates that early November is likely to be the best season, when soil temperatures remain warm, but moisture content has risen. However a wet summer would completely alter this picture.

The Roles of Fungi in the Terrestrial Ecosystem on Lundy

Fungi play a key role in the terrestrial food web on Lundy, as in all terrestrial ecosystems. One functional grouping, decomposer or saprotrophic fungi, are of great importance in the recycling of nutrients. They do so using enzymes which break down the components of plant litter and wood, eventually releasing CO_2, water and minerals. Their hyphae are in turn grazed by soil-, wood- and litter-inhabiting animals (detritivores), such as worms, thrips, mites and millipedes, which in turn form part of a food web which ends with the larger animals on Lundy, such as the pygmy shrew and many species of bird. On Lundy the most obvious decomposer species are many of the macrofungi, basidiomycetes and ascomycetes, both in the wooded areas and in different types of grassland and heath, but there are also many microfungi, some highly specific to litters of particular plant species, others much more widespread.

A second functional grouping is the many species of fungi which form mutualistic relationships with the roots of plants, termed mycorrhizas, and whose hyphae assist plants by uptake of key nutrients from the soil and litter, thus completing the recycling of minerals. On Lundy most of these 'helper' fungi are likely to be microfungi, forming single spores in the soil, and which infect the roots of herbaceous plants and grasses as Arbuscular Mycorrhizas (AM), although as yet no investigation has been made to prove their presence. Most belong to the family Engonaceae and a few, in the genus *Endogone*, form tiny, but visible, truffle-like fruit bodies, one of which was found in the 2003 survey in a rush clump (Hedger & George, 2004). A number of the trees on Lundy, including the sycamores *(Acer pseudoplatanus)* and ashes *(Fraxinus excelsior)* in Millcombe valley have similar AM partners to the grasses. However some of the other tree species on Lundy, for example all the species of oaks and pines, form associations called Sheathing or

Ectomycorrhizas with macrofungi (ascomycetes and basidiomycetes). These are sometimes specific to tree species, and are signalled by the presence of fruit bodies of the partner fungi under the tree in the autumn. These are produced by a mycelium which ramifies through the soil and litter, but which also envelopes part of the root system in a mycelial sheath, through which nutrient exchange takes place, thereby assisting the host tree.

A third functional grouping is the pathogenic fungi which invade living plants and trees on Lundy. The effects of these pathogens range from killing parts of the plant, to almost symptomless infections. Fungi which invade the plant and kill the tissue are often called 'necrotrophs' (lit. 'feeding off death') and their presence on plants is shown by brown areas of dead tissue on leaves and stems. The effects are often only local - for example, just a few brown spots on the leaves. On Lundy most of these necrotrophs are microfungi, some of which are specific to particular plant species, others have a wide host range. In contrast the fungal pathogens called 'biotrophs'(lit. 'feeding off life') infect the host with few or no symptoms. Infected plants may appear completely healthy, although there is sometimes some malformation of tissues. The production of spores by the fungus, for example in pustules on a leaf surface, may be the only sign that the plant is infected. These fungi have a very narrow host range, sometimes just one plant species. All are microfungi and on Lundy include the rusts (Uredinales), the smuts (Ustilaginales), the powdery mildews (Erysiphales) and the downy mildews (Peronosporales).

WOODLAND HABITATS FOR FUNGI ON LUNDY

The past land-use on Lundy, as with other small islands, has had a disproportionate influence on the vegetation and its associated fungi compared to the mainland. Clearance of such postglacial forest cover as existed on Lundy probably began in the Bronze Age and Hubbard (1971) considers that cutting of trees for construction and firewood by islanders and visiting ships, combined with the exposure, meant that the island was almost completely treeless as far back as the thirteenth century, although she cites evidence that scrub, such as gorse, willow and blackthorn, must have persisted. Large scale replanting of trees only began in the nineteenth century, many of them exotic species such as turkey oak, holm oak and Corsican pine, possibly accompanied by associated fungal species. The surviving tree cover is now restricted to the S.E. end of the island, especially the Millcombe Valley area (South Wood, North Wood, St John's Copse and Lower Millcombe), the small pockets of planted alders, sycamores, pines and oaks further up the east coast, including St Helen's Copse and Quarter Wall Copse, and the few scattered willows around the Quarry. As well as such 'true' woodland, the extensive gorse/blackthorn scrub behind Brambles Cottage and around the Flagstaff and the Ugly, as well as the rhododendron along the east coast path, also represent a type of woodland habitat (Dawkins 1974 in Hubbard 1997).

It has been estimated that about 80% of the macrofungi of the Netherlands are associated with trees (Arnolds & De Vries 1989 in Griffith *et al*., 2004), and the U.K. figure is probably similar. Most of the decomposer and mycorrhizal fungi

associated with the original forest cover on Lundy must have been lost, although Hedger & George (2004) have speculated that some of the wood decomposer species which they recorded fruiting on gorse and blackthorn on Lundy today, may represent persistence. Other species may have been introduced on the roots of the replanted trees or arrived as spores from the mainland. Of the 358 species of fungi at present recorded for Lundy only 65 were associated with trees, of which twelve were mycorrhizal species, the other 53 were wood and woodland litter decomposer species.

Wood Decomposer Fungi

The majority of the 53 species of decomposer fungi so far recorded in wooded areas were found fruiting on dead trees or fallen branches (wood decomposers), the rest were recorded from leaf litter or small twigs under the trees (litter decomposers). Commonest were the basidiomycete fungi popularly known as bracket fungi or polypores, but there were also species of other basidiomycetes, the agarics or gill fungi, and also of the sac or flask fungi, ascomycetes which also fruit on wood.

Primary attack on wood by fungi usually results in either bleaching (white rot decay) or the wood becomes brown and powdery (brown rot). The majority of wood decay on Lundy is by white rot fungi and the commonest species is undoubtedly the basidiomycete *Schizopora paradoxa*, (Plate 2) which can be found as a white crust with a surface of beautiful toothed pores, on rotting branches of nearly all tree and shrub species, even including rhododendron. Some other white rot basidiomycetes such as the 'zoned polypore', *Trametes versicolor*, also have a wide host range. In contrast other species have a narrow host range, for example, the aptly named 'blushing bracket', *Daedaleopsis confragosa*, found only on willows (*Salix* spp.), for example in the Quarries; the glistening white mushrooms of 'beech tuft' or 'porcelain fungus', *Oudemansiella mucida*, only on branches of the solitary beech *(Fagus sylvatica)* at Quarter Wall Copse; and the white crust-like *Lyomyces sambuci* (Plate 3) only on dead elder, *Sambucus niger*, especially in the Walled Garden at Millcombe. As already noted, Hedger & George (2004) speculated that the host preferences of many wood rot fungi on Lundy were different to the reports of 'normal' hosts in the literature, perhaps due to lack of the trees. One examples is *Phellinus tuberculosus*, (Plate 4) whose large hoof-shaped woody fruit bodies are normally found on *Prunus* and other rosaceous trees, but is often found fruiting on wood of dead gorse, *Ulex europaea*, on Lundy. Another is the 'beef steak mushroom' *Fistulina hepatica*, normally on oak, but found on sweet chestnut in the Millcombe Valley.

The ascomycete fungi involved in primary white rot attack on wood on Lundy include a number with hard black fruiting bodies - often called pyenomycetes. 'King Alfred's cakes', *Daldinea concentrica* (Plate 5), whose black fruit bodies are restricted to the ash trees *(Fraxinus excelsior)* in Millcombe valley, is a good example. Others include species of *Hypoxylon*, with groups of small hard rounded fruit bodies, for example *H. multiforme* on rhododendron wood, and species of *Xylaria*, with elongated black fruit bodies, such as the finger-shaped *X. polymorpha*, restricted to dead sycamore branches in Millcombe valley. Other ascomycete decay fungi appear on the underside of well-rotted branches and logs as small disc-shaped fleshy fruit bodies or

Plate 2: *Shizophora paradoxa*. Detail of fruit body on the underside of dead rhododendron log, east coast path. April 2005. *(Photo: David George)*

Plate 3: *Lyomyces sambuci* on dead elder in the Walled Garden, Millcombe Valley. April 2005. *(Photo: David George)*

Plate 4: *Phellinus tuberculosus* on dead gorse, behind Brambles. October 2003. *(Photo: John Hedger)*

Plate 5: *Daldine concentrica* (King Alfred's cakes) on dead ash in Millcombe Valley. April 2005. *(Photo: David George)*

Plate 6: *Mollisia cinerea* on dead willow in the Quarries. April 2005. *(Photo: David George)*

Plate 7: *Hypholoma fasciculare* (sulphur tuft) on dead rhododendron near The Ugly. October 2003. *(Photo: John Hedger)*

apothecia (discomycetes). Unlike the pyenomycetes they do not seem to be usually primary decomposers, but colonise wood in an advanced state of decay. The commonest are grey apothecia produced by *Mollisia* species (Plate 6). These may occur alongside the attractive bright yellow apothecia of *Bisporella citrina*.

Others of these minute discomycetes occur on specific hosts, for example troops of the beautiful, but minute, white discs of *Hyaloscypha stevensonii* are only found on undersides of well-decayed fallen branches of Corsican pines, *Pinus nigra* var. *maritima*, in the Millcombe Valley. Alongside these discomycetes on the well-rotted pine wood can be found another group of organisms, the myxomycetes, or slime moulds, which although protistans, and not true fungi, produce minute fungal-like fruiting bodies. Their plasmodia feed on the previous fungal and bacterial colonisers in the wood prior to fruiting. Species found to date include the pink *Arcyria denudata*, the intriguingly basket-shaped *Comatricha nigra* and the yellow pin-headed *Trichia varia*. On the drier upper surface of the pine logs, the confusingly similar, yellow, button-shaped, minute gelatinous fruit bodies of *Dacrymyces stillatus* may be found. This is actually a basidiomycete fungus. The fruit bodies are very tolerant of drying and the species is also a successful coloniser of the tops of fence posts and gates all over the island. It is closely related to the 'jelly fungus', *Tremella mesenterica*, whose orange gelatinous fruit bodies occur on dead wood of gorse, and to the 'ear fungus', *Auricularia auricula-judae* which colonises dead elder and is common in the Walled Garden in Millcombe Valley. Interestingly these three gelatinous species are amongst the earliest records of fungi from Lundy (Walker & Langham, 1971), probably because of the durability of their fruit bodies and lack of seasonality.

There are fewer fungi on Lundy which cause brown rot decay of wood, the most common being the yellow to orange-brown, crust-like fruit bodies of the 'polypore' *Coniophora puteana* and the related species, *C. arida*, which are very abundant on the many dead treated stumps of rhododendron by the side of the coastal path in the east side clearance areas, and which are slowly reducing these stumps to brown powder. Normally these species are recorded from conifer wood. Interestingly, many rhododendron stumps are also colonised by white rot fungi. These include the 'sulphur tuft' agaric, *(Hypholoma fasciculare)* (Plate 7) which forms clumps of sulphur yellow toadstools. Where the species occur together, contrasting brown and white rot can be seen in the same stump. In passing it should be noted that the bonfires in this area have stimulated the autumn fruiting of troops of a small brown-capped agaric, *Pholiota carbonaria*, which is restricted to burnt ground.

Mycorrhizal Fungi and Woodland Litter Decomposer Fungi

Under the trees, the fungi that are found fruiting on the soil or litter are either mycorrhizal, associated with the roots of the trees, or are decomposer fungi, breaking down the leaf and twig litter. The mycorrhizal species recorded to date are large and obvious late summer/autumn macrofungi, including agarics and boletes in the genera *Lactarius*, *Russula*, *Cortinarius*, and *Boletus* and the 'earth ball' (*Scleroderma citrinum*). They represent some of the earliest observations of fungi on Lundy in the early 1970s (Walker & Langham, 1971; Walker, 1972). Examples found in our 2003

survey (Hedger & George, 2004) included the dull yellow agaric *Russula ochroleuca* under the holm oaks in St John's Copse, and the brighter purple *R. krombholtzii (=R.atropurpurea)* under the beech in Quarter Wall Copse growing alongside the yellow-pored bolete *Xerocomus (=Boletus) spadiceus*. Our own records and past records combine to give a total of some twelve species of mycorrhizal macrofungi, a strikingly small total compared to a mainland woodland. Perhaps Lundy is truly depauperate in mycorrhizal fungi, but more must be present but not yet recorded. For example *Amanita muscaria*, the 'fly agaric', a large fungus with bright red cap with white spots, would be expected in association with the planted species of pine *(Pinus radiata, P. nigra* var. *maritima and P. sylvestris)*, as would the large bolete *Suillus luteus*, 'slippery jack', and yet neither have been recorded. This may be true of other almost universally common mycorrhizal species in the U.K., such as the orange brown agaric *Laccaria laccata*, 'the deceiver' and the related purple *L. amethystina*, 'the purple deceiver', both yet to be found on Lundy.

The litter under the trees is broken down by decomposer species of fungi. As their mycelium spreads through the litter it is often bleached by their action. As with the mycorrhizal fungi, some are associated with particular tree species, and may also be at least in part mycorrhizal. The best example is the small brown agaric *Alnicola suavis*, appropriately found growing on the leaf litter under the alders in St Helen's Copse, but also with the willows at the Quarry (Hedger & George, 2004). Other species of decomposers are more widespread and include a number of species of delicate, often small, white-gilled agarics in the genus *Mycena*, (Plate 8) and medium sized species of *Collybia*, also with white gills, but with flat white to brown caps and tough bendable stems, such as the dry-capped *C. dryophila*, also found decomposing bracken litter all over Lundy, and the 'buttery agaric', *C. butyracea*, a greasy-capped, late autumn species preferring acid litter, and found fruiting under the pines and gorse in Millcombe Valley. The larger woodland litter decomposer agarics include the 'shaggy parasol mushroom', *Macrolepiota rhacodes*, found in November 2003 fruiting in the nettles by the Castle (Hedger & George, 2004), but probably also present in the Millcombe Valley. This is similar to the 'parasol mushroom', *M. procera*, widespread in autumn in the grassland around the Old Light, but differs in having a scaly stem and in slow reddening of the flesh of the stem when bruised or cut.

Plate 8: *Mycena filopes* under willow in the Quarries. October 2003. *(Photo: John Hedger)*

GRASSLAND AND HEATH HABITATS FOR FUNGI ON LUNDY

Grassland and Heath vegetation covers most of Lundy and is the major terrestrial habitat. It is not however uniform. Hubbard (1997) divided the non-woody vegetation on Lundy into two categories: the Sidelands and the Plateau, and the same approach is followed here.

The Sidelands

Of the Sidelands, the east coast has the most species-diverse plant communities, especially on the shale slopes of the southern end, where the Lundy cabbage, *Coincya wrightii* has its stronghold. Moving further north along the east coast path into the granite geology, the dominance of rhododendron and then bracken reduces the diversity of plants and associated fungi, although there are a number of very interesting fungi in these localities associated with the plant cover, for example host-specific fungi on the rhododendrons, such as 'purple leaf spot' *Cercoseptoria handelii* and the aptly named 'bud blast', *Pycnostysanus azaleae*, which can be detected by its tiny pin-shaped spore structures on dead blackened flower buds. In contrast, the west and north coast Sidelands are much more exposed and botanically poorer, being dominated by just a few species, especially sea fescue *(Festuca rubra)* and sea pink (*Armeria maritima)*, so it is also likely to have fewer species of fungi.

Most of the species of macrofungi found on the granitic areas of the East Sidelands are also found on the Plateau, for example those associated with bracken, which dominates sideland areas such as Brazen Ward. These are mostly decomposer agarics growing as mycelia in the deep bracken litter, such as the bright orange *Hygrophoropsis aurantiacus*, 'the false chanterelle', (Plate 9) and grey-white species of *Collybia* and *Clitocybe*, the latter genus including the large, stoutly-stemmed, *C. nebularis*, 'the clouded clitocybe', which forms fruit body rings 2-3 m in diameter in the autumn in the bracken. In places where wet peaty soil occurs, especially in eroded exposures alongside the coast path around Gannets Bay, the tiny, but beautiful, pale-yellow agaric *Omphalina (=Gerronema) ericetorum* (Plate 10) fruits in small groups and was found to be abundant in our survey in April 2005. This fungus is associated with an alga which grows on the peat surfaces (=the lichen genus *Coriscium*). Areas of grass inside the bracken stands had some of the grassland species also found on the plateau, but the beautiful yellow coral-like fruit bodies of *Clavulinopsis corniculata* were more abundant on the East Sidelands than on the Plateau in November 2004. A very unusual dwarf form of this fungus (Plate 11) was also found at the same time on the West Sidelands in *Festuca rubra* turf near the North Light. Whether this is more widespread along the West Sidelands, or indeed if there is a distinct decomposer community in the *Festuca rubra/ Armeria maritima* turf is yet to be determined. The decomposers like *Clitocybe* and *Collybia* found in the East Sidelands were not recorded in our brief surveys along the west coast: the small yellow/brown agarics in the genus *Galerina*, were the only common macrofungi, especially *G. hypnorum*, (Plate 12) fruiting amongst polytrichum moss.

The majority of past records of plant pathogens are also from the East Sidelands (Hedger & George, 2004), reflecting the greater plant diversity. The rusts, (Uredinales)

(Above) **Plate 9**: *Hygrophoropsis aurantiacum* (false chanterelle) under bracken, near Brazen Ward. October 2003. *(Photo: John Hedger)*

(Right) **Plate 10**: *Omphalina (Gerronema) ericetorum* on wet peat. Coast path, Gannets Bay. April 2005. *(Photo: David George)*

Plate 11: *Clavulinopsis corniculata*, dwarf form. In *Festuca rubra* turf near the North Light. November 2004. *(Photo: Gareth Griffith)*

Plate 12: *Galerina hypnorum*. In moss on the edge of the path to the Battery. November 2004. *(Photo: Gareth Griffith)*

are often host-specific, but may form different spore types on two alternate hosts. The most productive time of year to survey these fungi is in the late winter, spring and early summer and our own visits in April 2005 and January 2006 have greatly extended the records of these fungi on Lundy, but many have yet to be found. One of the most obvious is *Phragmidium violaceum* which is common on bramble, *Rubus fruticosus* agg., as obvious purple spots on the upper leaf surface, below which yellow sporing structures (aecidia) are formed in the spring, followed by purple-black spore patches (telutosori) in summer and autumn. *Puccinia smyrnii* (Plate 13) can be easily found on leaves and stems of all the plants of the attractive yellow-flowered umbellifer, alexanders *(Smyrnium olusatrum)* in the lower Millcombe Valley. It forms pustules on which are yellow (aecidia) and later brown (uredosori) associated with deformed, swollen growth. Aecidia of *Uromyces dactylidis* (Plate 14) are of similar appearance on leaves of celandine (*Ranunculus ficariae)* also in Millcombe, whilst *Uromyces muscari* shows up as darker telutosori on the bluebell *(Scilla non-scripta)* leaves. Stinging nettles *(Urtica dioica)* infected by *Puccinia caricina* also show up in spring because of deformed growth of stems and leaves bearing bright orange aecidia. The spores from these plants infect an alternate host, species of sedge, *Carex,* in nearby grassland, on which other spore types are formed. Walking along the east coast path the bright orange aecidia of *Puccinia violae* are obvious on leaves of the dog violet *(Viola canina)*, accompanied by *Puccinia umbilici*, signalled by bright red spots on the leaf upper surface, with black telutosori below, on leaves of the wall pennywort *(Umbilicus rupestris)*. Less obvious, and infrequently recorded, are the rusts on ferns, belonging to the genus *Milesina,* which form white uredospores in spring on the old over-wintering fronds. We recorded three species of these rusts in our visit in January 2006: *M. dieteliana* was found on the clumps of common polypody *(Polypodium vulgare)* growing in the barn wall of Lundy Farm; on the clumps of ferns on the faces inside the Quarries we found *M. kriegeriana* on the broad buckler fern *(Dryopteris dilatata)*; *M. scolopendrii* on leaves of the harts tongue fern *(Phyllitis scolopendrii)*.

The smuts (Ustilaginales) are a group of plant pathogens related to the rusts, but which have yet to be recorded from Lundy. One example is *Ustilago violacea*, the 'anther smut'. On Lundy this would be expected on the sea campion *(Silene maritima)* and the red campion *(S. dioica)*, where infected plants are only revealed by the replacement of pollen by purple brown masses of spores in the centre of the flower - in addition female flowers are converted to male flowers. In April 2005, in spite of intensive searching of *S. dioica* plants in the Millcombe Valley and the east coast path, and a binocular search of the isolated flowering clumps of *S. maritima* on goat inaccessible ledges along the west and east coast, no infected plants were found. This is surprising, since *U. violacea* is very common on the two campions in very similar habitats on Skomer Island (Hedger, unpublished data). It is possible that this species, as well as the squill 'anther smut' *(Ustilago vaillentii)* on spring squill *(Scilla verna)*, also common on Skomer, will be found on Rat Island, which is the only part of Lundy without significant grazing (Hubbard, 1997), and which would profit from a survey in April/May.

Plate 13: *Puccinea smyrnii*, Aecidia on *Smyrnium olusatrum* (alexanders) in Lower Millcombe Valley. January 2006. *(Photo: David George)*

Plate 14: *Uromyces dactylidis*, Aecidia on *Ranunculus ficaria* (celandine). Upper Millcombe Valley. April 2005. *(Photo: David George)*

Plate 15: Possible *Mycosphaerella* sp. On *Coincya wrightii* (Lundy cabbage). Beach Road. April 2005. *(Photo: David George)*

However, during our search for *U. violacea* along the shale cliffs below and above the Beach Road in April 2005 we did find a number of other interesting pathogens on the cliff plants. On the lower cliff, in the splash zone, leaves of scurvy grass *(Cochlearea officinalis)* were heavily incrusted with white spores of downy mildew, *Albugo candida*. Higher up, records included dark patches on leaves of foxglove, *(Digitalis purpurea)*, caused by *Ascochyta molleriana*, and yellow patches on leaves of cuckoo pint *(Arum maculatum)* caused by *Ramularia ari*, both very common fungi on these hosts on Lundy. Of particular interest were pathogens on plants considered by Hubbard (1997) to be Lundy rarities: the *Phomopsis* state of *Diaporthe arctii* was found bleaching patches on leaves of the locally abundant balm-leaved figwort *(Scrophularia scorodonia)*, but the most exciting find was a species of *Mycosphaerella*, causing brown lesions (Plate 15) on leaves of the Lundy cabbage, *Coincya wrightii*. It is as yet undetermined, but is possibly *M. brassicola*, or an undescribed, host-specific species, and therefore a Lundy endemic. More material needs to be examined before this question can be answered.

The Plateau

On the Plateau, the very extensive areas of grassland, and heath, maintained by the intensive grazing and exposure on Lundy, represent a very important habitat for fungi, indeed one which is of significant conservation interest for the whole of the U.K.

Following Hubbard (1997) we have distinguished four main types of fungal habitat on the plateau: 1) short-cropped turf, comprising most of Middle Park, much of Ackland's Moor, the Airfield, the South West Field and Castle Hill; 2) taller and matted grassland, with *Molinia* and bracken, especially the area between Quarter Wall and Halfway Wall, with a subset of much wetter areas with *Sphagnum*, *Molinia* and *Juncus* around Pondsbury, in the Punchbowl Valley and in the shallow valley running down the east side of the island beside Quarter Wall to the Quarries; 3) the walled off areas of improved grassland around the farm; 4) the *Calluna vulgaris*-dominated areas north of Threequarter Wall. Of these habitats, the enclosed fields around the farm are most species-poor in both plants and fungi. In contrast, the most species-rich areas for macrofungi are the short-cropped turf, followed by the taller grassland and the *Calluna*. Most of the fungi recorded are decomposers, growing on plant litter or herbivore dung, but we did find one woodland mycorrhizal species, the 'cob web agaric' *Cortinarius anomalus*, associated with the clumps of willow and gorse by the Threequarter Wall gate on the east side of the island.

1. Short Turf Grassland

The decomposer macrofungi of the short cropped grassland are the most obvious to the visitor to the island in autumn, especially since they are abundant in the area around Lundy Old Light. However the nearby Airfield is another 'hotspot', as is the west side of Middle Park. They include large agarics such as the 'parasol mushroom', *Macrolepiota procera*, the 'field mushroom', *Agaricus campestris*, the 'horse mushroom', *Agaricus arvensis* and the purple coloured 'wood blewitt', *Lepista nuda*. In the short turf it is easy to see that many of these decomposer fungi grow through

the turf as 'fairy rings', obvious by the ring of fruit bodies formed at the edge of the growing mycelium, or as rings of darker green grass. The rings of *Lepista nuda* (Plate 16) are particularly abundant on the Airfield, but alongside can also be found rings formed by smaller agarics, the white, tough-stemmed, but edible, 'fairy ring champignon' *(Marasmius oreades)*, and the confusingly similar, but stouter-stemmed, 'false fairy ring champignon', *Clitocybe dealbata*, a poisonous species.

In addition there are a number of Gasteromycete ('puffball') species which grow in the short turf and these also sometimes form clear rings. They include *Vascellum depressum*, (Plate 17) a white, later brown, short-stalked puffball, 3-6cm diameter; *Bovista nigrescens*, a white, later black and leathery, stalk-less puffball, 2-5 cm diameter; and *B. plumbea*, with fruit bodies similar to *B. nigrescens*, but smaller, 1-3 cm diameter and turning from white to lead-grey as they mature. There are 'hot spots' for the autumn fruiting of these species - one in the very short turf on the left-hand side of the track just north of the gate through Threequarter Wall, another in the short turf by the Mangonel Battery at Threequarter Wall. However in winter the leathery fruit bodies detach from the soil and are blown all over the island, even ending up in the flotsam and jetsam on the beaches. In passing it should be noted that there are also two much larger grassland 'puffballs' on Lundy - the 'giant puffball' *Langermannia gigantea* was recorded by Walker & Langham (1971) in the S.W. Field, and we have found the empty stalked fruit bodies of *Calvatia utriformis* in the Graveyard.

Most of the decomposer fungi of the short turf grassland do not often form easily recognisable rings. These include *Hygrocybe*, a genus of sometimes strikingly brightly coloured agarics, popularly known as 'wax caps'. In our initial survey in October 2003 (Hedger & George, 2004) we found no *Hygrocybe* species, due to drought conditions that year, although 15 species had previously been recorded since 1970 by visiting members of the LFS (Hedger & George, 2004). In November 2004 we found 20 species, of which nine were new records for Lundy, bringing the total for Lundy to 24, making it the most species- diverse genus of macrofungus on the island. This total, which can be compared to the U.K. total of around 40 species (Griffith *et al*., 2004), is of great interest, since in recent years the diversity of *Hygrocybe* species in grassland has been used as an indicator of habitat quality, in particular of low soil nutrient status, and lack of nitrogen enrichment from artificial fertilisers or pollution. Boertmann (1995) considers that an overall site species total for *Hygrocybe* of 17-32, with 11-20 being recorded in a single visit, is indicative of national conservation importance in Northern Europe, a figure we reached in November 2003. In addition Boertmann considers some *Hygrocybe* species to be more fastidious indicators than others. In our own survey in November 2004 we found that *H. virginea*, a white-capped species, which is quite tolerant of high soil nitrogen, (Griffith *et al*., 2004), was the only species fruiting on the improved grassland of the farm fields. In contrast, in a survey of the short turf on the Airfield, and in Middle Park near the Mangonel battery, we found fifteen other *Hygrocybe* species in a search area of 250m^2. Large species included *H. coccinea* (scarlet), *H. punicea* (dark red), (Plate 18), *H. splendissima*, (Plate 19), (scarlet and yellow)

Plate 16: Ring of *Lepista nuda* (wood blewitt) near the Airfield. November 2004. *(Photo: Gareth Griffith)*

Plate 17: *Vascellum depressum*. Old fruit body. The Airfield. January 2006. *(Photo: David George)*

Plate 18: *Hygrocybe punicea*. The Airfield. November 2004. *(Photo: Gareth Griffith)*

Plate 19: *Hygrocybe splendissima*. The Airfield. November 2004. *(Photo: Gareth Griffith)*

Plate 20: *Hygrocybe pratensis*. The Airfield. November 2004. *(Photo: Gareth Griffith)*

Plate 21: *Hygrocybe conica*. The Airfield. November 2004. *(Photo: Gareth Griffith)*

and *H. pratensis* (Plate 20), (honey coloured). Smaller species included the bright green, later lilac or yellow, *H. psittacina*, *H. conica*, (Plate 21), orange-red, blackening with age, and the small white-cream species *H. russocoriacea*, which smells of leather. However, absence of improvement of the grassland is not the only factor affecting *Hygrocybe* species distribution on Lundy. In the much more acidic tall grassland north of Quarter Wall and around Pondsbury and just north of Threequarter Wall we found only *H. laeta*, a pinkish-brown medium-sized species, also found in the short turf areas, but presumably more tolerant of low soil pH. An even more interesting result in November 2004 was the finding of a medium-sized grey species of *Hygrocybe* fruiting abundantly on the thin peaty soil under the *Calluna* in the immediate vicinity of the Bronze Age fort at the North End of Lundy. This agaric was never seen in any other location on Lundy and appears to be *H. radiata*, (Plate 22), a northern European species, which has yet to be recorded for the U.K. according to Boertmann (1995). A dried specimen of this fungus has been deposited in the mycological herbarium at the Royal Botanic Gardens, Kew and will soon be subjected to critical determination by a specialist.

Plate 22: *Hygrocybe radiata*. Young fruit bodies. North End. November 2004. *(Photo: Gareth Griffith)*

Plate 23: *Entoloma* (*lampropus* group). The Airfield. November 2004. *(Photo: John Hedger)*

There are a number of other fungi which fruit alongside the *Hygrocybe* species in the short turf grassland on Lundy, especially on the Airfield. Significantly some of these have also in recent years been used, with the *Hygrocybe* species, as additional indicators of the conservation value of the site (Griffith *et al*., 2004). The agarics include species in the genus *Entoloma*, medium or small species mostly characterised by grey-brown caps and pink gills, and to date nine species have been recorded, including *E. lampropus*, a beautiful agaric with a steel-blue cap and stem (Plate 23), and *E. staurosporus*, with a conical brown cap. Members of this genus are difficult to identify and it is very likely that more species remain to be discovered on Lundy. In addition, in November 2004, we found growing alongside these agarics other 'indicator' fungi belonging to the Geoglossaceae, a family in the phylum Ascomycota or 'sac' fungi. These fungi form small tongue-shaped fruit bodies. Two were black species of *Geoglossum*, *G. fallax* and *G. glutinosum*, the other the much rarer green-coloured *Microglossum olivaceum*. The presence of these fungi, together with *Hygrocybe* species, and other grassland fungi, has been used by Rotheroe (1996) and others to indicate the conservation value of a grassland site.

2. Tall Grassland

Rough grazing of this kind dominates the centre of the area between Quarter WaÆ and Halfway Wall. Compared to the short turf areas it has few species of macrofungi. A few of the short turf grassland species of macromycetes are found, but usually only in patches of drier ground that has been grazed. The most common fungi growing between the *Molinia* and *Juncus* clumps are species of the agaric genera *Galerina* and *Agrocybe*, small agarics with a reddish-brown conical cap and gills, for example *G. tibiicystis*, *G. vittiformis* and *A. paludosa*, whilst the appropriately named *G. sphagnorum* was found in the wetter areas around Pondsbury, fruiting alongside two larger, long-stemmed, dark-gilled and brown-capped species of *Hypholoma*, *H. subericaeum* and *H. elongatum*. A most interesting feature of this habitat is the humid microclimate afforded by the dense clumps of *Juncus* and, to a lesser extent, *Molinia*. In October 2003, in spite of the very dry conditions, many records were made of decomposers, mostly microfungi, growing on the litter in the centre of clumps (Hedger & George, 2004), and this has been extended on each visit since, even in winter - six more records were obtained from *Juncus* clumps in January 2006. On all occasions the most common fruit bodies found were the minute (1-2 mm diameter) pure white-stalked cups of *Dasycyphus apalus*, very common in the large *Juncus* clumps around Pondsbury, growing alongside the equally minute sessile grey cups of *Mollisia juncina*. The large *Carex paniculata* clumps along the streams in Gannets Combe, and in the St John's valley, are an interesting parallel habitat, but a brief examination in January 2006 showed that they contain different host-related species of decomposer microfungi, for example *Mollisia caricina*. The same principle of host specificity applies to much of the plant litter on Lundy which is relatively slow to decay - other examples are the small elongated black fruit bodies of *Rhopographus filicinus* on dead petioles in bracken clumps, and the minute brown fruit bodies of *Leptopeltis nebulosa* on the dead fronds of the royal fern, *Osmunda regalis* growing on the walls of the Quarries.

One of the other features of the tall grassland is that the higher humidity favours the development of fungal fruit bodies on the herbivore dung, which tends to dry out in the short turf areas. Indeed the habitual presence of some of the Lundy ponies in a very rushy area near to the Quarter Wall gate makes this a productive area to search for coprophilous fungi. The very large quantities of herbivore dung deposited everywhere on Lundy are decomposed by specialised coprophilous fungi, many of which have spores which require passage through the gut of a herbivore before they will germinate. The species list of coprophilous fungi for Lundy remains small only because of lack of investigation (Hedger & George, 2004). Early colonisers are microfungi, such as the aptly named 'hat thrower' (*Pilobolus* spp.) which forms glistening mats on relatively fresh horse apples in the early morning and discharges its minute black sporangia onto surrounding grass. Older more decomposed horse dung is often covered with the minute orange disc-shaped apothecia of the ascomycete *Coprobia granulata*, and also produces large agarics such as the handsome egg-shaped capped *Anellaria semiovata*, and the pure white 'dung inkcap', *Coprinus niveus*. A related coprophilous agaric, *Paneolina foenisecii*, a small greyish-brown species with a rounded cap with a distinctly lighter edge, is probably the most common fungus on Lundy at all times of the year, and also occurs in large numbers in the short turf grassland, growing alongside the smaller pointed capped 'liberty cap' *(Psilocybe semilanceata)*. The 'field mushroom', *Agaricus campestris*, which, as already noted, is very abundant on Lundy, utilises well rotted dung, particularly horse dung, that has become incorporated into the soil. However its fruiting is restricted to the short turf area, and, in spite of the abundance of horse apples in the rushy pastures around Quarter Wall gate, we have never recorded it there.

3. Calluna Heath

The short heath of *Calluna vulgaris* and associated plants, which grows on the thin acid peat of the Plateau of the North End is very different to the rest of the island and remoteness has meant that past records, and our own surveys, have only involved brief visits. Some of the agarics recorded here are found elsewhere on Lundy growing on acidic litter under bracken, *Calluna*, or the *Molinia* areas, e.g. decomposer agarics such as the orange 'false chanterelle', *Hygrophoropsis aurantiacus*, and the cream-capped *Collybia dryophila*. However other fungi found here do not occur elsewhere on Lundy. *Collybia obscura*, a small purplish decomposer agaric with a tough flesh and unpleasant smell was only found at the North End in October 2003 (Hedger & George, 2004) and again in November 2004. Likewise, as noted earlier, the rare *Hygrocybe* cf. *radiata* was only recorded around the North End in November 2004. During the same visit, a spectacular myxomycete, *Leocarpus fragilis*, (Plate 24), was abundant, covering patches of *Calluna* with large bright yellow gelatinous plasmodia, later maturing to a mass of glistening dull red minute egg-shaped sporangia. Ing (1999) considers *L. fragilis* to be characteristic of the acidic litter of conifers and gorse, where the plasmodium migrates upwards to fruit on trunks well above the soil. No mention is made by Ing of *Calluna*, but the organism is obviously very successful in this habitat on Lundy.

DISCUSSION

Plate 24: *Leocarpus fragilis* (Myxomycete) fruiting on *Calluna*. North End. November 2004. *(Photo: Gareth Griffith)*

It could be asked whether a study of fungi on Lundy has any scientific value. Any of the fungi recorded would be likely to be also present on the mainland. However, the account presented in this chapter highlights a number of counter arguments. Firstly the national conservation status of Lundy means that a complete inventory of the organisms present is highly desirable, and although the lichens, part fungus, part alga, have been previously well documented (Noon & Hawksworth, 1973; James *et al*., 1996; 1997) the aim must be to raise the knowledge of Lundy fungi to the same status. As noted in the introduction to this chapter, the evanescent nature of fruit bodies of fungi makes this task difficult, but the present total of 358 species compiled from our own visits, and from previous records of LFS members, means that a good beginning has been made. Secondly, our studies have begun to reveal that there are some unique features to the ecology of fungi on Ændy, for example the unusual hosts for some of the wood-rotting fungi and the curious records of fungi from the North End. Perhaps there are 'island' effects on the fungi.

Thirdly, even if Lundy were an area of land on the mainland, the high diversity of the grassland fungi noted in this chapter would make a strong case for SSSI status. In the last 60 years there has been a loss of over 90% of species-rich grazing land and hay meadows in southern England, due to agricultural improvements, such as ploughing and reseeding, and application of fertilisers (Griffith *et al*., 2002; 2004). Since the early '90s, surveys have shown that these remnants of unimproved grassland and heathland in the U.K. also support many rare species of macrofungi, so much so that two SSSIs have recently been designated to conserve these fungi (Rotheroe *et al*., 1996; Rotheroe 2001). Many of these sites are tiny, including graveyards and lawns, but are chiefly characterised by low soil nutrient status and absence, in particular, of application of nitrogen. On Lundy a large proportion of the island is managed in ways which are favourable to these communities of fungi, with no fertiliser input and heavy grazing, the exception being the enclosed improved grasslands around the farm. The island should therefore be recognised as an important U.K. site for 'grassland' fungi. It is safe to predict that even more grassland species will be recorded in the future. The positive message is that the current management of Lundy is directed to conservation of biodiversity, and, if this includes the continuation of grazing of most of the island without fertiliser, whether organic or inorganic, these fungi are safe.

Ironically conservation activities on Lundy may also lead to the loss of some of the species of fungi! The current plans for eradication of the east coast rhododendron thickets may result in the loss of the dozen or so species of fungi presently recorded

for Lundy from rhododendron, for example the aptly named 'rhododendron bud blast', *Pycnostysanus rhododendri*, (Hedger & George, 2004). However, any loss is likely to be offset by an increase in plant biodiversity on the east side of Lundy, and perhaps re-introduction of more native species of tree along the east side of the island, along with their associated fungi.

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