Issue 1: Summer 2011

Fungal Conservation

INTERNATIONAL SOCIETY FOR FUNGAL CONSERVATION

www.fungal-conservation.org

The *International Society for Fungal Conservation* was established in August 2010, and now has members in over fifty countries. The objective of the Society is to promote conservation of fungi globally. It acts as a global federation for fungal conservation groups, supporting, guiding, co-ordinating and functioning as a forum for regional, national and local bodies seeking to promote fungal conservation. Membership is open to any individual or organization with a genuine interest in fungal conservation. The Society's Council consists of its Officers, Elected Councillors, Representatives of External Organizations and Regional Delegates.

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Representatives of External Organizations

International Mycological Association, to be appointed
IUCN Chytrid, Downy Mildew, Slime Mould and Zygomycete Specialist Group, Dr Mayra Camino [Cuba] mcamino<at>fbio.uh.cu
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IUCN Lichen Specialist Group, Dr Christoph Scheidegger [Switzerland] christoph.scheidegger<at>wsl.ch
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Asia (Central & Western), to be appointed
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Asia (South & Southeastern), to be appointed
Australasia, Dr Sapphire McMullen-Fisher (representative of Organization Member Fungimap), sapphire<at>flyangler.com.au
Central America & the Caribbean, to be appointed
Europe, Dr Vera Hayova [Ukraine] vera.hayova<at>i.ua
North America (Boreal), to be appointed
North America (Temperate-tropical), to be appointed
Oceania, to be appointed
South America (Temperate), to be appointed
South America (Tropical), to be appointed

Fungal Conservation

Issue 1: Summer 2011

Welcome to the first issue of *Fungal Conservation*, the combined newsletter and journal of the *International Society for Fungal Conservation*. The Society was established at a special international meeting of fungal experts held at the Royal Botanic Garden, Edinburgh in August 2010, and at the time of writing has a membership of 250 from 62 different countries.

Why is the Society needed? The fungi are a huge assemblage of organisms. Best current estimates suggest there are at least 1.5 million species worldwide, of which only around 5% have so far been discovered. Fungi comprise one of the great kingdoms of multicellular organisms, equivalent in status in every way to the animal and plant kingdoms – except in our level of knowledge. So, are they insignificant? Not at all. The first fungi played a crucial role in the establishment of terrestrial ecosystems through symbiotic relationships with plant roots – without them, it is doubtful that roots could ever have become sufficiently effective in water and nutrient uptake to maintain large multicellular terrestrial species. Now, the vast majority of land plants use fungi in this way. And where do those nutrients come from? Fungi are the ultimate recyclers, breaking down plant and animal tissues to allow their re-use by following generations of organisms.

What else do fungi do for us? Lichenized species play an important part in soil generation through the breakdown of the rocks on which they grow by acid secretion. Fungi are important as food resources, for many small vertebrates and invertebrates as well as for Man. Yeast makes it possible to make many kinds of bread – not to mention alcoholic beverages. Their inbuilt biochemical factories are the basis of many pharmaceutical products, including key antibiotics, statins that reduce cholesterol levels, and medicines that make transplant surgery possible.

Is there a downside to our relationship with the fungi? Ever since the dawn of agriculture, species have caused important plant diseases and post-harvest problems that lead to substantial food loss. But think about this a little more. In ecosystems that have not been modified by Man, fungal diseases are rarely more than debilitating to plants – otherwise the parasites would have become extinct along with their food sources. If we cut down the forests and replace them with countless hectares of monoculture with little or no genetic variety, it is not surprising that new fungal genotypes evolve to take advantage of the new food source. Clearly we need to protect our crops, but we need to recognize that it is our own actions that has rendered the protection necessary. And even if a small proportion of fungal species act in a manner that is inconvenient, that doesn't mean to say that the remaining ones don't deserve protection from our frequently cavalier actions on Earth.

Although the wellbeing of fungi is essential for life on this planet, amazingly, up to now, they have been almost totally overlooked by all mainstream conservation movements. But the fungi have no special features which protect them from destructive human activity. Like animals and plants, they too are endangered by climate change, habitat destruction and pollution. They too need their champions to protect them. The *International Society for Fungal Conservation*, which was established specifically for that purpose, is the first society in the world explicitly devoted

to conserving fungi. It has a long way to go in its mission to bring fungi into the centre of conservation policy, and to counteract all those negative impressions the popular mind. I just keyed in the word "fungi" to Google and found the following statement in one of the top three entries: "*Fungi is the name given to a strange group of living things including mushrooms, toadstools, moulds and thousands of other weird and wonderful things. It's safe to say that if you see something strange growing outside, and you're not sure what it is, it's probably a fungus."* At least *some* fungi are considered as wonderful, but it's not exactly a ringing endorsement.

If you're reading this as a member of the Society, then I hope you enjoy the experience, but please be aware that the ISFC will only flourish if a wide cross-section of the membership commit themselves to its support. There's plenty for you to do to raise the profile of the fungi in all sectors of society, but as Editor of *Fungal Conservation* I'd like you to remember that we can only publish material that is made available for publication. So please get writing. We aren't in the business of competing with academic journals, so we're happy to accept news items, short papers, project reports, red list information, profiles of rare or important species, information on sustainability, threats to species or habitats important for fungi (that means most of them!) etc. etc. And if you think of yourself as a lichenologist rather than a mycologist, please be assured that news of lichens will be equally welcomed – lichenologists have much to teach those of a non-lichenized persuasion in the conservation arena.

If you're not a member of the International Society for Fungal Conservation, then a special welcome to you. Please consider joining the Society, and do feel free to contribute. We need to interact with individuals and organizations both within and outside of the mycological world, and your opinions and experiences will be of great interest to us.

If you would like to submit an article to *Fungal Conservation*, then by all means email it to me, or ask for advice as to what is needed. Please include images where relevant, whether of fungi, people, conservation, habitats or anything else that will make your article more approachable to those who aren't diehard myco-conservationists. Do also please feel free to respond, comment, or add to any of the articles in this issue – many of them raise challenging issues, and some are highly inspiring.

I look forward to your messages…..

Paul Cannon
Editor, *Fungal Conservation*
email p.cannon<at>cabi.org

News articles

ISFC Successfully Lobbies for Change at COP10

Although the International Society for Fungal Conservation had only just been established, it was ready to lobby in Nagoya, Japan (October 2010) for change at the Tenth Conference of the Parties - the periodic intergovernmental summit to review progress with the Rio Convention on Biological Diversity. This was a good opportunity to gain some practical experience of the political side to conservation.

The issue at stake was the wording of one paragraph of the Global Strategy for Plant Conservation. This generally excellent document promoting the protection of plants unfortunately contained a well-meaning but actually damaging reference to the fungi. Section E, paragraph 10 contained the following statement: "accordingly the Strategy addresses the Plant Kingdom with main focus on higher plants, and other well-described groups such as Bryophytes and Pteridophytes. This does not imply that these lower groups do not have important ecological functions, nor that they are not threatened. Parties may choose on a national basis to include other taxa, including algae, lichens and fungi".

The problem was that the final sentence of this paragraph gave the mistaken impression that fungi are "lower" plants, that "lichens" are different from fungi, and that strategies for fungal conservation could be treated as an optional extra. Left unchanged, this wording could have unintentionally indicated that the CBD ignores fungal conservation.

As a result of lobbying (e-mails were sent to as many as possible of the national scientific advisory focal points for the convention), a small change in the wording was adopted, as follows: "while the Strategy addresses the plant kingdom with main focus on higher plants, and other well-described groups such as bryophytes and pteridophytes; Parties, other Governments and other relevant stakeholders may consider developing conservation strategies for other groups such as algae and fungi (including lichen-forming species)."

Although this fell short of what was requested, it did represent progress. The new text recognizes that lichens are fungi, and that algae (some of them, at least) and fungi are different from plants. It also talks in terms of the development of separate strategies for algae and fungi, rather than, as previously, the idea of including them in a plant strategy.

There was clearly some reluctance to recognize explicitly that a separate global strategy for the fungi is necessary, and the reason for that was, doubtless, a recognition that such a development would cost money. For us, it is abundantly clear that fungi and mycologists need to be integrated into the machinery of the conservation world, and many mycologists will sympathize with the view that the cost of developing a global fungal conservation strategy is very small compared with most of the other things governments spend our money on. So another lesson learned was for patience. It will be a long game, and at this stage getting any change at all in the right direction, no matter how small, should be seen as a real achievement for our new Society.

Contributed by David Minter email d.minter<at>cabi.org

The conservation knowledge gap for fungi

The table below was derived from IUCN data for a presentation on fungal conservation at the Asian Mycological Congress in Korea in August 2011. It highlights the grotesque imbalance between conservation efforts for fungi and other major organism groups.

	Estimated number of described species	Number of threatened species (IUCN Red List, 2011)	Proportion of species known to be threatened (%)
Animals			
Vertebrates	**63,654**	**6,959**	**10.9**
Invertebrates	**1,305,250**	**3,199**	**0.25**
Plants			
Flowering plants	**268,000**	**8,477**	**3.1**
Others	**39,674**	**621**	**1.6**
Fungi & Protists			
Brown Algae	**3,127**	**15**	**0.48**
Lichens	**17,000**	**2**	**0.01**
Mushrooms	**31,496**	**1**	**0.003**
Other fungi	**~35,000**	**0**	**0**

What messages do we receive from these figures? Firstly, much more effort is needed to record baseline data, to make existing information accessible and to carry out these global assessments for fungi. More funds are unquestionably needed, but we also need to re-examine our own priorities to make these assessments happen. Without them, there is no objective evidence to drive the priority reassessment that we all agree is needed. But it's worse than that – an uncritical glance at this table by a busy policy-maker with half (or more) of an eye on poorly informed public opinion might conclude that ***fungi are not endangered……*** So we also need to ensure that these decision-makers are put properly in the picture. Things are happening fast – not least due to the Sampled Red List activities described in this issue of *Fungal Conservation* – but our activities still need to step up another gear or two.

One could spend many hours in interesting discussions as to whether fungi were more or less likely to be endangered compared with charismatic megafauna, but we do not see any intrinsic reason why the proportion of endangered fungal species should be dramatically different from that of vertebrates. Until those discussions are complete and properly ground truthed, we might adopt the precautionary principle and expect to plan conservation management programmes for 9000-10000 species of fungi.

Contributed by Peter Buchanan email BuchananP<at>landcareresearch.co.nz
and Paul Cannon email p.cannon<at>cabi.org

Atlantic rainforests on the BBC

Non-specialists (especially non-mycologists) think immediately of tropical rainforests as the most important harbours of all kinds of biological diversity, but temperate habitats can be immensely important as reservoirs for fungi and lichens. The Atlantic hazelwoods of western Scotland are a key environment for a wide range of lichens (and at times certainly seem to enjoy equivalent rainfall…) to their tropical counterparts. Public awareness of their importance has been increased with a feature from BBC Scotland's programme *Landward*. View it at http://www.youtube.com/user/forgottenforestsIYF#p/a/u/2/cgcWtFaUBy4.

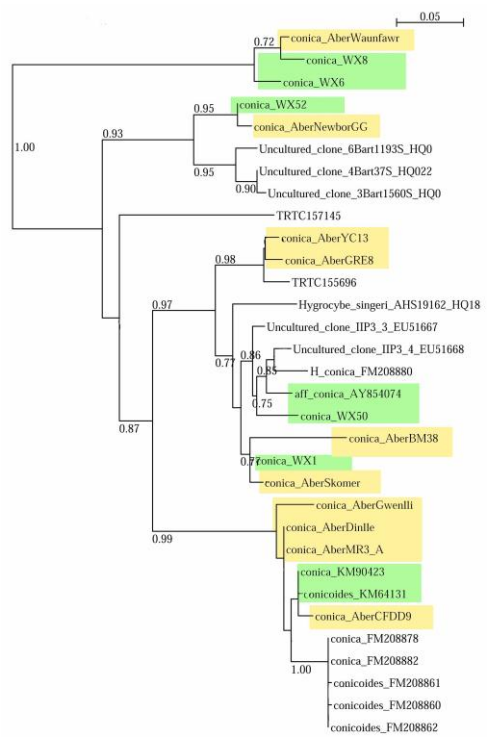
Two iconic species of the Atlantic hazelwoods: *Hypocreopsis rhododendri* (left) and *Lobaria pulmonaria* (right). *H. rhododendri* (given the vernacular name "hazel gloves" in Great Britain) is listed on the UK Biodiversity Action plan as vulnerable and receives general protection under the Wildlife & Countryside Act 1981 (see also article on p. 9). *L. pulmonaria* is not a rare lichen, but populations have declined and it is only common in high rainfall areas. It is harvested for use in perfumes, and there is concern in some quarters over the sustainability of this industry.

Contributed by Paul Cannon email p.cannon<at>cabi.org

Fungi of UK waxcap grasslands

So-called unimproved (i.e. unfertilized) grasslands have long been recognized as important for fungal conservation in Europe, with especial focus on species from the four families *Hygrophoraceae*, *Clavariaceae*, *Entolomataceae* and *Geoglossaceae*. There have been a number of survey and monitoring initiatives for these fungi in the UK, but their systematics remains under-studied and we do not have a modern molecular phylogeny-based classification for any of the groups concerned. This is particularly relevant as species concepts are uncertain, many are difficult to identify using traditional field methods, and cryptic species are suspected that may have distinct distributions, ecological requirements and conservation needs. If we can't define our species using objective methods and demonstrate effective methods for their monitoring, it is not easy to persuade the relevant stakeholders to support their conservation.

The UK Government's Department for Environment, Food and Rural Affairs (DEFRA) and Scottish Natural Heritage has funded a research project to investigate species of *Hygrocybe* and *Geoglossaceae* in the UK using a combination of molecular and morphologicagel methods, by a consortium including the Royal Botanic Gardens Kew, CABI, the University of Abersystwyth with valuable support from a series of local recording groups throughout England, Scotland and Wales. Initial results have shown strong indications that *Hygrocybe conica*, a speces considered as common and widespread (though variable) is a complex that contains a number of cryptic species, potentially with different conservation requirements.



Hygrocybe conica: images (© Derek Schafer, top left and © Martyn Ainsworth, bottom left). To the right, a preliminary phylogram of the *H. conica* complex showing a series of distinct clades; green-shaded taxa are derived from project samples, yellow-shaded samples are from sand-dune habitats.

Contributed by Paul Cannon: email p.cannon<at>cabi.org

Lichen use and regeneration in the Western Ghats, India

In India, lichens are commonly used to flavour meals, and in no small amounts. In the south of India, the spice mix *garam masala* is a key ingredient of many curry dishes and this mix may consist of up to 20% (approx.) of foliose epiphytic lichens. Thus, in the spice shops in Kerala, not only locally grown spices like cardamom and cloves are sold, but also bags with lichens may be purchased to include in the spice mix. The lichens are not cultivated but harvested from natural forests. In India, an estimated staggering total amount of 1000 metric tonnes of lichens are extracted from the wild each year. In the Western Ghats, epiphytic macrolichens are harvested by Paliyan tribes to generate supplementary income. Researchers were interested to learn if the Paliyans also made an effort to attain a sustainable yield of lichens in the long-term. Whereas the harvesters did not distinguish between lichen species, they did avoid forests where lichens had been recently harvested, resulting in an informal harvesting rotation schedule. Nevertheless, harvest was intensive: in one study, 63.3% of all forest trees showed harvesting scars and on average 29.5% of all lichens were removed from harvested trees. Regeneration of the harvested lichen communities started after between two and five years, with harvest incorporating tree bark (often included to bulk up the collections) extending the regeneration process.

Abstracted from the following papers:

Molleman, L., Boeve, S., Wolf, J., Oostermeijer, G., Devy, S. & Ganesan, R. (2011). *Environmental Conservation* **38**: 334-341. doi: 10.1017/S0376892911000142.

Wolf, J. (2011). Lichen use and regeneration in India. *International Lichenological Newsletter* **43**(2): 22-25.

Survey of fungal and environmental awareness amongst Egyptian schoolchildren

404 Egyptian schoolchildren from a range of age groups within the international/American school system were asked a series of questions about fungi and the environment. The results were mixed, and suggest that a great deal more needs to be done to bring conservation issues home to these young people. The results were as follows:

Have you ever visited a protected area in Egypt?	Yes: 20 (5%) No: 384 (95%)
Have you ever come across the term "endangered species" in your textbooks?	Yes: 363 (90%) No: 39 (10%)
Do you know any endangered species in Egypt?	Yes: 0 (0%) No: 404 (100%)
Which kingdom do fungi belong to?	Plants 32 (8%), Herbs 6 (1.5%), Micro-organisms 349 (86%), Fungi 11 (4%), Non-vertebrates 0 (0%)
Have you ever visited the website of the Egyptian Ministry of Environmental Affairs?	Yes: 95 (24%) No: 309 (76%)
How many protected areas are there in Egypt?	No correct answer

Disturbingly, the results of a similar survey amongst Egyptian journalists were not much better….

A group of scientists and science attentive community leaders have established, for the first time in Egypt, an international Egyptian NGO organization (International Foundation for Environment Protections and Sustainability) to address the issues of biodiversity conservation in Egypt (www.ifeps.org). Hopefully, this organization can begin to address the lack of knowledge about the environment in Egypt.

Contributed by Gihan Samy Soliman email Gihansami<at>yahoo.com

Primrose smut and moon carrots -- the rediscovery of extinct British fungi…

The long-lost British fungus, bird's-eye primrose smut (*Urocystis primulicola*), recognised as a species of "principal importance for the conservation of biological diversity" (BAP review 2007) had not been seen for 106 years until it was rediscovered by Kew and Natural England mycologist, Martyn Ainsworth, during a two hour 'ovary squeezing' session.

Smuts are species of inconspicuous, microscopic fungi that are found inside living host plants, in this case the red-listed wild pink flowered bird's-eye primrose (*Primula farinosa*) found in the North Pennines. The bird's-eye primrose smut has co-evolved with the plant and hijacks its ovaries, replacing its seeds with a black powdery mass of smut spores. Concealed in the ovaries, it is only when the bird's-eye primrose seed-pods are squeezed in the late summer, when the seeds are ripe, that this rare smut can be found.

In a similar story, the moon carrot rust (*Puccinia libanotidis*) was rediscovered in England after it was believed lost for 63 years. The moon carrot (*Seseli libanotis*), the plant that hosts this rust, is a red-listed wild plant confined in Britain to the chalky soils of the Chilterns, Gog Magog Hills and the South Downs.

Urocystis primulicola in ovary of *Primula farinosa* (l) and *Puccinia libanotidis* on leaf of *Seseli libanotis* (r).
Images © Martyn Ainsworth

Martyn Ainsworth, Senior Researcher in Fungal Conservation says, "It is always exciting to rediscover species thought to be extinct but to find one that has been lost for over 100 years, while carrying out a quick survey in a likely spot during a journey between England and Scotland, was an exhilarating 'Eureka' moment. To wipe these rare British fungi off the extinct list is a joy, and we hope that with further field surveying we can now provide a clearer picture of these species' current British distribution.

"Both these fungal species have been re-discovered on rare British plants, and therefore their conservation is dependent on that of their host plants and their habitats. I'd encourage all field naturalists to get out and start looking for so-called extinct fungi and find out about their relationships with other fungi, plants and animals so we can understand their habitat and conservation requirements better. There are so few of us doing this work, we need all the help we can get."

Extracted from a press release by the Royal Botanic Gardens, Kew; see also

Ainsworth, M., Woods, A., McVeigh, A. & Carey, J. (2011). Rediscovery of 'extinct' British rusts *Puccinia bulbocastani* on Great Pignut and *P. libanotidis* on Moon Carrot. *Field Mycology* **12**: 42-48.

The press release has attracted attention world-wide, including a feature on Scientific American's Artful Amoeba blog (http://blogs.scientificamerican.com/artful-amoeba/).

Fungus conservation in Scotland: Notes from the 2011 Scottish Fungus Conservation Forum

On July 19th David Genney, Scottish Natural Heritage, was joined by 12 mycologists when he hosted the 3rd annual meeting of the Scottish Fungus Conservation Forum (SFCF). The forum was set up in 2009 to help promote, prioritise and coordinate research, survey and field mycology for the benefit of fungal conservation in Scotland. The following is a summary of the main topics discussed.

Scottish Wild Mushroom Code

The Scottish Wild Mushroom Code was developed to promote responsible collection of fungi. The code has recently been updated to reflect changes in legislation and expert opinion. Printed copies are now available from SNH but on-line English and Polish versions are available to download. The Code will be distributed to local recording groups, foray organisers and those involved in commercial mushroom harvesting. The group agreed that it is impossible to monitor the level of harvesting and that effort should focus on promoting good practice.

Scottish Fungi website

The Scottish Fungi website was launched in July 2010 as a result of the combined effort of volunteer mycologists across Scotland. It provides information and advice on a wide range of topics including identification, local groups, eating, conservation, education and research. In its first year, the site has had 5,576 visitors, two thirds of whom were from the UK with the remaining third from over 100 countries. A third of people visited the site more than once,

spending an average of three to 10 minutes per view. The most popular pages are those dealing with identification, local groups, English names and the regular news items.
The 'Fungus of the Month' project has not resulted in large numbers of new records, but it was agreed to continue with the project because it keeps the site fresh and likely stimulates more interest than the species records suggest.

The site is now linked to Facebook and Twitter accounts to increase its online visibility. The Scottish Field Mycology Yahoo group remains the site's discussion forum and now has over 100 members.

Site Condition Monitoring
Site Condition Monitoring is the six year cycle that assesses the conservation status of Scotland's Sites of Special Scientific Interests (SSSI). Six (out of over 1200) SSSIs in Scotland are specially notified for their fungal interest. We have just reached the end of the second cycle and all sites have been assessed as '*Favourable condition'*. With reduced resources, the third cycle (2011-2017) will monitor a sub-sample of sites, but improve efficiency by drawing on observations from other site visits. This should ensure there are no drastic changes in habitat condition.

Plantlife and Plantlife Link Scotland (PLINKS)
PLINKS brings together botanist and mycologists to coordinate conservation action in Scotland. There are overlaps with the SFCF, but with less focus on fungi. Deborah Long of Plantlife Scotland reported that PLINKS are currently focussing on three key areas of work: 1) the review of protected species that are protected by law on Schedule 8 or the Wildlife and Countryside Act (1981); 2) the UK revision of the guidelines for selection of SSSIs; 3) implementation of the updated Global Strategy for Plant Conservation (GSPC) agreed at Nagoya last year.

Deborah also reported that Matilda Scharsach, who did an excellent job delivering Plantlife Scotland's lower plant and fungus project, has returned to Plantlife. Their intention is to now incorporate all the lower plant and fungi work into the Plantlife mainstream conservation plan.

Scottish Biodiversity Strategy Review
The current strategy is about to be reviewed. The SFCF agreed that they would work with PLINKS to ensure fungi are adequately protected by the revised strategy.

Research update
Three Ph.D. students, working with Andy Taylor at the James Hutton Institute, Aberdeen, reported on their work:

Katie Grundy described her ecological and molecular work on *Hypocreopsis rhododendri*, a species demanding conservation attention in Scotland, indeed the UK. She has already made some important discoveries about its ecology that will help future conservation management. This is work funded as part of SNH's Species Action Framework that focuses action on species with clear conservation objectives.

Susan Jarvis reported on the fungi of Caledonian Pine forests, enquiring as to whether any possible climatic changes might be indicated by the mycota. Root samples have been taken from 15 sites across Scotland. Molecular techniques have been used to identify the fungi present and this information will be used to relate any emerging patterns to edaphic factors. So far 60 species have been identified from 11,250 root tips. It appears that Velvet Bolete (*Suillus variegatus*) is very common throughout the pine woods investigated. In contrast, *Tylospora*

fibrillosa has only been found at two sites that are geographically close to each other. There is a high abundance at both these sites and it may be that the species has a western distribution.

Emily Carol is looking at the biogeography of our little understood arctic-alpine ectomycorrhizas as this is a habitat that is very vulnerable to changes in nitrogen deposition and climate. She has looked at 182 sites and recorded 62 species covering *Cortinarius*, of which there are c.16 apparently new species, *Russula*, *Lactarius* and boletes. A potential Gymnomyces has also been found with *Arctous alpinus*.

Caledonian pine forest at Glen Affric, NW Scotland (see previos page)

A report was also contributed on the waxcap grassland project where the systematics and ecology of fungi of waxcap grasslands is underway, accompanied by bar-coding of species present. The project is being carried out by CABI, RBG Kew and the University of Aberystwyth. Waxcap grasslands are an important feature of the Scotland's natural heritage and conservation is paramount.

Natural Talent Scheme

Roy Watling reported on the British Trust for Conversation Volunteers Natural Talent Apprentice Scheme. One apprentice, Alison Murfitt, presently in post is linked jointly with the National Trust for Scotland, a large land owning organisation that is interested in fungi, especially those in their grasslands. She is currently working on a project to look at the organisms growing immediately in the vicinity of waxcap fruit bodies, including bryophytes, to try and discover possible indicators of the fruiting microhabitat. Alison is the third mycological apprentice and this has been seen as a very successful way of training our future mycologists. There was concern that funding may be drying up for continuation of this successful scheme. Concern about the lack of related work at the end of the apprenticeship was also raised.

Fungal Surveillance

In response to an EU requirement to report on trends in protected species, Scottish Natural Heritage and The James Hutton Institute have teamed up to develop a field rationale and protocol for fungal surveillance. The project has so far held an expert workshop to review previous work and identify the main challenges. Liz Holden and Neville Kilkenny have also performed the vital initial task of collating and cleaning records of Scotland's rare/tooth fungi. Work will now concentrate on developing soil sampling protocols and using already developed species specific probes (for tooth fungi) to assess changes in species range and population size. A big task! Funding is secured until early 2013.

Contributed by Roy Watling, David Genney and Liz Holden email David.Genney<at>snh.gov.uk

Fungi and myxomycetes feature in new IUCN book

The United Nations declared 2010 the International Year of Biodiversity and, to mark that, the IUCN organized a special Internet project called "Species of the Day". Through this project, on each day of that year, a different organism was profiled on the IUCN Species of the Day website. Each profile included an illustration of the organism, its scientific name (plus any vernacular name), a distribution map, some text providing basic information about the species, and its IUCN conservation status assessment.

On five days of that year, the Species of the Day was a fungus, and on one day a myxomycete was featured. This was very encouraging evidence that the IUCN is now much more aware of fungi and fungus-like organisms than it was in the past.

All of those accounts have now been gathered together to form a most attractive book [*Species on the Edge of Survival*, published by IUCN & Harper Collins, ISBN 978-0-00-741914-2, UK price £14.99] and, yes, the fungi and myxomycetes are there. The plural "myxomycetes" is not a mistake: one species, *Diacheopsis metallica*, is profiled (a nivicolous listed as Near Threatened), but there is also a photograph of *Lamproderma acanthosporum* in the introduction. There is one lichen-forming fungus, *Erioderma pedicellatum* (listed as Critically Endangered), and four other ascomycetes: *Cryptomyces maximus* (provisionally listed as Critically Endangered), *Diehliomyces microsporus* (Data Deficient, but very strongly declining in its only known habitat), *Poronia punctata* (widely distributed, but listed as Vulnerable because of threats to its habitat) and *Zeus olympius* (provisionally listed as Critically Endangered, being known from only one mountain in Greece).

It was also cheering to an alphabetical order used in the introduction to list the main biological kingdoms represented in the book ("animals, fungi and plants"). The book is an encouraging step forward for fungal conservation, although the proportion of fungi compared with animals and plants still remains tiny. In particular, it was a pity to see no larger basidiomycetes, or rusts and smuts included. But with the ISFC now up and running, there is every hope that in future initiatives like this, they too will get represented.

Contributed by Dave Minter email d.minter<at>cabi.org

1500 fungi evaluated for conservation status

Lack of formal conservation evaluation of fungal species on a global level is a key failing for mycology, and one of the major reasons why fungi are so poorly represented in conservation strategy worldwide. A new project (see page 45 and http://www.cybertruffle.org.uk/redlidat/index.htm has addressed this issue in a novel manner, by partially mechanizing the evaluation process for a random sample of 1500 species of the *Ascomycota*. The results are not perfect – largely due to the incomplete nature of the available data sets – but we now have preliminary evaluations carried out using objective IUCN criteria for a wide range of fungi. The project should provide a powerful stimulus for further assessment of the species included, especially ground-truthing in cases where species are considered as likely to be endangered or even extinct.

The listing of an Australian *Hygrocybeae* community and its new species under State and Commonwealth legislations

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Abstract
Lane Cove Bushland Park (LCBP) in Sydney, New South Wales is a site in the middle of a high-density residential area. Centred about a tributary of Gore Creek that runs into the nearby Sydney Harbour, the warm temperate gallery forest is the location of at least 27 species in the *Hygrophoraceae* tribe *Hygrocybeae*. The *Hygrocybeae* Community of LCBP has been legislated under the NSW Threatened Species Conservation Act, 1995 as endangered. A Final Determination has listed nine taxa described from LCBP as either endangered or vulnerable under the appropriate section of the Act. In addition, the LCBP has been listed on the Register of the National Estate by the Commonwealth Heritage Commission as a site of national significance based principally on its mycological assemblage. These successful prototype initiatives have depended upon the collaborative efforts involving amateur mycology enthusiasts and a professional taxonomic mycologist as well as the local Lane Cove Council that is very pro-active in conservation. This synergy of initiative, originality of ideas and keenness of observation has achieved landmark decisions for mycology and conservation of fungi in Australia.

Introduction

Our knowledge of fungi – which have a vital role in maintaining the ecosystem and life-support systems – still remains extremely limited. Often trampled and overlooked than studied and conserved, fungi are even less well known than other cryptogams such as mosses, liverworts, lichens and algae.

Fungi are no less threatened than a surprising number of plant and animal species and have also become endangered by default –through inefficient administration, ignorance of their ecology, or simply because too few seem to have the interest, authority or responsibility for taking constructive action to safeguard them. The following account illustrates how initiative and analytical insight of amateur mycology enthusiasts when coupled with the skills of an expert taxonomic mycologist can work together to achieve landmark decisions for the conservation of fungi at Local, State and Commonwealth levels of Government.

Lane Cove Bushland Park (LCBP)

LCBP measures approximately 800 metres long and about 300 metres at its widest section and can best be described as a warm-temperate wet sclerophyll forest (see Fig.1). It is evergreen, hygrophilous in character in the upper portion and rich in thick stemmed lianes. The vegetation is a mixture of open forest and rain-forest species, but not luxuriant. In some sections as little as ten percent of the sunlight shining on the crown of the trees reaches the ground in the understorey. Epiphytes are relatively common on many of the tree trunks, especially in the upper catchment area of the tributary of Gore Creek. The water course that runs the length of LCBP is the location of a "gallery rainforest" at the bottom of the valley

surrounded by often steep-sided ridges and gullies which carry run-off rainwater into the tributary of Gore Creek and empties into the Sydney Harbour at Gore Cove.

In the lower or southern more open section of LCBP, grasses exist as ground cover amid the various species of eucalypt, angophora and coachwood. Several different species of ground orchids abound in the more sheltered sections in the mid and southerly aspect of the LCBP. The area records a rainfall of more than 1200 mm, the wettest months being January to July. Extremes of temperature are infrequent: average maximum summer temperature is around 24°C and the average minimum 18°C. Average winter temperatures are: maximum 16°C, minimum 7°C.

Fig. 1 North-South aspect of LCBP

The diverse landscape (Figs. 2-4) in the LCBP comprises a wide variety of vegetation complexes. It is in the gallery rainforest that has a north-south aspect between sloping hillsides, which govern shade and heat in autumn and winter, where the majority of species in the family Hygrophoraceae are found. The galleries add to the richness of the eucalypt open forest, which essentially becomes a buffer zone of dry sclerophyll between the gallery core-zone and the residential area around the perimeter of the LCBP.

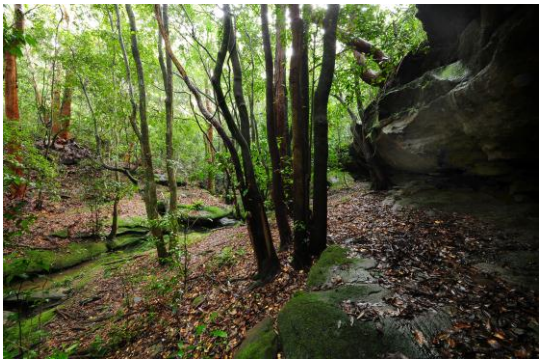


Fig. 2. Southern aspect of LCBP

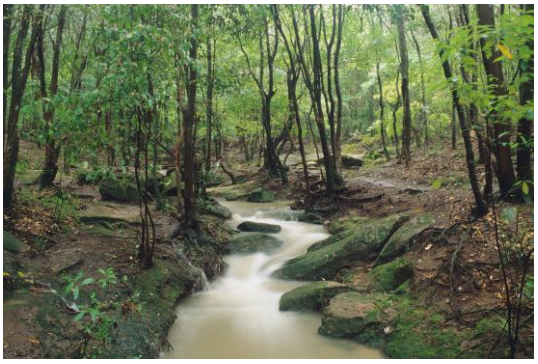


Fig. 3. Central aspect of LCBP

The two major rock types in LCBP are Wianamatta shale and Hawkesbury sandstone that give rise to two distinctly different types of soil. The shale produces deeper and more fertile clay soils, which also hold more water easily. The sandstone produces sandy, stony soils, which dry out readily and tend to be associated with steep slopes and rock outcrops over which drip water into leaf litter below – ideal conditions for certain species of *Hygrocybe*. The unusual combination of both soil types, coupled with the topography of the site in a north-south aspect, has created a range of unique habitats and ecosystems, which support the different colourful species in the family of *Hygrophoraceae*.

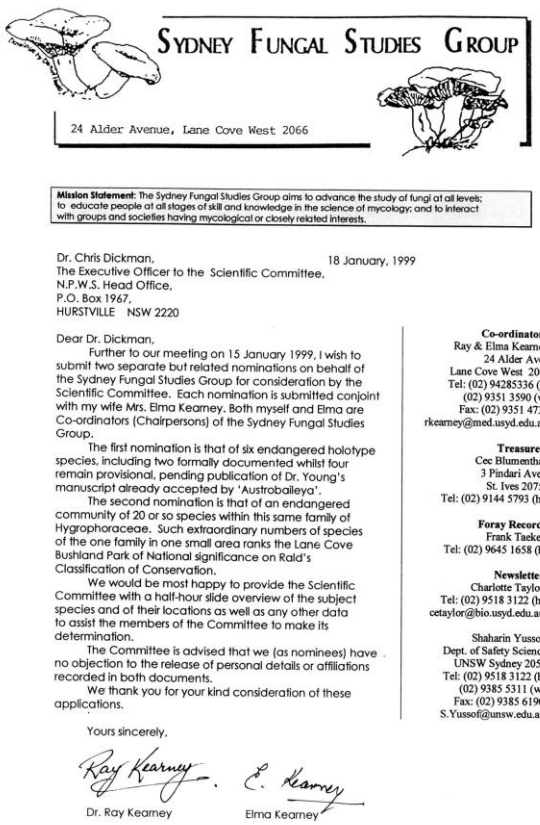
Fig. 4. Northern aspect of LCBP

For more than a decade, members of the Sydney Fungal Studies Group Inc. (SFSGI) had recorded a diverse range of fungal species,

including many in the genus *Hygrocybe*. However, most of the later species were unclassified, although photographic and field records were made. By 1997, more than 20 different species of *Hygrocybe* had been documented photographically by amateur mycologists Ray Kearney and his wife Elma to add to previous records kept by Mr van Klaphake, Bush Regenerator of Lane Cove Council and also a member of the SFSGI. Indeed, some species of *Hygrocybe*, given to a local resident and artist Julie D. Morris by van Klaphake are recorded in her paintings.

Scientific documentation in the Applications

In 1998, taxonomic mycologist Dr Tony Young received grants from the Australian Biological Resources Study (ABRS) to undertake studies on *Hygrophoraceae* along the eastern seaboard of Australia, including Tasmania. The authors drew his attention to their unofficial records and sightings of the species of *Hygrophoraceae* in LCBP in 1998 and a follow-up on-site visit marked the beginnings of the formal identification and classification of the collections from the LCBP that culminated in his publication (Young, 1999). With further assistance from Ray and Elma Kearney, it became clear that when Dr Tony Young investigated the entire collections sent to him, the number of species would easily exceed 25 and possibly reach 30 including variants. This collaborative association between the analytical insight of amateur mycology enthusiasts and the skills and experience of a professional taxonomic mycologist was the foundation upon which the initiative to enshrine mycology in both State and Commonwealth Legislation was launched.



SYDNEY FUNGAL STUDIES GROUP

24 Alder Avenue, Lane Cove West 2066

Mission Statement: The Sydney Fungal Studies Group aims to advance the study of fungi at all levels; to educate people at all stages of skill and knowledge in the science of mycology; and to interact with groups and societies having mycological or closely related interests.

Dr. Chris Dickman,
The Executive Officer to the Scientific Committee,
N.P.W.S. Head Office,
P.O. Box 1967,
HURSTVILLE NSW 2220

18 January, 1999

Dear Dr. Dickman,

Further to our meeting on 15 January 1999, I wish to submit two separate but related nominations on behalf of the Sydney Fungal Studies Group for consideration by the Scientific Committee. Each nomination is submitted conjoint with my wife Mrs. Elma Kearney. Both myself and Elma are Co-ordinators (Chairpersons) of the Sydney Fungal Studies Group.

The first nomination is that of six endangered holotype species, including two formally documented whilst four remain provisional, pending publication of Dr. Young's manuscript already accepted by 'Austrobaileya'.

The second nomination is that of an endangered community of 20 or so species within this same family of Hygrophoraceae. Such extraordinary numbers of species of the one family in one small area ranks the Lane Cove Bushland Park of National significance on Rald's Classification of Conservation.

We would be most happy to provide the Scientific Committee with a half-hour slide overview of the subject species and of their locations as well as any other data to assist the members of the Committee to make its determination.

The Committee is advised that we (as nominees) have no objection to the release of personal details or affiliations recorded in both documents.

We thank you for your kind consideration of these applications.

Yours sincerely,

Ray Kearney E. Kearney

Dr. Ray Kearney Elma Kearney

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Fig. 5. Cover note of the application

In January 1999, two applications (Fig. 5) were submitted by Ray & Elma Kearney, on behalf of the SFSGI, to the Scientific Committee established under the NSW Threatened Species Conservation Act, 1995.

A Final Determination of the Scientific Committee to list the *Hygrocybeae* Community of LCBP as an endangered ecological community

The first application, in pursuance of Division 3 of Part 2 of Schedule 1of that Act sought a determination to list the *Hygrocybeae* Community of LCBP as an Endangered Ecological Community. The species in the community were listed as formally identified and classified by Tony Young (1999), together with additions arising from the classification of further specimens sent to him. The Final Determination as legislated on 3 March, 2000 is reproduced as follows:

NSW SCIENTIFIC COMMITTEE

Final Determination

The Scientific Committee established by the Threatened Species Conservation Act, has made a Final Determination to list the *Hygrocybeae* Community of Lane Cove Bushland Park as an Endangered Ecological Community under Part 3 of Schedule 1 of the Act. Listing is provided for under Part 2 of the Act.

The Scientific Committee has found that:

1. The *Hygrocybeae* Community of Lane Cove Bushland Park is an assemblage of more than 20 species of fungi in the family *Hygrophoraceae* (*Fungi*, *Basidiomycota*, *Agaricales*, *Hygrophoraceae*).
2. The Community is restricted to a core zone along the Gore Creek catchment in the Lane Cove Local Government Area in Sydney. The majority of species occur in the warm temperate gallery rainforest centred on the banks of the north-eastern arm of Gore Creek and its tributaries in Lane Cove Bushland Park. This core zone also extends to the wet sclerophyll catchment, north of the tributary junction with Gore Creek. A minority of the species in the assemblage is found in a buffer zone of dry sclerophyll between the perimeter of Lane Cove Bushland Park and outer edges of the gallery canopy and along Gore Creek in Osborne Park.
3. The following species have been recorded in the community

Camarophyllopsis kearneyi	*Hygrocybe anomala* var. *ianthinomarginata*
Hygrocybe astatogala	*Hygrocybe aurantiopallens*
Hygrocybe aurantipes	*Hygrocybe austropratensis*
Hygrocybe cantharellus	*Hygrocybe cheelii*
Hygrocybe chromolimonea	*Hygrocybe erythrocala*
Hygrocybe graminicolor	*Hygrocybe helicoides*
Hygrocybe involutus	*Hygrocybe irrigata*
Hygrocybe kula	*Hygrocybe lanecovensis*
Hygrocybe lewellinae	*Hygrocybe mavis*
Hygrocybe miniata	*Hygrocybe reesiae*
Hygrocybe sanguinocrenulata	*Hygrocybe stevensoniae*
Hygrocybe taekeri	*Hygrocybe virginea*

   Other species in the Community have been collected but remain undescribed and unclassified, and other *Hygrocybeae* may be present.
4. Lane Cove Bushland Park is the holotype site [*i.e. collection locality of the type specimens*] for *Hygrocybe aurantipes*, *Hygrocybe austropratensis*, *Hygrocybe lanecovensis*, *Hygrocybe anomala* var. *ianthinomarginata*, *Camarophyllopsis kearneyi* and *Hygrocybe reesiae*. [Young, A.M., 1999, The *Hygrocybeae* (*Fungi*, *Basidiomycota*, *Agaricales*, *Hygrophoraceae*) of the Lane Cove Bushland Park, New South Wales. *Austrobaileya* **5**: 535-564].
5. The assemblage is not known to occur outside the Lane Cove Local Government Area. Furthermore, the number of species of *Hygrocybe* is very high compared with other known sites in Australia and overseas. Species will not have above-ground fruiting bodies at all times of the year. There may be differences depending on seasonal conditions and other factors.
6. Within Lane Cove Bushland Park, different species of *Hygrocybeae* have been reported from one to several specific locations. More species occur at the southern than at the northern end of the Park. The ecological requirements of most species are poorly known, but are likely to be associated with a dense tree canopy and sandstone rocks.

7. The Community is threatened by water-borne pollutants. Industrial pollutants occur particularly in the upper reaches of Gore Creek catchment and domestic contaminants arise from residential properties on the perimeter of Lane Cove Bushland Park. The Community is also at risk from encroachment by exotic weeds, dumping of rubbish and garden refuse, excess pedestrian traffic in areas sensitive to erosion, and inappropriate bush regeneration measures that disturb the forest canopy and native understorey plants.
8. In view of the small area occupied by the Community and the threats to its integrity identified in 7 above, the Scientific Committee is of the opinion that the community is likely to become extinct in New South Wales unless the circumstances threatening its survival cease to operate.

Dr Chris Dickman
Chairperson
Scientific Committee

Subsequent to this preliminary listing the following three species have also been added to the numbers of species in this assemblage:

Hygrocybe collucera (Young *et al*., 2001)
Hygrocybe griseoramosa (Young *et al*., 2001)
Hygrocybe rubronivea (Young, 2005)

Elma and Ray with a poster illustrating species listed as endangered or vulnerable

Application for a Determination to list Rare Native Species of *Hygrocybeae* (*Fungi*, *Basidiomycota*, *Agaricales*, *Hygrophoraceae*) of LCBP, under the Threatened Species Conservation Act, 1995.

The second and subsequent applications to the Scientific Committee sought to nominate the nine species described from LCBP collections of *Hygrocybeae* as Rare Native Species within the meaning of Schedule I (endangered), Part I of the Threatened Species Conservation Act, 1995. The nominees believed that these species would be eligible for listing as endangered or vulnerable species within the meaning of Section 10 and Section 14 and all of their subsections, as well as Section 28 and all of the subsections of the Threatened Species Conservation Act, 1995. The relevant species and their Final Determinations are:
Hygrocybe anomala var. *ianthinomarginata* - Vulnerable
Hygrocybe aurantipes - Vulnerable
Hygrocybe austropratensis - Endangered
Hygrocybe collucera - Endangered
Hygrocybe griseoramosa - Endangered
Hygrocybe lanecovensis - Endangered
Hygrocybe reesiae - Vulnerable
Hygrocybe rubronivea - Vulnerable
Camarophyllopsis kearneyi - Endangered

Nomination of Lane Cove Bushland Park for Listing on the Register of the National Estate, under the Australian Heritage Commission Act, 1975.

The initiative to prepare an Application, on behalf of the SFSGI, for Lane Cove Council, (the owner and manager of LCBP) to submit to the Heritage Commission was based upon the conservation value ranked, according to Rald's system, of national significance. Thus, on the basis of the total number of species of *Hygrocybe*, known officially to exceed 27, LCBP would easily be ranked in Europe as of heritage value.

The Australian National Estate which now has more than 11,000 entries is made up of cultural and natural heritage places which have special value. Compiled by the Australian Heritage Commission, the Register includes national estate places defined in the Australian Heritage Commission Act, 1975 as: 'those places, being components of the natural environment of Australia, or the cultural environment of Australia, that have aesthetic, historic, scientific or social significance or other special value for future generations, as well as for the present community' Section 4(1).

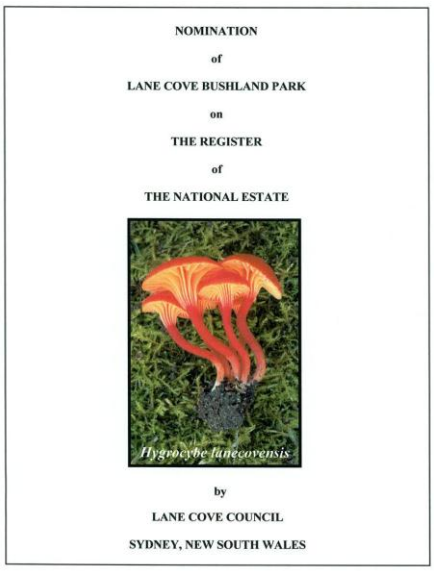


Fig. 7. Front cover of the application

Entry to the Register alerts planners, decision makers, business interests, researchers and the community at large to the existence and location of National Estate places and to their heritage value. The Commission does not manage places on the Register. That is the responsibility of Commonwealth, State and Local Government bodies. Being listed on the Register simply means it has been identified as a place worth keeping for the benefit of future generations. Each

place is examined on the basis solely of National Estate value measured against specific criteria.

The Commonwealth Government has particular obligations under the Australian Heritage Commission Act, 1975 for places entered in the Register of the National Estate. For example, under Section 9 (2) and Section 30, Commonwealth Government can assist the Commission in providing funds to other bodies to undertake programs of research to protect places in the Register of the National Estate. Commonwealth Government funding is available for the conservation of places listed on the Register through the National Estate Grant Program, the Commonwealth's major heritage funding program, which is co-ordinated by the Australian Heritage Commission. Grants may be awarded to non-profit bodies such as community, professional, academic, State and Local Government bodies.

In preparing the application, Ray and Elma Kearney, on behalf of the SFSGI, assisted Lane Cove Council in its nomination. The following criteria, used by the Commission for assessment of nominations, were identified as being relevant.

Criterion A: Its importance in the course or pattern of Australia's natural or cultural history

CATEGORY: A1 – IMPORTANCE IN EVOLUTION OF AUSTRALIAN FLORA (FUNGI)

- Introduction
- Birth of Australia
- Lane Cove Bushland Park – and its Ecotome
- Importance of Lane Cove Bushland Park in the Evolution of Australian Fungi
- Significance of genetic diversity in Lane Cove Bushland Park e.g., Figs. 8 & 9.
- Extent of diversity among species of *Hygrocybeae*
- Factors that contribute to the genetic diversity of fungal species of *Hygrophoraceae* in Lane Cove Bushland Park
  - a Mode of reproduction
  - b Diversity among fungi species per unit area in Lane Cove Bushland Park
  - c Fungal species with homologous and/or analagous structures in Lane Cove Bushland Park
  - d Types of natural selection among species of fungi in Lane Cove Bushland Park
  - e Patterns of evolution in fungal species in Lane Cove Bushland Park
    - Divergent evolution
    - Convergent evolution

Fig. 8 Diverse species, all of which have white spores

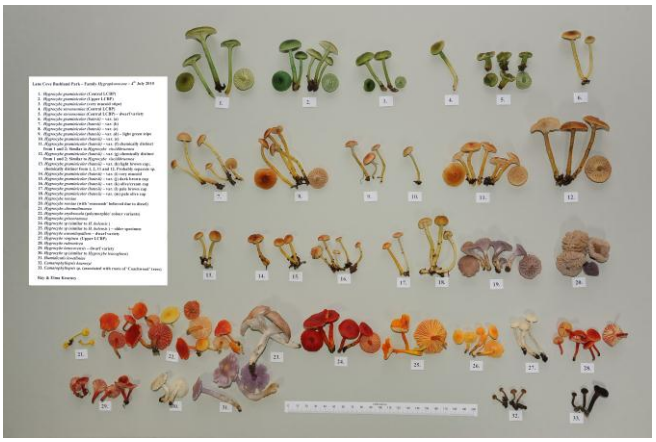


Fig. 9 A sample collection illustrating polymorphism and variants among the species in LCBP's *Hygrophoraceae*

f Population dynamics and life-history of fungal species in Lane Cove Bushland Park
g Interactions in the fungal communities of Lane Cove Bushland Park competition, predation and symbiosis

CATEGORY: A2 – IMPORTANCE IN MAINTAINING EXISTING PROCESSES OR NATURAL SYSTEMS IN LANE COVE BUSHLAND PARK

- Introduction
- Species variation, gene pools and environmental factors. See Fig. 10.
- Natural systems and processes that contribute to the unique ecosystems in the Lane Cove Bushland Park
- Topography and a north-south aspect (Fig. 1)
- Key factors for sustained development in Lane Cove Bushland Park
- Examples of different natural processes quite unique to Lane Cove Bushland Park (Figs. 11- 14)

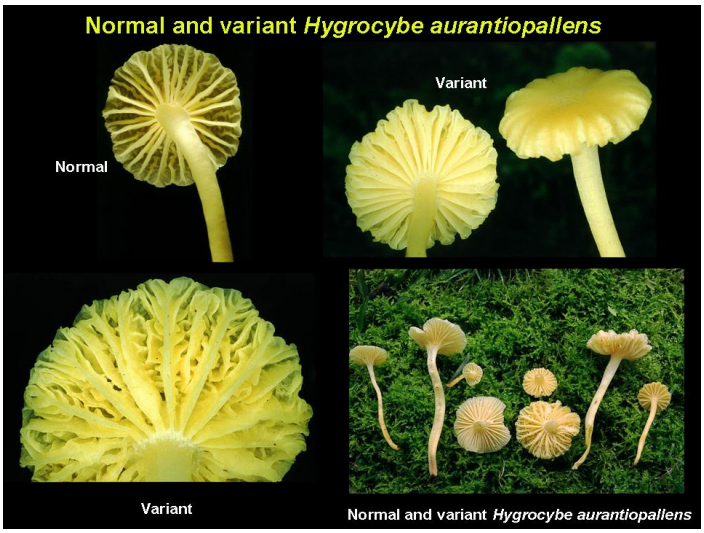
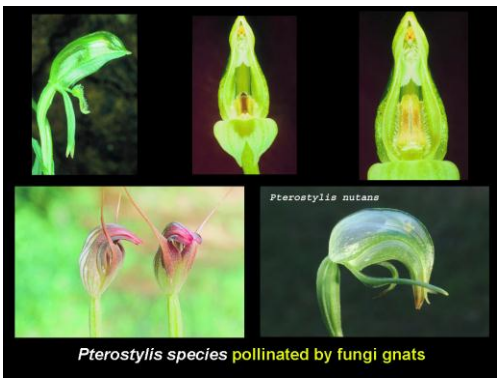
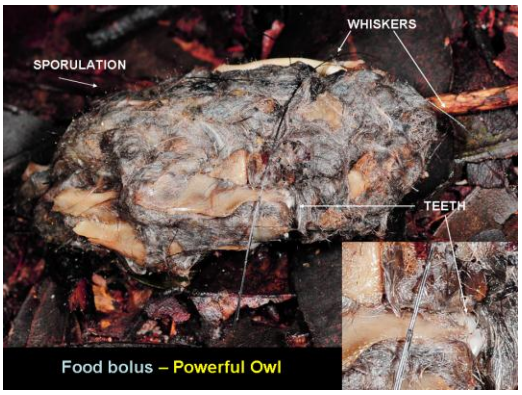


Fig. 10. Normal and abnormal basidiomata

Fig. 11. Fungi-gnat eggs laid in hymenium

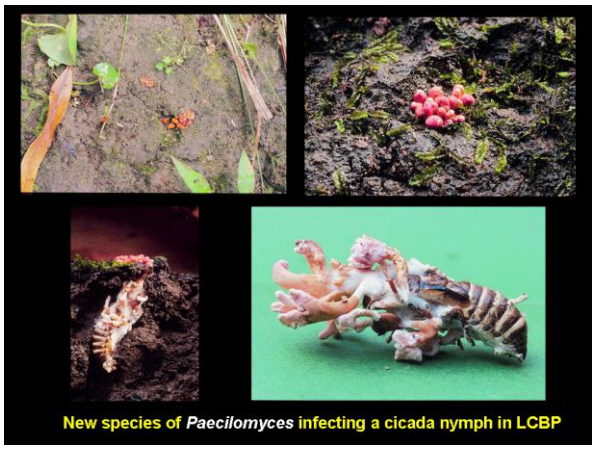


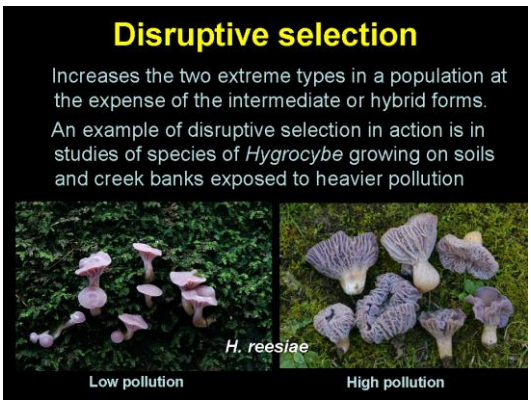
Orchids pollinated by fungi-gnats in LCBP

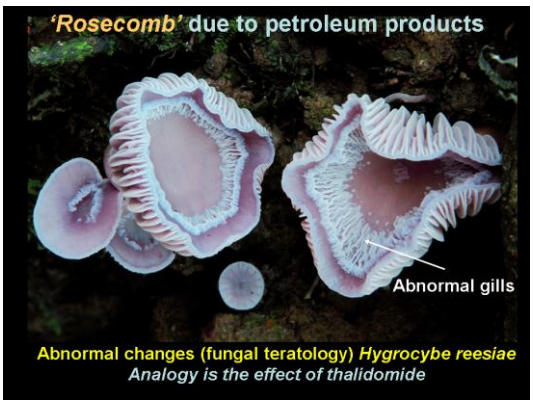


Figs 13, 14. Top predator in LCBP preys on e.g., ring-tail possums. (250-350 p.a.) Devours head whole. Bolus regurgitated to be colonised by microbes and fungi that recycle organic material.

- Lane Cove Bushland Park – a site for other unique fungi
- Lane Cove Bushland Park – a refugium
- Key threats to sustainable biodiversity in Lane Cove Bushland Park include:
  - a Effects of human population
  - b Condition of the ecosystem
  - c Distribution and abundance of fungal species
  - d Changes in genetic diversity
  - e Land clearance and related activities
  - f Impacts of introduced species
  - g Bushwalking and other human activities
  - h Lack of knowledge of biodiversity
  - i Effectiveness of conservation measures
  - j Adequacy of protected areas
  - k Adoption of integrated ecosystem-based management of Lane Cove Bushland Park
- The criteria for National Environmental indicators (NEI) apply to species of Hygrocybe in Lane Cove Bushland Park
  - a NEI should serve as a robust indicator of environmental change (Figs. 16 & 17)







  - b NEI should be sensitive to environmental change
  - c NEI should reflect a fundamental or highly valued aspect of the environment
  - d NEI should be either national in scope or applicable to regional environmental issues of national significance
  - e NEI should provide an early warning of potential problems
  - f NEI should be capable of being monitored to provide statistically verifiable and reproducible data that show trends over time and preferably, apply to a broad range of environmental regions
  - g NEI should be scientifically credible
  - h NEI should be easy to understand
  - i NEI should be monitored regularly with relative ease
  - j NEI indicator should be cost-effective
  - k NEI should be as aggregative as possible (ie amenable to combination with other indicators to produce more general information about environmental conditions)
  - l NEI should have relevance to policy and management needs

m NEI should contribute to monitoring progress towards implementing commitments in nationally significant environmental policies
n NEI should where possible and appropriate, facilitate community involvement

- A study of natural selection and genetic variation by DNA sequencing

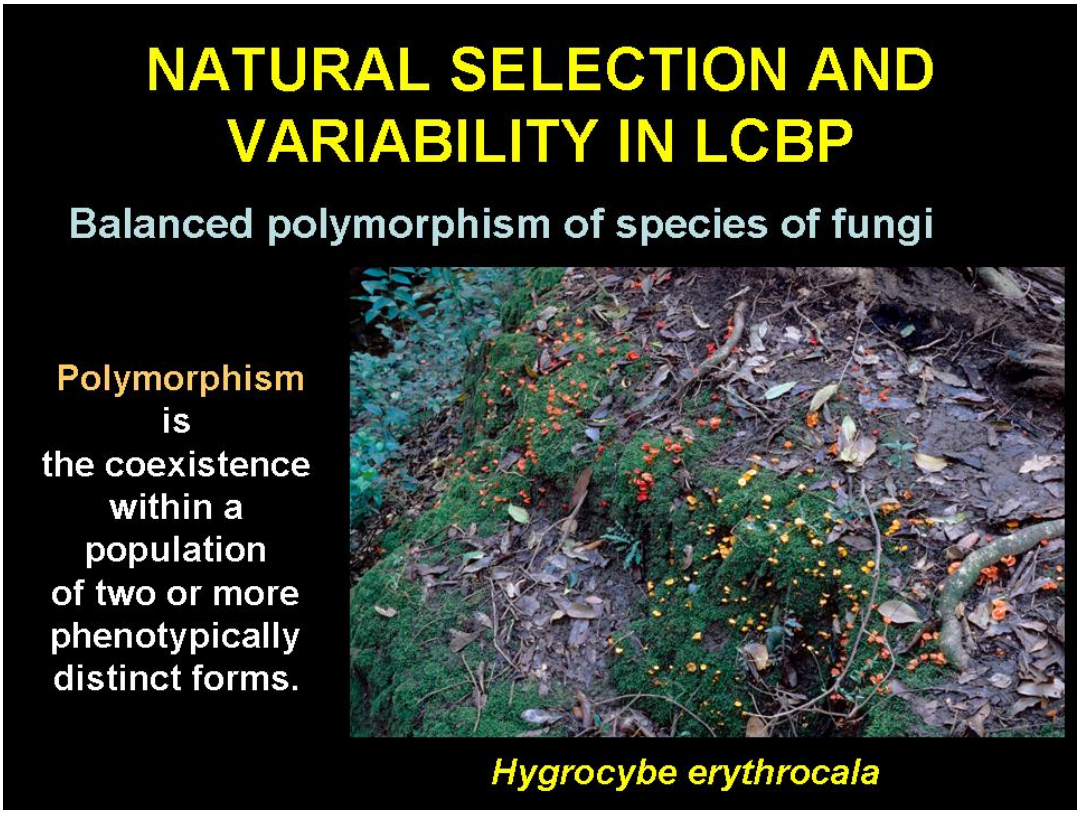
CATEGORY: A3 – IMPORTANCE OF EXHIBITING UNUSUAL RICHNESS OR DIVERSITY OF FLORA (FUNGI) AND LANDSCAPES IN LANE COVE BUSHLAND PARK

Criterion B: Its possession of uncommon, rare or endangered aspects of Australia's natural or cultural history

CATEGORY: B1 – IMPORTANCE FOR RARE, ENDANGERED OR UNCOMMON SPECIES (FUNGI), COMMUNITIES, ECOSYSTEMS AND NATURAL LANDSCAPES

CATEGORY: B2 – PRESERVATION AND PROMOTION OF VARIABILITY AMONG SPECIES OF *HYGROCYBE* IN LANE COVE BUSHLAND PARK

- Natural selection and variability in Lane Cove Bushland Park
  a Balanced polymorphism of species of fungi (Fig. 18)
  b Geographic variation in Lane Cove Bushland Park: clines and ecotypes
  c Frequency-dependent selection of species of fungi in Lane Cove Bushland Park



Criterion C: Its importance to yield information that will contribute to an understanding of Australia's natural or cultural history

CATEGORY: C1 – IMPORTANCE FOR INFORMATION CONTRIBUTING TO WIDER UNDERSTANDING OF AUSTRALIAN NATURAL HISTORY – RESEARCH SITE, TEACHNG SITE, TYPE LOCALITY OR BENCH-MARK SITE

Criterion D: Its importance in demonstrating the principal characteristics of:

(i) A class of Australia's natural or cultural places; or

(ii) A class of Australia's natural or cultural environments

CATEGORY: D1 – IMPORTANCE IN DEMONSTRATING THE PRINCIPAL CHARACTERISTICS OF THE RANGE OF LANDSCAPES, ENVIRONMENTS, ECOSYSTEMS, THE ATTRIBUTES OF WHICH IDENTIFY IT AS BEING CHARACTERISTIC
OF ITS CLASS.

Criterion E: Its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group

CATEGORY: E1 – IMPORTANCE FOR A COMMUNITY FOR AESTHETIC CHARACTERISTICS HELD IN HIGH ESTEEM OR OTHERWISE VALUED BY THE COMMUNITY

- To save the endangered and threatened community of fungi in Lane Cove Bushland Park
- Gaps in our knowledge

Fig.19. Bookmarks for educational purposes

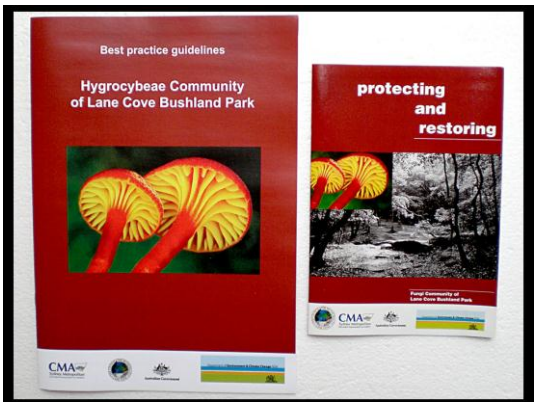


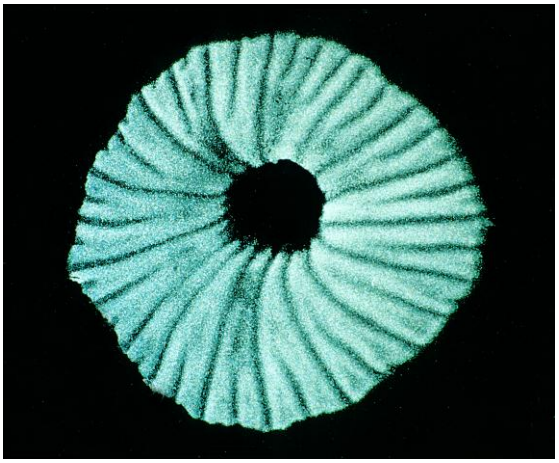
Fig. 20. Booklets for bush regenerators

The nomination, received early in 2000, by the Heritage Commission was enthusiastically entered on a temporary or Interim List in March 2000. In June, i.e., at the end of three months of the publication of the statutory notice, a recommendation in the Commission's final decision was made on the National Estate significance. Final approval for entry in the Register was made during the Commission's formal meetings and the process of incorporating the entry into Commonwealth Legislation was completed in October 2000.

Whilst the mycological component of the application was its major section, the Lane Cove Council, in its nomination included certain botanical and zoological features unique to Lane Cove Bushland Park. Since these listings an additional eight species have been identified as new or unclassified. Rald's classification for conservation has been up-graded (Rald, 1985; Vesterholt *et al*. 1999). A collection of greater than 22 species of *Hygrophoraceae* in one location ranks the site of International Significance. LCBP clearly fulfills this ranking with at least 35 species.

Conservation Importance of Waxcap sites. (Rald (1985), Vesterholt et al. 1999)

Conservation value	Total Hygrocybe taxa	Number seen in single visit
International importance	22+	15+
National Importance	17-21	11-14
Regional Importance	9-16	6-10
Local Importance	4-8	3-5
No Importance	1-3	1-2



In Europe, waxcaps are found in a variety of nutrient-poor grasslands which are either grazed or mown. In North America they occur in woodlands. However, in LCBP, they occur in a range of habitats e.g., soil, leaf mulch and moss in a warm-temperate wet sclerophyll forest. Most of our knowledge comes from the recording of the fruiting bodies (basidiomata), which appear mostly in autumn and winter, peaking late June to mid-July in the LCBP. The majority of the fungal organism is the underground mycelium, which is difficult to study. Unlike some mushrooms, waxcaps do not grow on dead wood. All the species of waxcaps from LCBP produce white spores (Fig.21) despite the colour of the fruiting structure. How long the mycelium lives or takes to develop before fruiting or what triggers fruiting is unknown. Some of the rare species may not be rare but simply fruit more rarely as DNA analysis suggests there is a poor correlation between fruiting bodies and the mycelia. Thus species whose fruit bodies are only very sparsely recorded can be widespread below ground. Neither controlled back-burns nor bushfires appears to affect fruiting of waxcaps as do consecutive droughts.

Threats

In Australia, there have been no formal studies of the nature of 'threats' on species of waxcaps found here. Overseas, the presence of waxcaps in grassland is a marker for low air/soil pollution. The greatest overseas documented threats are:

1. Loss of semi-improved grassland through development
2. Seeding and application of chemical fertilisers or pesticides as well as ploughing
3. Abandonment leading to colonisation by weeds and scrub

Overseas, the conservation of waxcap grassland is dependent on maintaining the low nutrient status of the grassland. Inputs of fertilisers such as nitrogen reduce the species richness of grassland fungi. It is noteworthy that LCBP was formerly 'Kelly's Flat' where cattle grazing on grassland was its former use and may have been critical in establishing the conditions for its current waxcap assemblage.

A suggestion is that *Hygrocybe* spp. originally evolved in grassy woodland glades and that historic deforestation (in Britain and Europe) and agriculture has in effect expanded the

habitat of these fungi. If this is true, then the assemblage in LCBP assumes even greater importance i.e., the assemblage is consistent with a more 'primitive' woodland glade adaptation rather than that of grassland – and largely predates the widespread use of inorganic fertilizers, pesticides and other chemicals. The effect of inorganic fertilizers on fruit-body production is known to be immediate. An application of ammonium nitrate fertilizer will cause a 4-fold reduction in fruit-body production. Lime or calcium carbonate inhibits the fruiting development of waxcaps. In the LCBP, sewage contamination of the creek will lead to high nutrients and chemical contaminants are positively detrimental.

In the UK, another consistent feature of habitats where waxcaps occur is the presence of moss cover. Recent overseas data indicate the waxcaps are humic saprotrophs where nitrogen-enrichment is a growth inhibitor. This suggests that their optimum survival in nitrogen-poor soil is met by having biochemical mechanisms that allow them to access nitrogen from organic humus. Any addition of nitrogen then is toxic that may favour a shift in balance between the soil bacteria and fungal mycelium.

Waxcaps do not like being enshrouded with tall grass or weed vegetation. Overseas reports indicate that the type of grazing animal (rabbit/sheep/cow) is not a factor in waxcap diversity. However, creatures that burrow and disturb the soil are damaging such as ants. Another factor found to be damaging is trampling by inhibiting the fruiting, by up to 50%.When considering restoration of habitat, we simply do not know whether re-colonisation involves incoming airborne spores or re-growth from residual patches of mycelium. Our attempts to 'transplant' waxcaps either by fruiting structures or by spores have uniformly failed. To date, there is no report of a mycorrhizal association between waxcaps and vascular plants.

Abnormal changes in a waxcap

Over the past few years, we have recorded for the first time abnormal changes in different species of waxcaps found in the LCBP. (Figs. 16 &17, p. 14, rosecomb in *H. reesiae*). One of these abnormalities is 'rosecomb' which refers to the distortions, lumps and gross malformations that occur on mushrooms (not necessary). Records of rosecomb were reported in 1881. Often gills are present on the top leading to the name rosecomb. In 1930 Lambert found rosecomb could be induced by such materials as kerosene, creosote and diesel oil. In 1983, rosecomb was confirmed for a cultivated mushroom to be due to contamination of the substrate with oil, diesel or distillate fumes.

Probable mechanism of rosecomb

Development of mushrooms is driven by genetic and epigenetic factors in a continuous interaction with the environment. Each successive stage of morphogenesis depends on specific sets of signals during the growth process. Endogenous genetic disturbances and exogenous factors can cause developmental errors. Rosecomb in *H. reesiae* is probably not a genetic mutation but rather genetic instability coupled with an exogenous factor such as diesel fumes to induce changes in morphogenesis. This morphogenic change appears to occur late in the development of the fruiting structure. In LCBP where rosecomb in *H. reesiae* has been recorded, the creek is heavily polluted, chemically and microbiologically.

Of vital important is that this conservation project has enlisted the support of Lane Cove Council and the local people, without whose active collaboration – and, wherever possible, participation – little of permanence would be achieved. Being active participants in these collective processes is only a beginning to give mycology a quality resonance.

Discussion

Each of these three initiatives, previously reported (Kearney & Kearney, 2000) was strengthened by the supporting scientific documentation and was accompanied by good quality photographs as well as site-location maps. Simply meeting a criterion does not in itself establish the significance of LCBP. It is the degree to it exhibits characteristics which are rare, influential within its type, endangered or threatened, particularly fine in exemplifying its type, particularly valuable for research, or which mark major stages for its type that the Heritage Commission and the Scientific Committee determined conferred significance. (Fig. 22)

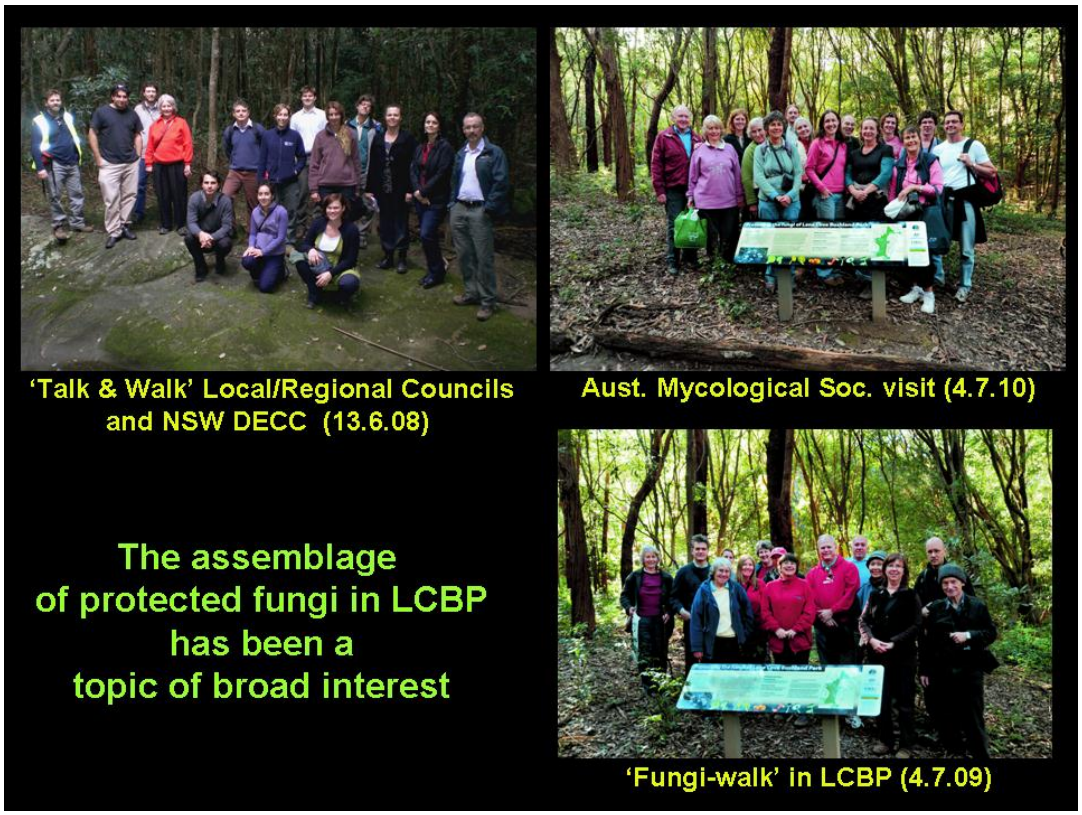


Fig. 22. "Talk and walk" events

The significance of these initiatives is that mycology has now been officially recognised for the first time, at all levels of government i.e., Commonwealth, State and Local as integral to conservation.

Scientists accept that extinction is an integral part of the process of natural selection. Species have a finite life span and, since life first appeared on this planet, fungi, plants and animals have evolved into different forms. The assemblage of fungi in Lane Cove Bushland Park is threatened and endangered. Some species are rare. Assemblages of species in different genera are likely to be documented for other sites throughout Australia and, in time, similarly listed.

The best way to safeguard the rare species is to ensure the conservation of the biotic community of which they are a part. Rarity is not of itself a cause for concern. Some species are inherently rare, often because they occupy a highly specialised ecological niche. But few species can survive outside their natural habitat.

Within this assemblage, in this secluded habitat, there are numerous variants that warrant analyses at the DNA level to determine common or disparate linkages. By using HPLC biochemical analyses, a collection of nine variants classified on the basis of macro features as *H. graminicolor* appear to represent three very distinct species.

Scattered remnants of a species can sometimes be brought together and concentrated in one part of the natural range to create a viable breeding nucleus and provide more efficient protection. Clearly, the aim for LCBP should be to forestall emergencies such as to translocate a species from its original habitat and establish it in an entirely new area. Rather, the solution is to accord LCBP effective protection. (Fig. 23)

Fig. 23. Interpretive sign at LCBP

In the knowledge that the Scientific Committee had made a Preliminary Determination, another precedent was about to be set. The Lane Cove Council successfully prosecuted not only the developer of a building site, but also the foreman who allegedly permitted spoil to wash from the building site into the tributary of Gore Creek. This landmark court case was influenced by a determination that a community of macrofungi was threatened and in danger of extinction by possible adverse impacts on their habitat.

A purpose of the application for LCBP to be registered on the National Estate was to give it the status of a sanctuary for these endangered fungal species in this unique community. Responsibility for ensuring that the LCBP on the heritage listing is adequate for the purpose of preservation of the fungal species rests squarely with Federal, State and Local governments and their relevant regulatory authorities. Over a decade since the listing of the community, a 'recovery plan' as required under the legislation has not yet been implemented by the Labor NSW State Government.

It is also vitally important that this conservation project, in setting this precedent, should enlist the support of the local people, without whose active collaboration – and, wherever possible, participation – little of permanence will be achieved.

As amateur mycologists, the authors are alarmed by the fact that environmental diseases are an outcome of a pervasive system of corporate priority setting, decision making, and influence with political and bureaucratic stakeholders. This 'structure of harm' is based on corporations compelled to maximize profitability and to prioritize wealth over human health and environmental well-being. What has become clear is the social and environmental costs have been externalized or shifted to taxpayers from the effects of pollution and environmental degradation threatening our life-support systems.

It is quite ironic in this so called 'age of science and materialism' that probably never before have ordinary individual men and women, including scientists, been confronted with so many moral and ethical problems. Scientists stress and seek objectivity whilst in the arts, by contrast, the emphasis is on subjectivity, i.e., experience through the individual conscious.

Science is thus limited to what is observable and measurable. Theories may be shattered, new names found and taxonomic adjustments changed – but the observations endure, and moreover, they are used over and over again. Because of this emphasis on objectivity, value judgements cannot be made in science in the way such judgements are made in religion, philosophy and the arts. Thus, whether or not something is good or beautiful or right in a moral sense, for example, cannot be determined by the scientific method. Most of the problems we now confront can be solved only by value judgements. Being active participants in these collective processes is only a beginning to give mycology a quality resonance.

Acknowledgements

We thank Dr A.M. Young for the opportunity to assist him in documenting the fungal species collected from LCBP. Without his taxonomic expertise, these applications would not have been successful. The members of the Sydney Fungal Studies Group Inc who assisted in field trips and Susan Butler: Bushland Manager, and staff of Lane Cove Council, to all of whom we are grateful.

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The Rio Convention and Fungi: a review of recent national biodiversity action plans and reports

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The Rio Convention and Fungi

As part of their commitments under the Rio Convention on Biological Diversity [CBD], countries which have ratified the convention prepare national biodiversity action plans and reports. These are prepared periodically, and most countries have published several. There are already more than one thousand, and they are openly available on the Internet [www.cbd.int/nbsap/search]. Fungi form a major part of the biodiversity of every country of the world, and it is the job of the *International Society for Fungal Conservation* [ISFC] to promote their protection. The action plans and reports therefore need to be scrutinized from a mycological perspective, to check that fungi are getting proper recognition as part of each nation's biodiversity, and that the conservation needs of fungi are being taken into account.

The present note lists those action plans and reports which were received by the CBD in 2011 up to the time of writing. Each document was evaluated from a mycological perspective. Part of this included assessment of the number of times fungi are mentioned in the document. Mention of fungi was defined as occurrence of any of the following words / part-words (in the language of the document): fungi, fungus, lichen, mushroom, mycete (e.g. as in "macromycete"), toadstool, truffle. To make evaluations rapidly understandable, a very simple system of star ratings (like those given to hotels by tourist agencies) was used, with a star awarded for a positive score in each of five features.

* Fungi mentioned.
* Fungi clearly, consistently and explicitly recognized as different from animals, micro-organisms and plants, and lichens recognized as fungi.
* Strategic consideration explicitly given to fungal conservation (example indicators: separate texts devoted to fungal conservation; lists of important fungus areas / fungal biodiversity hotspots; deficiencies in legal protection for fungi identified and plans present to rectify those deficiencies).
* Principal fungal habitats and roles taken into account (decomposers, dung fungi, endobionts, freshwater fungi, fungi on man-made products, fungi on naturally occurring inanimate substrata, lichen-forming fungi, marine fungi, mycorrhizal fungi, parasitic fungi).
* Knowledge gap for fungi recognized and plans present to address the problem.

Using this system, a score of five stars indicated that the document provided good coverage of fungi, with lower numbers of stars indicating shortcomings of various kinds. A further rating, "**coverage excellent**", was available only for five star documents. To achieve the "**coverage excellent**" rating, the document needed to contain: at least one separate section explicitly devoted to fungi; a list of important fungus areas / fungal biodiversity hotspots; a review of the country's legal protection for fungi (including plans to rectify any deficiencies); consideration of all of the following fungal habitats / roles present in the country: decomposers, dung fungi, endobionts, freshwater fungi, fungi on man-made products (agents of biodegradation and biodeterioration), fungi on naturally occurring inanimate substrata (peat, rock, soil etc.), lichen-forming fungi, marine fungi, mycorrhizal fungi, parasitic fungi (agents of animal diseases, fungicolous fungi, plant pathogens).

List of action plans and reports with evaluations

No stars

Bahrain. [The Fourth National Report to the Convention on Biological Diversity] [**URL**: www.cbd.int/doc/world/bh/bh-nr-04-ar.pdf]. **Language**. Arabic. **Date on report**. not noted. **Received by CBD**. 17 March 2011. **Notes**. Fungi not mentioned.

Guyana. *Guyana's Second National Report to the United Nations Convention on Biological Diversity* [**URL**: www.cbd.int/doc/world/gy/gy-nr-02-en.pdf]. **Language**. English. **Date on report**. 1999-2003. **Received by CBD**. 19 May 2011. **Notes**. Fungi not mentioned.

Islamic Republic of Iran. *Fourth National Report to the Convention on Biological Diversity* [URL: www.cbd.int/doc/world/ir/ir-nr-04-en.pdf]. **Language**. English. **Date on report**. October 2010. **Received by CBD**. 14 June 2011. **Notes**. Fungi not mentioned; fungicides mentioned once.

Palau. *Third National Report* [**URL**: www.cbd.int/doc/world/pw/pw-nr-03-en.pdf]. **Language**. English. **Date on report**. not noted. **Received by CBD**. 10 February 2011. **Notes**. Fungi not mentioned.

Solomon Islands. *Government of Solomon Islands Fourth National Report to the Convention on Biological Diversity* [URL: www.cbd.int/doc/world/sb/sb-nr-04-en.pdf]. **Language**. English. **Date on report**. 2011. **Received by CBD**. 25 July 2011. **Notes**. Fungi not mentioned.

Venezuela. *Cuarto Informe Nacional Convenio de Diversidad Biológica de la República Bolivariana de Venezuela* [**URL**: www.cbd.int/doc/world/ve/ve-nr-04-es.pdf]. **Language**. Spanish. **Date on report**. February 2011. **Received by CBD**. 8 April 2011. **Notes**. Fungi not mentioned.

Venezuela. *Estrategia Nacional para la Conservación de la Diversidad Biológica de la República Boliveriana de Venezuela* [**URL**: www.cbd.int/doc/world/ve/ve-nbsap-v2-es.pdf]. **Language**. Spanish. **Date on report**. August 2010. **Received by CBD**. 1 April 2011. **Notes**. Fungi not mentioned.

One star ★

Albania. *Fourth National Report to the United Nations Convention on Biological Diversity* [**URL**: www.cbd.int/doc/world/al/al-nr-04-en.pdf]. **Language**. English. **Date on report**. 31 March 2011. **Received by CBD**. 1 April 2011. **Notes**. Fungi mentioned 3 times, but status not clear (mentioned once in context of flora), lichen (mentioned 1 time); lichen-forming fungi treated as separate from fungi; no evidence of separate planning.

Australia. *Australia's Biodiversity Conservation Strategy 2010-2030* [**URL**: www.cbd.int/doc/world/au/au-nbsap-v2-en.pdf]. **Language**. English. **Date on report**. 2010. **Received by CBD**. 26 January 2011. **Notes**. Fungi mentioned once, only as caption of one illustration.

Belarus. *Strategy on conservation and sustainable utilization of biological diversity for 2011-2020* [**URL**: www.cbd.int/doc/world/by/by-nbsap-v2-en.pdf]. **Language**. English. **Date on report**. 11 November 2010. **Received by CBD**. 6 January 2011. **Notes**. Fungi not mentioned. Separate status of mushrooms (2 mentions) not explicit and lichens (1 mention) treated as "lower plants".

Cook Islands. *Cook Islands 4th National Report to the Convention on Biological Diversity* [**URL**: www.cbd.int/doc/world/ck/ck-nr-04-en.pdf]. **Language**. English. **Date on report**. 8 April 2011. **Received by CBD**. 14 April 2011. **Notes**. Fungi mentioned twice (as component of plant kingdom).

El Salvador. *Cuarto Informe al Convenio Sobre Diversidad Biológica El Salvador* [**URL**: www.cbd.int/doc/world/sv/sv-nr-04-es.pdf]. **Language**. Spanish. **Date on report**. not noted. **Received by CBD**. 30 March 2011. **Notes**. Fungi mentioned once; lichen mentioned twice; separate status of fungi not explicit (animal and plant diversity each got their own whole section); lichens treated separately from fungi and as part of plant kingdom.

France. *National Biodiversity Strategy 2011-2020* [URL: www.cbd.int/doc/world/fr/fr-nbsap-v2-en.pdf]. **Languages**. English, French. **Date on report**. not noted. **Received by CBD**. 20 May 2011. **Notes**. Fungi mentioned twice, but separate status of fungi not explicit.

Guyana. *Guyana's Third National Report to the United Nations Convention on Biological Diversity* [**URL**: www.cbd.int/doc/world/gy/gy-nr-03-en.pdf]. **Language**. English. **Date on report**. 2004-2006. **Received by CBD**. 19 May 2011. **Notes**. Fungi mentioned once, but separate status of fungi not explicit.

Slovenia. *Convention on Biological Diversity 4th National Report on implementation. Republic of Slovenia* [**URL**: www.cbd.int/doc/world/si/si-nr-04-en.pdf]. **Language**. English. **Date on report**. 2010. **Received by CBD**. 7 April 2011. **Notes**. Fungi mentioned 9 times plus mycete (mentioned once), with some indication of being taken into account in plans, but status not clear (mentioned more than once as part of plant kingdom, and once as microbial life).

Three stars ★★★

Bosnia and Herzegovina. *The Strategy of Bosnia and Herzegovina and Action Plan for Biodiversity and Landscape's Protection* (NBSAP BiH 2008-2015) [**URL**: www.cbd.int/doc/world/ba/ba-nbsap-01-en.pdf]. **Language**. English. **Date on report**. January 2008. **Received by CBD**. 15 April 2011. **Notes**. Fungi mentioned 37 times plus lichen (mentioned 13 times), mushroom (mentioned 3 times), mycete (mentioned 3 times), truffle (mentioned once); lichen-forming species recognized as fungi and well-integrated; fungi recognized as separate from animals and plants; clearly taken into account in planning; some recognition of different fungal categories present, but incomplete.

Four stars ★★★★

Serbia. *Biodiversity Strategy of the Republic of Serbia for the Period 2011-2018* [**URL**: www.cbd.int/doc/world/cs/cs-nbsap-01-en.pdf]. **Language**. English. **Date on report**. 2011. **Received by CBD**. 16 March 2011. **Notes**. Fungi mentioned 17 times plus mycete (mentioned once), clearly recognized as separate from animals and plants, and lichens (mentioned 8 times) explicitly recognized as fungi; mushrooms (mentioned 4 times) considered as part of policy on foraging; truffles (mentioned once) considered as part of forest resources; some attention given to separate fungal categories; some attention given to dealing with knowledge gaps in fungi; fungi present on logo.

Commentary

This star rating system is clearly a rather blunt tool. It makes no effort, for example, to evaluate coverage of chromistan and protozoan fungal analogues, nor does it indicate whether proposed actions for fungi are good: it simply notes whether or not they exist. The review is, nevertheless, very revealing. From a mycological perspective, there is room for improvement in every report, but the situation is not hopeless. Although no document was awarded five stars, the review shows that action plans and reports which properly recognize fungi can be and are being made. Serbia's report was the best among those reviewed, with four stars, and the report

of Bosnia and Herzegovina received three stars. All of the other action plans and reports, however, were either very poor in respect of fungi, or did not cover fungi at all.

This review has only looked at those action plans and reports which were submitted in 2011. There are many earlier reports from many other countries available from the same website. Members of the ISFC are encouraged to visit that website, and study the action plans and reports of their own and other countries. In the cases of action plans and reports which do not mention fungi, or where coverage is poor, Members may wish to encourage and help those responsible for the documents to introduce or improve the mycological aspects. To do that, it is necessary to establish a dialogue. A good place to start is the National CBD Focal Point Contact for the country. A list of names, addresses and e-mail addresses of those national focal point contacts can be found on the Internet [www.cbd.int/countries/contacts.shtml].

Suggestions for improving the simple star rating system used here would be appreciated, as would evaluations of other national action plans and reports from a mycological perspective using the same criteria. If this type of review is found to be useful, similar reviews of future action plans and reports could be made in later issues of this newsletter and, if appropriate, a fuller record could be maintained on the ISFC website. Monitoring the star ratings for individual countries could be used to show whether or not change (and hopefully improvement) is occurring in coverage of the fungi.

First Actions for a Venezuelan Lichen Red List

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Until now, no country in Latin America has included fungi and lichenized fungi in their red lists. Efforts in fungal conservation and first attempts to establish red lists have been made in Argentina, Colombia and Cuba (Aguirre & Rangel 2007). The conservation of lichens is strongly linked to the threats upon the existing vegetation where they exist. Unfortunately, in Venezuela many natural habitats have been subject to fragmentation processes and general destruction by man. Even though lichens have been known to exist in the most extreme habitats, not all have the same resistance and capabilities to survive in any environment. Deforestation is the main factor in the destruction of extensive natural areas with a great variety of habitats for lichens. Tropical forests are continually invaded for urban expansion and agriculture uses (Hallingbäck & Hodgetts, 1996). In Venezuela the fragmentation and destruction of ecosystems has reached concerning levels and in some cases has reached a point of no return to the original conditions (Rodriguez *et al*., 2010). The destruction of habitats leads to fragmentation of the area of distribution which affects reproduction, thereby decreasing the capacity of perpetuation of the species in lichens and other groups (Rangel 2000).

Since 2008, with the sponsorship of IEA-PROVITA (Initiative for Endangered Species in Venezuela), work on a preliminary red list of lichens was started (Hernández, 2009). To be able to know what is endangered or not you first have to know what exists. Little is known of the lichen collections in Venezuela besides Vareschi's catalog in the 70s (Vareschi, 1973), Lopez Figueiras' catalogue of his Andean collections (Lopez Figueiras, 1986), Marcano´s Checklist from the Andes (Marcano *et al.*, 1996) and Feuer´s Venezuelan checklist (Feuer, 2008). This might sound like a lot, but many regions and collections have been left out from these publications. The project had in its objectives to carry out an inventory of all the existing fungal reference collections in Venezuela plus what could be compiled from fungal reference collections outside the country. All this information was to be compiled in a single database.

In 2010 the project was adopted by the "*Libro Rojo de la Flora Venezolana*", a revision of the first edition published in 2003 (Llamozas *et al*., 2003). The second edition included the previously excluded groups of Algae, Fungi and Bryophytes. The objective of the project is for this preliminary list to serve as a basis for future projects in which a list with broader criteria can be made, i.e. including more species.

17 reference collections in Venezuela include lichens. 80% of all these collections have been introduced in a database for this project called the Venezuelan Lichen Database. Information from six foreign reference collections was also included. The Venezuelan Lichen Database has 33 fields and includes information relating to the specimen (collector, collection dates, determination, locality, duplicates, etc.), taxonomy (family, species, etc.) and ecology (habitat, substrate, bioregion, etc.). The two reference collections with most holdings are **VEN**, the Venezuelan National Herbarium in Caracas (14010 specimens) and **MERF**, the collection at the Pharmacy Faculty at Universidad de los Andes in Mérida (32241 specimens). The database has nearly 50 thousand entries without including duplicates.

Using the ecological data from this database and the existing information from catalogues and checklists from Venezuela an endemic species list has been started, plus a preliminary red list for lichens (Hernández, 2009). Threats to natural populations of lichens from Venezuela were measured on the basis of particulars of geographical distribution, habitat quality, and especially the risks of land transformation and habitat destruction in natural regions of Venezuela (Rodriguez *et al.* 2010). In the process of assigning a degree of threat the

methodological approach from IUCN was followed, which included the categories: Critically endangered (CR), Endangered (EN), and Vulnerable (VU) and near threatened (NT). (IUCN Species Survival Commission, 2001).

Of the 1360 species in the Venezuelan Lichen Database, 546 were selected for more in-depth study. The endemic list is expected to include between 75 and 100 species.

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The caterpillar fungus, a flagship species for conservation of fungi

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Ophiocordyceps sinensis in montane grassland, Jigme Dorji National Park, Bhutan

Flagship species, as defined by *Fauna and Flora International* (see also e.g. Dietz et al. 1994; Caro & O'Doherty, 1999), are high profile and charismatic species that may play a significant ecological role and often have important cultural associations. Flagship species act as symbols for the threats to the broader ecosystem in which they occur, and can thus provide a catalyst for wide-ranging conservation activities. The caterpillar fungus *Ophiocordyceps sinensis* (often referred to as "Cordyceps" or yartsa gunbu) is one of a select group of fungal species for which there is global concern for conservation and sustainable harvest (Cannon et al. 2009; Negi et al. 2006; Sharma 2004; Winkler 2008), and it clearly qualifies for flagship status. It is advantageous to think of *O. sinensis* in this way for two reasons. Firstly, it emphasizes its importance to non-specialists and provides an easily understood message for the lay community. Secondly, conservation activities in support of this species can act as a framework for others and a stimulatory mechanism to bring fungi into the mainstream of conservation decision-making.

Fungi have historically been ignored by many conservation management specialists, yet play critical roles in ecosystem function (Dahlberg 2001; Dix & Webster 1995; Schulze &

Mooney 1994) and have high demonstrable value to the human race. There are many reasons for this neglect of an entire kingdom of organisms, including their often ephemeral appearance, their extreme diversity at species level, and the desire of many conservation practitioners to reflect public demand when setting priorities. We therefore face considerable challenges in our attempts to gain equivalent status for fungi with even remotely charismatic megafauna. In this context, it is unrealistic to expect funding in the short term of conservation assessments and global management plans for all 100000 described species of fungi, let alone the estimated 1.4 million undescribed taxa (Hawksworth 1991; Müller & Schmit 2007). It is also inappropriate to expect national and regional conservation agencies to develop and implement legislation for the protection of any particular species without a robust scientific case. It is however entirely reasonable to ensure that flagship species of fungi are given requisite conservation support to ensure their survival.

So, what do we need to do to establish the caterpillar fungus as a generally accepted flagship species, with all the associated protection benefits that this status can bring? Action is required in a number of areas.

1. We need to understand the taxonomy better. A number of morphological variants has been assigned species rank in the past twenty or so years (e.g. Zang & Kinjo, 1998; Liu et al. 2002), and there is increasing evidence of genetic diversity over its host range (Liang et al. 2008). Are these real species with independent evolutionary history and distinct distributions, ecological requirements, phamaceutical qualities and potentially also conservation concern? Or are they minor variants, the result of local environmental effects? Further molecular research is also needed, to establish robust phylogenetic species concepts. It is clear that not all the material sequenced that has been identified as *Ophiocordyceps sinensis* actually belongs to that species (Stensrud et al. 2007), and many reports of its culture must be erroneous (Jiang & Yao 2002). This has major implications for establishing the authenticity of Oriental *materia medica*, and even more so for the many derivative preparations that are marketed in both East and West.
2. We also need to understand the taxonomy of the host caterpillars better. There are nearly 50 species of *Thitarodes* currently recognized, almost all of which occur within Cordyceps harvest regions and are potential host organisms (Nielsen et al. 2000). The current poor state of knowledge is emphasized by the fact that neither of the two species of *Thitarodes* implicated as hosts in preliminary research in Bhutan had previously been described (Maczey et al. 2010). There is also very little robust data (at least published data) that link the caterpillar and imago stages of the life cycle; molecular methods hold great promise in this area.
3. Host-parasite relations and population biology are also poorly understood. Can individual *O. sinensis* genets infect multiple species of *Thitarodes*? There is some evidence now of evolutionarily distinct populations (or are they species?) in different parts of the overall geographical range (Chen et al. 2002; Liang et al. 2008). Particularly in the southern part of its range where there are physical barriers between populations, it might be expected that fungi and insects develop as independent host-parasite units. For any species, it is advisable to preserve as large a proportion of the gene pool as is possible, especially in our era of global environmental change.
4. It is important to learn more about interactions with the wider ecosystem of fungus and insect, individually and collectively. Evidence to date suggests that *Thitarodes* species are non-specific root feeders (Cannon et al. 2009), but there is little reliable evidence to back up this assertion. The impact of this herbivory on plant productivity is unknown (as is the mediatory impact of parasitism by the fungus). This is relevant for all sorts of reasons, including the availability of grazing land and the ability of Cordyceps grasslands to resist desertification. It doesn't even seem to be clear whether

O. sinensis production is stimulated or reduced by grazing, whether by yaks or wild mammals. Conservation policy increasingly (and rightly) focuses on ecosystem-level actions, so we need a holistic approach to understanding our flagship species.

5. Interactions with one particular species – *Homo sapiens* – cannot be ignored. On the one hand, we represent by far the greatest threat to survival of Cordyceps, both directly by unsustainable harvest and indirectly through habitat loss, climate change etc. On the other hand, the very value placed on the product is a powerful incentive to ensure its continuing availability. There is great interest in solving this problem through alternative sources of supply, either through farming or industrial culture. Little information on such approaches is in the public domain, but so far neither has had a noticeable impact on prices of wild-provenanced material. The importance placed by traditional medicine practitioners on Cordyceps as a dual organism, the premiums generally available for "natural" or "organic" products, and the rise of Cordyceps possession as a status symbol in some societies all indicate that wild harvest will continue to be a prized attribute for years to come.

Ophiocordyceps sinensis being traded at the market in Xining, Qinghai (China), June 2010

Conservation interfaces with economics, politics and diplomacy as well as science. Even if it were justifiable in scientific terms, a complete ban on collecting would be unachievable and would have devastating consequences for the many people dependent on its harvest. We must focus on two other priorities: gathering basic data and putting precautionary conservation measures in place. Perhaps the most important data we lack are reliable estimates of population size. There seems to be consensus in some quarters that Cordyceps is not currently over-harvested in that no noticeable decrease in numbers has been noted, but this view does not appear to be backed up by robust data and some of its promulgators could be influenced by

conflicts of interest. At least in some parts of its range, numbers of fruit-bodies at individual sites vary substantially from year to year, as might be expected from natural populations, with some indications that numbers build up gradually and then crash (Cannon et al. 2009). We therefore need to know the natural variation in population sizes to be expected, and inevitably it will take some years to build up an accurate picture.

Ophiocordyceps sinensis for sale in a high-end Oriental medicine shop, Xining, China

As the science behind the species is uncertain and will remain so (in part) for some time to come, precautionary conservation measures are appropriate. This has to involve a risk management element to assess the likelihood of long-term damage to populations by existing or proposed new policies. All of the Cordyceps producing countries have put some mechanisms in place to regulate the harvest, including restricting collection period, number of collectors and areas of harvest, and management of the sale processes. The impact of these measures needs to be evaluated, and where possible they should be harmonized to reduce the risk of cross-border issues. If all stakeholders are fully consulted, the reasons for regulation are transparent and the measures taken are fair to all, the likelihood of successful implementation is maximized.

Designation of *Ophiocordyceps sinensis* as a flagship species does not require any special actions within the international conservation regulatory framework (as administered by the IUCN), and in a sense this would be a political rather than scientific decision. It also does not preclude its exploitation, so long as this is carried out in a sustainable manner. However, if expert representatives from the four stakeholder countries wish to assign flagship status to the species, it would be a symbol of their determination to ensure that it will survive to provide long-term income for the people with which it coexists.

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Saving the forgotten Kingdom in Egypt

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Very little information about fungi from the Middle East and north Africa is currently available on-line. For most countries within this region, published information is scattered and often difficult to access. Egypt is, however, an exception. A fully revised checklist of Egyptian fungi, including lichen-forming species (Abdel-Azeem, 2010), has taken the number of species recorded there to over 2200, approximately double what was previously catalogued. In terms of species numbers, the *Ascomycota* form the single largest group within this checklist, with about 1560 species, of which about 160 are lichen-forming, and about 1000 are known only from their conidial (asexual) states.

A new project funded by an EOL fellowship (http://www.eol.org/content/page/175) will provide web-based information on the 400 non-lichen-forming ascomycetes of Egypt with known sexual states (including marine ascomycetes recorded from Egyptian waters, a group extensively studied in recent years). The objective is to enhance the information about these organisms, by adding descriptions, illustrations and conservation status evaluations compatible with the categories and criteria of the *International Union for Conservation of Nature* [**IUCN**], with additional links to information already available on-line through Cybertruffle (http://www.cybertruffle.org.uk/eng/index.htm), and to make all of that available through the *Encyclopedia of Life* [**EoL**].

Efforts will be made to digitize further information relating to fungi of the Middle East and North Africa (particularly distributional data currently existing only as paper resources), with the aim of making coverage of the target species of this project more full. Wherever possible, those records will be allocated latitude and longitude co-ordinates which correctly reflect the level of accuracy of the original information. This fellowship will result in the following main outputs:

- A minimum of 400 **EoL**-compatible web pages, each relating to a different non-lichen-forming ascomycete species known to occur in Egypt.
- **IUCN**-compatible evaluations of the conservation status of each of those species.
- Development within *Cyberliber* of a mycological bibliography relating to fungi of the Middle East and North Africa.
- Completion of what is, in effect, a pilot study assisting the databases on the *Cybertruffle* server to share information with **EoL**.

Egypt has paid special attention since 1983 to issues of natural resources protection and biodiversity. It has also established a system and legislation for conservation of natural heritage under directives and support of the political leadership, emphasizing integration of development sectors with environmental protection and natural resource conservation for the benefit of the present generation and the generations to come. Law 102 of 1983 empowered the Prime Minister to designate certain areas to be declared as protectorates (protected areas). A Prime Minister's decree defines the limits of each protected area and sets the basic principles for its management and for the preservation of its resources. Currently, 29 protectorates are declared which represent 15% of the total area of Egypt. However, in Egypt as well as many other countries, fungi have been overlooked in planning and preparation of biodiversity conservation plans.

The challenges involved in addressing fungal conservation in Egypt are therefore, predictably, daunting, but making available baseline data is an important step to achieving recognition for this unique group of organisms.

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Egypt Biodiversity Conservation Action Plan: http://www.egyptchm.org/chm/implementation/action_plan.htm
Egypt Clearing House Mechanism (CHM) for Biodiversity**:** http://www.egyptchm.org/
Egypt's Biodiversity: http://www.egyptcd.com/pub_biodiversity.html
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Name of Multilateral Environmental Agreement	Date of Ratification(R)	Date of Entry Into Force(E)	Date of Signature(S)
Convention on Wetlands of International Importance Especially as Water Fowl Habitat (RAMSAR)	9/9/1988	9/9/1988	
Convention Relative to the Preservation of Fauna and Flora in their Natural State	21/02/1935	14/01/1936	
International Plant Protection Convention	22/07/1953		
African Convention on the Conservation of Nature and Natural Resources	16/03/1972		
Protocol to Amend the Convention on Wetlands of International Importance Especially as Water Fowl Habitat	9/9/1988		
Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)	4/1/1978	4/4/1978	
Convention on the Conservation of Migratory Species of Wild Animals (Bonn)	11/2/1982	1/11/1983	
Convention on Biological Diversity (CBD)	2/6/1994		

Name of Multilateral Environmental Agreement	Date of Ratification(R)	Date of Entry Into Force(E)	Date of Signature(S)
Agreement for the Establishment of the Near East Plant Protection Organisation	13/04/1995		
Convention Concerning the Protection of the World Cultural and Natural Heritage	7/2/1974		
United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertfication, Particularly in Africa	7/7/1995		
Agreement for the Establishment of a Commission for Controlling the Desert Locust in the Near East	6/7/1967	21/04/1969	
International Tropical Timber Agreement	16/01/1986		
International Tropical Timber Agreement, 1994			8/11/1994
Protocol Concerning Mediterranean Specially Protected Areas	8/7/1983		
Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean			10/6/2019

NGOs for protection of environment and conservation

Egypt-African Conservation Foundation: www.africanconservation.org/explorer/egypt
Habi Center for Environmental rights: http://www.hcer.org/
International Foundation For protection of Environment and Sustainability: ……..
Nature and Science Foundation: http://www.naturescienceeg.org/about%20us.html
Nature Conservation Egypt (NCE): http://www.ncegypt.org/
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Culture collections in Egypt

Only two centers are recorded in the World Directory of Collections of Microorganisms (DCM) (wfcc.info/datacenter.html): EMCC (WDCM583) Egypt Microbial Culture Collection, Cairo Microbiological Resources Centre (Cairo MIRCEN), Ain Shams University, and NODCAR WDCM822 Marwa Mokhtar Abd Rabo, National Organization of Drug Control and research in Egypt. In addition, Moubasher and his colleagues founded the Assiut University Mycological Centre (AUMC) in 1999 where more than 6 000 fungal isolates belonging to more than 500 species are preserved under low temperature (5 °C), deep-freezed (-80 °C), and lyophilized; this is the biggest reference culture collection in the Arab countries. The centre also has a collection of dried specimens (i.e. a fungarium) which is rare in Arab countries. In spite of this the AUMC is not yet registered with the WFCC.

Who is responsible in Egypt for protection of fungi?

In 1997 the Ministry of Agriculture established the Egyptian Wildlife Service as the first national institution concerned with the formulation and implementation of policies pertaining to the protection of wildlife. In 1982, it was replaced with the Egyptian Environmental Affairs Agency (http://www.eeaa.gov.eg), which has become recently a department of the State Ministry of Environmental Affairs. The National Biodiversity Unit, Academy of Science and Scientific Research (http://www.asrt.sci.eg), Universities, National Institutes, Zoological and Botanical Gardens and NGOs are also charged with the task of protection of organism, including fungi.

At present, the main objective for fungal conservation in Egypt is to raise awareness of the issue among the public in general and students' in particular. To achieve that, a group of Egyptian scientists have established an NGO called the *International Foundation for Environment Protection and Sustainability* to work on protecting the environment and biodiversity. International support will, however, be needed if progress is to be made. More specifically, there is the need for an *Arab Mycological Association* to promote all aspects of mycology, including fungal conservation, in the Arab world.

The *Ascomycota* and the Sampled Red List Index scheme

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Introduction

The website. This article is about how the conservation status of 1500 ascomycete species was evaluated at a global level. Nothing like this has ever previously been attempted and, not surprisingly, the work has many imperfections. But it has uncovered a lot of important lessons. They are discussed here. Full information about this work, together with all of the detailed evaluations and documentation can be found on the website *Global Sampled Red List Index of the Ascomycota* [www.cybertruffle.org.uk/redlidat]. Although this article can be read independently, to get the most out of it, you need to visit that website and be familiar with its contents.

Conservation is just like any other job: you need to monitor progress. Those populations you're trying to protect - are they still in decline, or have they become less endangered as a result of your efforts? To answer questions like that, you need a baseline evaluation followed by periodic checks. In conservation, fortunately, there are well-established procedures for this. The *International Union for Nature Conservation* [IUCN] has defined conservation status categories (extinct, extinct in the wild, critically endangered, endangered, vulnerable etc.) and more or less objective criteria for allocating species to them. They were originally set up for vertebrates, but use was quickly and rather successfully extended to plants and then invertebrates. Although modifications will be needed before they work well (that is another story), they can also be used for fungi. In short, thanks to the IUCN, mycology has the basic tools for monitoring conservation work.

Monitoring is easier for some groups than for others. If you want to monitor conservation progress, and you work with amphibians, birds, mammals, reptiles or maybe even fish, you're lucky. There aren't so many species, they're all well known, and you have lots of enthusiasts providing plenty of high-quality information. It's possible to make reliable estimates for all of them. But get on to the plants, and you'll quickly find things much more difficult. There are far more species, and far fewer sources of information. If you then go on to the groups where real biodiversity is to be found - the fungi and invertebrates - the problems are enormous. Most species have not yet been described, and there's almost nobody around who can identify them, let alone provide evidence of how their populations are faring. Under those conditions, you can forget the idea of evaluating every species. Without a radical change in funding for conservation biology (and don't hold your breath), it's simply not going to be practical. A different way is needed, and that led to the idea of a Sampled Red List Index scheme.

The Sampled Red List Index scheme was designed for monitoring large and poorly-known groups. The idea is beautifully simple. Instead of trying to evaluate everything, you take a random sample of species in the group which interests you, and you evaluate that sample. Because the species have been selected randomly, statistical methods can be applied. That means it's possible to make statements about the group as a whole and to know the chances of those statements being true. You can't, of course, tell what's happening to individual species, unless they happen to be among those randomly chosen, but you can say how the group as a whole is performing. You will be able to answer the question, for example, "are the ascomycetes as a whole in decline, or are their populations in general remaining intact?" All

this means that sampled red list indexes are potentially an important tool for fungal conservation.

The Sampled Red List Index scheme has been adopted by the Rio Convention. In April 2002, at a meeting of signatories of the Rio Convention on Biological Diversity [CBD], 188 nations committed themselves to "... achieve, by 2010, a significant reduction of the current rate of biodiversity loss at the global, regional and national levels..." Just think about those words:

- "*significant reduction*" (as a minimum, that must mean something real, which can be demonstrated statistically);
- "*rate*" (to establish a rate, you need a minimum of a baseline and one other set of observations, and to establish a change in a rate, you need that baseline and at least two other sets of observations);
- "*biodiversity*" (that means all organisms, not just birds and mammals);
- "*global*" (that means the whole planet).

That was some commitment! As the 2010 deadline approached, it became increasingly evident that governments were going to fall a long way short of this grand promise. For birds and mammals, baseline measurements and some subsequent observations were achieved, but for all other groups of animals (annellids, anthozoans, arthropods, brachyopods, bryozoans, ctenophores, echinoderms, molluscs, nematodes, other vertebrates, priapulids, rotifers, tardigrades etc. etc.) and for ALL groups of fungi, micro-organisms and plants there wouldn't even be baseline measurements in place. Not surprisingly, the Sampled Red List Index scheme, which provided the hope of a shortcut and the covering of serious global political nakedness, was adopted as one of the CBD's official indicators for the 2010 targets. The benefit of this for conservation work was that funding became available for sampled red list index work. Some of that funding came the way of mycology through the UK Darwin Initiative's project *Conservation of Microfungi: a voice for unprotected and vulnerable organisms* [www.cybertruffle.org.uk/darwin-microfungi].

How it started. The Sampled Red List Index scheme was instigated by the *Zoological Society of London*, with an initial workshop in March 2005. To their credit, fungi were included in the planning from day one, and three mycologists participated: Anders Dahlberg, Christoph Scheidegger and me. Since then, the *Zoological Society of London* has done all the co-ordinating work for the scheme, and various different organizations (mainly IUCN Species Survival Commission specialist groups) are making contributions. To date, however, only one component has addressed the fungi. That was done through the Darwin Initiative project already mentioned, which had as one of its objectives the preparation of a Global Sampled Red List for the Ascomycota.

Materials and methods

Before starting, we took advice. Statistical experts at the *Zoological Society of London* were consulted before the sample of ascomycetes was made. Their advice was that a simple random sample of all species was the best, and that a stratified random sample (with an internal structure, for example to ensure proportional representation of each ascomycete order) was neither necessary nor desirable. They also advised that sample sizes of 900 and 1500 species would produce results with 90% and 95% confidence limits respectively. We decided to work with 1500 species and the 95% confidence limits.

What we sampled. The next step was to determine the sampling pool. We started with every ascomycete binomial in *IndexFungorum*, including anamorphs and teleomorphs. That list contained two components: the first comprised accepted names (i.e. names accepted by

SpeciesFungorum) and their synonyms, and the second consisted of the other names - the names of unknown application. Starting with accepted names, we removed all synonyms, so that for accepted species there was only one name in the list, and that was the currently accepted name. Then, with names of unknown application, where the basionym was known, only the most recent combination was kept, and all other nomenclatural synonyms were removed. The remaining names - recombined epithets with no known basionym - were all left in the sample pool: nothing else could be done with them. In that way, we came as near as possible to having one name in the pool for every different species.

Making the sample random. It was clear, even from a quick look at this pool, that species were not randomly distributed. The reason was that, during development of the *IndexFungorum* database, huge numbers of names from different sources were imported in bulk on different occasions, so that within the database different types of names were not randomly distributed. There are areas where most names are of lichen-forming fungi, or of European species, or of recombinations from obscure forgotten and then rediscovered works. To get round this problem, every name in the pool was allocated a random number. Those records were sorted in numerical order by that random number, and then, in that order, given another set of random numbers. By the time they were sorted in numerical order by that second set of random numbers, the order of records in the pool was truly random. A third set of random numbers was then used to select the shortlist of 1500 species names needed for the 95% confidence limit sample.

Reviewing the sampled names. Having got the shortlist, the next step was to review the names. Because *IndexFungorum* is still incomplete, further checks were necessary. For example, the review showed that a small proportion of the randomly selected names related to fossil fungi. There was no point in trying to evaluate their conservation status: by and large, they could be presumed to be already extinct for millions of years. The result of the review was an improvement in the quality of information about the names selected, and detection of some species which could not remain in the sample shortlist. These unsuitable names were replaced by further names selected by the same random number sequence which produced the initial 1500 names shortlist, and a note was made about each rejected name, and the reasons for rejection.

Source data for the evaluations: manual searches. For each of those 1500 names it was necessary to find out as much as possible about when, where and on what the species had been observed. This was challenging. First of all, because fungal nomenclature is not stable, it would be necessary to search not only under the currently accepted name of each, but also under every known synonym. On average there were about three synonyms for every name. That meant searches using about 6000 names to be sure of getting information about the 1500 species. In an ideal world, we should have visited every reference collection in the world, and looked for specimens or cultures of every one of those 1500 species. More than 150 such collections are listed on the *International Mycological Directory* website [www.cybertruffle.org.uk/imd]: looking for 6000 names in 150 collections would have meant about 900,000 searches. We should also have checked every published reference in every publication. Taking as a single example the journal *Mycotaxon*, which has issued just over 100 volumes to date, that would mean searching for 6000 names in every index - another approximately 600,000 searches. That would have to be repeated for all of the other main mycological journals, and not all of them have indexes. Then we should search for further information through the Internet: 6000 searches of Google (which is not the only Internet search engine). Finally, we should also have asked individual mycologists if they had any field observations of these species which they had not published. Clearly, within the confines of a single small project, this was not going to happen.

Source data for the evaluations: computerized searches. The only realistic solution was to make computerized searches. That was the route we took, not least because it meant that sequential searching using every known synonym was merely a matter of programming. Instead of looking at individual collections (and thanks to generous collaboration) we aggregated data from three main on-line fungal databases (*Cybertruffle*, the *Fungus Records Database of Britain and Ireland*, and the *USDA Fungal Databases*). To this core was added information from the editorial queue of *Cybertruffle* (about 500,000 records which were not yet available on-line because they were still being edited). These databases and the editorial queue of *Cybertruffle* provide a remarkably extensive coverage because they include so many digitized records from national and regional checklists and other major mycological works dealing with individual countries.

In addition, we scanned the indexes of several of the main mycological journals, and of various other mycological publications. We then converted those images to text using Optical Character Recognition software, and made a searchable database of the resulting records (that database is now openly available on *Cyberliber*). Finally, where available, information from the great mycological catalogues (*Index of Fungi*, *Petrak's Lists*, *Saccardo's Sylloge*, and *Zahlbruckner's Index Universalis*) was added. A full list of the sources used can be found on the Information Sources page of the *Global Sampled Red List Index of the Ascomycota* website. The several million records of all types of fungi which these collective sources represented was the source information on which our evaluations were based.

Applying the IUCN criteria to source data. As already observed, IUCN criteria, as they currently stand, are difficult to use because they are incompatible with some aspects of fungal biology. When evaluating randomly sampled species, this problem becomes acute, because there is a strong pressure to make some real evaluation (not just "data deficient"), and in general there are very few records on which to base the decision. As a first step, it was important not to over-estimate the number of records available for a species. For example, there might be several catalogue entries all based on the same original collection. Counting each of these as a separate record would introduce bias. To prevent this, the sum of all catalogue entries for a given species was divided by three and rounded to the nearest whole number, and that figure was used in estimating the total number of records.

Another potential source of bias was detected in respect of dates. Unlike the other main database sources, information from the USDA Fungal Databases contained no collection dates, so that it was impossible to tell from those records when the fungus had been observed. In cases where a species was backed by large numbers of records from the USDA Fungal Databases, but not from other sources, the result was that the number of dated records was disproportionately small, and this in turn sometimes led to the species being placed in a more endangered category than was realistic. Wherever such cases were detected, a correction was made.

It is doubtful whether even one of the 1500 species evaluated had sufficient information to comment intelligently on population trends and, for almost all of them, distributional information was basic. Some additional factors were therefore added so that, wherever possible, some sort of evaluation, however crude, could be made. A matrix was constructed, taking into account the following factors:

- total number of records;
- number of those records with a known date;
- proportions of dated records before and after two key years (1930 and 1960) (a decline in dated records could, in some circumstances, be evidence of a decline in populations);
- numbers of associated organism genera and species (this factor detected species with a narrow range of associated organisms);

- numbers of continents and countries (this factor detected potential endemism);
- whether or not the country was well- or poorly-explored for mycology (this subjective categorization of countries was only used when the sampled fungus was potentially an endemic);
- whether or not the fungus was lichen-forming (a narrow range of associated organisms could be expected for lichen-forming species).

Full details of that matrix can be found on the project website. The matrix, which applied the factors in a very cautious and conservative manner, was then used to supplement the IUCN criteria when allocating each species to a particular IUCN category.

Results

Evaluations available on-line. All 1500 evaluations have been made available on-line on the *Global Sampled Red List Index of the Ascomycetes* website. For each evaluated species, there are three separate web pages. The first is the evaluation itself, set out in a format compatible with the IUCN Red List Assessment questionnaire, but with additional hyperlinks providing direct access to relevant information in *Cyberliber*, *Cybernome* and *IndexFungorum*. The second contains a distribution map. The third is a detailed listing of all the evidence used to arrive at the evaluation.

For most species, the amount of available information was very low indeed. Out of the 1500 species evaluated, 1071 were represented by fewer than 11 records, 366 by between 11 and 100 records, 57 by between 101 and 1000 records, 4 by between 1001 and 10,000 records, and 2 by more than 10,000 records.

Most species were therefore evaluated as Data Deficient. Out of 1500 evaluations, 1423 (about 95%) were evaluated as Data Deficient. The evaluations of 1308 of these were unqualified. For the remainder, some brief comments were possible, as follows: 51 were evaluated as Data Deficient [possibly Least Concern], 43 were evaluated as Data Deficient [probably least concern], 3 were Data Deficient [probably Vulnerable], 6 were Data Deficient [possibly Endangered], 1 was Data Deficient [possibly Critically Endangered], 9 were Data Deficient [possibly Extinct], and 2 were Vulnerable. All the other 77 (about 5%) evaluations were Least Concern.

Some species are apparently known only from one country. As part of the evaluation process, a note was made of those sampled species which were possibly endemic (those species recorded only from one country). In all, 914 of the 1500 randomly sampled species were known only from one country. These were distributed as follows: USA (110 potentially endemic species), Brazil (69), France (51), India (44), Germany (43), Italy (37), Australia (36), Japan (32), Argentina (27), South Africa (25), Czech Republic (21), Philippines (19), Russia (19), Indonesia (18), New Zealand (18), China (18), Canada (16), Austria (14), Chile (14), Portugal (14), UK (12), Sweden (11), Ukraine (10), Sri Lanka (9), Taiwan (9), Venezuela (9), Ecuador (8), Spain (8), Antarctica (7), Cuba (7), Finland (7), Mexico (7), Costa Rica (6), Hungary (6), Tanzania (6), Kazakhstan (5), Malaysia (5), Poland (5), Sierra Leone (5), former Czechoslovakia (5), Belgium (4), Colombia (4), Madagascar (4), Netherlands (4), Papua New Guinea (4), Puerto Rico (4), former USSR (4), Algeria (3), Cameroon (3), Democratic Republic of Congo [Zaïre] (3), Denmark (3), Greece (3), Norway (3), Pakistan (3), Paraguay (3), Rumania (3), Trinidad & Tobago (3), Uruguay (3), Bosnia Herzogovina (2), Bulgaria (2), Congo (2), Egypt (2), Georgia (2), Greenland (2), Kenya (2), Luxembourg (2), Morocco (2), New Caledonia (2), Peru (2), Sao Thomé & Principe (2), Tunisia (2), Turkmenistan (2), Afghanistan (1), Angola (1), Armenia (1), Belize (1), Bermuda (1), Central African Republic (1), Dominica (1), Estonia (1), Ethiopia (1), French Guiana (1), Guinea Bissau (1), Guyana (1), Iraq (1), Korea (1), Laos (1), Libya (1), Nigeria (1), Norfolk Island (1), Panama (1), Réunion

(1), Serbia (1), Singapore (1), Suriname (1), Tadjikistan (1), Togo (1), Turkey (1), Uganda (1), Uzbekistan (1), Vanuatu (1), Yemen (1), Zambia (1), former French Equatorial Africa (1) and former Yugoslavia (1).

Some species apparently have only one known associated organism. A note was also made of those sampled species for which only one associated organism genus was recorded (in a few cases, particularly for associations with organisms other than flowering plants, one associated organism family, order or even class was also noted). Just over 700 of the 1500 species were in these categories. Associations were very widely spread. The genera with the most fungi uniquely associated with them were: *Pinus* (16 uniquely associated species), *Quercus* (15), *Homo* (12), *Acer* (9), *Fagus* (8), *Prunus* (8), *Solanum* (8), *Salix* (7), *Alnus* (6) and *Citrus* (6). Although not specifically noted as part of this work, most lichen-forming species also, by implication, had only one associated organism: their symbiont.

Discussion

A tenfold increase in the number of fungi evaluated globally. At the time of writing, only three species of fungi are present in the IUCN Red List: one is the basidiomycete *Pleurotus nebrodensis* (Inzenga) Quél., the other two are the lichen-forming ascomycetes *Cladonia perforata* A. Evans and *Erioderma pedicellatum* (Hue) P.M. Jørg. In addition, 109 other fungal species have been evaluated in various individual numbers of the *IMI Description Sheets of Fungi and Bacteria* since 2006. Apart from these, very few if any other fungi have been evaluated at a global level using the IUCN categories and criteria. The present work has thus increased by about tenfold the number of globally evaluated species.

First published examples of fungal conservation status evaluations. The information used to make the assessments of the IUCN Red List species *Cladonia perforata*, *Erioderma pedicellatum* and *Pleurotus nebrodensis*, and the reasoning leading to those assessments appear not to have been published (at least not in the format of the IUCN Red List assessment questionnaire). Similarly, none of the 109 species evaluated in recent *IMI Description Sheets* have had the assessment information and reasoning published. They are, in every case, a simple statement that, using a defined version of the IUCN categories and criteria, the species was assessed globally at a particular level. The 1500 evaluations of the present work thus appear to be the first, or at least very early published examples of how the evaluation process is being carried out for fungi. As a result, they have value as examples which can be copied or, better, improved when subsequent evaluations of species are carried out.

Evidence of how little is known about the conservation status of fungi. About 95% of all ascomycetes evaluated here were Data Deficient. Being based on a random sample, the present evaluations enable us with some confidence to make certain observations about the conservation status of ascomycetes in general. Thus it seems reasonable to suppose that if evaluations of all other known ascomycetes were made using the same data resources, this percentage would remain roughly the same. The tenth edition of the *Dictionary of the Fungi* (Kirk et al., 2008), traditionally an authority on these matters, estimated that a little over 97,300 species (two thirds of them ascomycetes) had been described up to the time of its publication, and acknowledged the most widely accepted estimate, of 1.5 million fungal species globally (Hawksworth, 1991), which includes an element for those not yet discovered. On the basis of those figures, only about 7% of all fungal species have so far been described. The random sample of 1500 species underwriting the present work is thus a sample only of that 7%, making it hard to avoid the conclusion that well over 90% of all fungi (described and undescribed), and possibly over 99%, cannot yet be properly evaluated for conservation because we simply do not have enough information.

An important political aspect. This exercise has therefore very clearly and objectively demonstrated how little is known about the fungi. There is an important political slant to this demonstration. To the uninitiated, the IUCN categories Not Evaluated and Data Deficient seem very similar. "If there is not enough information to make an evaluation, why bother?" The answer is that moving species from Not Evaluated to Data Deficient constitutes a shift in responsibilities. In simple terms, Not evaluated means "lazy scientists haven't done their job", while Data Deficient means "hard working scientists have tried to evaluate, but need more resources". From that point of view, the more fungi which can be moved from Not Evaluated, even to Data Deficient, the stronger will be the case when asking for support.

The quality and quantity of source information is important. It is instructive to compare the 1500 evaluations of the present work with the 109 evaluations made in the *IMI Description Sheets* series. Of those 109 evaluations, 55 (about 51%) were evaluated as Data Deficient, 51 (about 46%) as Least Concern, 1 (about 1%) as Near Threatened and 2 (about 2%) as Vulnerable. Like the present results, virtually all are either Data Deficient or Least Concern. The proportions of these two categories are, however, very different. That difference is surely a reflexion of the greater amount of source information used when preparing *IMI Description Sheets*, which have used new and much more rigorous standards since 2006. Those standards include consultation of a range of sources significantly wider than it was possible to use for the current work, including (in addition to those used in the present work) the *GBIF*, *New Zealand Landcare Fungi and Bacteria*, and *New York Botanic Garden Virtual Herbarium* websites, specimens in the fungarium at the national British fungus collection in Kew, the CABI database, and the first 50 pages or all pages (whichever is fewer) found by a search of Google. Furthermore, the *IMI Description Sheets* are in all cases written with the involvement of an expert in the relevant fungal group. Thus, if the current work were repeated, but with sources and expert attention levels similar to those provided for the *IMI Description Sheets* evaluations, the proportion of evaluations resulting in Data Deficient would probably decline to about 50%, and the proportion resulting in Least Concern would probably rise to nearly 50%. That change in proportions provides an insight into how IUCN categories and criteria work.

At very low levels of information, IUCN criteria cannot be used to establish conservation status. Most IUCN categories express a view about the conservation status of the organism (extinct, extinct in the wild, critically endangered etc.), but one (Data Deficient) merely comments on the quantity and quality of the information. Data Deficient is the only evaluation possible at very low levels of information. As more information becomes available, the first real conservation status category which can be used seems to be Least Concern: it's easiest to detect which species are common and look likely to stay that way. Substantially more information is needed, however, before all Least Concern species can be identified (that category is also used for uncommon species which have no obvious threats), and even more information is needed before the other categories can be considered.

For the ascomycetes, even with access to all existing information, at best about 50% would remain Data Deficient: the amount of information needed before other categories can be identified is currently simply not available anywhere. The matrix of additional factors used in the present evaluations did not alter this general picture. At most, it enabled us to add comments like "possibly Least Concern" as suffixes to the overall Data Deficient evaluations. It is also evident that, unless new information is generated - new observations of successful and unsuccessful searches for these 1500 species - a re-evaluation in five or ten years time (such as has always been envisaged for this scheme) will simply result in more species slipping back to Data Deficient.

Potential endemics. Given their size, it is not surprising that the USA and Brazil should have high levels of apparent endemism among the sampled species. If an attempt is made, very roughly, to group countries into regions of approximately similar size, a different picture

emerges. Temperate Europe has about 250 apparently endemic species, south Asia about 170, the neotropics about 130, temperate North America about 130, subsaharan Africa about 60, Australasia about 60, north Eurasia (Kazakhstan, Russia, Scandinavia) about 50, temperate South America about 50, and other parts of the world (Antarctica, northern Africa, western Asia) about 30. Since the sample was random, it's likely that all possible endemics among known ascomycetes will be similarly distributed. It would be dangerous, however, to jump to the conclusion that this is evidence for greater endemism in Europe: that may be true but, more probably, these figures may simply indicate that more ascomycetes have been described from Europe than elsewhere.

There seems to be very little published about fungal endemism. It clearly exists, but there may have been a reluctance to address the question, given the very low levels of data. Some very rough statistics about potential fungal endemics can be obtained from various websites on the *Cybertruffle* server, as follows:

- Brazil, 3377 species of fungi, of which 2047 are potential endemics = possibly 61% endemism [www.cybertruffle.org.uk/brazfung];
- Chile, 3886 species of fungi, of which 1955 are potential endemics = possibly 50% endemism [www.cybertruffle.org.uk/chilfung];
- Cuba, 5538 species of fungi, of which 2200 are potential endemics = possibly 40% endemism [www.cybertruffle.org.uk/cubafung];
- Dominican Republic, 2366 species of fungi, of which 699 are potential endemics = possibly 30% endemism [www.cybertruffle.org.uk/dorefung];
- Georgia, 6515 species of fungi, of which 2598 are potential endemics = possibly 40% endemism [www.cybertruffle.org.uk/gruzfung];
- Puerto Rico, 3192 species of fungi, of which 789 are potential endemics = possibly 25% endemism [www.cybertruffle.org.uk/puerfung];
- Trinidad & Tobago, 1647 species of fungi, of which 407 are potential endemics = possibly 25% endemism [www.cybertruffle.org.uk/trinfung];
- Ukraine, 6684 species of fungi, of which 2217 are potential endemics = possibly 33% endemism [www.cybertruffle.org.uk/ukrafung];
- Venezuela, 3886 species of fungi, of which 1334 are potential endemics = possibly 34% endemism [www.cybertruffle.org.uk/venefung].

These figures are reasonably compatible with the results from the current work. It is far from clear whether fungi share the same patterns of endemism as animals and plants, and there is not, at present, enough information to start making specific comments about levels of endemism in the fungi. The day when such comments will be possible can now, however, be seen on the horizon.

Associated organism genera. Much the same caution is needed when looking at information about fungi with apparently only one associated organism genus. If lichen-forming species are included, these fungi comprise well over 50% of all ascomycete species sampled. If that proportion is reflected throughout all ascomycetes, it will surely have an impact on calculations of total species numbers in the fungi. It is a pity that major biodiversity initiatives like GBIF do not provide information about associations, since that information is enormously important in the ecosystem approach to conservation. More information about the conservation status of associated organisms would be very useful. In cases where a fungus was only known in obligate association with an endangered species, the fungus could automatically be given the same conservation status as its associated organism.

Although more information is clearly needed, it is telling that almost all the genera with the highest number of uniquely associated fungi are temperate forest trees. It is almost heresy to suggest that biodiversity hotspots in temperate regions can compare with tropical rainforest,

but in the case of fungi, this may be the case. An insect can find its next host in a tropical rainforest by flying down, for example, a scent gradient, but fungi do not have directed flight: finding the next correct associate in an area of high plant diversity is extremely problematic for them. Is it possible that tropical rainforest encourages a high diversity of generalist fungi (able to colonize different associated organisms), but not of specialists? Perhaps temperate forests, with their extensive stands of few species are a better place to look for high diversities of specialist fungi.

Conclusions

This first Sampled Red List Index evaluation of ascomycetes is ground-breaking. It is the first large-scale attempt to evaluate the conservation status of fungi using IUCN categories and criteria, and may be the first where the source information and the reasoning behind the evaluations has been published. The very high proportion of species evaluated as Data Deficient is the first concrete evidence of how little is known about the conservation status of this phylum. Care is needed to ensure that the size of the problem - this level of ignorance - does not deter funding bodies from supporting further work. Fascinating information about endemism and specialist associations with other organisms is starting to emerge. The matrix of additional factors was of some use in helping to identify IUCN categories, but is likely to become valuable only when information levels are higher. If signatories of the CBD are serious about using sampled red list indexes, there needs to be funding for field studies and research into these 1500 species, and it needs to be starting now.

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Raising the profile of fungi on the Internet: editing Wikipedia

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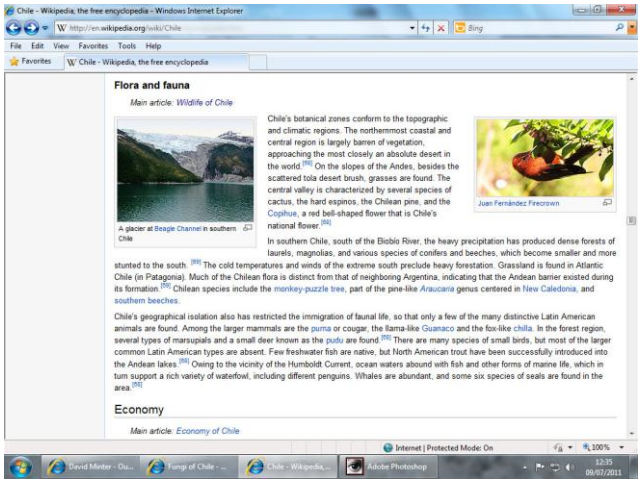
If fungal conservation is to make progress, we need to make sure people are aware that fungi are different from animals and plants and that they are essential for sustainable life on this planet. Now that the Internet is so widely used, the profile of fungi on the web should be a concern for all members of our new Society.

One of the biggest sources of information worldwide is Wikipedia, the open on-line encyclopedia [http://en.wikipedia.org/wiki/Main_Page]. Like it or not, everybody uses it.

The great thing about Wikipedia is that it is open. Anybody can edit and change it. If you're like me, perhaps you recognize this, but don't know where to start. I didn't, but one evening I sat down and started to teach myself. There were lots of mistakes at first, and I'm still no expert, but already I have made changes to a range of Wikipedia pages where fungi should have been mentioned but weren't. Figs 1 and 2 show part of the English language Wikipedia page for Chile before editing and after editing. Look at the difference. Beforehand, "Flora and fauna" and no mention of fungi. After, "Biodiversity" and "Animals", "Fungi" and "Plants" all given equal weighting in alphabetical order [if you have sharp eyes, you will see that in the bottom left of Fig. 2 there are the words "Error on page" - this is something to do with the browsing software, and is not the result of my editing]. Table 1 lists pages which I have already changed. The changes may not be perfect, but they are a step in the right direction. If you can see improvements you'd like to make, learn to edit pages. Then there's nothing to stop you from making them better yourself!



There are a lot of pages like the Chile page used to be, and they all need editing so that fungi are correctly represented. Table 2 of this article, lists some pages of the English language version of

Wikipedia which need to be changed. One person can't do it all: this should be a Society-wide activity. The present article aims to help you get started.

Summary of how to do it

- Find a page you want to change
- Save an image of it before editing
- Review existing discussions about the page
- Prepare your text
- Go into edit mode, and add the text
- Review the result
- When satisfied, add an edit summary and save the edits
- Save an image of the page after editing

First steps

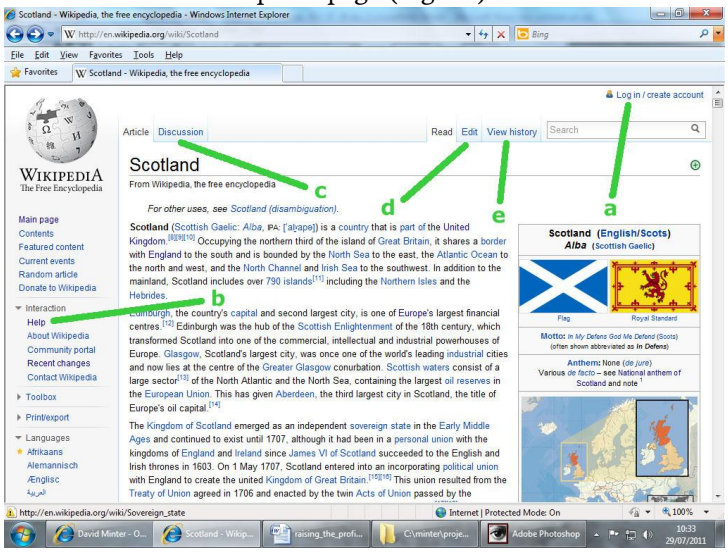
After you have found a Wikipedia page which you think you can improve, you need to make a record of what it was like before your changes. If you're using MS-Windows, that's easy. Just hold down <Shift> and press <Print Screen> once. That action transfers an image of what's currently on screen into the memory of your computer. Then load MS-Paint or Adobe Photoshop or some similar program for editing images, create a new file, and use "paste" to put the screen image into it. Save it in JPG format in a suitable folder, giving it a name which makes clear what it is, that it shows the screen before editing, and when you made it. For example, the "before" Antarctica page above might be called "antarctica_before_2011_07_07.jpg".

Next, prepare the text you would like to see on the Wikipedia page. MS-Notepad or some similar text editor is suitable for this. It's best to keep this text separate because its safety is not guaranteed once it's on Wikipedia. Being an open system, it is very easy for someone else to revert a changed Wikipedia page to its earlier state if for any reason they don't like what has been done. When you've got your text ready, it's time to start editing.

Some dos and don'ts

Before you try to do edit a page, there are several things it's useful to know.

Although almost all Wikipedia pages can be edited by anybody - the system is remarkably open - it's generally better to register with Wikipedia. If you do that, your changes will be taken more seriously and will have a better chance of surviving. Other editors will suppose that you are genuine, and not just there to make trouble. You can register by clicking at the top right hand side of the Wikipedia page (Fig. 3a). You will need to supply a pseudonym (Wikipedia advises for good reasons that you don't use your own name), your e-mail address, and a password. Pages prone to vandalism - senseless or damaging changes - are protected at various different levels, and some of the pages you may want to edit are likely to be in that category. Protected pages can only be edited by people registered with Wikipedia (and before you can start editing them, several days must pass since you registered): it's another reason why you need to register.



The option "Help" on the side bar to the left of the page contains a lot of good advice (Fig. 3b), particularly for beginners. You can click on any of the topics listed there for more information about what they mean. By doing that, you will be starting to explore a huge resource of help for editors. Frankly, it's amazing what is there and, if you are like me, exploring those resources will only increase your respect for this remarkable resource.

Before changing any page, it's a good idea to click on the Discussion tab at the top of the page (Fig. 3c). Under the Discussion tab, you will see issues about that page which have already come up and been resolved. That will help you to measure what sort of changes might be appropriate.

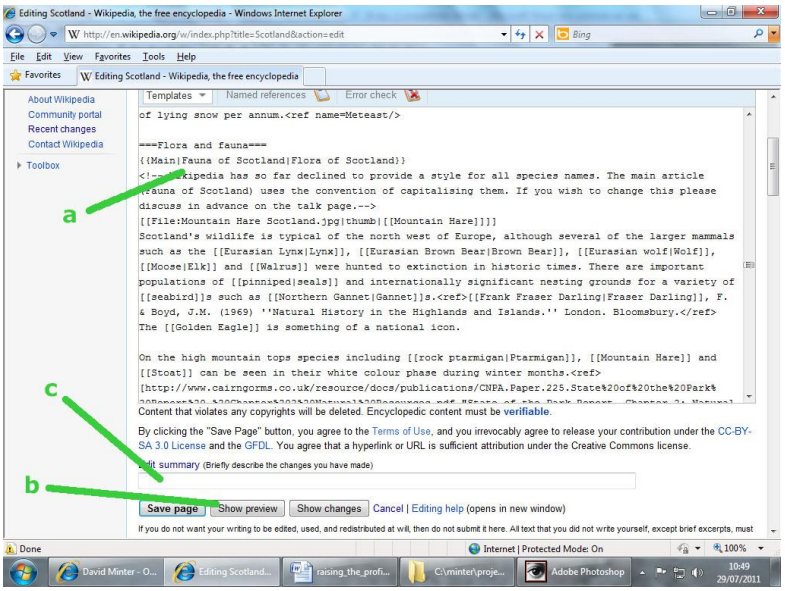
Editing

Go back to the main page from the Discussion tab. If the page is not protected (or if it's several days since you registered), you will see near the top an Edit Tab (Fig. 3d). If you click on that, you can edit the page. Learn to walk before you try to run: start with something easy. Simple editing is just "cookbook" work. Look at what other people have done, and copy them. Headings are preceded and followed by the equals sign "=", different numbers of equals signs indicating different heading levels. You can refer to other pages in Wikipedia by putting two opening square brackets before their name and two after their name. In particular, make sure that your statements are backed up by genuine references. To do references, look at how other people have done them. You can also click on "Cite" above the editing box, and then select "Templates" and that may make preparing references easier.

Remember when editing that you are contributing to an encyclopaedia entry. That means the amount of information you are adding should be appropriate to maintain balance within the current topic. If you are editing a page devoted to a single country, for example, and you write huge amounts about fungi on a country page, you can expect to see it immediately deleted as being unbalanced. Better therefore for a country page to keep information about fungi brief and within a section on biodiversity. If you have more information, consider setting up a new page about fungi of that country. At present, in the English language version of Wikipedia, only Australia has such a page: now there's a challenge for you!

Reviewing your editing work

When you think you've made all the changes you wanted, take a look below the editing box (Fig. 4a). You will see three menu buttons: "Save page", "Show preview" and "Show changes" (Fig. 4b). Click on "Show preview" and you will be shown what the result of your efforts looks like. At this point, nobody else can see your changes, because they have not yet been saved. It is likely that you will have missed some



detail, or mistyped something and, if so, you can go back to the editing box (you'll find it at the bottom of the preview page) and continue correcting.

When the preview looks exactly like you want it to, go to the "Edit summary". It's immediately above the three menu buttons just mentioned (Fig. 4c - the arrow is pointing to the box which needs to be filled in). It's good manners in the Wikipedia world to put a few words in that box to indicate why you made the changes. Something like "added information about fungi" should be enough. By putting those words in, you help to establish your own credibility.

Saving your editing work

When all of that is done, click on "Save page".

If you have added a reference which is a hyperlink, or anything even slightly adventurous like that, you are likely at this point to see some distorted letters on screen, and to be asked to type them in as an anti-spam device. After you have done that, click again on "Save page". If all has gone well, you have just finished your first Wikipedia edit.

Next, and very important, make a copy of the screen as it looked after your editing. That way, you have before and after evidence to show that you've made some progress.

Problems and discussions

Don't be surprised if someone immediately undoes the change you've made. It's a common occurrence, and it can happen astonishingly quickly. Sometimes it's even just a Wikibot (a Wikipedia robot - you rapidly encounter a whole new Wikivocabulary when you get involved with editing!) which has done it. It's easy to take this as a personal affront. It's not. It's just the way Wikipedia works and, in fact, there is a very strong emphasis and tradition within Wikipedia for politeness and goodwill. If your editing gets reverted, it means you haven't found consensus. Don't even think of changing it straight back again. That will get you nowhere.

If your changes are rejected by someone, click on the View history tab at the top right of the page (Fig. 3e) and you will usually find some reason given for the rejection. You should then to go to the discussion tab for that page, and initiate a discussion about the rejected topic. Editing a Discussion tab is similar to editing the page itself. There are only a couple of important points to remember: first, the newest discussions are always at the bottom of a page, and second, when you have added the point you wish to make, before saving the page, sign off. This is done by typing four tilde characters "~~~~" after the end of your comment. When you do this, the Wikipedia software automatically attributes the comment to you, and date-stamps it. By making sure your contribution to the discussion is not anonymous, you help to build your credibility with other Wikipedia editors.

You then need to wait, going back periodically to the discussion page to see what comes up. Never add lots of different comments from different computers so that it looks like your views have widespread support. In Wikipedia, that practice is called "sockpuppetry" (some more Wikipedia vocabulary), and it's totally contrary to "Wikiethics". Don't get emotionally involved and avoid "edit wars". Sometimes it's just best to walk away.

Another important point

As a policy, Wikipedia discourages people from editing pages in pursuit of a personal agenda or vendetta. The objective of Wikipedia is to produce a free and open on-line encyclopaedia. It should be balanced. That needs to be remembered. A greater presence for fungi on Wikipedia, for sure, helps promote fungal conservation, but that should not be the driving reason for contributing to Wikipedia. The driving reason should be that fungi are important and if they are not represented at the same level as animals and plants, the encyclopaedia is not balanced.

It is worth pointing out that all of this activity described in these paragraphs is directed at rather general pages, like the main pages for individual countries. These often have a section entitled "Flora and fauna" or "Biodiversity", but have rarely had the attention of a mycologist. In addition to general papers, there are already many specialist pages for the fungi and, having been written by mycologists, these tend to be of very high quality indeed. By all means, add to those pages as well as raising the profile of fungi on the general pages.

Raising the profile of fungi on Wikipedia is likely to be an important (and rather cost-free) activity of the Society for some time to come. Fungi need to be adequately represented not just in the English language version of Wikipedia, but also in all other languages of the encyclopaedia. That means, wherever there is a reference to biodiversity and fungi are not mentioned, or wherever the phrase "flora and fauna" occurs, we should be asking ourselves, "is this something which needs to be changed to include fungi?" I invite you all to take up this challenge. Anyone with Internet access can do this work. The encyclopedia improves. Everybody benefits.

Send me your successes (before and after JPG format images), so that the Society can keep track of progress. If you have problems, ask me: I'll help at first, but don't expect me to help forever - it's better for the Society to have a whole cadre of experts, not just one beginner. Our aim should be to make it look strange on Wikipedia if biodiversity is being discussed without fungi being mentioned.

Good luck!

Table 1. Some English language Wikipedia pages where information about fungi has been added

Antarctica	Fungus and plant information separated. Now evident that there are many more fungal species in Antarctica than plant species
Biodiversity	"Flora and fauna" changed (after some resistance!) to "all living things"
Botany	Separate nature of fungi and separate status of lichenology and mycology clarified
Caribbean	Fungal component added to biodiversity section
Chile	Fungal component added to biodiversity section
Conservation	Fungi added to definition of conservation
Conservation biology	"Insects and other groups" changed to "Groups other than vertebrates" and fungal component added
Conservation movement	Fungi added to definition of conservation movement
Environment of the United States	"Biota" section subdivided into "Animals", "Fungi" and "Plants" and fungal information added
Georgia (country)	"Fauna" removed from "Geography". "Biodiversity" added as a section, with subdivisions for "Animals", "Fungi" and "Plants", fauna information added to "Animals" subdivision, and new information added for "Fungi" and "Plants"

Marine biology	"Lifeforms" divided into "Animals", "Fungi" and "Plants and algae" (more work needed there!), and information about fungi added
Organism	Order in definition changed from "animal, plant, fungus, or micro-organism" to "animal, fungus, micro-organism, or plant"
Red list index	Order of taxa in list changed from "vertebrates, invertebrates, plants and fungi" to "animals (invertebrates and vertebrates), fungi and plants"
South Sudan	"Flora and fauna" changed to "Fauna, Flora and Mycobiota". Fungal information added
Ukraine	Subdivisions for "Animals" and "Fungi" added to "Biodiversity" section, animal information moved to "Animals" and new information added for fungi
Venezuela	Information about fungi added to "Biodiversity"
Wildlife of Brazil	Fungal information added to "Biodiversity" section. "Fauna" section renamed to "Animals", "Flora" section renamed to "Plants", new section established for fungi, and fungal information added
Wildlife of Chile	"Fauna" section renamed to "Animals", "Flora" section renamed to "Plants", new section established for fungi

Table 2. Some examples of English language Wikipedia pages where information about fungi is needed - there are lots more!

Alaska	There is no information at all about biodiversity. A chance to lead with the fungi. The same is true for many other US states, and many subnational units of other countries.
Australia	There is no information explicitly about biodiversity. A chance to lead with the fungi.
Biodiversity of New Zealand	"Flora" and "Fauna" need to be replaced with "Animals" and "Plants" and the order made alphabetical. A section on "Fungi" then needs to be added after "Animals" and before "Plants".
Brazil	"Biodiversity" needs to be separated from "Geography" and subheadings are then needed for "Animals", "Fungi" and "Plants". Information about fungi needs to be added.
California	"Fauna and flora" needs to be separated from "Geography" and renamed "Biodiversity". Subheadings are then needed for "Animals", "Fungi" and "Plants", and the flora and fauna information needs to be redistributed to the "Animals" and "Plants" sections. Information about fungi needs to be added.
China	There is no information at all about biodiversity. A chance to lead with the fungi. The same is true for Canada, Denmark, France, Greece, Kenya, Spain, UK and many other countries.

Germany	"Biodiversity" needs to be separated from "Geography" and subheadings are then needed for "Animals", "Fungi" and "Plants". Information about fungi needs to be added.
Morocco	"Biodiversity" needs to be separated from "Geography" and subheadings are then needed for "Animals", "Fungi" and "Plants". The biodiversity information needs to be distributed within the "Animals" and "Plants" subheadings. Information about fungi needs to be added.
New Zealand	"Biodiversity" needs to be separated from "Geography" and subheadings are then needed for "Animals", "Fungi" and "Plants". The biodiversity information needs to be distributed within the "Animals" and "Plants" subheadings. Information about fungi needs to be added.
Norway	A rather good page, but maybe it could be improved by changing the order in which groups are mentioned, and listing lichen-forming and non-lichen-forming fungi as separate components of fungi rather than as two distinct entities.
Portugal	"Biodiversity" needs to be separated from "Geography". Subheadings are then needed for "Animals", "Fungi" and "Plants", and the biodiversity information needs to be redistributed to the "Animals" and "Plants" sections. Information about fungi needs to be added, after "Animals" and before "Plants".
Russia	"Biodiversity" needs to be separated from "Geography". Subheadings are then needed for "Animals", "Fungi" and "Plants". Information about fungi needs to be added.
Saudi Arabia	"Biodiversity" needs to be separated from "Geography". Subheadings are then needed for "Animals", "Fungi" and "Plants". Information about fungi needs to be added.
Scotland	"Geography and natural history" needs separating into two sections, "Geography" and "Biodiversity". The new section "Biodiversity" needs splitting into subheadings "Animals", "Fungi", "Plants". "Flora and fauna" information needs to be moved from "Geography" and distributed within "Biodiversity" subheadings "Animals" and "Plants". Information about fungi needs to be added, after "Animals" and before "Plants". [Wales is similar]
South Africa	"Fauna and flora" needs to be separated from "Geography" and renamed "Biodiversity". Subheadings are then needed for "Animals", "Fungi" and "Plants", and the flora and fauna information needs to be redistributed to the "Animals" and "Plants" sections. Information about fungi needs to be added, after "Animals" and before "Plants".
Sweden	There is no information at all about biodiversity. This is the land of Elias Fries!
USA	There is no section for biodiversity. A "Biodiversity" section needs to be established, and biodiversity information needs to be moved from "Geography and environment" and reallocated to subheadings in "Biodiversity" for "Animals" and "Plants". Information about fungi needs to be added, after "Animals" and before "Plants".

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INTERNATIONAL SOCIETY FOR FUNGAL CONSERVATION (ISFC) MEMBERSHIP APPLICATION

APPLICANT INFORMATION

NAME

Title: **Male / Female**

First Name(s): **Preferred Name:**

Family Name:

POSTAL ADDRESS:

CITY:	**COUNTRY:**	**POSTCODE:**

EMAIL:

TELEPHONE NUMBER:

MOBILE PHONE NUMBER:

FAX NUMBER:

AREA OF INTEREST / OFFERS OF ASSISTANCE

Please indicate relevant fungal group(s) and/or geographic region that you are most interested in:

Offers of assistance to ISFC? Please let us know if you are able to assist with publicity, membership, newsletter contributions, or other areas:

USE OF CONTACT DETAILS

I agree to my contact details being printed in the ISFC Membership Directory – Note, this is optional.

YES or NO (PLEASE CIRCLE PREFERENCE)

ANNUAL MEMBERSHIP FEE

Currently, Membership of ISFC is free, but this will change as the Society develops. You will be notified when this occurs. Donations to ISCF for the promotion of fungal conservation are welcome. Keep in touch with the Society through its website:

http://www.fungal-conservation.org/

Please email your completed form to:

Peter Buchanan, ISFC Membership Secretary, at:

BuchananP@LandcareResearch.co.nz