Issue 4: February 2014

Fungal Conservation

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Note from the Editor

This issue of *Fungal Conservation* is being put together in the glow of achievement associated with the Third International Congress on Fungal Conservation, held in Muğla, Turkey in November 2013. The meeting brought together people committed to fungal conservation from all corners of the Earth, providing information, stimulation, encouragement and general happiness that our work is starting to bear fruit. Especial thanks to our hosts at the University of Muğla who did so much behind the scenes to make the conference a success. This issue of *Fungal Conservation* includes an account of the meeting, and several papers based on presentations therein.

A major development in the world of fungal conservation happened late last year with the launch of a new website (http://iucn.ekoo.se/en/iucn/welcome) for the Global Fungal Red Data List Initiative. This is supported by the Mohamed bin Zayed Species Conservation Fund, which also made a most generous donation to support participants from less-developed nations at our conference. The website provides a user-friendly interface to carry out IUCN-compliant conservation assessments, and should be a tool that all of us use. There is more information further on in this issue of *Fungal Conservation*.

Deadlines are looming for the 10th International Mycological Congress in Thailand in August 2014 (see http://imc10.com/2014/home.html). Conservation issues will be featured in several of the symposia, with one of particular relevance entitled "Conservation of fungi: essential components of the global ecosystem". There will be room for a limited number of contributed papers and posters will be very welcome also: the deadline for submitting abstracts is 31 March. **A satellite meeting focusing on how to make IUCN conservation assessments** will also take place on 3 August, just before the congress starts. Please put this in your diaries if you are going to Bangkok.

Thank you once again to those dedicated people who have sent articles for publication in *Fungal Conservation*. I hope you the reader appreciate their efforts, and are encouraged to contribute to the next issue!

News items

Report from the 3rd International Congress on Fungal Conservation, Turkey, 11-15 November 2013

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Normally at this time of year, activity along the Turkish Turquoise Coast is winding down. The serene and sunny autumn days seemed to be for the sole pleasure of snoozing dogs on the beach and the odd fishermen casting a line from the jetty. However, things changed recently when a throng of mycologists and fungal enthusiasts who were participating in the third International Congress on Fungal Conservation descended on the small seaside village of Akyaka from every corner of the globe.

Organised by Dr David Minter (ISFC president) and Professor Dr Mustafa Isiloğlu (and supported by the Mohamed bin Zayed Species Conservation Fund and Muğla Sıtkı Koçman University), the Congress attracted representatives from 38 countries who met with the shared aim of promoting fungal conservation.

David Minter and Mustafa Isiloğlu

The Congress melded science, education, infrastructure and politics through an intensive week of reviews of mycological conservation research; development of infrastructure for fungal conservation; training workshops on the global fungal RED-listing process; regional reporting on the status of fungal conservation; discussion of social and political issues relating to fungal conservation, as well as opportunities to explore Turkish fungi via guided forays in the local forests.

The Congress was received with tremendous hospitality and formality with a procession of local suited dignitaries participating in the opening ceremony. This was followed by a high-octane presidential address by David Minter who warmly welcomed participants and gave an overview of the ISFCs achievements, notably, the six-fold increase in membership since the society's inauguration in August 2010. Other activities and achievements include the Society's active website and three issues of the digital publication, *Fungal Conservation*, as well as a campaign lobbying for greater inclusion of fungi in school curricula. However, perhaps of greatest importance is the official recognition of the significance of fungi by the world's first global environmental organisation, the International Union for the Conservation of Nature (IUCN).

The first session of the conference addressed the importance of political process in fungal conservation and the frameworks and means by which fungi can gain greater profile and conservation status. The Chair of the Species Survival Commission of the IUCN, Simon Stuart, opened the session with an overview of the structure and function of the IUCN and an explanation of the five specialist fungal groups. This was followed by a presentation on the importance of political engagement in fungal conservation by former Australian senator, Lyn Allison. Lyn provided invaluable advice on political campaigning and understanding how parliaments operate drawing our attention to the need for greater contribution to political process by fungal conservationists. Also hailing from the southern hemisphere, Peter Buchanan provided an overview of the Global Taxonomy Initiative and the importance of mycologists being part of such initiatives.

Mycologist, Peter Buchanan from New Zealand.

The second day of the Congress was dedicated to a review of fungal conservation progress across the globe presented as regional and country reports. Most countries share similar challenges to fungal conservation including the dearth of mycologists, funds, RED-listed species, and action plans, coupled with public and political disinterest. However, the Chilean report, presented by Giuliana Furci provided a refreshing and exciting example of how the motivation and passion of one person culminated in the formation of Fundación Fungi and the inclusion of fungi in Chilean environmental legislation. Consequently the Chilean government is obliged to provide mycological baselines in every Environmental Impact Assessment as of December 2013.

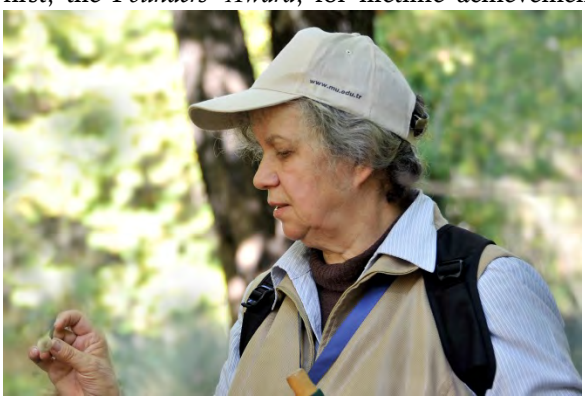
Australian former politician, Lyn Allison and founder of Fundación Fungi, Giuliana Furci.

Following the plenary session of the ISFC on the third day we headed into the forests of the Kazanci and Cicekli areas. With temperatures in the mid twenties and no rain in the previous week, the field sites were fairly dry however dozens of keen eyes spotted several species including various *Lactarius* spp., *Russula foetens, Coprinus sp., Mycena seynii, Psathyrella candolleana, Agrocybe* sp., *Lentinus tigrinus, Tubaria* sp., *Suillus* sp., *Coriolopsis polyzona, Ganoderma lucidum, G. resinaceum, Trametes versicolor*,

Scotomyces subviolaceus, Hirschioporus abietinus, Chondrostereum purpuerum, Pisolithus arrhizus and *Scutellinia* sp. among others.

The following day Michael Krikorev and Greg Mueller ran an important workshop on the global fungal RED-listing process via the new website that has been developed by Michael, Greg and Anders Dahlberg. Three additional workshops entitled, *Fungal Conservation: Raising Awareness*, *Conservation of Myxomycetes* and *Conservation of Desert Truffles: an example of how to use information sources for RED-listing* provided participants with not just information but the tools and knowledge for direct action initiatives.

Another important aspect of fungal conservation is acknowledgement of efforts and excellence. David Minter announced at the General Assembly that two new award categories had been established. The first, the *Founders' Award*, for lifetime achievement to fungal conservation was awarded to Maria Lawrynowicz from Poland. Maria is a Founder Member of the European Council for Conservation of Fungi and an outstanding contributor to fungal conservation, particularly the conservation of hypogeous fungi. Maria's presentation on the World Heritage-listed Bialowieza Forest – which dates back to 8000 BC and contains the last remaining stands of European primeval lowland mixed forest where 1900 fungal species have been recorded – was a reminder of the importance of conserving such habitats for all biodiversity.



Maria Lawrynowicz examines a specimen.

The second, the *President's Award*, was for outstanding promotion of fungal conservation was awarded to Giuliana Furci for her abovementioned achievements through the formation of Fundación Fungi and to Ahmed Abdel-Azeem for founding the Arab Society for Fungal conservation (received in his absence by Mr Abdul-Rahman Ibrahim Mustafa and Ms Fatma Salem).

A diverse and interesting selection of posters was presented at the Congress and Maria Ławrynowicz picked up a second award, the *Congress Award* for the best poster presentation for her poster entitled *Conservation Problems of Hypogeous Fungi*. Highly commended prizes were awarded to The Fungal Conservation Group of Latin America for its poster reviewing the status of fungal conservation in the Caribbean, Central America and South America, and to Handan Cinar and colleagues for their poster entitled *Critically Endangered Species from Turkey*.

In addition to the formal presentations, there was plenty of opportunity for informal interactions and participants gleaned many ideas and strategies for fungal conservation including possibilities for editing Wiki-websites to improve the profile of fungi; the importance of strategic timing in finding windows of opportunity for inserting fungi into legislation; opportunities to tap into the corporate sector; and remembering that while scientists provide the foundation of fungal knowledge, others are necessary to mobilise public and political interest and activate conservation. After such an intensive and inspiring week it's always a little sad to think that it will be another four years until we meet again, at a location that is currently being determined – keep an eye on the ISFC website. But at least for now, the dogs can return to their slumber and the fishermen can cast their lines undisturbed.

The calm returns to Akyaka, Gökova Bay.

The official conference photo. See table on following page for a key to participants. Thanks to Boris Ivančević for providing the image and compiling the list.

1.	De Dominicis Vincenzo	Italy
2.	Diamandis Stephanos	Greece
3.	Abdul-Rahman Ibrahim Mustafa	Egypt
4.	Perini Claudia	Italy
5.	Pouliot Alison	Australia / Switzerland
6.	Bölük Ezgin	Turkey
7.	Özbay Selen	Turkey
8.	Yılmaz Ferah	Turkey
9.	Ünal Güler	Turkey
10.	Daniele Inita	Latvia
11.	Keleş Emel	Turkey
12.	Şen İsmail	Turkey
13.	El-Fallal Amira Ali	Egypt
14.	Amir Al-Ghamriny	Egypt
15.	Nadia Al-Sheshtawy	Egypt
16.	Marwa Saad Fathi	Egypt
17.	Vasco Aida	Netherlands
18.	Baş Sermenli Hayrünisa	Turkey
19.	Işıloğlu Mustafa	Turkey
20.	Minter David	UK
21.	Furci Giuliana Maria	Chile
22.	McMullan-Fisher Sapphire	Australia
23.	Apetorgbor Mary	Ghana
24.	Diamandis Paula	Greece
25.	Ławrynowicz Maria	Poland
26.	Hayova Vera	Ukraine
27.	Franco Molano Anna Esperanza	Colombia
28.	Kryvomaz Tetiana	Ukraine
29.	Harsh Nirmal Sudhir Kumar	India
30.	Nadyeina Olga	Ukraine
31.	Salem Fatma Mahmoud	Egypt
32.	Sell Indrek	Estonia
33.	Kaya Abdullah	Turkey
34.	Buchanan Peter	New Zealand
35.	Doğan Hasan Hüseyin	Turkey
36.	Estupiñán Natalia Vargas	Colombia
37.	Gonou-Zagou Zacharoula	Greece
38.	Mohammed Abdel-Latif Ayad	Egypt
39.	Akata Ilgaz	Turkey
40.	Triantafyllou Marina	Greece
41.	Uzun Yusuf	Turkey
42.	Ngadin Andrew Anak	Malaysia
43.	Çaka Şerife	Turkey
44.	Solak Halil	Turkey
45.	Ivančević Boris	Serbia
46.	Strack Betty	USA
47.	Sharp Cathy	Zimbabwe
48.	Altuntaş Deniz	Turkey
49.	Çınar Handan	Turkey
50.	Yaratanakul Güngör Mehrican	Turkey
51.	Uzun Yasin	Turkey
52.	Güngör Halil	Turkey
53.	Sankaran K. V.	India
54.	Cannon Paul	UK
55.	Senn-Irlet Beatrice	Switzerland
56.	Mueller Greg	USA
57.	Quezada L. Maura	Guatemala
58.	Karadelev Mitko	Macedonia
59.	Sundberg Henrik	Sweden
60.	Svetasheva Tatyana	Russia
61.	Taylor Joanne	UK
62.	Torrejon Herrero Miguel	Spain
63.	Michaud Alain	France
64.	Jürgens Katrin	Estonia

Recovery times in tropical forests

A paper published in *Proceedings of the Royal Society B* by Philip Martin, Adrian Newton and James Bullock (see http://dx.doi.org/10.1098/rspb.2013.2236) has major implications for fungal and lichen conservation. They demonstrated that the timescales necessary for restoration of tropical forests vary for different organism and trophic groups. Above-ground biomass was the quickest to recover, while below-ground biomass lagged behind. Tree species richness stabilised after only fifty years, but epiphyte richness did not reach equivalence to undisturbed forest for any of the sites examined. The take-home message is that just because your restored forests have trees in them, their associated organisms are unlikely to recover in human-measurable timescales.

Biodiversity offsetting: can we swap biologically valuable areas?

Biodiversity offsetting is becoming big news. On the face of it, everything sounds reasonable: protected land needed for human development (forestry, road building, housing development etc.) is exchanged for other land in a more economically convenient location. In the UK, various schemes have been proposed involving sweeteners (increased area to be donated for conservation purposes, double the number of trees planted as are destroyed etc.) The devil is in the detail: ancient woodland with all its fungal diversity (not to mention other organism groups) cannot be equated with secondary woodland or newly planted sites – see news item above – and there are no clear indications that such sites will become equivalent in biodiversity terms. The British Ecological Society has addressed this issue, and stresses that offsetting needs to be assessed on the basis of the best scientific knowledge. Their report can be accessed at this web address: http://www.britishecologicalsociety.org/wp-content/uploads/Biodiversity-offsetting-BES-report-FINAL.pdf

European Charter on Fungi-gathering and Biodiversity

A Charter on fungi-gathering and biodiversity is in the final stages of approval by parties to the Council of Europe's Bern Convention on the Conservation of European Wildlife and Natural Habitats. The draft Recommendation to members can be accessed here. The key will be in the implementation, but the words of the document are significant. It concludes with the following statement:

[The Committee] RECOMMENDS Contracting Parties to the Convention, and INVITES Observer States and Organisations, to:
1. Devote special attention to Fungi and micro-Fungi in the implementation of their international obligations and also in the achievements of the 2020 targets adopted in the framework of the Convention of Biological Diversity;
2. Take into consideration the European Charter on Fungi-gathering and Biodiversity and apply its principles in the elaboration and implementation of their policies related to the sustainable use of biodiversity;
3. Inform the Standing Committee on the measures taken for the implementation of this recommendation.

If you are a citizen of the Bern convention states, then make sure your Government takes notice!

Ahmed Abdel-Azeem (on left) and colleagues spread the word in the Arabian peninsula…..

Fungi, keystones of evolution and earth processes

Here follows a meeting report by Alison Pouliot (alison.pouliot@anu.edu.au) *published on the Australian Fungimap website* (http://fungimap.org.au/).....

Fungimap folk are well aware of the challenges for a mushroom in a fauna-and-flora-centric world. Along with the trials of rapidly changing environmental conditions on local and global scales, there are also socio-cultural factors of trying to increase public and political awareness of the kingdom Fungi. The Fungimap Conservation Committee and interested individuals are working to improve the profile and conservation of fungi in Australia. One approach is to look at what's happening in fungal conservation elsewhere in the world.

The British Mycological Society, British Lichen Society and Linnean Society of London recently held a meeting, 'Fungi, keystones of evolution and earth processes'. The diverse program aimed to engage a broad audience on the role of fungi in terrestrial evolution; their diversity, interactions and ecological significance; as well as address scientific and political conservation issues. Advancements in molecular taxonomic techniques and the value of fungi in the global economy were also presented.

Fig. 1. Ectomycorrhizal pine tree grown in a root observation chamber on natural soil at the University of Sheffield. Image © Prof. JR Leake and Dr DP Donnell.

The symposium opened with a journey back in geological time with Jonathan Leake asking us to consider the evolutionary history of fungal-symbioses and the significance of mycorrhiza in driving biogeochemical cycles.

Bryn Dentinger, head of mycology at the Royal Botanic Gardens (RBG) Kew, then discussed the difficulty of estimating fungal diversity and the daunting reality that fungal extinction rates likely exceed rates of discovery and description. He also explored the promises and pitfalls of next-generation sequencing, particularly in the context of unseen and cryptic biodiversity.

FIG 2. A tiny selection of fungal diversity collected from an Ecuadorian cloud forest. Image © Bryn Dentinger

FIG 3. Bow Cottage on the Holnicote Estate, Exmoor Somerset. Thatched roofs like this can hold treasure-troves of pre-industrial materials. Image © Dr Rebecca Yahr

Peter Crittenden and Rebecca Yahr both presented cutting edge lichen research. Peter discussed lichen dominance in boreal-artic environments and their role as principal primary producers in these systems. Rebecca reported on her lichen research on the building materials of pre-industrial English houses, lifting the lid on the huge magnitude of biodiversity losses in the temperate zone before descriptive science had really been born. Paul Cannon and James Wearn from RBG Kew introduced us to the role, significance and exploitation of endophytes, reminding us that almost every leaf in every corner of the world contains endophytic fungi! David Minter gave us a fervent yet worrisome update on the current representation of fungi by various conservation organisations, highlighting the commonplace disregard for and misrepresentation of fungi.

In the evening, truffle expert Jim Trappe delivered an interesting exploration of how Australia came to be the centre of global truffle evolution and the curiosities of mammalian mycophagy. Contemplating such evolutionary significances seemed especially apt in the room (according to the commemorative plaque) where Charles Darwin and Alfred Russel Wallace first discussed the concept of the origin of species by natural selection. However, apparently this was not the case and neither Darwin nor Wallace were actually present at that historic meeting and their paper was read to the Fellows by Lyell and Hooker. All the same, the historical setting added an interesting dimension to discussions on a kingdom that had yet to be properly recognised or defined in their time.

FIG 4: Truffle expert Jim Trappe at the Linnean Society. Image: Alison Pouliot.

Following the conference I visited RBG Kew and the appropriately named Fungarium that houses over 1.2 million specimens. Bryn Dentinger and Begoña Aguirre-Hudson share the formidable task of decrypting 'fungal identity', compounded by the subjectivities of interpretation, hieroglyphics of mycologists' handwriting, and a further dimension introduced by recent molecular approaches.

FIG 5: Fungal specimen collections at the RBG Kew Fungarium. Images: Alison Pouliot

FIG 6: Fungal sculptures by Tom Hare. Images: Alison Pouliot

Wandering through the gardens later in the afternoon, I stumbled across a cluster of *Craterellus cornucopioides* towering an astonishing three metres high! Meanwhile up on the hill, giant *Coprinus comatus* had begun to deliquesce. These particular specimens were in fact woven from willow by sculptor, Tom Hare. Fungal conservation needs ways to access new advocates and the arts play an important role in increasing the visibility of these often less visible organisms, as well as re-enchanting the fungal world. Hare has arguably captured both an intriguing aesthetic while maintaining a level of morphological accuracy.

The 7th of November marks a century since Alfred Russel Wallace's death. I wonder how this revolutionary naturalist, renowned for his unconventional ideas and interest in both scientific and social issues would tackle the challenges of biodiversity loss in 2013. While fungal conservation issues are inevitably complex, solutions are also likely lie in unconventional and imaginative ideas that incorporate both scientific and social approaches.

**Many images available for use, please contact Alison for details. Thanks to Prof. JR Leake, Dr DP Donnell, Dr Bryn Dentinger and Dr Rebecca Yahr for the use of their images in this blog.*

Thanks also to Paul Cannon, David Minter and David Hawksworth for organising the symposium. The full program of talks is available here.

Announcement: 26th Congress on Nivicolous Myxomycetes

Yannick Mourgues (AMHVO) and Marianne Meyer & Espérance Bidaud (FMBDS):
Email contact myco48@gmail.com

L'Association Mycologique de la Haute Vallée d'Olt (AMHVO) et la Fédération Mycologique et Botanique Dauphiné-Savoie (FMBDS) sont heureux de pouvoir vous inviter à la 26ème session des journées d'étude et de recherche des espèces nivicoles des Myxomycètes. Celle-ci aura lieu dans le département des Hautes-Alpes (05200) dans la commune d'Embrun, du dimanche 4 mai (arrivée à partir de 16h00) au vendredi 9 mai 2014 (départ après le déjeuner), au Village Vacances du Chadenas (chadenas-vacances.com).

Sites de prospection :
Les sites de prospections dépendront des conditions météorologiques, d'enneigement et d'accès, et seront définitivement sélectionnés la semaine précédente. Ils seront choisis pour l'essentiel à moins d'une demi-heure de route de l'hébergement : Col de la Coche, Station de ski de Crévoux, Mont Guillaume, Vars… Le mercredi sera consacré à une sortie à la journée.
Le programme sera annoncé le dimanche soir de votre arrivée.

Articles

Bringing fungi into the conservation conversation: The Global Fungal Red List Initiative

Gregory M. Mueller[1], Anders Dahlberg[2], and Michael Krikorev[2]
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[2]Swedish Species Information Center, Uppsala, Sweden

Species of fungi are not immune to the threats that put animal and plant species at risk, i.e., habitat loss, loss of symbiotic hosts, pollution, over exploitation, and climate change. Yet fungal conservation is not yet commonly discussed, considered, or acted upon by the conservation community, and the conservation status of the vast majority of fungal species has not been assessed. This greatly hinders the inclusion of fungi in conservation discussions, access to funding programs, policy decisions, and conservation actions.

Conservation scientists, land managers, and other decision makers need information on the conservation status and trends of organisms to carry out their work. The IUCN Red List provides this information. The Red List is widely recognized as the most comprehensive, objective global approach for evaluating the conservation status of animal, fungus and plant species. It has a large impact on the setting of policies and priorities in nature conservation as conservation action is commonly motivated and directed to species on the established and recognized Global Red List. However, only three species of fungi are included among the 21,286 globally red listed species, two lichens and one mushroom http://www.iucnredlist.org. The List is developed through data submitted by organizations and individuals, and to date, there has been a lack of initiatives nominating fungal species from the mycological community.

A concerted effort by the mycological community is needed to address this problem. Omission of fungi in Red Lists invites the mistaken conclusion from conservation agencies that fungi are either not threatened, are difficult to work with in conservation, or worse, that mycologists are not interested in fungal conservation. Including fungi on the Red List communicates the presence and value of fungi to politicians, decision-makers and other stake-holders including the public at large. Red list evaluations also identify gaps in our knowledge of fungal biology and diversity – e.g., taxonomic problems, distribution and autecological requirements, difficulty of identifying and defining individuals, and, challenges of determining the drivers and constraints on population dynamics.

Even though fungal conservation has attracted significant interest in Europe since the European Council for Conservation of Fungi (ECCF) was formed in 1985, fungal conservation at the international level is a relatively new focus for both the mycological and conservation community. Until recently, fungi were classified as one group under plants in the IUCN Species Survival Commission (SSC) hierarchy. The elevation of Fungi to an independent area of focus with five discrete SSC Specialist Groups during the 2009-2012 quadrennium was an important advance http://www.iucn.org/about/work/programmes/species/who_we_are/ssc_specialist_groups_and_red_list_authorities_directory/fungi/. Significantly, IUCN members passed a resolution during the 2012 World Conservation Congress calling for "… all of the component parts of IUCN … and the

conservation movement more generally, to place much greater emphasis and priority on the conservation of fungi …" (Box. 1).

Box 1. Action items from IUCN Resolution 33 overwhelmingly passed at the World Conservation Congress. The full text of the resolution can be found at: https://portals.iucn.org/docs/iucnpolicy/2012-resolutions/en/WCC-2012-Res-033-EN%20Increasing%20the%20attention%20given%20to%20the%20conservation%20of%20fungi.pdf

The World Conservation Congress, at its session in Jeju, Republic of Korea, 6–15 September 2012:

1. CALLS ON all of the component parts of IUCN, including Members, Commissions and the Secretariat, and the conservation movement more generally, to place much greater emphasis and priority on the conservation of fungi, and to recognize that fungi constitute a kingdom in their own right, and so the much-used phrase "animals and plants" is not a sufficient description of all life on Earth;

2. REQUESTS SSC, working with Members and partners as required, to greatly increase the number of fungal assessments for the *IUCN Red List of Threatened Species*, focusing, among others, on:

    a. species dependent on highly threatened places, habitats or associations, and so which are *a priori* likely to face high extinction risk;
    b. species for which extinction risk data have already been compiled, e.g. the 3,117 North American taxa for which data are maintained by NatureServe;
    c. groups of fungi that are believed to be effective indicators of the impacts of major threatening processes such as nitrification;
    d. well-known, charismatic fungi, including those of high value as food for humans; and
    e. statistically representative samples of some of the better known fungal groups; and

3. CALLS ON all governments to give greater priority to mycology, including mycological taxonomy and the discovery and description of currently unknown species, and to underline the importance of building greater capacity in the science of mycology worldwide as an essential basis for future conservation measures.

There are now a number of national and regional fungal conservation committees, and the International Society for Fungal Conservation was formed in August 2010. Symposia on fungal conservation have now been held during several national and regional conferences and the 3rd International Congress on Fungal Conservation took place in Turkey 11-15 November 2013 http://www.fungal-conservation.org/icfc3/. These are all important steps, but much more is needed to coordinate this growing awareness and interest, and to provide a program for interested mycologists to contribute to conservation efforts. To this end, the five IUCN SSC Fungal Specialist Groups, with the collaboration of the IUCN SSC office and Red List Unit, and funding from the Mohamed bin Zayed Species Conservation Fund, have developed the "Global Fungal Red List Initiative.

THE GLOBAL FUNGAL RED LIST INITIATIVE

The Initiative is designed to significantly add to the number of fungal species evaluated and submitted for inclusion on the IUCN Global Red List. The initial goal is to engage the mycological community (professional and amateur) and assess at least 300 fungal species by the end of 2015, ensuring global representation and coverage of all major taxonomic groups. Nominations of fungal species (including lichens) to be assessed, along with data required for making the assessment, are needed by the end of 2014 to meet this deadline. Details of the initiative were presented at the 2013 fungal conservation congress in Turkey. The Initiative was well received. The exciting challenge will be to get as many mycologists / lichenologists to contribute with their indispensable knowledge during 2014. The success of this initiative depends on contributions from many in the mycological community.

The results of this initiative will highlight that:

- Fungi are in need of conservation
- Fungi can be, and need to be, part of the broader conservation agenda

The initiative aims to raise the awareness of fungal conservation among policy makers, the conservation community, mycologists, and the general public. It will serve as forum to educate, inspire, and engage the mycological community. The work will integrate fungi into general conservation initiatives and open up funding opportunities to address listed fungal species.

The initiative consists of five steps: (1) develop a list of species to assess, (2) collect the data needed for assessment, (3) undertake a preliminary assessment and identify data gaps; develop the finalized list of species to be fully assessed, (4) perform assessment on the finalized list of species and submit the results to IUCN for publication in the Global Red List, and, (5) disseminate the information to the conservation and scientific community, and policy makers, publicize the results to the general public, and build upon the work to further conservation efforts.

Develop a list of species to assess and collect the data needed for assessment.
Nominations of species for evaluation are encouraged from all members of the mycological / lichenological community (professional and amateur). Species are nominated through the Initiative's interactive website http://iucn.ekoo.se/. On this site, one can nominate species and/or add information to nominated species to ensure accuracy and completeness. The site facilitates submission, adding comments, and formatting of data and images required for assessing the conservation status of the nominated species.

The goal is to both develop a list of candidate species that are likely to be globally red listed if evaluated, and to engage as much of the mycological community as possible. Rather than make *a priori* decisions on which taxa or how many species to assess, the initiative encourages community involvement with a goal to develop a list that is taxonomically and geographically inclusive and that includes a sufficient number of good candidate species to ensure that a significant number of species will be assessed. Recommendations for prioritization of species to nominate are provided in Box 2.

Undertake a preliminary assessment and identify data gaps; develop the finalized list of species to be fully assessed. The five Fungal Specialist Groups, with the help of the IUCN Red List Unit, will use the data submitted through the website to undertake a preliminary assessment and identify data gaps.

A red list evaluation estimates the potential change in the species' population size over time, aiming to infer extinction risk. Data on the species distribution, population size, population trends,

generation length, and risks are needed to make an assessment. Dahlberg and Mueller (2011) summarizes the basic aspects and usefulness of red-listing in a mycological context, and suggests methods for fungal red-listing that are applicable to most fungal groups, even with limited information on the species being considered.

Box 2. Suggested prioritization of species to nominate for assessment through the Global Fungal Red List Initiative. This initiative aims to get as many fungal species assessed and published on the global IUCN Red List in 2014 and 2015 as possible. Therefore, nominations of species with adequate information on their ecology, distribution, population status and trend that are likely to be globally red listed if evaluated are encouraged.

1. Focus on:
   a. Species that are rare and/or that have very restricted distributions.
   b. Species dependent on highly threatened places, habitats or associations as they are *a priori* likely to face high extinction risk.
   c. Species that are regionally widely distributed but are typically found in low abundance and that are steadily declining due to habitat decline (in area and quality) or other causes.
   d. Species for which extinction risk data have already been compiled at a national or regional level; thousands of macrofungi, lichenized fungi, and other fungal groups are included in individual country red-lists.
   e. Groups of fungi that are believed to be effective indicators of the impacts of major threatening processes such as changing land use and nitrification.
   f. Well-known, charismatic fungi, including those of high value as food for humans.

2. Exclude:
   a. Species with far too little data to be evaluated (these would be treated as NE, Not Evaluated).
   b. Species that can confidently be judged as having large, stable or increasing numbers of localities/populations (these would be treated as Least Concern, LC).
   c. For regional and national red lists, species with taxonomic uncertainties, that are not indigenous, or that are only recently described (e.g., not regularly reproducing for less then 10 years) (these would be treated as NA, Not Applicable).

Information from this preliminary assessment, together with the data forming the basis for the evaluation (e.g., global distribution map, ecological information, description of threats, references etc.) and photos will be available on the website. The community can supplement the pre-assessments with additional data and/or comments. The finalized list of species for evaluation will consist of all the nominated species for which adequate data are available. Formal assessments will be undertaken by members of the Fungal Specialist Groups, selected other mycologists, and IUCN SSC and Red List Unit staff. The IUCN facilitators will ensure that the assessments meet all the documentation requirements. Assessments will be completed before March 2015 to meet the submission deadline required to have the species published on the IUCN Global Red List by autumn 2015.

Disseminate the information to the scientific and conservation community, publicize the results to the general public, and build upon the work to further conservation efforts. Having species on the published IUCN Red List is not the end to the process. Significant media attention will be possible when a large numbers of fungi are included in the yearly updates to the Red List. Additionally, the Red List website provides various ways for different audiences (general public, media, conservation

scientists, policy makers) to learn about the value of fungi and threats to their survival (http://discover.iucnredlist.org). Other sites like Arkive (http://www.arkive.org) and the Encyclopedia of Life (http://eol.org) use data from the Red List to reach additional audiences.

This is an exciting and important time for fungal conservation. Fungi have the attention of IUCN and other conservation organizations. It is critically important that the mycological community takes advantage of the opportunities that this attention affords. The Global Fungal Red List Initiative is a key component of the activities needed to significantly move fungal conservation forward.

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The Fungi Museum in Zagreb, Croatia

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Last autumn a permanent exhibition of fungi, conceived as an education facility and museum, was established in a central location in Zagreb, Croatia. This unique facility is now open to the public - albeit so far only by arrangement as it is not fully staffed as yet. Founded and financed by Zagreb City Council in collaboration with "Kamilo Blagaić" Mushroom Society, the museum is a brainchild of Croatia's foremost mycologist, Professor Romano Božac, who will direct the institution.

Part of exhibition area


VELIKA GNOJIŠTARKA
Coprinus comatus(Mull.ex Fr.)S.F.Gray
IZVRSNA (Choice)

Fungi for display are freeze dried in a laboratory freeze dryer, donated by the Croatian Chamber of Commerce. The process permanently retains the shape and colour of specimens remarkably well.

So far there are 500+ taxa on display, with more in deep freezers awaiting their turn in the freeze dryer, and additions arriving regularly from some of 3000 collectors across Croatia.

Amongst the displayed photographs by Prof. Božac (see right)there is one of his truffle hunting dogs. On one occasion they had found a specimen of a novel species of the black truffle, since named *Tuber donnagotto,* after the dogs, Donna and Gotto.
There are other new taxa already on display, including *Pluteus aurantiogranulatus* and *Calocybe gambosa* var. *cinerea*.

See also the following links:
http://www.zagreb-touristinfo.hr/?id=159&solo=1208&l=e
http://www.gdkb.hr/aktualno/overview/77
http://www.gdkb.hr/edukacija

A good candidate for International Fungus Day

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Temple of Hathor, Dandara, Qena, Upper Egypt.

Documentation of the world fungi may be dated back to 4500 B.C., when ancient Egyptians produced a number of hieroglyphic depictions of plants (many of which are psychedelic) on walls and within texts throughout Egypt. Temples with countless pillars are shaped like huge mushrooms with tall stems, umbrella caps, and mushroom engravings distributed all over the country. These are shaped like *Amanita* sporophores, and some like *Psilocybe*. Others look like bracket fungi and are decorated with pictures of an incredible variety of plants (Arthur 2000). In the Egyptian Book of the Dead, the Papyrus of Ani (Budge 1967), mushrooms are called "the food of the gods," or "celestial food" and "the flesh of the gods."

The **Great Temple** at Abu Simbel, which took about twenty years to build, was completed around year 24 of the reign of Rameses the Great (which corresponds to 1265 BCE). It was dedicated to the gods Amun, Ra-Horakhty, and Ptah, as well as to the deified Rameses himself. It is generally considered the grandest and most beautiful of the temples commissioned during the reign of Rameses II, and one of the most beautiful in Egypt.

Four colossal 20 meter statues of the pharaoh with the double Atef crown of Upper and Lower Egypt decorate the facade of the temple, which is 35 meters wide and is topped by a frieze with 22 baboons, worshippers of the sun.

It is believed that the axis of the temple was positioned by the ancient Egyptian architects in such a way that on October 22 and February 22, the rays of the sun would penetrate the sanctuary and illuminate the sculptures on the back wall, except for the statue of Ptah, the god connected with the Underworld, who always remained in the dark. People gather at Abu Simbel to witness this remarkable sight, on October 21 and February 21.

These dates are allegedly the king's birthday and coronation day respectively, but there is no evidence to support this, though it is quite logical to assume that these dates had some relation to a great event, such as the jubilee celebrating the thirtieth anniversary of the pharaoh's rule.

In fact, according to calculations made on the basis of the heliacal rising of the star Sirius (Sothis) and inscriptions found by archaeologists, this date must have been October 22. This image of the king was enhanced and revitalized by the energy of the solar star, and the deified Ramesses the Great could take his place next to Amun Ra and Ra-Horakhty.

Due to the displacement of the temple and/or the accumulated drift of the Tropic of Cancer during the past 3,280 years, it is widely believed that each of these two events has moved one day closer to the Solstice, so they would be occurring on October 22 and February 20 (60 days before and 60 days after the Solstice, respectively).

Based on the aforementioned information I suggested the international fungus day to be on October 22. This is due to the role of Egypt in documentation and conservation of fungi since ancient time and I think Ramses II is one of the famous pharaohs and solar event in The **Great Temple** at Abu Simbel is a cosmopolitan one.

Journey Across Fungal Conservation in Serbia

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The first issue of Fungal Conservation carried a very interesting article (Abdel-Azeem & Minter 2011) providing an analysis and evaluation of the extent to which fungi and care for their conservation featured in national action plans and reports which countries had drawn in accordance with Rio Convention. A clear and simple five-criterion rating system was presented, named the Micheli Guide to Fungal Conservation. We were given yet another welcome tool that mycologists may use to exert more influence on those responsible for creating the actual policy of conservation of nature and biodiversity. Under the Micheli Guide rating system, Serbia was given the leading position among various countries on account of its concern for fungi in its national biodiversity action plan. Since we are talking about a country that has recently gone through very difficult times, a positive rating of official national documents may have come as a surprise to those unacquainted with the mycological tradition in this country and the efforts to protect the fungi made in the past two and a half decades. However, if we look at the last hundred or so years of mycology in Serbia, we will see a delicate thread woven by a small number of mycologists. Despite circumstances, continuity has been preserved, and Serbian mycologists today endeavour, standing on the shoulders of their predecessors, to protect the rich world of fungi and preserve it for future generations.

Foundations and tradition

In Serbian culture and tradition, people neither like nor dislike mushrooms, with respect to their use as food. It is worth noting that various kinds of mushrooms may be bought on local market stands. Language is fairly rich in folk names for various mushrooms (Hadžić & Vukojević 2008; Vukojević & Hadžić 2013), and ethnographic literature abounds in very old data on fungi (Ivančević 1986). We owe tremendous respect to the pioneers of mycology from the 19th and early 20th centuries in Serbia. They worked under far more difficult conditions than their counterparts in western Europe, with whom they collaborated at the time of dynamic development of mycology as a new biological discipline. Numerous fungal taxa related to Serbia, even some fungal genera, were named after local mycologists in honour of their work, such as *Wojnowicia* Saccardo 1892 or *Ranojevicia* Bubak 1910.

Vojteh Lindtner, 1904-1965, a mycologist who discovered and described many new fungal taxa in Serbia and founded the National Herbarium of Fungi.

In the course of the 20th century, the territory of Serbia became part of Yugoslavia. There were many researchers studying different groups of fungi, lichens, pathogenic fungi, wood-decay fungi, macromycetes, myxomycetes (ex fungi), fungal ecology, physiology or biochemistry of fungi, etc. We shall mention here only the towering figure of Vojteh Lindtner, owing to whose hard work the largest mycological collection in the former Yugoslavia was compiled at the Natural History Museum in Belgrade (BEO) between 1935 and 1965. Today this collection forms the central part of the Serbian National Fungarium, boasting several tens of thousands of samples, a large number of holotypes, isotypes, topotypes and other valuable specimens including the oldest specimens collected by researchers from 19 century. Many new species were described by Lindtner himself or in cooperation with other mycologists. The genus *Lindtneria* Pilát 1938 was named after him, in honour of his work. After Lindtner, the macromycetes of Yugoslavia and Serbia were studied by the esteemed Milica Tortić from Zagreb, whom some

European mycologists will remember with reverence. At the time, mycology was treated mostly as part of botany in schools and universities. However, numerous scientific and research papers on fungi were published.

Professor Maria Muntañola-Cvetkovic, who in the late seventies introduced to Serbia the concept of a separate position of fungi in the living world

Maria Muntañola-Cvetković, a Belgrade University Professor, was the first in Serbia to explicitly recognise fungi as a separate kingdom, in accordance with the tendencies prevalent in the world. Together with her team, she described a dozen new fungal taxa (*Aspergillus aureolatus* Munt.-Cvetk. & Bata 1964; *Penicillium jugoslavicum* C. Ramírez & Munt. 1964; *Aspergillus protuberus* Munt.-Cvetk. 1968; *Diaporthe* / *Phomopsis helianthi* Munt.-Cvetk. *et al* 1981 etc.) and raised an entire generation of mycologists. In her comprehensive survey of new concepts in mycology (Muntañola-Cvetković 1978), she described numerous fungal features differentiating fungi from plants and animals and quoted the then current taxonomic division of the living world according to Ainsworth (1973). That paper and the university textbook on general mycology that followed (Muntañola-Cvetković 1987), paved the road to distinguishing the fungal kingdom from the plant kingdom in the educational system in Serbia. From then on, school textbooks described the fungi as a separate kingdom, and the public began to grow accustomed to that hitherto weird idea. It was an extremely important moment that provided a special position for fungi and their treatment separate from flora and fauna, which finally resulted in a positive assessment in the Micheli Guide!

Flora, Fauna and Fungia

Psilocybe serbica (isotype) exicate from the Natural History Museum in Belgrade – new species found by Meinhard Moser and V. Lindtner in 1963.

The break-up of Yugoslavia had tragic consequences for the whole society, even science (Stone 2000). Mycology continued to develop, albeit at a slower pace. When a comprehensive monograph on biodiversity of Serbia and Montenegro (Stevanović & Vasić 1995) was published, it contained separate chapters on fungi (Ivančević 1995) and lichens (Savić 1995) as separate parts of biodiversity. The book proposed a list of globally significant fungal taxa, for which the state of Serbia should have special responsibility in its territory, as well as specific measures for conservation of these and all other macromycetes and lichens. In order to underscore their uniqueness, the chapter on fungi introduced the term *fungia* as a counterpart to the terms flora and fauna, which has since become current in various publications and scientific papers in Serbia. This book, although nowadays fairly old, has been of enormous importance, as it has since been used as a starting point in making biodiversity conservation strategies and similar documents drawn by the state administration at the national level. Accordingly, the Action Plan evaluated by Azeem & Minter (2011), as stated in the Plan itself (Radović & Kozomara 2011), was built around that study. The Action Plan was issued by the Government of Serbia in compliance with the international agreements and the Serbian Law on Ratification of the Convention on Biological Diversity, and was drawn up by a group of authors. The topics related to biodiversity were covered without involvement of mycologists, but the biologists involved consistently applied the principles on the division of the living world that had been accepted in Serbia. The fungi were therefore treated as a separate kingdom.

Beginning of official fungal conservation

People started picking edible commercial mushrooms on a large scale in Yugoslavia in the mid eighties, mainly for export to Western Europe. Because the greatest part of those mushrooms came from the territory of Serbia, it was in Serbia that the first regulations concerning market control and fungal conservation were made. Those regulations and the measures they provided for were not ideal and they have been amended in the endeavour to achieve an optimum solution for the conservation and management of fungi (Ivančević *et al* 2012). Still, it must be said that it was early on that the state administration made an effort at fungal conservation. The next decade saw the founding of the Mycological Society of Serbia in 1992, the oldest mycological organisation in Serbia, recognised by the Serbian Ministry of Science as the national representative society of mycologists. The Society was presented internationally at the XI Congress of European Mycologists at Kew, London, when Serbia became involved in the work of the ECCF through its national representative (Høiland 1993). The first Preliminary Red List of fungi in Serbia (Ivančević 1998) was compiled and published over the next several years. The academic sphere also began to take more interest in mycology. In addition to the general course in mycology, the Biological Faculty in Belgrade introduced several specialised courses around that time, such as Physiology of Fungi, Basic Biochemistry and Genetics of Fungi, Biology of Medicinal and Edible Fungi, Ecology and Diversity of Fungi, Lichens. The Agricultural Faculty in Belgrade introduced General Mycology course with around 85 students per year, and Mycology was studied in detail at Belgrade faculties of Forestry and Pharmacy, as well as at universities in other cities such as Novi Sad, Kragujevac, etc.

Poster for an exhibition of the Mycological Society of Serbia dedicated to conservation of fungal habitats with earthstars as the flag species, from 2010. Title reads "Do not destroy the forests, for you will extinguish the stars!"

A few years ago, the state administration finally accepted the stand espoused by mycologists that rare and threatened fungi need to be included in the environmental protection programmes. A new Nature Conservation Law (2009) was adopted. Mushrooms were listed as a separate group of organisms, different from and on a par with plants and animals. The provisions relative to the strictly protected species finally allowed inclusion of rare and endangered species of fungi, in addition to the commercial species that had previously been the only ones protected under the Environmental Law. Provisions were also made for some hypogeous species, owing to the recent intensive studies into the truffles. This Law finally allowed for evaluation of fungi to be officially included in environmental protection procedures. The Law provided that fungi on their merit alone could be a reason to single out and protect a certain area, even though other biodiversity components were not under threat. The assessment of the value a certain area holds for its fungal populations has recently been included in regular procedures performed by state agencies dealing with nature conservation and protection in Serbia. Standardised methodology developed for such assessment has recently been presented at III International Congress of Fungal Conservation (Ivančević 2013). Furthermore, under the new Law, protective measures were applied to a forest near Belgrade, covering an area of 21ha, solely due to the fact that it provided habitat to a number of rare fungi and evaluated by mycologists as a Prime Mushroom Area with *Myriostoma coliforme* being the flag species (Ivančević 2005).

The new millennium

Over the past dozen years, several teams in Serbia have been researching successfully the medicinal fungi and their components isolated from the fungi found in natural habitats in Serbia, as well as their antimicrobial and antioxidative effects (Soković *et al* 2006; Glamočlija *et al* 2009; Savić *et al* 2011; Klaus *et al* 2011a,b; etc). Other groups have also been studied, such as myxomycetes, traditionally treated as "honorary fungi". Around a hundred species of myxomycetes have been recorded in Serbia (Ing & Ivančević 2000), and the largest collection is housed in the National Fungarium at the Natural History Museum in Belgrade (BEO). The fungarium also boasts the largest national collection of lichenised fungi, whose distribution and species inventory for Serbia have been studied by Savić & Tibell (2006). New information system and database with GIS capabilities have been developed for the National fungi collection.

The first data on the wealth of truffles in Serbian forests go back to 1777 (Milenković 1998). The recent studies of the distribution of hypogeous fungi and their diversity (Milenković 1998; Marjanović *et al* 2010) are also worth noting. They have resulted in a collection of around 1000 specimens, including more than 70 species and varieties from Serbia, also housed in the BEO, and even a discovery of a new species *Tuber petrophilum*, with an interesting and specific ecology and distribution in a small area in western Serbia (Milenković et al. 2014). The area around the locus classicus of this species was automatically protected under the new law. Nowadays, *Tuber magnatum*, the famous white truffle, is harvested in Serbia and exported to Italy, which is a little known fact.

Around dozen different amateur NGO associations of mushroomers came into being around the turn of the century. These associations have organised over hundred exhibitions of fungi in various public premises and museum galleries throughout Serbia and these exhibitions have invariably attracted huge attention. A number of books and guides to mushrooms for general audiences have also been published, placing the emphasis on the characteristics of Serbian fungi (including Davidović 2007, Hadžić 2002, Hadžić & Vukojević 2008, Radić 2002, Uzelac 2009, Vukojević and Hadžić 2013 and others). These publications followed in the footsteps of similar editions published in Serbia in the times of Yugoslavia, such as "Fungi of Yugoslavia" (Focht 1979). The Mycological Society of Serbia has issued its own general audience science magazine and newsletter World of Fungi (in Serbian). This popularization of mushrooms and their slightly more frequent appearance in the media have made the general public more interested in fungi.

Milestones in the conservation of fungi in Serbia

1978 – The concept of a separate position of fungi in the living world.
1991 – First legal provisions on fungal protection in Serbia.
1995 – New term Fungia instead of "fungal flora" in official document.
1997 – Preliminary Red list of Fungi.
1999 – First legal document to list fungi separately from plants.
2005 – First area officially proposed for protection for fungi.
2009 – First provisions for non-commercial fungi - 107 protected fungal taxa. Rare and threatened fungi included in the official state conservation programmes.
2010–2013 – Assessment of fungal component of biodiversity included in state conservation programmes

The arduous path to the ears of the state administration is certainly not a short or a solitary one. The success Serbian mycology has achieved advancing along that path was recognised under the Micheli Guide. It would be unfair for any single individual to claim the credit for this for themselves alone on

the basis of some recent activities. The progress in Serbian conservation legislation and good Micheli results are a consequence of a long evolution and a serious effort made by a number of dedicated mycologists over several decades. And much more remains to be done for proper fungal conservation that the kingdom of fungi truly requires.

This text does not aim to give a full account and assessment of the tradition and history of mycology and fungal conservation in Serbia, or to cite bibliography of several hundred mycological works stretching from the nineteenth century to the present day. Much has therefore been left out, such as mycological studies in forestry, or numerous individual papers on distribution of macromycetes etc. Our wish was merely to shed some light on this subject and hopefully kindle interest among the readers who had little information about mycology and development of fungal conservation in Serbia.

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Some Critically Endangered Species From Turkey

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Turkey is a large peninsula that situated between south-eastern Europe and Asia. It has three phytogeographical regions which are Euro-Siberian, Mediterranean and Irano-Turanien with different climate features. Diverse topographic structure and a wide range of temperatures have created great macrofungal diversity.

In ongoing taxonomic studies, approximately 2500 species have already been reported from Turkey. Among these species, 272 taxa are categorised and nine species are classified as critically endangered according to IUCN red list guide lines (Işıloğlu et al, 2004). In this study, six of those critically endangered species of larger fungi are described, with information about their habitats and

distribution in Turkey. Their status suggests that their populations are threatened with extinction in Turkey, due to rapid population decline or very small population size (IUCN, 2013).

Disciotis venosa

Fruiting body 5-20 cm across, saucer-shaped to flat and with a short stalk, strongly grainy, veined toward the centre and pale to dark brown. External surface whitish to dark yellow with smooth surface and wrinkled, ribbed towards the base. When fresh fragile, 3-10 mm thick, with an odour like chlorine and mild taste. Grows singly or in group. Paraphyses 8-10 µm, light brown and septate, some of them segmented toward the base. Asci eight-spored, 320×20 µm. **Ascospores** 19-24×12-14 µm, hyaline, ellipsoidal, smooth, sometimes with small droplets at both ends outside the spore wall. **Habitat** among herbs and mossy soil, near the floodplain, hedges. In many years occurring in masses in April-May.

Species name	Collector	District	Year
Disciotis venosa	F. Yılmaz Ersel	İzmir	2004
	A.Afyon	Konya-Derbent	1997
	M. Işıloğlu	K. B Anadolu	1998
	M. H. Solak	Balıkesir	2002
	F. Gücin	Kozak	1995

Geopora cooperi forma cooperi

Fruiting body 1-7 cm across, light to dark brown, globose or partially pulvinate, surface strongly warted, ochre to dark brown, covered with setae. Inner surface cerebriform, hymenium tissue whitish to light brown, odour aromatic with mild taste. **Ascospores** 19-26×13-16 µm, broadly ellipsoidal, smooth, thick-walled with a central oil droplet. **Habitat** commonly under conifers, growing in groups from early spring to late summer and autumn.

Species name	Collector	District	Year
Geopora cooperi forma cooperi	M. H. Solak	İzmir	2002

Myriostoma coliforme

Fruiting body 2-10 cm across, globose. When they mature, the exoperidium breaks into 7 to 14 rays which curve back and push the fruit body up. The inner pseudoparenchymatous layer is fleshy and thick pale yellow to dark brown. **Basidiospores** 4×6 µ in size, brown, globose, irregularly warted. **Habitat** in deciduous forests and mixed forests, gardens and grazed grasslands.

Species name	Collector	District	Year
Myriostoma coliforme	A.Asan	Edirne	2002
	S. Aktaş	Antalya	2006
	H.H. Doğan	Türkiye	2011

Pseudohydnum gelatinosum

Fruiting body 25-50 mm across, flat to flabellar, sometimes conchate, stipitate. Surface rough-furfuraceous, toward margin smooth and crinkly, white or seldom greyish to dark brown. Hymenium whitish, intensely spinose, the spines to 5 mm long. Flesh soft, odourless, tasteless, imbricate. **Basidiospores** 5-6×4-6 µm, hyaline, globose to subglobose, smooth. Hyphobasidia pyriform to oblong, septate, 10-15×7-9 µm, with 4 epibasidia, cystidia not seen, septa with clamps. **Habitat** on very rotten conifer wood, especially on stumps, in summer and autumn.

Species name	Collector	District	Year
Pseudohydnum gelatinosum	F.Gücin	Bursa	1996
	M.H. Solak	K.B. Anadolu	1997
	A.Kaya	Maraş	2006
	M. Abatay	Antalya	1988
	I.Akata	Ilgaz	2010
	C. Öztürk	Karaman	2001
	S. Sümer	Bolu	1982

Sarcoscypha coccinea

Fruiting body 1-7 cm, initially goblet shaped, then cup to saucer shaped or oval, hymenium vermilion to blood red, surface pinkish to ochre, with whitish granular flakes, margin remaining turned inward for a long time, with a short to very long stem, growing singly or in groups. Paraphyses thin, cylindrical, seldom septate, with red granular contents which turn green with iodine. Asci eight-spored, 400-450×12-16 µm, uniseriate. **Ascospores** 30-40×9-12 µm, ellipsoidal, hyaline, smooth, usually with many small droplets. **Habitat** on dead wood and on branches of broadleaved trees, under *Alnus, Acer, Salix* and *Ulmus* in damp places in hilly or montane elevations, also in alder groves; fruiting February-May.

Species name	Collector	District	Year
Sarcoscypha coccinea	M. H. Solak	Çanakkale	2003
	M. H. Solak	K.B. Anadolu	1997
	A.Pekşen	Samsun	2000
	A.Pekşen	Samsun	2003
	K.Gezer	Antalya	2000
	M. Işıloğlu	Antalya	1997
	K. Gezer	Denizli	2007

Tricholoma sulphureum

Fruiting body 2-8 cm across, when young hemispherical, then convex, sometimes conic, margin acute, surface smooth, dull, sulphur yellow to ochre brown and floccose toward the center. Flesh sulphur yellow, thin, with a disgusting odour, taste mild. Lamellae sulphur yellow, broad, notched, margin smooth. Stipe 25-90 × 8-20 mm, cylindrical, ventricose or clavate, sulphur yellow with grey to purple-reddish longitudinal fibrils, base whitish, corticate, fragile. Solitary to gregarious. **Basidiospores** 8-11×5-7 µm, hyaline, broadly ellipsoidal to amygdaliform, smooth. Basidia with 4 sterigmata and clamp connection, 35-45×9-10 µm and cylindric-clavate. Cystidia not seen. Marginal cells hyphoid, 21-26×2-4 µm. **Habitat** in hardwood and coniferous forests, among leaf or needle litter, summer and autumn.

Species name	Author	District	Year
Tricholoma sulphureum	F.Yılmaz	Balıkesir	1997
	M.H. Solak	Balıkesir	2002
	D. Yağız	Karabük	2005
	A.Afyon	Konya-Beyşehir	1996
	E.Turgut	Samsun	2006
	A.Pekşen	Samsun	2003

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Some Endangered Taxa From Turkey

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In this study, four endangered Turkish macrofungi taxaare presented, with descriptions and distributions.

In recent decades, according to the IUCN Red List categories and criteria, fungal red-list assessments have been produced in many European countries. The Endangered category includes species considered to be facing a very high risk of extinction in the wild, and it is determined according to criteria such as reduction in population size, area of occupancy, and/or a population size estimated to number fewer than 250 mature individuals. In Turkey, a total of 25 macrofungi species are in this endangered category (Işıloğlu et al., 2004).

Abortiporus biennis

Fruiting body turbinate, also irregularly undulating and lobed when old, 85-215 mm in diameter. Upper surface of pileus smooth, indistinctly undulating to partially pitted, velutinous-tomentose, firstly whitish, then ochre to brown, margin thin and undulating-lobed, white before, spotting red-brown when handled or brushed, lower surface labyrinthine-porose, at first whitish, blotched reddish-brown when damaged, pores 0.3-1 mm diam., tube length 2-5 mm. Stipe cylindric-conic, average 25 mm thick, 60 mm long. **Basidiospores** 4-6×3-4.5 µm, ellipsoidal, smooth, hyaline, thin-walled, with drops. Chlamydospores 3-5×3-4 µm, subglobose, thick-walled, with drops. Basidia narrowly clavate, 17-34 × 4.5-6 µm, with 4 sterigmata and basal clamp. Gloeocystidia cylindrical, 30-100 × 6-10 µm, containing drops. **Habitat** on soil in pastures, gardens, park grounds and forests, always associated with buried wood such as stumps.

Province	**Collector**	**Year**
Muğla(Akyaka)	M.Işıloğlu	1995
Artvin (Ardanuç-Cevizli)	K.Demirel	1999
Karaman-Alanya	H.H.Doğan et al.	2005
Kahramanmaraş (Hacıömer village)	A.Kaya et al.	2009

Lactarius luteolus

Cap convex, 3-6 cm across, buff becoming brownish in age, velvety, dry, with a white bloom. Gills white to cream, becoming yellowish to brown when handled, adnate to subdecurrent. Stem 20-60 x 5-10 mm, whitish to buff spotting brown, dry, with a bloom. Flesh whitish spotting brown. Latex white, plentiful, sticky. Odour strong and foetid. Taste mild. **Basidiospores** 7-8.5 x 5-6 µm, ellipsoid, amyloid, ornamented with isolated warts, spore print white to cream. **Habitat** on soil in broadleaved and mixed woods.

Province	**Collector**	**Year**
Trabzon(Maçka)	E.Sesli	1993
Giresun (Dereli)	E.Sesli	2002
Trabzon	M.Işıloğlu et al	2004

Leucocoprinus brebisonii

Cap 2-3 cm across, hemispherical when young, then flattened, slightly umbonate, the whole cap is dark brown to nearly black when in bud, cuticle breaking into minute erect scales as the cap expands. **Stem** 25-50×2-4 mm, fibrillose, pure white with membranous ring and blackish scales towards the base. **Flesh** white and thin. Smell strongly fungusy. **Gills** free, crowded, pure white. **Basidiospores**:

broadly elliptic or ovoid with a germ-pore 6-8.5 x 4-5 µm. Spore print white. Cheilocystidia thin-walled, clavate to obtusely fusiform, hyaline, surface squamules formed of tufts of elongated hairs. **Habitat** in coniferous woods, in autumn.

Province	**Name of Author**	**Year**
Osmaniye (Zorkun Yaylası)	M.Işıloğlu and N. Öder	1995
Malatya	M.Işıloğlu and N. Öder	1995
Antalya (Düzlerçamı, Kemer,Alanya)	K.Gezer	2000
Tokat	İ.Türkekul	2000
Balıkesir	M.H.Solak et al.	2002
Çanakkale (Kazdağı, Bigadiç)	M.Öner and T.Gezer	2004
İzmir (Kozak plateau, Yukarıbey village, Çamurluklar area	F.Yılmaz Ersel and M.H.Solak	2004

Pithya vulgaris

Fruiting body 4.5-15 mm across, cup or disc-shaped, hymenium pale yellow to orange, smooth, outer surface and margin lighter and frosted with white, base with white felty mycelium, rather short-stemmed. Asci 8-spored, 210-285 x 11.5-15 µm. Ascospores 10.5-15 µm, hyaline, smooth, normally with one guttule. Habitat singly or gregariously in mixed forest of *Abies* sp. and *Cedrus libani*.

Province	**Name of Author**	**Year**
Karaman (Ermenek Damlaçalı District)	H.H.Doğan and M.Işıloğlu	2002

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Fungi from forests for food, medicine and livelihood: conservation issues in India

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Human activities have caused an unprecedented decline in biodiversity during the past half-century. The growth of large urban areas, construction activities such as dams, buildings and roads, encroachment on vast areas of forest lands for extension of arable expanses and mining operations are examples of direct onslaughts on nature which have steadily depleted biodiversity. Beside this natural calamities like landslides, and cloud bursts in the fragile Himalayan region is disturbing the habitat of many fungi. Unsustainable collection and overexploitation of biological resources further aggravates the situation. Further, poorly controlled legal trade and illegal trafficking pose threats to *in situ* conservation of biodiversity.

Fungi are the source of food, medicine and livelihood for the people living in and around Indian forests. There are many edible and other fungi (mushrooms) collected, consumed and also marketed in these areas. Unsystematic collection leads to overexploitation and may result in extinction of one or more species.

***Termitomyces* spp.**

Some edible fungi collected and sold in the tribal markets in central India during growing season (monsoon months) are species of *Termitomyces* associated with termite fungal combs and mounds (Harsh et al. 1996, 2000). Our studies revealed that nearly 2.5 tonnes of this mushroom were estimated to be sold in 15 local tribal markets in central India during one growing season (Harsh et al. 1993). It has been observed that over the years the quantity coming to the market is on decline. It came to the knowledge that ant hills (termite mounds) are worshipped by the tribal in central India on a special day during rainy season called *Nag Panchami* (Nag = Cobra; Panchami = fifth day of *Savan* (July – August) month of the Hindu calendar) as they are believed to be the homes of cobras. It is also a tradition among these people that *Termitomyces* growing on those ant hills which are worshipped are neither collected nor eaten. On hindsight it may be considered as a conservation approach for the fungus.

Termitomyces heimi being sold in a tribal market in central India

Astraeus hygrometricus

Another wild fungus which is collected and sold in market in tribal areas in central and north India is *Astraeus hygrometricus*, locally called as *phutphuta* or *putput*. It occurs in the forests of *Shorea robusta* trees. It is among the first edible fungi to appear in rainy season (July – August). Women, men and children are involved in collection and sale. Nearly 200 kg was brought this year in one location in Uttar Pradesh – Gorakhpur market (information shared by Mr. Mohammed Juber, a local mushroom enthusiast). It is cooked and tastes like egg curry. It has been observed that its excessive collection is impacting on tree health because its subterranean nature means that sporophores are dug up, thus disturbing the soil cover which gets further eroded in following rains thus exposing the roots to desiccation and injuries. A field forester informed that more fruit bodies are observed after fire on the forest floor. As the fungus grows in ectomycorrhizal association with its host tree *Shorea robusta*, any adverse effect on the tree would certainly affect the fungus.

Astraeus hygrometricus being sold in the market

***Morchella* spp.**

Morels (*Morchella esculenta*) are edible fungi collected from hills of north India which have great global significance due to their extraordinary taste and flavour. Nearly 65 tonnes of dry morels are exported to international markets from India. However, recent reports suggest that the quantity is declining. While climate change is attributed to this decline, overexploitation and habitat destruction cannot be ruled out. *Morchella* spp. growing are among the most valued wild mushrooms in Western Europe, particularly France, Germany, Italy and Switzerland. International trade in dried morels is estimated to be 150 tons annually. The suppliers are India, China, Turkey, Pakistan, North America and Eastern Europe. Pakistan and India are the main producing countries, each producing about 50 tonnes of dry morels annually (equivalent to fresh morels of 500 tonnes), all of which is exported. Total world trade in morels is of the order of US$ 50 to 60 million (FAO 1995). In Himachal Pradesh and Jammu & Kashmir, two north Indian states, morels (*gucchi*) are collected systematically during the growing seasons (spring and sometimes after rainy season) and sold to established markets both fresh and as dried mushrooms (Kumar & Sharma 2010). Online sale occurs from Himachal Pradesh (such as www.alibaba.com; www.tradeindia.com; www.agriculturesource.com).

Morchella esculenta (photo source ohapbio12.pbworks.com)

Morels are the only fungi which have been given legal status in India as Minor Forest Produce, in Himachal Pradesh (one of 38 permitted - GOVERNMENT NOTIFICATION NO. FFE-B-G(9)-9 / 94- II DATED 28.2.2003). The Pradhans (Village Heads) of the Gram Panchayats (Village Bodies) in Himachal Pradesh have been given the right as Forest Officers to issue permits for transport of minor forest produce collected from the forests in the concerned panchayats (the Himachal Pradesh Forest Produce Transit (Land Routes) Rules, notified vide Notification No. Fts. (A)/3-1/77 dated 20.11.1978 and published in the Rajpatra, Himachal Pradesh (Extra Ordinary) dated 4th March, 1978). The local panchayat charge a fee of Rs.10,000 per 100 kg for selling morels in the market. But a major chunk of the produce reaches the market clandestinely, an official said.

A news item appearing in one of the national newspapers 'The Times of India' (March 04, 2013) reported "Climate change takes toll on morel mushroom" as it states that guchhi (morels) are disappearing fast from the mountains. The environmental changes have apparently taken a toll on the traditional earnings of hundreds of people in Himachal, who used to collect and sell guchhi in the spring season. The news item quotes a local gucchi collector Mr. Chande Ram of Manali that until a decade back, guchhi used to grow everywhere - in orchards, fields and jungles but it was already March and there was no sign of guchhi anywhere. He further attributes that the environment is changing and the disappearing gucchi may be part of that change. The news report says that the

spring season last year had also noticed a big decline in guchhi production despite good snowfall and this year (2013) the traders believe that the decline shall continue as lower area orchards have no gucchi. The paper has quoted a local gucchi trader Mr Guman Chand who said "Nobody will believe that I used to collect nearly 50 kg dry guchhi from villagers nearby 15 years back. Last year, I had collected only 3.5 kg. I am sure it will disappear completely in the next 10 years".

Ophiocordyceps sinensis

Caterpillar fungus (*Ophiocordyceps sinensis*) collected from the alpine meadows of the Himalaya is collected and fetches good prices in Chinese markets. The scenario is such that whole villages (nearly 80 per cent population) except elderly and small children go and stay in the alpine meadows taking makeshift tents, beddings and food to sustain for nearly three months as soon as the snow starts melting in March – April in these areas for collection (Negi et al. 2006). Before 1995 there were only a few collectors and they did not use to get a good price, however, the number of collectors as well as the harvest kept on increasing till 2007. Members of the families come back on leave from jobs so that they can contribute to *O. sinensis* collection due to its higher economic return. A primary collector can collect about 45 to 55 mummified larvae and fungus in a season. In Munsyari market in Pithoragarh district in north India alone nearly 90 kg of the produce was sold in 2009. About 300-500 kg of *O. sinensis* per annum illegally traded from Dharchula (India) to Nepal and finally to International market. The sources reveal that the collection is declining gradually after 2007 as the number of collectors are increasing every year and disturbing the habitat and fragile ecology of the Himalaya. The state government has put in place a policy for collection of this fungus through local village cooperative bodies to regulate collection and legalise its trade. About 48000 local employment days were generated per year in tea shops and restaurants, and transportation of food material to the collection areas (personal communication by G. C. Pant). This year (2013) on June 16 – 17 cloud burst and massive landslides not only caused habitat destruction but also loss of life of many collectors – some were rescued by the army using helicopters.

Collection of *O. sinensis* in Chipla Kedar, Pithoragargh, India (photos courtesy Dr. A.N. Shukla)

Unsustainable harvesting practices are being followed and this will result in site deterioration. Overexploitation will lead to vulnerability of the species. As the income from the collection is very high, people are ignoring traditional practices and long-established agriculture and animal husbandry are on decline. Social relations are under stress because of competition for collection and money involved. It is high time that policy interventions are put into practice for sustainable harvesting looking to the vulnerable status of the species. At present no defined legal protection provisions to the *O. sinensis* exist in "Wildlife (Protection) Act, 1972, EXIM policy of India, Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)".

The state government has put in place a policy for collection of this fungus through local village cooperative bodies (Van Panchayats – Forest village bodies)) to regulate collection and legalise its trade, but illegal trade still continues. Scientific collection and exploration to report the presence of

fungus in different parts of the region along with documentation of the occurrence, status of the wild population and to formulate a strategy for conservation as well as adopting sustainable harvesting practices are required. To reduce the pressure on some identified areas new areas for collection are to be opened. Traditional rights of the collectors are to be recognized and community based natural resource management system is to be put into practice. It is also necessary that people involved in the collection and trade of the fungus are to be educated about the negative effects of improper collection and storage practices.

Other fungi

In central India wood decaying fungi (*Lenzites acuta, L. vespacea, Microporus xanthopus, Trametes cingulata, T. elegans, T. lactinea* etc.) are being collected from the forests by the local tribes in bulk and sold at about US$ 20 per kilogram on the international market. From our first report in 1996 (Harsh et al. 1996) the quantity of these fungi has gradually reduced and overexploitation leading to habitat destruction can be attributed as the cause. Initially the State Forest Department refused to consider the collection as Non Wood Forest Produce so no regulations were imposed. Of late the State Government has taken steps to ban the collection of these fungi from the forest areas. I wonder whether it is too late?

Basic strategic deficiencies at country level

To conserve and use fungal diversity in a sustainable manner, it is imperative to understand prevailing policies and legal support for conservation and frame appropriate mechanisms to regulate collection and trade. Current concerns include:

1. Failure to link conservation of forest and non-forest natural areas with ecological security of the country
2. Poor understanding of issues and concerns of local communities reflected in development and welfare initiatives
3. Local communities alienated from environmental issues considering government interventions as anti-people -- or economics prevail over environment
4. Poorly controlled legal trade and illegal trafficking pose threat to *in situ* conservation of biodiversity
5. No or poor environment impact assessment of collection methods, cycles and site conditions will further affect extent and quality of natural areas
6. The apathy of policy makers and governments in accepting fungi as integral part of biodiversity resulting into absence of any regulations or ill framed policies

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First steps in myxomycete conservation activities

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Myxomycetes an ideal model for building conservation strategy

Slime moulds are eukaryotic, phagotrophic, fungus-like organisms, which living nearly in all terrestrial ecosystems. In previous systems slime molds include several groups: *Myxomycetes* -"true slime moulds", *Protosteliomycetes* – microscopic relatives of *Myxomycetes*, *Dictyosteliomycetes* –soil inhabitants, *Copromyxida* – animal dung inhabitants, *Acrasida* – with individual independent cells that can act as one organism, *Plasmodiophoromycota* – cell parasitic species. All this groups have a plasmodial stage in their life cycle. Modern systems recognize only *Dictyosteliomycetes*, *Protosteliomycetes* and *Myxomycetes* (Adl et al., 2012). *Copromyxida* belong to the same phylogenic branch as *Amoebozoa*. No close relatives are known for *Acrasida* and *Plasmodiophoromycota*. The conservation strategy model begins with *Myxomycetes*, characterized by a remarkable transformation from an animal-like to a fungus-like form. These organisms develop very rapidly, have a high reproductive potential, and seem to possess effective dispersal mechanisms. Myxomycetes tend to be rather inconspicuous. Most parts of the myxomycete life cycle exist as vegetative stages, mobile free-living plasmodia that typically thrive in cool and shady moist places. They feed on bacteria, protozoa, yeast cells, fungi, organic remains etc. After a period of feeding and growth, fruiting bodies develop in drier and more exposed locations. Most are relatively ephemeral. They contain numerous spores which can be dispersed by wind and will eventually germinate and develop into a plasmodium under suitable conditions. Myxomycetes spend a portion of their life cycle in a state where their very presence in a given habitat can be exceedingly difficult if not impossible to determine. Their inconspicuous nature and complex life history strategy provide an immense challenge in biodiversity assessments, so have often been neglected. This has far-reaching consequences for estimates of the number of species and their conservation. There is convincing evidence that we know only about 20% of the actual diversity in many protist groups. Considering the dramatic losses of habitats, a large portion of the Earth's biodiversity will disappear before it has been discovered (Foissner & Hawksworth, 2008).

Problems of evaluation of myxomycete distribution

Myxomycetes are found in nearly all terrestrial ecosystems worldwide from Antarctica to desert. Approximately 30% of the species are cosmopolitan. The highest diversity is in the temperate climatic zone of the northern hemisphere, where moisture and decaying organic matter are available. Myxomycetes are associated with a number of different microhabitats. These include remains of woody origin, fallen logs, the bark surface of living trees, forest floor litter, the dung of herbivorous animals, and herbaceous plants. Myxomycetes are fundamentally terrestrial organisms and they have a significant impact on the species diversity of soil microorganisms. Study of rDNA from soil shows that myxomycetes (including protostelids and dictyostelids) are a dominant group of protists in this habitat (Stephenson et al., 2000). Temperature and humidity are the main factors limiting myxomycete distribution and abundance in nature. Climate, altitude and plant type also represent an important factors influencing the occurrence of myxomycetes. Species richness tends to increase with more diversity and biomass of the vascular plants providing various types of detritus that support the bacteria and other microorganisms needed to feed myxomycetes. The pH of the substrates may also represent an important factor influencing the distribution of these organisms, although many myxomycetes appear to have a relatively wide pH tolerance (Wrigley de Basanta, 2000). Myxomycetes have a cosmopolitan distribution due to a presumed easy dispersal by wind and water. Feeding by invertebrates may also help to spread spores. These properties allow them to exploit successfully habitat islands occurring both temporally and spatially in nature.

A distribution map presents only the fruiting body stage of myxomycetes. It is certainly possible that there are habitats where myxomycetes live as amoebal and plasmodial populations only

and do not fruit. Approximately 50% of all described species of myxomycetes are known only from the type locality or fewer than five localities worldwide. It seems likely that many of these "species" are no more than morphologically distinct biotypes present in particular habitats or confined to a certain regions of the world (Stephenson et al., 2000). A number of the more common and widespread morphospecies actually consist of complexes of geographically restricted apomictic clonal lines (Clark, 2004). These genetically isolated lines are capable of independent evolution, which can lead to the accumulation of minor morphological differences that reflect specific adaptations to the particular set of environmental conditions in which they occur. Direct environmental sampling with the use of molecular techniques such as DNA probes would represent a way of detecting hidden amoebal and\or plasmodial populations of myxomycetes, which would be regarded as "sink" populations in terms of dispersal capacities (Foissner & Hawksworth, 2008).

Threatens for myxomycetes

Myxomycetes have not yet been sufficiently evaluated for conservation status, but at least some are undoubtedly threatened by climate change, disturbance, habitat destruction and pollution. A particular habitat within which a species of myxomycetes has been established may persist for only a short period of time. The species always survives by reestablishing itself in some new habitat, which may be the same location if conditions once again become favorable. In unfavourable conditions spores may be covered by proteoglycans and create cysts. Plasmodia also can transfer to the survival stage scletotium. Urban pressure can change native biota of myxomycetes, because in town introduced species often appear. Parks and gardens can harbour more biodiversity of myxomycetes than in native ecosystems of the same regions. Acid rain reduces species diversity from the order *Physarales* as result of leaching lime from the soil, which need for normal morphogenesis. In general, members of the *Stemonitales* develop under more acidic conditions than do members of the *Physarales* and the *Trichiales* (Stephenson et al., 2000). Climate change has an especially important effect on nivicolous myxomycetes, occurring at the edge of melting snow at high altitude.

Conservation activities

The IUCN Specialist Group promoting Conservation of Myxomycetes is beginning to prepare a foundation on which future conservation policy for Myxomycetes can be developed.

UK

First steps for conservation of myxomycetes was the creation of a myxomycete reserve by Bruce Ing in Wales near the town of Mold, in a small town park in agreement with the Forestry Commission. In this place native ash and hazel grow on calcareous soils with introduced poplars and maples. Protection actions are the termination of clearing of dead wood and leaves, which are favorable substratum for myxomycetes.

Russia

1) In 2005 Yuri Novozhilov proposed to include 21 endangered species of myxomycetes in the Red Book of Nature of Leningradskaya oblast in Russia: *Colloderma oculatum, Comatricha longa, Cribraria purpurea, Diachea splendens, Diderma floriforme, D. niveum, D. trevelyani, Didymium serpula, Lepidoderma carestianum, L. tigrinum, Enteridium splendens, Lindbladia tubulina, Physarum alpinum, Ph. auriscalpium, Ph. flavidum, Ph. globuliferum, Ph. listeria, Stemonitis splendens, Hemitrichia serpula, Metatrichia floriformis, Trichia alpina*.

2) In 2007 Alexander Lebedev recommended including in the Red Book of Tver' oblast 10 species of rare myxomycetes: *Arcyria glauca, A. minuta, Brefeldia maxima, Colloderma oculatum, Diderma fallax, Didymium iridis, Hemitrichia intorta*, *Lycogala conicum*, *Physarum famintzinii, Ph. oblatum.*

Ukraine

1) Preliminary analyses of threat were made for 278 species of myxomycetes in Ukraine. Species considered as endangered included 12 myxomycetes species, with 22 mainly nivicolous species being assessed as vulnerable (Kryvomaz, personal data).

Cribraria purpurea – endangered species in Ukraine and in Leningradskaya oblast of Russia. Image © Alain Michaud

Potentially endangered myxomycetes in Ukraine are: *Barbeyella minutissima, Colloderma oculatum, Cribraria ferruginea, C. mirabilis, C. purpurea, Diderma chondrioderma, Elaeomyxa cerifera, Lamproderma columbinum, Lepidoderma tigrinum, Licea pusilla, Physarum tenerum* and *Trichia subfusca.*

Potentially vulnerable myxomycetes in Ukraine are: *Diderma alpinum, D. meyerae, D. niveum, Didymium dubium, Lamproderma aeneum, L. carestiae, L. cristatum, L. cucumer, L. echinosporum, L. ovoideoechinulatum, L. ovoideum, L. pulveratum, L. retirugisporum, L. splendens, L. zonatum, Lepidoderma alpestroides, L. carestianum, L. chailletii, Physarum albescens, Ph. alpestre, Ph. vernum* and *Trichia alpina.*

Lamproderma ovoideum – a very common nivicolous species in European Alps, but presumably vulnerable in Ukrainian Carpathians; can be affected by climate change on a global level. Image © Alain Michaud

Also in Ukraine 34 species of myxomycetes were identified, which are rare not only in Ukraine, but in the world as well. This is likely to be the result of general data deficiency. They include *Arcyria globosa, Badhamia melanospora, Clastoderma debarianum, Comatricha ellae, C. longipila, Cribraria macrocarpa, C. splendens, Diderma chondrioderma, D. cingulatum, D. montanum, Didymium sturgisii, Echinostelium apitectum, Fuligo muscorum, Hemitrichia intorta, Lepidoderma tigrinum, Licea inconspiqua, L. tenera, Oligonema flavidum, Perichaena pedata, Physarum citrinum, Ph. confertum, Ph.* conglomeratum, Ph. decipiens, Ph. *digitatum, Ph. gyrosum, Ph.*

licheniforme, Ph. murinum, Ph. notabile, Ph. oblatum, Stemonaria longa, Stemonitopsis amoena, S. gracilis, Trichia alpina and *T. lutescens.*

2) Detail evaluations were made for the biggest genus of myxomycetes, *Physarum.* A total of 40 *Physarum* species have been recorded in Ukraine. Only three species – *Ph. album*, *Ph. cinereum* and *Ph. cinereum* are certainly not threatened, widely distributed and found in the whole of Ukraine. Six species: *Ph. bivalve*, *Ph. leucopus*, *Ph. compressum*, *Ph. contextum*, *Ph. globuliferum* and *Ph. psittacinum* are not threatened also, and are at least fairly common in Ukraine. Seven species – *Ph. flavicomum*, *Ph. leucophaeum*, *Ph. citrinum*, *Ph. decipiens*, *Ph. gyrosum*, *Ph. mutabile* and *Ph. pulcherripes* are probably not threatened, as they are recorded from several Ukrainian regions. But 60% (24 species) of the genus was found once or only several times from a limited number of Ukrainian regions. From this big group *Ph. albescens*, *Ph. alpestre* and *Ph. vernum* need to be emphasized, which are nivicolous species and are proposed to be plaved in the endangered category, due to the threat from climate change. *Ph. lakhanpalii* is usually found in tropics but in Ukraine was discovered in the mediterranean climate of Crimea. Some species from this big group – *Ph. bitectum*, *Ph. didermoides*, *Ph. pusillum* and *Ph. virescens* are rare not only for Ukraine. *Ph. licheniforme* and *Ph. digitatum* that were collected in strongly threatened habitat types in the vicinity of megapolises near Lviv and Kyiv (Dudka et al., 2011).

Physarum psittacinum – a fairly common and beautiful species. Image © Alain Michaud

3) Irina Dudka is preparing a proposal for the next edition of Red Book of Ukraine (Dudka, personal data) to include *Oligonema aurantium*. This species is very rare in Ukraine and was found only once in Desnans'ko-Staroguts'kiy National Nature Park (Dudka & Krivomaz, 2005). From Europe it is known from only two records: the first one in Netherlands (*locus classicus*) and the second one in Great Britain. Criteria for inclusion in the next edition of the Red Book of Ukraine include:

- species that only occur in threatened habitats
- species that are described as new for science from Ukraine and are unknown in other countries or species with very limited world area
- species are characterized with macroscopic features allowing field recognition

Germany

Martin Schnittler (Schnittler, personal data) placed 413 myxomycetes species from Germany into nine conservation categories:

1. very common: on most local species lists, regularly to be found when checking the microhabitat;
2. common: usually to be found during systematic surveys of the respective microhabitat;
3. fairly common: occasionally found, but well over 100 records from Germany known;
4. rare: but more than 20 records;
5. very rare: less than 20 records known;
6. extremely rare: less than 5 records known from Germany;
7. extinct or presumably extinct: not recorded since more than 40 years;
8. data deficient: no assessment possible;
9. not estimated:

Species only recorded in cultures or those found occasionally in microhabitats which have not yet been systematically investigated, will be assessed as data deficient. Notoriously confused species will be assessed in this category as well.

Global-level assessment

1) For nivicolous myxomycetes emphasize threats by climate change. Tentative evaluations of conservation status for ten nivicolous species were made: *Diacheopsis metallica, Diderma alpinum, Didymium dubium, Lamproderma echinosporum, L. ovoideum, Lepidoderma carestianum, L. chailletii, Physarum albescens, Ph. vernum, Trichia alpina* (Kryvomaz et al., 2010). The strong association between nivicolous myxomycetes and melting snow patches suggests that their distribution is likely to be strongly and negatively affected by global warming as winter snow cover diminishes.

2) The first myxomycete *Diacheopsis metallica* was published in Red List Species on the Edge of Survival (Species on the Edge of Survival, 2011).

3) Evaluation of conservation status for 10 species of order Trichiales: *Arcyria denudata, A. minuta, A. stipata, Calomyxa metalica, Hemitrichia clavata, Metatrichia vesparium, Perichaena chrysosperma, Trichia decipiens, T. scabra, T. varia* (Kryvomaz et al., 2012). Information base include specimens, databases, bibliographic sources and field observations. Using the program "Geocat" (geocat.kew.org) estimates were made of extent of occurrence and occupancy. For each species population trend and threats were analyzed, and evaluation using IUCN criteria took place.

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Conservation of *Tricholoma* species in Turkey

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The genus *Tricholoma* is one of the classic genera of the *Agaricales*. Nearly a thousand *Tricholoma* taxa have been recorded from different places of the world, although the identity of perhaps the majority of these names remains uncertain. In the field, *Tricholoma* species can be easily recognized. They have fleshy, fibrous fruiting bodies with a smooth to suede-like, fibrillose or scaly cap and emarginate lamella (Singer 1986; Shanks, 1997; Knudsen and Vesterhold, 2008; Kibby, 2010). Species identification can be difficult as many species appear similar.

All species of *Tricholoma* are assumed to be mycorrhizal with coniferous trees and shrubs (Singer, 1986; Shanks, 1997; Knudsen & Vesterhold, 2012). Additonally, Kibby (2010) reported that some *Tricholoma* have been recorded with *Helianthemum* and *Dryas*. It seems that this genus is very important for forest ecosystems.

IUCN status and biodiversity of *Tricholoma* in Turkey

In Turkey, 68 taxa of the members of the genus *Tricholoma* have been reported (Solak et al. 2007), though 16 of these names are not current according to *Index Fungorum*. Among these taxa, *Tricholoma anatolicum* has a special significance for the Turkish macrofungus biota (Figure 1), and was originally described from our country (Intini et al. 2003).

Figure 1. *Tricholoma anatolicum* (photographed by H. Alli)

Tricholoma anatolicum belongs to the "matsutake" group of *Tricholoma*. This fungus occurs only in sandy soil of *Cedrus libani* forests. While these forests are primarily distributed in the Taurus mountain range located in the Mediterranean region, they also occur in limited areas in the Middle Black Sea Region (Çatalan-Erbaa and Akıncıköy-Niksar) and Sultandağı-Afyon (Odabaşı, 1990; Akkemik, 2003). *T. anatolicum* has been observed at eleven localities (Doğan & Akata, 2011). The fruiting periods is a limited time from October to November (Doğan & Akata, 2011). *T. anatolicum* is a good edible species due to its special aroma and taste (Intini et al., 2003), so it has economic value and is collected by local people. It is also exported, particularly to Japan. We do not have accurate figures for the quantity collected, but Doğan & Akata (2011) reported that more than 50 tonnes of *T. anatolicum* may be exported depending on climatic conditions. Collectors may dig the top layer and expose the immature fruiting bodies, and there is no collection legislation. Due to these threats, the species should be monitored and protected to ensure its sustainability. *Tricholoma caligatum* and *T. terreum* are also collected for food (Figure 2). While, *T. terreum* is a widespread species in Turkey, *Tricholoma caligatum* is not so frequently encountered and therefore should also be monitored.

Figure 2. *Tricholoma caligatum* (photographed by H. Alli)

Assessments of the IUCN category of some *Tricholoma* species of Turkey have been published recently. *Tricholoma sulphureum* is considered to belong in the Critically Endangered category. Similarly, *T. equestre*, *T. sejunctum*, *T. stans* and *T. ustaloides* are considered to be Vulnurable. In Europe, *T. colossus* is reported as a threatened species (Dahlberg & Croneborg, 2006). It is recorded from 21 countries and included in the Red List of 13 nations. This species has been recorded from Turkey in 5 localities (Solak et al., 2007), but it has not been assessed for Red List status. In Turkey, the IUCN category of all *Tricholoma* species should be determined by further studies and the species which are threatened should be monitored and protected.

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Fungi and the Action Plan for the Conservation of Biodiversity: what happens in Tuscany (Italy)?

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Fungi are well-known for their gastronomic value. They are also often accused of having a negative impact on the environment. Our group has attempted to emphasize the importance of fungi as key-players in biological processes to a wider audience and to make different communities, from the scientific world to governmental bodies, aware of the need to include them in nature conservation activities.

Thanks to the Important Plant Areas (IPAs) programme, a target of the two European Plant Conservation Strategies (2002–2007 and 2008–2014), fungi - treated at the same level as plants - were included among the actors. In fact the Planta Europa network and the Council of Europe allows for non EU states to consider habitats and organism groups not listed in the Habitats Directive and Natura 2000 programme for conservation action plans. To recognize an IPA good information on distribution, ecology and threat status is needed to meet the three criteria: threat, richness and habitat distinctiveness (Perini *et al.*, 2011).

In Tuscany the first attempts to describe key sites containing rare and or threatened fungal species and/or because of high fungal diversity dates back to the first years of the new millennium. Participation in the Italian IPA project and the publication of a Tuscan Red List has been fundamental. Further attempts to emphasize the value of habitats for their larger fungi have been made and finally fungi are included in the action plan for the conservation of biodiversity at least at regional level. There is a prospect that this regional approach will be translated to a national leve. The

methods applied and some examples of mycological key-sites or AFP (Animals, Fungi and Plants) target species for some habitat types that need conservation, are reported.

Tuscany covers a high variety of environments from the Tyrrhenian coast through a hilly landscape up to the mountains, and covers nearly 23.000 km^2. It is more or less similar in size to Macedonia and half the area of The Netherlands or Switzerland, that have databases with checklists, redlists and/or important fungi areas.

The data on epigeous larger fungi were the results of surveys by the University of Siena, field excursions with amateurs and last but not least of the collaborative mapping project of the Tuscan Region between 1995-2005.

An important factor in designation key areas is the presence of threatened fungi. The lack of a list of fungal species that are known to be globally or "regionally" threatened or endemic (with the exception of *Pleurotus nebrodensis*) and the lack of their presence in the appendix of the Habitats Directive, brought us to look first at the 33 fungal species proposed for Appendix 1 of the Bern Convention (Dahlberg & Croneborg, 2006) and to the Candidates for a European Red List (www.wsl.ch/eccf), and investigate suspected threatened species restricted to the Mediterranean Biogeographical Zone. For the national project on important plant areas 42 fungal species, proposed by Italian mycologists, were included. These were 26 species proposed for the Appendix of the Bern Convention and present in Italy, 15 species that were assessed in the Italian Checklist as rare or threatened and *Pleurotus nebrodensis*, a near-endemic of Sicily (Perini *et al.*, 2011).

Stimulated by the relatively few initiatives that describe key-areas for fungi (Perini *et al.*, 2011), a first draft for Tuscany was presented at the EMA congress in Yalta 2003, comparing the methods adopted in the UK with the ones proposed by Planta Europa (Perini & Laganà, 2003). In the following years other contributions were discussed during different meetings evaluating habitats from a mycological point of view ((Parmasto *et al.*, 2004; Perini & Laganà, 2003; Perini & Salerni, 2004). This experience at a local level was enforced by the participation of mycologists in the national IPA project and, going from the Alps in the north to Sicily in the south, eight areas were highlighted to be important for fungi (Blasi et al. 2009, 2010; Venturella et al. 2011). In this way various habitats in Tuscany have been evaluated for conservation actions not only because the fauna and/or flora was interesting but also because of the presence of important, rare and/or threatened larger fungi and/or of a high fungal diversity, and were described in the Tuscan Biodiversity Action Plan.

A transnational approach does not necessarily translate well to a regional level. For example, mires are well-known habitats needing protection and are listed in the EC project "Natura 2000". In the Apennines of northern Tuscany, montane mires are few and occupy only a very small area and were identified as sites of community importance and designated as Special areas of Conservation (SAC). The value of this habitats has been underlined by the presence of an interesting fungal diversity. Some species redlisted in other countries were found for the first time (e.g. *Entoloma poliopus*, *Gymnopilus bellulus*, *Hygrocybe laeta*, *Inocybe acutella*, *Omphalina oniscus*). *Entoloma cuspidiferum* and *Galerina paludosa* are strictly linked to *Sphagnum* communities, and *Arrhenia lobata* and *Rickenella mellea* are arctic-alpine species and therefore at the southern limit of their distribution (Perini *et al.*, 2002).

Another example can be seen in the Nature Reserve ''Bosco di Sant'Agnese'' which is dominated by evergreen Mediterranean woodlands and scrublands, especially by native *Cupressus sempervirens* that covers an extensive area. This reserve has an important fungal diversity with three fungal species described new for science, various listed for the first time at national or regional level, and *Sarcosphaera crassa*, one of the proposed species for the Bern convention, present with in various localities. This species was described by Giorgio Santi in 1789 on the Mount Amiata (central Tuscany), in the so-called "Bosco della Trinità". We found this ascomycete in the 1990s in the nearby Natural Reserve "Pigelleto", but today the only locality in Tuscany where it is still present is the S. Agnese wood (Pecoraro *et al.*, 2006).

The "Montagnola Senese" is a Site of Community Importance because of Habitats, Plants and Animals (Habitats Directive 92/43/EEC). Here during more than 40 years of mycological surveys over 500 larger epigeous fungi were observed and 60 species have great conservation value because of their threat status. Two are included in the list of fungi proposed for the Bern Convention Appendix and listed among the European candidates as vulnerable in the Mediterranean zone (Croatia): *Boletus dupainii* and *Leucopaxillus compactus*. The first taxon was assessed at national level and reported as "vulnerable" (VU) and in Tuscany classified as "endangered" (EN) (Perini *et al.*, 2011).

So step by step other areas were analyzed and results communicated, but this is not sufficient! Fungi are still not properly represented. In conclusion we hope that our experiences in developing the Tuscan Biodiversity action plan and at the Tuscan Council for Biodiversity will demonstrate a new way to communicate the importance of fungi, and encourage others to include fungi in conservation and managment programmes.

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Ex situ conservation of fungi from forests of India – a national type culture collection

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Fungi are important biotechnological tools to meet the requirements of food and medicine of growing populations. Due to over exploitation, human disturbances and/or natural calamities many of these organisms are being lost every day and need to be preserved in the laboratories in ex-situ culture collections. The World Data Centre for Microorganisms (WDCM) and The World Federation of Culture Collections offer searchable indices of over 400 registered culture collections in more than 50 countries worldwide. Many culture collection homepages can also be found through the WDCM.

The Forest Pathology Division of Forest Research Institute, Dehradun, India houses the National Type Culture Collection (NTCC) of wood rotting fungi and forest pathogens. The rich collection currently has 988 fungal cultures belonging to 140 genera and 298 species of relevance for forest ecosystems. A few cultures have been received from other international culture collections. The oldest culture of 1939 is of a *Stereum* sp. (No. 220/S) isolated from a pole of sal (*Shorea robusta*) wood collected from FRI campus, Dehradun.

A reference card is made for each culture bearing the NTCC number, name of the fungus, name of the host, date of collection, etc. The cards also contain information about the substrate from where cultures were isolated, suffixing 'S' indicates culture obtained from sporophore (fruit body), 'C' indicates culture obtained from context of the sporophore and 'R' indicates culture obtained from the rotted wood. The cultures are maintained in a wooden incubator at 8°±1°C on PDA medium culture tubes and sub-culturing of these fungi is done every 2 – 3 months. A duplicate set of cultures is maintained in mineral oil (liquid paraffin) at 15°±1°C. The cultures are checked regularly for contamination during initial growth. There are more than one culture for some species.

Wood rotting white-rot fungi belonging to *Basidiomycota* constitute the major portion of the cultures in NTCC (443 in number), distributed among 57 genera and 115 species. Some of the species of white-rot fungi have immense value in biotechnology such as bioremediation, enzyme (laccase, cellulases, xylanase) production, biodeinking, biopulping and medicinal uses. Brown-rot fungi comprise 148 cultures, distributed among 21 genera and 32 species. Some of the species of this group have potential for bioremediation and source of enzymes (Cellulases, xylanases).

There are 36 fungsal cultures present in the NTCC of species that have established nutritional and pharmaceutical values. One of them, *Ganoderma lucidum* is considered as the 'King of the herbs' and its nutriceuticals are given to patients with more than 20 different maladies including migraine and headache, hypertension, arthritis, bronchitis, asthma, gastritis, hypercholesterolaemia, hepatitis, cardiovascular problems and cancer including leukaemia. Another important fungus in NTCC is the wonder caterpillar-fungus *Ophiocordyceps sinensis* (= *Cordyceps sinensis*) which is found in the alpine meadows of the Himalaya. It is known for performance enhancement and as a longevity booster. *Echinodontium tinctorium* which infects the living trees of *Taxus baccata* is reported to have anticancer properties. *Phellinus linteus*, known as phansomba in Maharshtra (western India) is known to contain anticancer drugs.

The Biodiversity Convention (Rio de Janeiro, Brazil, 1992) has created an awareness of the importance of biodiversity and also initiated promulgation of laws for the protection of biodiversity resources. There is one more aspect which needs immediate attention, to raise cultures of as many microorganisms as possible and preserve them for screening for human welfare. In this light, the fungal cultures of NTCC are invaluable resource of national and international importance.

Myco-entanglement - public perceptions of fungi in biodiversity conservation

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At a very young age, I was fortunate to stumble into the world of some very inspired individuals, otherwise known as *field naturalists*. Their influence expanded my imagination through the discovery of invertebrates, bryophytes, intertidal creatures, fossilised forms, things with wings and spines and scales... but most impressively, fungi.

Mycena interrupta changed my world. That a life so tiny, so blue, so exquisite, so unseen could exist, affected me in a way that I only came to fully understand much later in retrospect.

Image 1: The tiny exquisite form of *Mycena interrupta*

Image 2: Golden jelly bells

There were also golden jelly bells on logs. And perfect pink parasols. Unseen birds that laid miniscule eggs in satellite-dish nests.

Image 3: Perfect pink parasols.

Image 4: Eggs of unseen birds in satellite-dish nests.

Sticks that appeared to grow caterpillars. Spaceships that landed all around me when I wasn't looking.

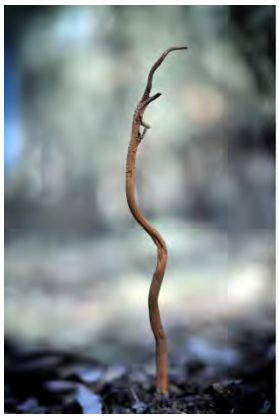

Image 5: Sticks that appeared to grow caterpillars.

Image 6: Random spaceships.

And an ear that cried sad red tears.

Image 7: A crying ear.

But the jewel in the crown only revealed itself once the sun had slipped over the horizon. When the sounds of furtive nocturnal creatures intensified my curiosity. It was the eerie green glow of the

bioluminescent, *Omphalotus nidiformis* that truly enchanted my world, infecting me with a life-long fungal passion.

All of this was a revelation of the incredible diversity of life that continues to become more extraordinary every day. However, as I grew older, it also, became more troubling. How on earth were we to look after them *all*?

Each autumn I conduct various fungal ecology forays to introduce *Homo sapiens* to fungi. But with each year that passes, my field sites, diminish. This year, some of them looked like this.

Image 8: These once-rich fungal habitats have since been ravaged by the impacts of fire, deep-rooted vegetation removal, grazing and cropping.

These sites were once all rich in fungi.

Fungal conservation, conservation of all biodiversity, becomes an ever-greater challenge. Congresses such as this provide a vital means to address such challenges.

Many of the presenters at this conference have focussed, unsurprisingly, on fungi. I'd like to diverge slightly and talk about human-fungal relationships. In particular, about some research I've been doing into perceptions of fungi in Australia and Europe and how understanding such perceptions might feed into conservation. I also ask how we might more effectively communicate the aspirations of mycologists and fungal conservationists to broader audiences, to raise the profile of fungi.

I don't doubt for a moment that all of us here appreciate the astonishing beauty, complexity and importance of fungi. However, effective fungal conservation requires us to not only convey this more widely, but also to inspire action. We might begin by asking whether this is really a job for mycologists. Or do we need to engage the skills of others to help re-imagine fungi, to ensure the survival of fungal diversity as we negotiate urgent issues of habitat and species loss?

Taxonomy underpins fungal conservation. New technologies such as DNA barcoding are incredibly powerful tools that have catalysed our understanding of relationships and accelerated taxonomy. Molecular techniques are revealing the staggering depths and complexities of the fungal kingdom. But they have also taken many of us out of the field, where connections are made, sensorial engagements, other ways of knowing fungi, ways that inspire caring. Meanwhile, genes and genomes may become even more obscure for those who are less scientifically literate. Do we need to consider how this advancement in scientific technology, despite all the obvious benefits, affects public capacity to effectively contribute to the conservation of fungi?

There's been much discussion of the challenges to mycology and fungal conservation that typically revolve around deficiencies – of mycologists, funds, species knowledge, public recognition, political interest, and so forth. These issues were all identified at the Whitby meeting and were common to most countries. It seems from the country reports presented at this congress that all still exist in most. All relate to the need to raise the profile of fungi. But perhaps less commonly considered is how we might translate the invisibility or imperceptibility of fungi. Many fungal conservation issues hinge on abstract scenarios based largely on invisible, far-away factors. That is, we're essentially asking people to conserve something they mostly can't see, are removed from, and often poorly understand. Most of the time, many people can only respond from second-hand, relayed, non-experience[i]. Moreover, there is often little recognition of how fungi have any connection with our own well-being and survival. This is further compounded by a long history of negative association and poor press, at least in the Anglophone world. How can we realistically expect people to adopt conservation-oriented perspectives let alone any notion of fungal empathy? In situ sensorial experience, actually connecting with fungi is perhaps the most obvious way, although such opportunities are not available to everyone. The use of allegory, metaphor and synecdoche to elucidate the less visible or more abstract concepts of the fungal kingdom could also be a useful starting point. There is a long history of the use of such tropes as an integral part of illustrating other scientific concepts.[ii]

Another challenge is that of scale, both temporal and spatial. How do we shift from the local, to imagine global issues in the context of fungi and the various processes and threats that compromise their existence? While many scientists move fairly easily between spatial and temporal scales, we can't assume this to be a skill common to the wider community. It seems the way fungal conservation issues have been portrayed is that they're often too abstract, on abstruse scales, and have little direct obvious relevance to people's lives. Various researchers have shown that many people don't have the necessary environmental conceptual structures to comprehend the complexities or urgency of environmental issues. For example, cognitive linguist George Lakoff discusses the necessity of frames or schemas that allow us to understand both the nature of climate change and how we might respond[iii]. Many parallel challenges relating to imperceptibility, scale, function and process also exist in issues of conserving fungi. While many fungal conservation issues may be ecological and environmental, they require socio-political solutions that are likely to require a cultural and political reorientation.

In my own fungal conservation research, I've decided to focus on the links between *Homo sapiens* and fungi. I've begun by trying to get an impression of how fungi have been portrayed historically in the press. To date I've assessed an extensive archive of Australian newspaper articles dating back over a century and have begun looking at British & Swiss press archives to provide some kind of European comparison.

At times, one might be lead to believe that fungi intentionally go out of their way to wage their own war against humanity as suggested by these article titles from Australian newspapers: *Potential killers stalk Victoria's fields*[iv]; *Killer mushrooms invade picnic spots*[v]; *Wild fungi death trap*[vi]*; Poisonous mushrooms claim victims by the hundred*[vii]*;* and *Beware the killer mushrooms*[viii].

Fortunately there were also some more positive representations, although these were rare exceptions such as:
Underground lovelies[ix]; *Don't overlook the beauty of the mushroom*[x]; *The enchanted wood*[xi]*; Autumn glory*[xii]*;* and *The fantastic fungus*[xiii].

So have these portrayals of fungi perhaps influenced their inclusion or exclusion in Australian biodiversity management? This is difficult to determine, but to get some impression, I've been examining policy, legislation and various types of biodiversity and national park management documents. I began by analysing the management plans of forty Australian National Parks, with a similar approach to how Dave Minter assessed the Biodiversity Strategies of the signatories of the Convention on Biological Diversity[xiv].

In summary, of the 40 plans I've perused, thirty percent make no mention of fungi. These are management plans that among other aims, such as managing tourism and infrastructure are supposed to "manage" biodiversity. Of those that do mention fungi, almost 90% are in reference to fungi as pathogens, that is, as agents of disease. As agents of disease, fungi were mentioned only in the context of being a threat, with no mention of other fungal species that might require protection from threats. While acknowledging that there are some seriously destructive pathogenic fungi, the fact that fungi are only mentioned as disease agents and not as organisms performing vital ecological roles or being in need of protection inevitably has great potential to influence public perception of fungi. The fact that Australia's piece of national biodiversity protection legislation, *The Environment Protection and Biodiversity Conservation Act* 1999 only mentions two species of fungi – both as 'threats' – is another prime example of how public understanding of fungi might be negatively influenced[xv].

On average each report had less than three references to fungi, relative to 185 to plants and 175 to animals. All of these Management Plans were written within the last 25 years, during which time one might have hoped public understanding of fungi to have grown, especially given the increased production of fungal resources such as field guides in the last three decades. Furthermore, all states and territories had various acts and policies in place to protect biodiversity at the time the management plans were written, although admittedly these acts and policies also made no or inadequate reference to fungi in definitions of biodiversity.

The Management Plans that did mention fungi other than as agents of disease only did so in very generic statements such as, "The park contains a large variety of fungi"[xvi]. Without exception, the 70% of Plans that did mention fungi, all showed taxonomic confusion. Of those that actually defined biodiversity, all defined it incorrectly as not being inclusive of fungi. Fungi were also often wrongly or inappropriately classified; as "lower plants", "non-vascular plants", "lower life forms" or "micro-organisms".

In terms of action towards fungal conservation, only one of forty Plans made a cursory suggestion toward fungal conservation, that being to: "Encourage survey and research into flora (including rare or threatened species), plant communities, fungi and bryophytes in the park"[xvii]. However, it doesn't take much reading between the lines to recognise that the word "encourage" along with the absence of any further recommendations, actions, allocated funding or other resources might suggest a lack of any genuine commitment.

These findings reflect all the same issues identified by David Minter. None of this will come as any surprise to many of you. I've essentially reconfirmed what we already knew. However, the absence of fungi in these plans suggests that biodiversity managers, policy writers, conservation funding bodies and those that influence the future of fungal conservation are perhaps less aware of the lack of inclusion of fungi in such documents. These findings may therefore be a useful lever to open dialogues with conservation managers to expand concepts of biodiversity and include fungi in conservation.

This leads me to ask the obvious question, "How do we inspire public and political interest in fungi and fungal conservation"? Who are the best translators, story-tellers, messengers and strategists to convey and negotiate issues of fungal conservation? Various researchers across numerous fields have demonstrated that people make decisions on a multiplicity of factors, outside of factual information. As fungal conservationists we must also consider these factors rather than just assume that more or better information will in itself lead to more conservation-oriented perspectives.

Education is of course intrinsic to increasing knowledge and understanding environmental issues, including those that involve fungi. However, education on its own is not enough and more data doesn't usually inspire an environmental ethic or advance conservation. For example, while species loss is an environmental crisis, environmental crises have become normalised, so more information on further threatened species is unlikely to make much difference. Urgent warnings about massively accelerated extinction rates or impacts of climate change are likely to be transmitted as routine tweets, than as events that might give us pause[xviii]. Hence, continuing to impart more data may not be the best strategy. Another approach might be to consider ways to connect intellect, affect and emotion. To explore the interface between science, relationality and imagination. To inspire action driven not just by anxiety, but by hope.

Of course we need to map, measure and quantify fungal diversity if we are to effectively manage and conserve it. But I also think it's vital that we don't allow fungi to become just a set of numbers. Fungi are so much more than something to be simply counted. I'm not suggesting that we stop counting, but rather that we might also consider ways to enrich this, with other ways of knowing fungi, to re-imagine the affective dimensions of fungi. Australian environmental historian, Libby Robin, says that "Counting alone is not enough. Caring, is also essential. This is what motivates action, including political action."[xix]

I applaud Dave Minter for initiating the ISFC along with Tom May for initiating and driving Fungimap in Australia along with everyone working on fungal conservation. Such organisations are vital, but ultimately, I believe it's about individuals, as David and Tom have shown. It's about passion and drive and determination of individual people. Whether part of a committee, society, organisation or friends-of group, it's individuals who make the real difference and drive change.

Fungal conservation requires both scientific and social contributions and those to facilitate communication. We also need to engage the third and often overlooked corner of the conservation triangle, that is, the need for political involvement to reinforce and legislate conservation measures. Fungal conservation will never have the economic urgency of environmental issues such as those concerning water or soil or others that are seen as more closely connected to human well-being. Science may provide the foundation of knowledge for conservation, but aesthetic, humanistic and political contributions, are what turn knowledge, into action.

I'm aware that I've posed more questions regarding fungal conservation than I've answered. But I guess my intention is to prompt a reconsideration, a re-imagining of what fungal conservation is and could be.

Let's not reduce this amazing kingdom only to numbers. Let's also not forget the tiny pink parasols, the crying ear and the glowing ghosts that might inspire not only young minds, but hearts as well.

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The Global Fungal Red List Initiative

A short guide to red-listing non-lichen-forming ascomycetes with some on-line information sources

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Introduction

Thanks to generous funding by the *Mohamed Bin Zayed Species Conservation Fund* and much initiative and hard work from Anders Dahlberg, Michael Krikorev and Greg Mueller, an interactive website, the *Global Fungal Red List Initiative* [**GFRLI**], has been set up for red-listing fungi [http://iucn.ekoo.se]. Organized on behalf of the five fungal specialist groups of the IUCN Species Survival Commission, the aim is to make fungal red-listing easy. That is important because few people have experience in evaluating fungi using IUCN Categories and Criteria [www.iucnredlist.org/documents/redlist_cats_crit_en.pdf].

This paper is a short guide to help you red-list non-lichen-forming ascomycetes, with advice about some on-line information sources. The guide will hopefully add consistency to evaluations, but

comment and discussion are needed. Please suggest improvements and additions. Because the sources are all available on the Internet, anybody can access them. They are an absolute minimum, and for authoritative evaluations other sources should also be consulted. See also the *Global Sampled Red List Index of the Ascomycota* website [www.cybertruffle.org.uk/redlidat]. A clear statement about source material makes it easier for peer-reviewers to accept your evaluation. If you evaluate a fungus covered by my Specialist Group, please consult the on-line information sources listed here, and state clearly that you have used them [recommended wording: 'This evaluation used on-line information sources recommended by Minter (2014)' and cite this paper in the bibliography].

Getting started

Open the website [http://iucn.ekoo.se] and familiarize yourself with its layout. Click on 'View All Proposals' to see what's already been done. Click on any of the species already proposed, and look at the page layout. The distribution maps are disconcerting: the projection used is Mercator (or something very similar) and northern latitudes are disproportionately large. Furthermore, a single record for Canada, for example, results in the whole area of Canada becoming coloured. It's a very blunt tool. Leaving aside the map, review what has been written in each section about the selected fungus. If you look at a range of different species, you will see variation in the amount of detail provided. Which ones are best? They are the ones to use as models for your first evaluation.

Before you try to make that first evaluation, gather all of your information together in a text editor or word-processor separate from the website. Then, when everything is ready, you can cut and paste paragraphs into the different sections of the website. Bear in mind that you will also need a good illustration of your fungus, and it must be one for which you have copyright or permission to use from the copyright owner.

When you are ready, you can log-in. On the first occasion you will have to set up an account. After that is done, click on 'Add New Proposal', and you will be given an interactive screen on which to enter your data. Having selected the name of the species you want to evaluate, the interactive screen will state on the left hand side 'Proposed by: Michael Krikorev'. It gives the uncomfortable impression that the evaluation has already been made. That is just a glitch in the program. Ignore it: after you have gone to the prompt 'Do you want to propose this species for a Global Red List Assessment' and clicked 'yes' Michael's name will be replaced by yours.

Preparing the data: the fungus name

Make a list of all the scientific names which have been used for your fungus. *IndexFungorum* [www.indexfungorum.org] and *Mycobank* [www.mycobank.org] are two websites which supply information about currently accepted fungal names and their synonyms. You need the synonyms because the other information necessary for evaluating your fungus could be out there under any of those names. Then decide which names in your list are worth using in searches. Some may be obscure and never taken up, but often several will have been used in the past. Make clear which names you have used for searching by citing them in the taxonomic notes section of the evaluation. It's daunting, but take heart, some of the key websites check all synonyms for you automatically.

Observational information

To red-list a species, you need observational information (where, when and on what it has been observed). Consult ALL of the following on-line databases (they all, more or less, check synonyms for you automatically), and please alert me to useful databases not on this list.

- *Association of British Fungal Groups* [http://cate.abfg.org]. Much overlap with the *Checklist of Fungi of the British Isles* website.
- *Belgian Species List* [www.species.be/en/index.php].
- *Checklist of Fungi of the British Isles* [www.fieldmycology.net/GBCHKLST/gbchklst.asp]. Much overlap with the *Association of British Fungal Groups* website.

- *Cybertruffle* [www.cybertruffle.org.uk]. Find the fungus using *Cybernome* [www.cybertruffle.org.uk/cybernome/eng]. If observational information is available, a hyperlink "Biological Records Database" will be visible.
- *Dutch species catalogue* [www.nederlandsesoorten.nl/nlsr/nlsr/english.html].
- *E-biodiversity - the Estonian biodiversity website* [http://elurikkus.ut.ee/index.php?lang=eng].
- *GBIF - the Global Biodiversity Information Facility* [http://data.gbif.org].
- *The Database of the Former IMI Reference Collection* [www.herbimi.info]. Much of the information in this database is incomplete and needs further editing. Use it with caution.
- *Landcare Research New Zealand* [http://nzfungi.landcareresearch.co.nz/html/mycology.asp].
- *USDA Fungal Databases* [http://nt.ars-grin.gov/fungaldatabases].

Additional observational information relating to original collections and type specimens can be found in the original descriptions of species, and in the catalogues of *Saccardo's Sylloge Fungorum*, *Petrak's Lists*, *Index of Fungi*, *Saccardo's Omissions*, and *Petrak's Omissions*. Very occasionally you may also need to use the catalogues for lichen-forming fungi (*Lamb*, and *Zahlbruckner*). Much of this information is only a click away when you check fungal names in *IndexFungorum*. It can also be accessed through *Cyberliber*, the on-line digital mycological library [www.cybertruffle.org.uk/cyberliber]. When evaluating the conservation status of non-lichen-forming fungi (any fungi, actually), all catalogue references to all relevant scientific names should be taken into account.

The on-line databases listed above do not provide comprehensive information. *GBIF*, for example, has limited functionality: it will tell you where and when your fungus has been seen, but nothing about associated organisms or substrata. Collectively these databases provide good coverage of a few countries (e.g. Belgium, Chile, Cuba, Dominican Republic, Estonia, Georgia, Ireland, Netherlands, New Zealand, Puerto Rico, Trinidad & Tobago, Ukraine, UK, USA, Venezuela), sketchy coverage of some others (e.g. Argentina, Australia, Brazil, Canada, India, Kenya, Malaysia, Nigeria, Slovakia, South Africa, Sri Lanka, Tanzania, Uganda) and poor coverage of most of the remainder (e.g. Antarctica, Belarus, China, Iran, Iraq, Japan, Kazakhstan, Kyrgyzstan, Moldova, Mongolia, Russia, Tajikistan, Turkmenistan, Uzbekistan).

That means other sources of information must be explored to improve coverage. At present, that can only be done by making several different type of search. A straight search of *Google* [www.google.co.uk] is likely to result in many hits. Some (perhaps most) will be irrelevant, but you may encounter high-quality amateur sites, for example, with valuable observational information. A search of *Google Images* [www.google.com/imghp] can also be useful in finding relevant websites. *Google Scholar* [http://scholar.google.co.uk] should be helpful in finding relevant research papers. Remember that Google is not the only search engine. For Chinese sources, for example, *Baidu* [www.baidu.com] is important, and for Russian sources *Yandex* [www.yandex.com] can be consulted. Be aware of the 'filter bubble' phenomenon: Internet search engines often use algorithms which offer different results based on the track-record they have of a given user.

Cyberliber provides open access to almost 400,000 pages of mycological literature. These include key regional works not available elsewhere on the Internet (such as Ethel Doidge's checklist of South African fungi and lichens published in *Bothalia*, and the fungal volumes in the series *Flora of Spore Plants of Kazakhstan*). In addition, *Cyberliber*'s cumulative index search [www.cybertruffle.org.uk/cyberliber/huntspec.htm] will find occurrences of a species name (and often of its synonyms) by searching about a million records from indexes of mycological publications. It may also be worthwhile using the search facilities on the *Biodiversity Heritage Library* website [www.biodiversitylibrary.org].

The information collected from all of these sources can be used in several different sections of the **GFRLI** evaluation form. Locality information helps you to describe the geographical range. The dates when observations have been made in each country are useful for evaluating populations, trends and possible local extinctions. You are also likely to have a list of associated organisms and substrata and, perhaps, additional information about the biology of the fungus. These can be used in the

Habitat and Ecology section. Finally, you may have found information about the regional conservation status of the fungus which can be used in the Conservation Actions section.

It is often necessary to make the most of very limited observational information. A species known from only one country is more at risk than a species known from more than one countries. A species known from one continent is more at risk than a species known from more than one continent. A species known from only one associated organism is more at risk than a species known from more than one associated organism. No records for 50 years from a country with a long tradition of field mycology and good nature conservation practices is stronger evidence of extinction than no records from a country where nobody has been looking. Considerations of this sort were used as an overlay on top of IUCN criteria when the *Global Sampled Red List Index of the Ascomyceta* was prepared, and the website for that project has a detailed discussion of the issues involved [www.cybertruffle.org.uk/redlidat].

Estimating extent of occurrence and area of occupation

The **GFRLI** website does not mention the terms "extent of occurrence" and "area of occupation" (it's an understandable decision to keep things simple), but in fact these two statistics are expected when evaluations are submitted to IUCN, and the sooner fungal conservationists get used to them, the better.

Extent of occurrence is defined as the area covered by a polygon connecting the furthest separate points where the organism has been observed. The idea is to have some measure of how likely the organism is to suffer extinction as a result of a catastrophic event. The smaller the extent of occurrence, so the theory goes, the smaller the catastrophic event required to wipe out the organism.

Area of occupation is a measure of the area actually covered by the organism. The statistic was originally devised for elephants, hippos and other animals, and measured the area they were wandering about in. When its use was taken up for plants, a decision was made that each observation should be regarded as the centre of a hypothetical square 2 km × 2 km. We have inherited that definition and put it into use for fungi.

The question then arises, how (without a PhD in maths) does one calculate the area of the polygon on the surface of a globe? Fortunately, there's a neat piece of software developed by Steve Bachman at the Royal Botanic Gardens, Kew. It's called *Geocat* [http://geocat.kew.org], and with it, you can click on a map to mark all the points where your fungus has been found. It then calculates the extent of occurrence and area of occupation for you, and even offers an opinion of what each statistic means in conservation terms. To use the software, open it with a suitable web browser, click on "Start a new project", then click on "ADD POINTS", then click on "Enables EOO/AOO" (it's not obvious - its top right of the screen), then away you go (if you explore, you will also find more sophisticated ways to use the website).

It's not perfect. If the polygon covers a really big part of the globe, for example with several records in Africa, others in North America, and a third cluster in Asia, the software bursts into tears and produces very variable results. To get round that problem, it is best to produce individual estimates for each continent, and then add them together at the end.

Associated organism names

It is important that the scientific names of associated organisms are spelt correctly and, where possible, be accompanied by the author(s) of the name. The following on-line sources should be consulted.

- **Algae**. *Algaebase* [www.algaebase.org].
- **Animals**. *Encyclopedia of Life* [http://eol.org].
- **Bacteria**. *List of Prokaryotic Names* [www.bacterio.net].
- **Fungi**. *IndexFungorum* [www.indexfungorum.org].
- **Plants**. *The Plant List* [www.theplantlist.org] useful because it often provides opinion about the acceptability of a given name, but not as extensive in coverage as *The International Plant Names Index* [www.ipni.org].

- **Protists**. *Encyclopedia of Life* [http://eol.org].

The *Global Names Index* [http://gni.globalnames.org], the *Catalogue of Life*. [www.catalogueoflife.org] and *Wikipedia* [www.wikipedia.org] are also very useful.

Conservation status of associated organisms

If only a small number of organisms are associated with the fungus you are evaluating, it may be relevant to check whether they themselves are red-listed. That can be done by consulting the *IUCN Red List of Threatened Species* [www.iucnredlist.org]. If the only plant known to bear your fungus is itself endangered, then the fungus is likely to be at least as endangered, and probably even more so. This is useful information for the Population and Trends section of the **GFRLI** evaluation form.

Threats

Investigative journalism techniques are needed here, and the Internet is a very fertile place for such research. Don't think only in terms of academic pubications. Blogs, newspapers, and commercial sites may also have valuable informaton. The common threats to organisms come from climate change, habitat destruction, persecution, pollution, and unsustainable use. With what you have already found out about the geographical distribution of your fungus, ask yourself if any of these could possibly be relevant. Here are some example questions.

Climate change. Is the fungus sensitive to climate? Is it in a habitat threatened by climate change? If climate change makes that habitat untenable in one place, does the fungus have alternative habitats to go to and the means of travelling there? Will such a fungus be treated as an invasive when it is, in fact, a refugee?

Habitat destruction. Are any of the places where the fungus is known designated as protected areas? Are any of those protected areas threatened, for example by proposals for industrial development? Are the protected areas where the fungus occurs managed in a way sympathetic to the needs of the fungus? Is there evidence of habitat destruction in other places where the fungus is known? Is that habitat destruction widespread or localized? Chopping down rainforests for oil palm plantations is not the only type of habitat destruction. War, for example, can be as bad for fungal populations as it is for everything else.

Persecution. Is the fungus perceived as undesirable? If it is associated only with one plant species which is itself endangered, for example, it is possible that well-meaning but misguided conservationist might try to eradicate it. Are chemical controls in use aimed at other organisms, but which could adversely affect the fungus? Some fungi are persecuted because they are viewed as invasives. Some of those categorized as invasives may in fact be refugees.

Pollution. Is anything known about the susceptibility of this fungus to pollution? If so, what evidence is there for that type of pollution in areas where the species is known to occur? Are associated organisms susceptible to pollution? If so, will that mean the habitat for this fungus is threatened? Pollution can take many forms, some may not seem at first sight like pollution. For example antibiotic dietary supplements for domestic animals may render their dung unsuitable for specialist fungi.

Unsustainable use. Is the fungus being collected at unsustainable levels? If this is suspected, try typing the scientific name, or better a vernacular name for the fungus into Google along with the word 'buy'. Doing this in a range of different languages could tell you how international that trade has become. You then have the problem of trying to assess the scale of the operation in each country. What is the harvesting season? How much is being harvested daily? Weekly? Over what area? Who is doing the harvesting? Who is buying? Who is distributing? Who knows about it? Are the buyers aware of possible conservation concern? There are many questions. Unsustainable trade in wild species tends to be secretive in nature. Knowledge of how social media websites function and fluency in the

relevant language become useful. Frankly, fungal conservation here urgently needs the experience and expertise of those working with endangered animals and plants: we have so much to learn.

Conservation actions

The various searches already recommended are likely to have picked up any on-line information about in situ conservation. It is also worth bearing in mind that some fungi are stored in culture collections. Although the reason they are stored is rarely if ever for their protection, the fact that they are alive outside their natural environment is relevant. Genetic material of the fungus may also be stored even if the sequence is only part of the whole code of the species. The following websites may be useful for locating isolates in culture collections and stored genetic code.

- *CABI Culture Collection* [http://cabi.bio-aware.com/Biolomics.aspx?Table=GRC+catalogue].
- *CBS Culture Collection* [www.cbs.knaw.nl/Collections/Biolomics.aspx?Table=CBS strain database].
- *National Center for Biotechnology Information* [www.ncbi.nlm.nih.gov].

Concluding remarks

The new **GFRLI** website is a big step forward for fungal conservation in general and the IUCN red-listing process in particular. Three years ago, I attempted to propose a fungus for the IUCN red list, and found that, while theoretically possible, it could not be done in practice because the IUCN's own database of organism names did not include any fungi. I typed in the name of my species and was told by the computer that it had not been recognized.

What a change now! Thanks to collaboration from Paul Kirk and *IndexFungorum*, the IUCN's database has been populated with fungal names, and thanks to Anders Dahlberg, Michael Krikorev and Greg Mueller, together with the generosity of the *Mohamed bin Zayed Species Conservation Fund*, there is now a website dedicated to making fungal red-listing easy. It's important for fungal conservationists to support their efforts by proposing species through this website.

It's a step in the right direction, but it's not the end of the journey. By making the process more easy, some corners have been cut. When fungal conservationists have had the experience of proposing a tranche of species, and when the IUCN Species Survival Commission fungal specialist groups have had the experience of reviewing those proposals, we will all have a much better idea of what we are doing and where we are going.

Even at this stage, however, it is important that this website is not allowed to degenerate into some kind of "red-listing lite" process. The case made for each species must be scientifically rigorous. Source websites listed here are only the beginning. Most information needed is still not on-line, but basic standards for source information, and readily available tools like *Geocat* can help us all improve our ability to propose and protect these beautiful organisms. After receiving your helpful feedback and suggestions for improvement, I hope to publish a more developed form of this note on the Internet with updates as appropriate. Recommendations suitable for one group of fungi are helpful: fuller recommendations for all groups would be better. I therefore invite the other Chairs of IUCN Species Survival Commission fungal specialist groups to consider a fuller document covering all fungi.

At present, to make an evaluation, we need a human to sift through sources (many already digitized), and select and re-type the information into a different computer system. Looking further into the future, I hope there will be co-operation between the various main fungal databases to mechanize some of that work. Many aspects of evaluation do not need a human present, so long as the computer can be programmed to recognize decisions it cannot make. It should be possible one day to type the name of a species, and for the computer then to search different occurrences databases and, in real time, produce a simple evaluation of the organism's current conservation status.

Fungal conservation and the CBD: focus on Belgium. A Micheli Guide Review

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Introduction

Belgium has just submitted its revised *National Biodiversity Strategy and Action Plan* to the Rio Convention on Biological Diversity [**CBD**], so now is a good time to ask how well its government is delivering fungal conservation. This *Micheli Guide* [www.fungal-conservation.org/micheli.htm] review is based entirely on the plans and reports Belgium has produced for the **CBD** - the Belgian government's own descriptions of what it has done and plans to do - but, as with book reviews, the facts are accompanied by this reviewer's interpretation and opinions.

Belgium signed the **CBD** on 5 June 1996. Since then, it has sent thirteen documents to the Convention, all in English. All are openly available on-line from the **CBD** website [www.cbd.int/nbsap]. Two, about the Cartagena Protocol on Biosafety, are outside the scope of the present review. I assessed the others using the Micheli Standard Evaluation Form [www.fungal-conservation.org/micheli/cbd-report-form.doc].

How the Micheli Standard Evaluation Form works

To measure how much attention fungi get compared with animals and plants, the form provides three lists of words: one for fungi, another for animals and the third for plants (see text box). By counting how often each occurs in the document under review, you get an estimate. But beware! That estimate is very rough and ready. Although these lists accurately measure attention to fungi, they consistently and very markedly underestimate attention to animals and plants. This is because English has only a few vernacular words for fungi (and all the main ones are in this list), but there are many English words for animals and plants which are not present (for example 'arthropod', 'bat', 'bee', 'beetle', 'butterfly', 'crustacean', 'dolphin', 'dragonfly', 'duck', 'falcon', 'poplar', 'rose', 'willow' etc.).

Fungus words are 'fung' (as in 'fungal', 'fungi' and 'fungus'), 'lichen' (but not German words like 'wissenschaftlichen'), 'myc' (as in 'ascomycete', 'basidiomycete', 'mycology' etc.), 'mould', 'mushroom', 'rust' (but not 'crustacean'), 'smut', 'toadstool', 'truffle' and 'yeast'). **Animal words** are 'amphibian', 'animal', 'bird', 'fauna', 'fish', 'insect', 'mammal', 'reptile' and 'vertebrate' (which will also find 'invertebrate'). **Plant words** are 'bryophyte', 'conifer', 'fern', 'flora', 'flower', 'moss' and 'plant' (but not phrases like 'sewage treatment plant').

The form also asks five questions. **1**. Are fungi mentioned? **2**. Are they clearly and consistently recognized as different from animals and plants? **3**. Is strategic consideration given to fungal conservation? **4**. Are fungal habitats and roles taken into account? **5**. Is the knowledge gap for fungi recognized, with plans to address the problem? Five 'no' answers mean the document is totally deficient in its coverage of fungal conservation. Four 'no' answers mean seriously deficient. Three mean deficient. Two mean poor. One means nearly adequate. None (i.e. all answers are 'yes') means adequate (doing the minimum necessary). To be good, the document must score five 'yes' answers AND, in the opinion of the reviewer, be protecting fungi at more than the necessary minimum. To date, no **CBD** document reviewed has been worthy of all five 'yes' answers, and most are evaluated as poor or worse.

The numbers of animal, fungal and plant words in Belgium's **CBD** documents are shown in Table 1. Fungi have clearly received far less attention than animals or plants and, for the reasons given above, the imbalance is much greater than these very rough and ready and conservative statistics show.

Table 1. Number of times selected animal, fungal and plant words occurred in CBD country reports from Belgium

Document name [date received by **CBD**]	Animals	Fungi	Plants
First National Report [5 May 1998]	191	9	92
Second National Report [17 August 2001]	119	27	95
Thematic Report on Forest Ecosystems [11 September 2002]	31	2	20
Thematic Report on Protected Areas [17 July 2003]	11	0	1
Report on Implementation of GTI Work Programme [20 September 2004]	110	32	49
Third National Report [7 September 2005]	296	67	252
National Biodiversity Strategy and Action Plan [18 January 2007]	208	9	114
Review of the Implementation of the Protected Areas Work Programme [3 April 2007]	17	0	4
Voluntary Report on Implementation of the Programme of Work on Marine and Coastal Biological Diversity [13 February 2009]	62	0	9
Fourth National Report [5 October 2009]	119	19	145
National Biodiversity Strategy and Action Plan (version 2) [7 July 2014]	288	11	148

Reports where fungi are not mentioned at all

There are three reports in this category. Two deal with protected areas. They contain no evidence at all that fungi are taken into account when defining protected areas in Belgium. Using animals and plants to define protected areas results in places rich in animal and plant diversity getting protected. Fungi may also benefit, but if so, then it's only by happenstance. We know, for example, that some habitats are highly diverse in fungi, but not in plants. In addition, protecting particular plant species does not necessarily protect the fungi associated with them: not all pine-inhabiting fungi, for example, are found in every pine forest - some pine forests are richer in some fungi, and other pine forests are richer in others. There is no evidence from the protected areas reports that the authors are aware of the concept of 'Important Fungus Areas', even though such areas undoubtedly exist in Belgium [for one example, see www.inbo.be/docupload/2321.pdf]. Overlooking fungi when designating protected areas is not good.

The third report deals with marine and coastal biodiversity. Type 'Belgian coast' into Google Images, and you will see extensive and beautiful beaches backed by dunes where marram grass (*Ammophila arenaria*) is abundant. Marram is critically important for these ecosystems, and fungi are critically important for marram. Type 'mycorrhiza ammophila' into Google and you very rapidly find evidence that arbuscular mycorrhizal fungi play a key role in establishment, growth and survival of marram and other coastal dune plants [http://cadair.aber.ac.uk/dspace/handle/2160/2449], and that sporulation of the beneficial fungi may be affected by climatic factors. Without taking fungi into account, how can plans be made to protect these dunes? And there are lots of other fungi in these ecosystems, all playing their own particular and important roles. What about all the lichen-forming fungi in the lichen-rich dune heaths? What about the specialist sand-dune ascomycetes and basidiomycetes? What about marine fungi?

Each of these three reports gets five 'no' answers and no 'yes' answers: from the perspective of fungal conservation they are all totally deficient.

The Forest Ecosystem Report

In this report, there were only two references to fungi. The first was in the context of undesirable alien organisms. The second was a brief statement about monitoring various organisms within Brussels region. Fungi mentioned? Yes. Fungi clearly and consistently recognized as separate from animals and plants? Maybe. The report contains no mention of ectomycorrhizal fungi, even though their presence is necessary for the survival of forests, nor of fungal saprobes and the ecological services they provide by recycling nutrients. Fungal endobionts are not mentioned, nor any other fungal symbioses (and there are lots out there, ranging from mutualism through to strongly parasitic - a whole spectrum of ecological roles where many of the natural checks and balances of forests are to be found). There is no evidence in this report of awareness that temperate forest trees sustain enormous fungal diversity. The report names *Fagus sylvatica*, *Larix decidua*, *Picea abies*, *Pinus nigra*, *P. sylvestris*, *Pseudotsuga menziesii*, *Quercus petraea* and *Q. robur* as the country's main forest trees. Collectively, these are known throughout their range to be associated with literally hundreds if not thousands of different fungal species [www.cybertruffle.org.uk/cybernome/eng], and for all of these trees the number of known associated fungal species continues to grow. If this huge diversity really is being taken into account, why is there no mention of it?

This report gets three 'no' answers and two 'yes' answers: from the perspective of fungal conservation it is deficient.

The National Biodiversity Strategy and Actions Plan of 2007 and its 2014 revision

The 2007 document and its 2014 revision both make a promising start. The mushroom *Tricholomopsis rutilans* appears among photographs on both front covers. In both the definition of biodiversity at the start of part 1 states that, 'biodiversity, or biological diversity, is the variety of all life forms - plants, animals, fungi and micro-organisms', and on several other occasions both reports clearly state that fungi belong in their own separate biological kingdom. That's very good. Two 'yes' answers already.

Unfortunately, after such a good start, both documents lose the plot. There is then only one other mention of fungi in each: an expression of concern that genetically modified crops might be bad for mycorrhizal fungi. As a mention, it is not so bad. It recognizes that fungi are valuable and might be threatened. What a pity both documents failed to take this further. Having recognized that fungi are on a par with animals, plants and other biological kingdoms, each plan goes on to mention animals more than 200 times, and plants more than 100 times. What happened to the fungi? Why didn't the fungi get fair treatment? Let's try to find out.

Look at how animal words are used in these documents and it rapidly becomes clear that 'fish' accounts for just over 50% of all occurrences. That is so unlikely to be random that I immediately wondered, 'are Belgians pre-occupied with fish?' The answer is, 'no more so than anyone else'. A quick scan of recent **CBD** reports from European countries showed that references to fish were prominent in all of them. 'Fish' accounted for at least 30% of all animal words in the reports of Bulgaria, Croatia, Denmark, the EU, the former Yugoslav Republic of Macedonia, Germany, Iceland, Ireland, Italy, Liechtenstein, Lithuania, Malta, the Netherlands, Norway, Portugal, Spain, Sweden, Turkey and the UK. Documents from countries outside the EU also show this pattern. If it weren't for the presence of two landlocked countries in the list above, a cynic might wonder if this emphasis were more to do with fishing rights turf wars than protection of nature.

'Flora and faunaism'

In both documents 'animal' and 'fauna', and 'plant' and 'flora' are the most prominent words from the Micheli lists. They appear overwhelmingly in the following phrases: 'animals and plants', 'plants

and animals', 'fauna and flora', 'flora and fauna'. In every case they are a lazy and misleading shorthand for biodiversity. Such use implies that animals and plants are the only components of biodiversity, which is simply not true, and by making that implication, fungi and other organisms like bacteria and protists get excluded. Both documents could be greatly improved by replacing those misleading phrases with something more precise. Here are some examples from the 2007 version (the 2014 version is similar).

- Page 16. 'Groundwater pumping leads to desiccation of wetlands and disappearance of related fauna and flora'. Wetlands support a huge diversity of specialist fungi: in the 1940s, Ted and Martin Ellis, in eastern England, issued a whole exsiccatum series entitled 'Marsh and Fen Fungi'. Belgium, just over the North Sea, must surely share most if not all of those species. They are threatened by desiccation just as much as any animal or plant. Better to say 'related animals, fungi and plants'.
- Page 23. 'The 'Contrat d'avenir pour les wallonnes et les wallons' was adopted by the Walloon Government on 20.01.2005. One of the objectives of this Contract is to stimulate efforts to avoid the disappearance of animal and plant species, in line with the EU Objective to halt the loss of biodiversity by 2010. To this end, the Contract proposes to mobilise all available human resources and integrate existing activities to create a real network of protected natural environments favourable to the development of fauna and flora'. Why not fungi too? If animals and plants are to thrive, conditions must be favourable for fungi.
- Page 39. 'For instance... ...information campaigns could address the following issues: soil management best practices, impacts of pesticides on wild fauna...' What about impacts of fungicides on wild fungi?
- Page 55. 'Plants and microbes have long been, and remain today, an important basis for the development of medicines such as quinine, morphine, penicillin etc.' At the start of part 1, the document correctly defined biodiversity as 'plants, animals, fungi and micro-organisms', and *Penicillium* - the source of penicillin - is a fungus, so why suddenly omit fungi at this point? Better to say 'Fungi, micro-organisms and plants'.
- Page 61. 'More research is needed to gain an idea of the effects of present day agrotechnology on both agricultural biodiversity and wild flora and fauna'. Better to say 'wild animals, fungi and plants'.
- Page 70. 'An increasing amount of scientific research on the flora and fauna of Antarctica is underway...' This is ridiculous. The mycobiota of Antarctica is far more extensive than its flora. Better to say 'animals, fungi and plants of Antarctica'.

These small editorial changes would result in an enormous improvement. The documents explicitly recognize that fungi are a separate component of biodiversity, so why not enjoy the credit for explicitly including them throughout the text?

Fungal habitats and roles

The fourth question on the Micheli form is: 'are fungal habitats and roles taken into account?' Since both the 2007 and the 2014 document both mention mycorrhiza, even if only once, it is clear that the authors were aware of at least one important ecological service provided by fungi. But mentioning it once, and then only in the context of threats from genetically modified crops, could hardly be described as 'taking fungal habitats and roles into account'.

The knowledge gap

The fifth question on the Micheli form is, 'is the knowledge gap for fungi recognized, with plans to address the problem?' The answer is a clear, 'no'. Sadly, the document itself is clear evidence of the knowledge gap (and of the serious lack of awareness of the importance of fungi). That self-evident evidence was not recognized by the authors, and no plans were made to do anything about the problem.

Summary
In these two documents, fungi were mentioned, and correctly and clearly recognized as a separate group of organisms, but there was no strategic consideration of their conservation, no evidence that fungal habitats and ecological roles have been taken into account, no recognition of the knowledge gap for fungi, and no plans to address that problem. Each document gets two 'yes' answers and three 'no' answers. From a fungal conservation perspective they are both deficient.

CITES, the Bird Directive and the Habitats Directive - a case for strategic consideration of the fungi

There are a few places where 'fauna and flora' and 'animals and plants' cannot be easily replaced by 'animals, fungi and plants'. Most involve the Convention on International Trade in Endangered Species [**CITES**]. That convention covers 'fauna and flora' because those consulted at the time did not make sure fungi were included. The spirit of the convention surely extends to protecting fungi endangered by international trade. Unfortunately, the wording of the convention (the part any good lawyer would emphasize) does not. But some fungi are endangered by international trade, and they too need protection: boletes, chanterelles, medicinal fungi (like *Ophiocordyceps sinensis*), morels and truffles are all potential candidates.
The only other common animal word in these documents is 'bird'. Looking at how it is used leads to a similar issue. The conservation movement owes a great debt to birdwatchers. Being so numerous and influential, they have provided the political pressure which drives conservation along. The prominence given to birds in these two documents reflects the powerful lobbying by birders, not just in Belgium, but across the European Union as a whole, and that leads us to EU conservation law. In the words of its own website [http://ec.europa.eu/environment/nature/legislation/habitatsdirective], the Birds Directive, together with the Habitats Directive 'form the cornerstone of Europe's nature conservation policy'. It is not surprising that birds are emphasized in these documents, but what is the implication of the Habitats Directive? Unfortunately, like **CITES**, the EU Habitats Directive deals with conservation of wild fauna and flora. As the EU website already cited says, the Habitats Directive protects over 1,000 animals and plant species. Fungi are not covered. Doubtless the spirit of the directive extends to protecting them, but the wording, like that of **CITES**, does not. These loopholes in international conservation law need to be closed.

The First National Report

The word 'fungus' occurred nine times (once in relation to biodiversity of the Brussels Capital Region, once in relation to work in China, and seven times in the context of ex situ collections, generally alongside bacteria as 'micro-organisms'). The word 'yeast' occurred five times (only in the context of ex situ collections). The words 'lichen', 'mould', 'mushroom', 'rust', 'smut', 'toadstool' and 'truffle' did not occur at all. There were no instances of 'myc' as a combination of letters (as in 'mycology', 'basidiomycete' etc.). There was no mention at all of fungi for the Flemish and Walloon Regions (i.e. for well over 95% of Belgium). Fungi were mentioned once in the context of conservation, but that was in the section about work in China. There was no consideration of in situ fungal conservation in Belgium. There was one photograph of a fungus (*Isaria* sp.) growing in pure culture, and *Cryptococcus neoformans* was mentioned once.

By comparison, the animal words used for this evaluation occurred almost 200 times (and many other animal words were also present in the text), and plant words occurred almost 100 times (and other plant words were also in the text). The dominant animal words were 'fish', 'bird', 'fauna' and 'animal', and the dominant plant words were 'plant' and 'flora'. These words were prominent for the

same reasons as in Belgium's National Biodiversity Strategy and Action Plans: 'flora and faunaism', **CITES**, the Birds Directive and the Habitats Directive.

It is not clear whether the authors of this report understood that fungi are a separate group of organisms - fungus words did not occur frequently enough - but at least the fungi were not explicitly confused with plants. There was no evidence of strategic thinking about fungal conservation. Belgium has excellent fungal culture collections and these were mentioned in the context of ex situ conservation, but the text makes clear that these collections exist as a service to the scientific and industrial communities. In other words, they are primarily for exploitation of fungi; there was no evidence of any policy to store fungal cultures because the species are threatened. There was no evidence of fungal habitats and ecological roles being taken into account, and no recognition of the knowledge gap for fungi, nor plans to deal with that gap. So this report gets two 'yes' answers and three 'no' answers: from a fungal conservation perspective it is deficient.

The Second National Report

The word 'fungus' occurred twelve times (three times in relation to inventory work by the National Botanic Garden of Belgium, once each in relation to work in Benin, Cuba, Papua New Guinea, sub-Saharan Africa, and west Africa, three times in the context of ex situ collections, generally alongside bacteria as 'micro-organisms', and once in the title of one bibliographic reference). The word 'yeast' occurred three times (only in the context of ex situ collections). The word 'lichen' occurred twice (one in relation to the National Botanic Garden's inventory work, and the other in relation to work in Papua New Guinea). The word 'mushroom' occurred twice, both times in relation to work in west Africa. The words 'mould', 'rust', 'smut', 'toadstool' and 'truffle' were not used. There were eight instances of 'myc' as a combination of letters in 'mycorrhizal' (three occurrences, two for west Africa, one for Belgium itself), 'mycology' (used to describe a database, a publication and reference collections) and 'mycothéque' (used in the context of one reference collection).

By comparison, the animal words used for this evaluation occurred almost 120 times, and plant words occurred almost 100 times. The dominant animal words were 'bird', 'fish', 'fauna' and 'animal', and the dominant plant words were 'plant' and 'flora'. The reasons for these words being dominant seemed to be the same as in the National Biodiversity Strategy and Action Plan documents: more 'flora and faunaism'.

Fungus words were too infrequent to tell if the report authors understood that they are a separate group of organisms, but in several instances there was evidence of confusion with plants (e.g. use of terms like 'flora' rather than 'mycobiota'), and confusion about the status of lichens (listed separately from fungi). There was no evidence of strategic thinking about fungal conservation. Although the word 'mycorrhiza' was used, there was no evidence of fungal habitats and ecological roles being taken into account, and there was no recognition of the knowledge gap for fungi, nor were there plans to deal with that gap. Many references to fungi in this report related to work outside Belgium. It's great that less wealthy countries are being helped with research on fungi. It's a pity that, in this report, Belgium showed so little interest in protecting its own fungi. This report gets one 'yes' answer and four 'no' answers: from a fungal conservation perspective it is seriously deficient.

The Third National Report

Fungus words occurred 67 times. The word 'fungus' itself occurred 28 times (twelve times in relation to inventory work by the National Botanic Garden of Belgium, ten times in all for collaborative work in China, Cuba, Gabon, Papua New Guinea, southeast Asia and tropical Africa, five times in the context of ex situ collections, generally alongside bacteria as 'micro-organisms', and once in the word 'fungicide'). The word 'yeast' occurred five times (only in the context of ex situ collections). The word 'lichen' occurred seven times (four times in relation to inventory work within Belgium, twice in relation to scientific publications, and once in relation to work in Papua New Guinea). The word

'mushroom' occurred twice, both times in relation to laws governing wild harvesting in the Brussels Capital Region. The word 'mould' occurred once in the context of 'slime moulds'. The words 'rust', 'smut', 'toadstool' and 'truffle' were not used. There were 24 instances of 'myc' as a combination of letters in various words including 'ethnomycology' (work in Benin and Burkina Faso), 'mycology' (work in Benin, Burkina Faso and Gabon) and 'mycorrhizal' (in west Africa, and in Belgium itself).

By comparison, the animal words used for this evaluation occurred almost 300 times (and other animal words were also present in the text), and plant words occurred more than 250 times. The dominant animal words were 'bird', 'fish', 'fauna' and 'animal', and the dominant plant words were plant and 'flora'. The reasons for these words being dominant seemed to be the same as in the National Biodiversity Strategy and Action Plan documents.

Although fungi were sometimes described as micro-organisms, and lichen-forming fungi sometimes treated separately from other fungi, the authors of this report in general got the basic taxonomy right: they recognized that fungi are a distinct group of organisms. It was encouraging to see fungi mentioned more often, but there was still no evidence of strategic planning for fungal conservation, or of consideration of fungal habitats and ecological roles (except, curiously, a little for other countries where Belgian scientists were working). There was still no acknowledgement of the knowledge gap for fungi, nor were there any plans to deal with that gap. This report gets two 'yes' answers and three 'no' answers: from a fungal conservation perspective it is deficient.

The Fourth National Report

Fungus words occurred 19 times. The word 'fungus' itself occurred 10 times (mostly in definitions of biodiversity, never in reference to collaborative work outside Belgium). The word 'lichen' occurred five times. The word 'mushroom' occurred once (in relation to Africa). The words 'mould', 'rust', 'smut', 'toadstool', 'truffle' and 'yeast' were not used. There were three instances of 'myc' as a combination of letters, in each case as part of the name of a taxonomic group ('Ascomycetes' etc.).

Animal words occurred almost 200 times (and other animal words were also present in the text), and plant words occurred almost 150 times. The dominant animal words were 'fish', 'bird', 'animal', 'amphibian' and 'fauna', and the dominant plant words were 'plant' and 'flora'. The reasons for these words being dominant seemed to be the same as in the National Biodiversity Strategy and Action Plan documents: 'flora and faunaism' rampant.

This report contains several very clear statements recognizing that fungi are different from animals, micro-organisms and plants: Belgium's first national report to do this, and a very welcome development. Unfortunately, it also contains several other instances where fungi are equally explicitly confused with plants. Most of these occurred because fungi received attention in the section relating to the Global Strategy for Plant Conservation. That raises some important issues for fungal conservation, which will be discussed later. It does, however, mean that this report, despite some positive developments, cannot be said to have got the science right. This report gets one 'yes' answer and four 'no' answers: from a fungal conservation perspective it is seriously deficient.

The Report on Implementation of the GTI Work Programme

GTI is an abbreviation for the **CBD**'s Global Taxonomy Initiative, set up to deal with the so-called 'taxonomic impediment': the world's biodiversity is very poorly known, with far too few people and resources available to put the problem right. Having the **GTI** as its theme makes this report a bit different. It is just about taxonomy, so some Micheli form questions may not be appropriate. We cannot expect this report to take much account of fungal habitats and roles, but it really should deal with the knowledge gap for fungi, a problem overlooked by all Belgium's other **CBD** documents. With taxonomy as its theme, this report mentions fungi more often than those other documents and, although there is plenty of 'flora and faunaism', they are correctly and consistently recognized as

separate from animals and plants. But does that mean all is well with Belgium's attention to the knowledge gap for fungi? Let's take a closer look.

The word 'fungus' occurs 15 times in the document. Two instances simply record the country's fungal reference collections with no evidence to show they are actually in use to tackle the 'taxonomic impediment'. Four others relate to collaboration in tropical Africa and the Indo-Pacific region (great for addressing the 'taxonomic impediment' at a global level and surely also enhancing Belgium's pool of taxonomic expertise if only indirectly). Another simply affirms that natural history societies in Belgium are active and include mycologist members: true, no doubt, but hardly a contribution from the government. Two of the remainder are about the Species 2000 / Catalogue of Life project, and the rest relate to research projects within Belgium or in Europe as a whole. These are devoted wholly or partly to fungi and myxomycetes (but funding sources are not given). The letters 'myc' are mostly found in phrases which also have the word 'fungus' - they have already been discussed. The one exception was for a project on mycorrhizal fungi symbiotic with trees in Europe and Africa. The word 'lichen' occurs three times, all relating to research projects at two universities (funding sources not stated), and the word 'yeast' occurs once as part of the description of Belgium's culture collections, again without evidence that the resource is in use to tackle the 'taxonomic impediment'. It's a pity that information about funding is absent: if the government is paying, it should receive credit for the work. In summary, some resources are being provided and some work is going on, but on examination coverage is less extensive than it looked at first sight, and it is not always clear how the work described is helping to reduce the knowledge gap for fungi.

On the other hand, the report does not mention any plans for raising a new generation of taxonomists. There is no discussion of how infant, primary and secondary school curricula should stimulate interest in those organisms for which taxonomists are needed (Finland, to its credit, recognized these issues and included them in the country's Fourth National Report). Such discussions should range beyond just schools. They should also ask, 'are there museums with exhibitions about the overlooked taxonomic groups which we all agree are so important?' (again, well done Finland) and, 'where is the funding for these important educational components?' and, 'are there tertiary-level courses suitable for producing qualified taxonomists?' The report doesn't mention money (those newly trained taxonomists will want salaries): the long time taken to train taxonomists should not be wasted. If 'citizen science' - contributions by amateurs - is to be a factor, where is the provision to support their public-spirited involvement, and where are the plans to ensure the few professional taxonomists can co-ordinate them?

We can at least say that the report recognizes part of the knowledge gap for fungi and that some steps have been taken to deal with some parts of the problem. Two cheers.

'Flora and faunaism' - an intellectual straitjacket disastrous for conservation

Deconstruct these documents, and two conflicting themes emerge. On the one hand, there is solid science, typified by the several times repeated unambiguous, clear and correct statement that biodiversity means animals, fungi, plants and micro-organisms. On the other hand, there is persistent use of the traditional term 'flora and fauna' as an out-of-date and lazy shorthand to mean biodiversity in general. It's so strange to see them together. It's like reading a document about chemistry which refers equally to elements like oxygen, potassium and uranium, and to the old alchemist concepts of air, earth, fire and water, as though both concepts were correct and compatible.

Conservation of biodiversity cannot be achieved by considering only the producers (plants) and consumers (animals). We must also protect the recyclers, and recognize the ecosystem services provided by fungi and micro-organisms. No fungi: no mycorrhizas: no forests or agricultural crops: no air to breathe and no food. Taking fungi and the checks and balances they contribute out of the equation is like looking at a clock and saying, 'if we remove the escapement mechanism, it will run so much more quickly!' Thinking only in terms of 'flora and fauna' or 'plants and animals' leads directly to exactly that sort of mistake.

Throughout these reports we have seen the fungi overlooked and consistently undervalued (the present paper is about fungi, but it must be evident to all that micro-organisms have been similarly treated). The intellectual straitjacket of 'flora and faunaism' is to blame. It's the reason why, throughout the world, displays in natural history museums are so locked in to fur, feathers and dinosaurs, and educational curricula provide such poor coverage of fungi in the biological sciences. It's the reason why mycologists continue to occupy obscure corners of botanical institutions. It's the reason mycologists haven't been consulted when **CBD** documents are prepared. And its influence is so deep seated as to be almost subconscious: many contributors to Belgium's 2007 National Biodiversity Strategy and Action Plan were employed by the 'Federal Public Service for Health, Food Chain Security and Environment'. Even the title of their organization reflects the blind bias of 'flora and faunaism'. It's not a food chain. Food doesn't go from here to there and then stop. It comes round again to be re-used. It's a nutrient cycle. They forgot the fungi.

Fungi and the Global Strategy for Plant Conservation

The two conflicting themes are most evident in Belgium's fourth national report to the **CBD** because information about fungi was included in the section devoted to the Global Strategy for Plant Conservation. That strategy is the result of years of activity by botanists, and is widely recognized and adopted by **CBD** countries. In conservation terms, it's a great achievement. Mycologists should and do welcome it. But it is all about plants, and fungi are not plants. Botanists are undoubtedly well-meaning when they try to include fungi in their strategy - in that way fungi get at least some mention in **CBD** reports - but those kind intentions do not translate into genuine benefit for fungal conservation. They just perpetuate the misconception that 'flora and fauna' is the same as biodiversity. A totally new global strategy for fungal conservation is needed with the same status as the plant strategy. Good conservation cannot be based on a fundamental misunderstanding.

Challenges for everyone

Belgium was chosen for this review simply because at the time of writing, it was the most recent country to have submitted documentation to the CBD. From the perspective of fungal conservation, Belgium's **CBD** documents have not received good scores - it would be unrealistic to pretend otherwise - but there is the potential for much good to come out of this review.

In its strategy, Belgium has correctly recognized that fungi are different from animals and plants, so it would be logical and consistent to acknowledge the loopholes in **CITES** and the Habitats Directive and work towards closing them. With its long history of mycological expertise, the country could also support development of a 'Global Strategy for Fungal Conservation'. It would be a great response to the IUCN's 2012 call to all governments 'to give greater priority to mycology… …as an essential basis for future conservation measures'. All of these activities would be compatible with objective 12 of Belgium's biodiversity strategy (to influence the international agenda within biodiversity related conventions), they would be particularly compatible with objective 12.2, where Belgium aspires to play a leading role, and they would carry the additional kudos of winning approval from fungal conservationists and getting a 'yes' to the third question on the Micheli form: 'is strategic consideration given to fungal conservation?'

Giving fungi appropriate recognition in the conservation arena is a joint responsibility of the national conservation agencies and the mycologists who are expert in their field. Funding is almost always a serious constraint, both in employing fungal experts and providing research grants, but it must be recognized that the conservation agencies themselves are often given inadequate financial support. Conservation is also highly dependent on support from a public that is poorly educated in fungal matters. Nevertheless, it costs nothing to get the terminology right, and little or nothing to make it clear that our knowledge is inadequate of fungi and their conservation requirements. Even these small steps will have an impact in the longer term.

Resolution WCC-2012-Res-33-EN of the IUCN's 2012 World Conference in Korea called for increasing attention to be given to conservation of fungi, and unequivocally stated that 'the much-used phrase "animals and plants" is not a sufficient description of all life on earth'. We, as fungal conservationists, must use that resolution. We must learn to recognize where conservation policy is failing fungi, and we must become good at drawing those deficiencies to the attention of governments in a diplomatic and positive manner. We must also develop our capacity to respond to their requests for information and advice. Consultations about biodiversity should be inclusive, with representatives of all biological kingdoms having a direct voice at the same level: the glass ceiling which currently prevents mycologists from being heard must become a thing of the past. If all of this happens, the outcome will be more than terminological accuracy in **CBD** reports: the world will know a great deal more about fungi, their myriad roles will be recognized in the global ecosystem, and – perhaps – global extinction rates will be slowed.

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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.

Officers

President, Dr David Minter [UK] d.minter<at>cabi.org
Vice-President. Dr Lorelei Norvell [USA] llnorvell<at>pnw-ms.com
Secretary. Dr Marieka Gryzenhout [South Africa] gryzenhoutm<at>ufs.ac.za
Treasurer. Dr Jo Taylor [UK] drjotaylor<at>yahoo.co.uk
Membership Secretary. Dr Peter Buchanan [New Zealand] buchananp<at>landcareresearch.co.nz
Editor. Dr Paul Cannon [UK] p.cannon<at>cabi.org
Communications Officer. Dr Maria Alice Neves [Brazil] maliceneves<at>gmail.com

Elected Councillors

Dr Rafael Castañeda Ruíz [Cuba] ivigoa<at>infomed.sld.cu
Dr Stephanos Diamandis [Greece] diamandi<at>fri.gr
Prof. David Hawksworth [UK] d.hawksworth<at>nhm.ac.uk
Prof. Maria Ławrynowicz [Poland] miklaw<at>biol.uni.lodz.pl
Prof. Roy Watling [UK] caledonianmyc<at>blueyonder.co.uk

Representatives of External Organizations

International Mycological Association, Dr Marieka Gryzenhout [see above for details]
IUCN Chytrid, Downy Mildew, Slime Mould and Zygomycete Specialist Group, Dr Mayra Camino [Cuba] mcamino<at>fbio.uh.cu
IUCN Cup fungi, Truffles and their Allies Specialist Group, Dr David Minter [UK] d.minter<at>cabi.org
IUCN Lichen Specialist Group, Dr Christoph Scheidegger [Switzerland] christoph.scheidegger<at>wsl.ch
IUCN Mushroom, Bracket and Puffball Specialist Group, Dr Greg Mueller [USA] gmueller<at>chicagobotanic.org
IUCN Rust and Smut Specialist Group, Dr Cvetomir Denchev [Bulgaria] cmdenchev<at>yahoo.co.uk

Regional Delegates

Africa (Central), Dr George Ngala [Cameroon] gnngala<at>yahoo.com
Africa (Northern), Dr Ahmed Abdel-Azeem [Egypt] zemo3000<at>yahoo.com
Africa (Southern), Dr Cathy Sharp [Zimbabwe] mycofreedom<at>yoafrica.com
Antarctica, Dr Paul Bridge [UK] p.bridge<at>cabi.org
Arctic, Atlantic and Indian Oceans, to be appointed
Asia (Central & Western), to be appointed
Asia (Eastern), Dr Tsutomu Hattori [Japan], hattori<at>affrc.go.jp
Asia (Northern), to be appointed
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

Supporting the International Society for Fungal Conservation

The Society is young and has enthusiastic members, but it urgently needs financial support because at present it has no money to pay for even the most basic activities, such as setting up a website and producing promotional literature. Anybody with access to Paypal (*www.paypal.com)* can send a contribution. Instructions about how to do this are set out below.

What is PayPal and is it safe?

- PayPal is a safe and secure facility for making payments over the Internet. Once your account has been set up with PayPal, you can pay in a few clicks of the mouse.

How do I use it?

- If you do not already have one, you will first need to set up a PayPal account. Go to **www.paypal.com** (or to the PayPal Website in your country. PayPal operates in more than 190 countries).
- Sign up and follow the instructions to set up a new account. You will need to input details of a credit card or bank account to be used for payment.

Once your PayPal account is set up, the rest is easy:

Please note, the following instructions were prepared for using www.paypal.com as configured in March 2012. It is always possible that PayPal could change the configuration of their website, so please be prepared for variations.

- On the Paypal website click on the send money tab;
- Use the following address for payment - **fungalconservation@yahoo.co.uk**;
- Make sure that you pay in **GB Pounds Sterling**;
- Indicate the amount you would like to donate;
- Select "Personal" and then select "Gift";
- Click on "Continue";
- Make sure you identify yourself in the message box of the e-mail which PayPal will send to the ISFC;
- The funds will be withdrawn from your credit card account (or bank account) and transferred to the PayPal account of The International Society for Fungal Conservation;
- You will receive an email receipt showing that payment has been made, and telling you how that payment will appear in your credit card statement;
- The Treasurer of the ISFC receives an email saying that we have received your payment;
- Your PayPal receipt is your proof of purchase, and no other acknowledgement will be made by the ISFC.

If you are in the UK, you can also contribute by writing a cheque payable to the International Society for Fungal Conservation and posting it to the Society's Treasurer, Dr Joanne Taylor, 27 Station Road, St Monans, Fife, KY10 2BN, UK. If you want to support the Society in other ways, please e-mail your suggestions and offerings to: fungalconservation@yahoo.co.uk.

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