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The Future of Fungi

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Editorial: The Future of Fungi

Mycology, it appears, is going through somewhat of a Renaissance. In recent years, a number of popular books have been published which have branched out into the mainstream and caught the attention of the general public. One book, Merlin Sheldrake's *Entangled Life* (Sheldrake, 2020), even found its way to being serialised on BBC Radio 4. This is to say nothing of a recent feature film on fungi which boasts an Oscar-winning actress as a narrator.

A common thread in this new trend of mycology is its approach to fungi—whilst previous mycological booms have focused on the mushroom as a physical object (of taxonomic, gastronomic, or even psychedelic interest), this current wave has a deep interest in the metaphorical meaning of mushrooms. Anna Tsing's *Mushroom at the end of the world* (Tsing, 2017), for instance, approaches the popular edible species *Tricholoma matsutake* (S.Ito & Imai) Singer as a way to open our imaginations about collaborative survival. Similarly, several authors have drawn comparisons between the nature of fungi and queerness (Griffiths, 2015; Kaishian and Djoulakian, 2020) or cripness (Palmer, 2020).[1] This differing, and more holistic, view of mycology is even changing how we view fungi as organisms, with a recent paper drawing novel connections between mycology and behavioural ecology (Aleklett and Boddy, 2021), putting forward an argument that fungi are organisms with intent and purpose.

Undoubtedly, this trend of mycological interest growing outside its traditional confines has also brought more people to the field. As recognised by a number of observers, and most recently documented by Doug Bierend (Bierend, 2021), mycology is increasingly becoming a broad church as a diverse selection of people find fungal answers to a diverse range of questions—both scientific and societal. Importantly, this is not to suggest that mycology as it is traditionally practiced, with its focus on taxonomy and ecology, has become irrelevant. Indeed, the opposite is true; as fungi become more prominent in societal discourse and policy, there is an increasing need to ensure we know what species we have, where they can be found, and what environmental factors control their distribution. Regarding the former, there remains much debate about how new species might be described—particularly regarding so-called 'dark taxa'. Following the relatively recent rejection of adopting DNA-only types, a recent paper has put forward a range of potential solutions (Lücking *et al.*, 2021). Much of the conflict arguably derives from mycology's split disciplinary heritage—with both microbiological or botanical nomenclatural conventions finding application for different fungal groups but neither meeting the broad and distinct needs of the entire fungal kingdom. Regardless, whatever solution is eventually reached will arguably represent a watershed moment for mycology.

Finally, it is worthwhile touching on recent advances in fungal conservation. As recently highlighted at a BMS talk by Greg Mueller, there has been a substantial increase in the number of fungi on the IUCN red list, with the number increasing from 3 species in 2013 to 425 species as of writing. Furthermore, two international organisations—Re:wild and the IUCN Species Survival Commission—alongside the Chilean government, have recently recognised the Fundación Fungi's Fauna Flora Funga Initiative (see Kuhar *et al.*, 2018), which calls for fungi to be recognised as one of the three kingdoms of life critical to protecting and restoring the Earth, for fungi to be included in conservation strategies, and for mycologically inclusive language to be used (i.e. "animals, fungi and plants" in place of the phrases such as "plants and animals"). Such success suggests a bright future for fungi—and an increased need for mycologists at all levels.

[1] Crip is a slur reclaimed by the disabled community and is used here solely in this context after a discussion with the referenced author.

In this issue of the BMS Newsletter, we look forward to the future of fungi—and of mycology. Corina Marcos explores how citizen scientists can best get involved in mycology. Liz Holden imagines the 'tricorder'—a field mycologist fit for the modern age. Tony Leech, in turn, announces a new Norfolk Mycota and details how the Norfolk Fungus Group has modernised their recording process. Clare Blencowe interviews Geoffrey Kibby about his ongoing *Mushrooms and Toadstools* series and discusses the impact of technology on field guides. Field guides are also the topic of discussion for Arthur Chater and Debbie Evans who put forward a history of the Welsh Rust Group (now renamed the Welsh Phytoparasitic Microfungi Group) and how their publications have evolved. Reports are published from Alaina Cockerall and Bryan Chang the recipients of the 2020 Undergraduate Bursaries and announcements are made of those currently undergoing research as recipients of the 2021 awards. This work, past and present, is highly exciting and suggests a bright future for mycology in the UK. Finally, reviews are published from the *BMS Talks* series concerning the cutting edge of mycology.

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Citizen science engagement: For the fungi

Learning how much we don't know about fungi has been one of the most exciting things to discover on my fungal journey so far. I have only been completely obsessed for the past eight months, and those have been a whirlwind tour of exploring each of the various fungal avenues. I think a lot of people on this path go through a similar pattern - trying to absorb all the information out there as quickly as possible, then waiting to see where the dust falls and what area of the mushroom world they want to investigate more deeply. The following is my take on citizen science, the potential it holds and ways to engage more people, coming at this as a newcomer and a beginner.

Having started this process through deciding I wanted to learn how to grow mushrooms, I am now at the point of realising that there is so much work to be done in broadening our knowledge of kingdom fungi. If we want to understand more any time soon and conserve what there is, more people need to be actively engaged in gathering data on the huge diversity of fungi.

Academic vs Amateur

I aspire to know a lot more one day and am going down the academic route of starting a degree, however I am also a firm believer in citizen science and the value of data. A degree will take me six years, but I want to be contributing to and encouraging others to contribute to this effort starting now. The scale of the work that needs to be done and the urgency of the current loss of habitat around the world, makes this even more pressing. In looking into which degree to pursue, it seems that although there are degrees for medical mycology, there are none for mycology alone in the UK. The demand for certain degrees will fall within the limits of our current system, where there are a lot of jobs in the medical field but not so many for the sake of understanding fungi and for conservation as a whole.

This is where citizen science can pick up the baton and run with it. In collaboration with scientists, citizens can be out in the field gathering meaningful data, which scientists can then use to write papers and further investigate the largely unseen world of fungi.

Who will help?

There is a huge potential pool of people who are either already interested in fungi, or who could be persuaded to take a little interest. This could even be during activities they already do, for example birdwatchers, families going for walks in the woods, ramblers, gardeners, photographers and beekeepers. The mycological community could reach out and say we need your help!

In learning about the role of fungi within our ecosystem, it feels like staring at a magic eye picture and not being able see it, until you see the fungi. They are the missing puzzle piece in our ability to understand nature, and ourselves as being a part of nature. There is something about them that can even change the way we think - once you know that fungi form symbiotic relationships with most of the world's plants, you begin to see collaboration as the way that predominates, and 'survival of the fittest' as a lens that has outrun its usefulness.

There are so many different reasons you should care about fungi, and I believe there is at least one if not many, that will resonate with everyone.

Where to start?

In various mushroom communities on social media, there are new people joining all the time. A common question seems to be, “I’m interested in mushrooms, but I don’t know where to start.” Or “It all seems a bit overwhelming.” Indeed it can seem overwhelming, especially if you are prone to distractions and side tangents, of which there are many when learning about mushrooms - what should someone learn about first? Mushroom growing, myco-materials, medicinal mushrooms, mycorrhizal relationships and the wood-wide web, mycorrhizal applications in gardening, mycoremediation, solutions to breaking down plastics, foraging, antiviral properties for bees, psilocybin therapy trials, photography, art, conservation, microscopy, DNA barcoding - the possibilities go on. The easier it is for people to pursue their interests in this field, the more beneficial the outcome. As you probably know, people who are interested in mushrooms like to talk about it, quite a lot… (guilty) you never know who they will talk to about it and who else they might inspire, and so the message spreads.

The other thing I have found is that the mushroom community are very friendly and supportive of beginners, no matter how many times someone posts, “My grow kit looks funny, what did I do wrong?” there are people on hand to help them out without judgment. There is an atmosphere of knowledge sharing rather than knowledge hoarding.

My route was deciding to try and grow mushrooms, with a grow kit to start with and then gradually learning how to grow them myself. That kept me absorbed for a few months, while I listened to the Mushroom Hour Podcast, which was a rapid exposure to the many, many different aspects of kingdom fungi. There is something for everyone, and once you have found your way in you gradually pick up on other areas and start to care more and more, and your interests broaden.
This wide appeal should be a great benefit to increasing citizen science, as the more people who are interested, the more people will want to go on and learn about identifying mushrooms, and from there on to the whole process of collecting, doing microscopy, and DNA barcoding. Not everyone will, but there is a greater pool of people who might.

However, if there was a way to also involve people who are not going to be completely myco-obsessed, but can still gather meaningful data, that would be hugely beneficial too.

Breaking up the identification process

To do this, perhaps the whole process could be broken down in an accessible way, so that someone walking through the woods and noticing a mushroom, could be signposted to a resource that could be the start of a journey they were not prepared for…

From social media mushroom ID groups, onto recording platforms like iNaturalist, how to take better photographs and improve data quality, through to microscopy and DNA barcoding. Even if that person thinks, “OK well I just wanted to take a photo and find out what this is…” it would be useful that they were then made aware that there’s a whole other process out there, if they decide one day they might like to come back to it and ‘level up’. Just as how in mushroom growing its best to start with a grow kit and work backwards in complexity, the same can be true for mushroom identification.

Everyone with a passing interest should be able to look at the process and start somewhere. It should include various ‘How to’ guides, like how to dry mushrooms, how to make a spore print.

Highlight any potential 'barriers' to someone getting involved, and how to overcome those. For example, an easily accessible email or letter template for asking landowner permission to collect a specimen. Pointers to who can help or resources that can help at various parts of the process. For the existing mushroom community, it would be useful to know what is preventing people entering the full info required—e.g., not aware that they could record scientific data, didn't know how, lack of time, not interested etc. Some surveys could be put out on social media pages and groups. Encouraging people to join their local fungus recording groups is I believe, the best way for someone to experience looking for fungi and getting the right sort of 'eyes' to spot things they hadn't noticed before. However not everyone has a group close enough, or is able to travel to the survey meetings, and sometimes people are just reluctant to join or are more introverted.

It would be great if in addition to the recording groups, a network of individuals could be linked up, who take part in the identification process or parts of it, to improve the quality of data being collected. There could be several people who already have a microscope, who would be willing to analyse samples from people out taking photos of and collecting specimens. That person could then in turn send the samples off to another person, who has the facilities to do PCR, and decide if its possible/necessary for that specimen to be preserved at a fungarium.

The 'higher level' stages of microscopy and DNA barcoding might not be of interest to everyone, but there will be plenty who do take an interest in this, even if they are not especially interested in fungi, learning these skills may hold appeal to a younger audience as well.

Recording platforms

The various recording platforms available are a bit confusing to new users and a potential barrier to entry. Firstly, the question arises of which system to use—iNaturalist does not collect all the information required, but it does have an app and enables logging records out in the field easily, as well as helping the user identify something through the photo alone. This of course has its drawbacks when the ID provided is not always accurate. FRDBI gathers lots of information but isn't as straightforward to use and people may lose interest if they have only a passing interest in making a record. Some people don't know that any recording system exists at all, so at the very least more promotion of these is needed, including promotion within existing mushroom communities on social media. There is a huge number of potential citizen scientists in these groups.

Records which don't have enough information to make a positive ID, could be picked up by local recording groups / interested individuals scanning the records to see if there is anything unusual that could be followed up.

One big project or an ongoing drive?

To create maximum engagement, and to take advantage of the already increasing interest in mushrooms and mycology, various initiatives to get people involved as well as an ongoing drive should prove effective. A couple ideas for this—if people don't find it easy to join a local fungus recording group, they could go and see what mushrooms they can find in their garden, or a local park. Perhaps there could be a drive for people to record the fungi they can see in their gardens on a certain day or days. An art competition could be held for designing a fungi-related t-shirt, drawing on the number of different ways fungi can inspire people.

Lastly, I think that the efforts to engage people to become citizen scientists and care about fungi,

could be linked to ways to generate funding for microscopy and DNA barcoding. This would mean that the voluntary efforts of everyone involved could be taken further, and meaningful data amassed at a greater pace. For example, a fungi-related t-shirt from the winner of the art competition could be sold and the profits go towards sending off DNA samples to be analysed, or the consumables required for the process. In the same way that people buy grow kits for growing mushrooms, why not have a 'MycoKit' for identifying mushrooms? Proceeds from these could again go towards furthering DNA barcoding. A list should be made easily available of a 'kit' that anyone can put together with things from around the house, but sometimes it's just easier to buy a complete set of what you need, together with instructions. Plus, what are people going to buy their fungi-obsessed friends next after they have bought them a grow kit?

I think citizen science has a huge role to play in growing our understanding of the fungal world. Engaging more people in this process has many benefits not just for the fungi, but for conservation as a whole.

Corina Marcos

Tricorders: the future for field mycology?

As a field mycologist I am interested in the identification and recording of our fungi to help us establish a better understanding of their ecology and diversity. This has been a passion of mine for over 40 years now, alongside a delight in sharing it with others!

For many field mycologists much of the delight in our work has to be the finding of the wonderful fruiting structures that for so many years have been the only way to identify what we see. It doesn't just happen in the field of course – most field mycologists will also find pleasure in the microscopic beauty of these organisms, necessary to appreciate, in order to begin the inevitable challenge of using the available keys, for identification of cryptic species.

Currently there is then the frustration of not being able to key a fungus to name – a scenario familiar to all with this interest. Is the collection too young or too old? Is the species not included in the key…? Try a different key. Is it my inability to work the key? (Tends to be my default position!!) Is the species undescribed? Actually the latter is possible, but to find out it would need to be sent to a genus expert and these folk are few and far between and already overwhelmed with work.

Many times I have wished for a 'Tricorder' – those of you familiar with the Star Trek programs will know that this little handheld device can be pointed at any kind of life form and then made to analyse it! As with many things presented in the Star Trek franchise, this idea is coming ever closer as molecular technologies become more accessible.

Does this mean the end of road for field mycology? Well, of course not. At the moment we are still providing the verified named collections, the molecular profiles of which enable the molecular profiles from soil samples to be named. The ability to correctly distinguish species is still vital.

Those of us that currently rely on fruit body identification/indicator species when undertaking fungal surveys can hopefully look forward to a time when methodologies have been developed using molecular techniques that tell us more about the below ground fungal community – how it is functioning and what it is composed of – we have always known that many fungi will not be fruiting during survey visits. This can only be an important step forward and something that I think generations of field mycologists can feel proud of enabling. It will be so interesting to see which species turn out to be truly rare and which species are just rare fruiters!

Having seen the pleasure that the public get from having their eyes opened to this 'hidden kingdom' I think that there will still be many folk wanting to learn about actual fungal fruiting bodies rather than their DNA – traditional field mycology will still have a valued place within the broad understanding of fungal science.

For me personally, the route of investigation using molecular technology just doesn't have the same appeal as the more traditional approach. The enormous diversity of the kingdom means that there will always be many approaches to and applications for the discipline. Thank goodness that there are those who take delight in the molecular. It seems to me that we are heading in the right direction and the future of all forms of mycology has never looked brighter.

Liz Holden

A new Norfolk Mycota*

** This article originally appeared in the May 2021 Issue of the BMS Recording Network News*

Tony Moverley has earned the gratitude of Norfolk mycologists (and other round the country) by bringing together the Norfolk fungus records in an accessible form. The database contains 90,000 records of approximately 3650 taxa, including myxomycetes and oomycetes but not lichens. He has created an output in the same format as the late Richard Shotbolt's Naturbase5 which was based on 60,000 records but had not been maintained since Richard left Norfolk in 2008. It is intended to make the Mycota available to interested parties in a form that will run on home devices.

The new database has built on the work of many. In 1997-98 Dave Leech (in receipt of a grant from English Nature) digitised approximately 35,000 paper records made by Reg and Lil Evans after they returned to Norfolk in 1976. To these, Richard added many of Ted Ellis's records, from Wheatfen between 1916 and 1987. An ever-growing band of Norfolk recorders, supplemented by those from elsewhere, have continued to add records.

Tony's achievement allows the uploading of around 30,000 Norfolk records made since 2008 to the Fungus Record Database of Britain and Ireland as well as to the local biological record centre (Norfolk Biodiversity Information Service). Work will now proceed to add historical records and to search other sources of information.

Approximately 475 taxa have been added to the Norfolk list in eleven years. This boom has been made possible through the efforts of many recorders. Amongst the most prolific have been Anne Crotty, Trevor Dove, James Emerson, Keith Fox, Steve & Gill Judd, Yvonne Mynett, Jenny Kelly, Tony Leech, Neil Mahler, Steve Pinnington, Jonathan Revett, Ian Senior and Stewart Wright (microfungi). This revision of the Norfolk Fungus Record Database has been facilitated by the adoption of a county recording spreadsheet. Members of the Norfolk Fungus Study Group (and others) are invited to send records to one member who accumulates them monthly and passes them to those who have submitted data, including the county fungus recorder who can investigate any doubtful records. At the end of the year, the records can be uploaded after further 'cleaning'. The sheet has been developed by Steve and Gill Judd and incorporates many 'hints' to make the records more compatible with the databases to which they will, in time, be uploaded. We have attempted to do this without making it daunting for the casual recorder.

Please let us know if any recording group would like a copy of this spreadsheet which, if necessary, could be modified for local use.

Tony Leech
Norfolk County Fungus Recorder
tonyleech3@gmail.com

In Conversation with Geoffrey Kibby

Geoffrey Kibby will be familiar to BMS members as the editor of Field Mycology and author of many mushroom books. After having written a few field guides and a children's book on fungi[2], working with various publishers, in around 2010 Geoffrey ventured into self-publishing and has since produced six volumes on identification of specific genera of British fungi as well as his *Mushrooms and Toadstools of Britain and Europe* series.

In May 2021, shortly after publication of Volume 3 of 'Mushrooms & Toadstools', I caught up with Geoffrey on Zoom to ask him about his experience of working on the book and what he's got coming up next.

In Volume 1, you introduced 'Mushrooms & Toadstools' as a three-volume series, but you're now working on Volume 4. It must be quite an epic undertaking?

It didn't feel like that when I started but, yes, that rapidly became apparent! Originally, I thought I would get it all in one volume but by the time I had done around 600 mushrooms and I was only about a quarter of the way through the agarics I realised *that's never going to work…* I thought I would cherry-pick species to include but these volumes have ended up including something like 95 % of the British list, for the agarics anyway (it's not quite so comprehensive for the polypores etc). Volume 3, for example, includes over 320 *Cortinarius* species.

I had envisaged being finished in about a year and a half. That was more than six years ago now, with another year to go at least. It has been a much bigger project than I anticipated.

Self-publishing can be quite daunting. It costs several thousand pounds to do a print run for a volume in my 'Mushrooms & Toadstools' series, so it's quite a big risk. Especially for the first one when you don't know how many you'll sell. Luckily the response has been amazing, so much so that I have had to print more of each volume.

What inspired you to start?

Looking at other field guides, basically. None of which *on their own* provided quite what I wanted... That's what gave me the idea for a guide which includes more species, better descriptions and original paintings, drawn from a field mycologist's perspective. It's rare to have the author of a field guide also producing the illustrations; in that respect, I'm lucky, I do both. I knew from the outset I wanted the illustrations to convey as much information as possible (including chemical reactions, microscopy, associations, etc), to aid identification.

My model was the Wakefield & Dennis guide, *Common British Fungi* (1950), the only British guide which showed the microscopy on the page alongside illustrations of the fruitbodies. My ambition was for a modern day, exhaustive 'Wakefield & Dennis' – as cutting edge as possible. And I wanted a book where everything would be on facing pages. Nothing annoys me more than having to turn somewhere else in the book, either to find the description or the microscopy. So that was another guiding principle I gave myself: everything should be on those facing pages.

[2] *Pocket Spotters: Mushrooms & Fungi* (2004) – you can still find second hand copies available. *Ed.*

By chance I had an operation on my foot and could not move around much for about a month. It seemed a good opportunity to start the book. Although I tend to procrastinate and put things off, once I get into it, I am quite disciplined at ploughing through. I'll knuckle down for several hours every day.

The illustrations in Volumes 2 & 3 of 'Mushrooms & Toadstools' are produced with an Apple iPad and Apple Pencil, using the Procreate digital illustration app. How much has this technology influenced your work?

For the first volume, I produced all the illustrations in watercolour and watercolour pencils, which then had to be scanned and often also edited on the computer to correct the colour. Volume 1 took me two and a half years, whereas Volume 3 was completed in just one year. That difference is mostly down to the technology.

On the iPad I can do a painting in about 15 - 20 minutes, press 'send' and it's on the computer – straight into my desktop publishing package. Being digital also allows for very easy editing of an image.

I don't know of anyone else who's produced a complete field guide on the iPad. My volumes are probably unique in that respect?

Some of the visual characteristics of fungi are so subtle, they must be difficult to capture in illustrations. Were there any characters to you had to work creatively to represent?

Pruinose stems are difficult, like in *Hebeloma*. They're hard to illustrate because at the size they are reproduced in the book you either have to exaggerate the pruinosity, or include a close-up.
I really enjoyed the challenge of illustrating the *Cortinarius*. Some of them have fabulous colours, shapes and textures. *Cortinarius leucoluteolus* (page 109), for example, has a satiny shimmer to the cap – luckily I had a live specimen to paint from for that. And I love doing the viscid ones, like *Cortinarius vibratilis* (page 109). The more you do it, the more efficient and fluent you get at the technique, particularly when learning a new tool like the Apple Pencil.

One of the advantages of digital is you can get digital brushes with different effects, for example longer-haired brushes which can give the impression of a fibrillose stem in one or two strokes. It's great fun. If you're into illustration, I would highly recommend giving the technology a go.

Was there a group you found a particular joy to illustrate?

Boletes are always lovely. But there were also groups that surprised me. I was dreading doing the Coprinoid fungi, but when I got down to doing them, and researching the group, I really enjoyed illustrating them. The same with *Psathyrella*.

Probably 50 % of the year I spent producing the book was on research, digging into the literature and getting help from people like Derek Schafer and Penny Cullington. It's been brilliant because I've learnt as much as I'm imparting. I've learnt more in the past three years than I've probably learnt in the last 50, because I've read so much literature and had my finger on the pulse with the latest papers.

What's it like producing a series like this while the British mycota is expanding so rapidly?

You just have to accept that from the day you print the book, it's out of date. For example, since Volume 2 came out (which was only last year) there have already been another four *Amanita* added to the British list.

We're adding probably close to 100 species to the British list *every year* and molecular studies are leading to major revisions in taxonomy: many Sarcodons have turned into Hydnellums, for example[3]. It's been serendipitous that, while I've been working on the book, a number of large, important papers and monographs have come out, just as I was beginning to target that particular group. Kare Liimatainen et al.'s 'magnum opus' on *Telamonia*[4], for instance, which came out while I was working on Volume 3.

You've been editor of the BMS journal *Field Mycology* for 21 years – is there much interplay between that and your work on your books?

Well, I've discovered I can't really do both at the same time. If I'm working on the magazine I have to stop working on the book for a few weeks.

I remember that I had just finished Volume 1 of 'Mushrooms & Toadstools' when an article was submitted to *Field Mycology* on the Ping-Pong Bat fungus, *Favolaschia calocera*[5] – the first record for Britain. I got that into Volume 1 at the last second before it went to the printers. One of the advantages of digital is you can very quickly shuffle things around, as each individual illustration is a separate object on the page.

More recently, Andy Overall reported a *Cortinarius* new to Britain – *Cortinarius vicinus*[6] which had been confirmed by Kew through DNA analysis – just as I had finished Volume 3, and I thought, "*well it's not going to be complete if I don't put it in!"* so I had to quickly shove things aside and slip that in, with a brief description.

You've mentioned that the libraries at Kew have been an invaluable in researching your books – can you tell us a bit about them?

Well, access to the libraries has been a BIG problem during the pandemic as we've been locked out. I'm very lucky I've got so many references at home. And, of course, the internet is amazing. There were a couple of things I needed to email Martyn Ainsworth for, and he has been helpful in supplying some key references while Kew has been closed.

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[4] Liimatainen, K., Niskanen, T., Dima, B. *et al.* Mission impossible completed: unlocking the nomenclature of the largest and most complicated subgenus of *Cortinarius*, *Telamonia*. (2020). Fungal Diversity 104**,** 291–331 https://doi.org/10.1007/s13225-020-00459-1

[5] Ainsworth, A. M., Farley, D., Gainey, P., Penna, P. and Suz, L.M. Invasion of the Orange Ping-Pong Bats: the rapidly changing distribution of *Favolaschia calocera*. (2015). Field Mycology, Volume 16, Issue 4, 113-120 https://doi.org/10.1016/j.fldmyc.2015.09.004

[6] Overall, A. *Cortinarius vicinus* new to Britain. (2021). Field Mycology, Volume 22, Issue 2, 64-65 https://doi.org/10.1016/j.fldmyc.2021.04.011

The BMS library is excellent. It's got all the major modern works and lots of very old historical books as well. For example there's a 24-volume set on *Cortinarius – Atlas des Cortinaires* – which the French have produced, held in the BMS library, which I've used extensively in researching Volume 3, containing loose-leaf illustrations done in watercolour. It's an amazing resource for the artwork and information on microscopic characteristics.

Sounds like the *Cortinarius* have been a big focus for you this year?

Figure 1. Geoffrey Kibby with a dummy copy of 'The genus Cortinarius in Britain', on our Zoom call.

Yes, during lockdown, Mario Tortelli and I have been working on a volume on the genus *Cortinarius*, in A4 hardback format. It will have photographs and paintings, with keys to the British species. We're going to spend this season tinkering with it, trying out the keys and perhaps adding a few more species, with the intention of publishing in 2022.

There has been nothing major published in Britain on *Cortinarius* since Peter Orton's work in 1955, so this felt like a worthwhile spin-off project from Volume 3.

What have you got planned for Volume 4 of your 'Mushrooms and Toadstools' series?

Volume 4 will contain *Inocybaceae*, *Entolomataceae* and *Bolbitiaceae* which I am anticipating will be about 450 to 500 species in total. I have started, I've already done a few pictures.

I will be looking for good reference pictures for *Inocybe* and *Entoloma*, so if people have images they'd be willing to share, please get in touch.

What do you expect to be focussing on this season?

I can't wait for the mushroom season to start now, because there are groups that I want to go out and start looking at which I've now got the literature for, like *Psathyrella*, which I wouldn't have bothered with before. However, *Inocybe* and *Entoloma* are my main targets for this season. I shall have to collect every and all specimens that I see, paint them (even if I don't know what they are), and hopefully get the unusual ones DNA'd and named.

Favourite site

Epping Forest, which I've been exploring since I was 12 or 13…. over 50 years and I still love going there. Every year we find new species. It's an inexhaustible site for fungi. There's always something new to find: that's the joy of mycology, isn't it?

Clare Blencowe

Volumes 1 to 3 of Mushrooms and Toadstools of Britain and Europe by Geoffrey Kibby are available from booksellers including Summerfield Books, NHBS and Pemberley Books.

Helping the identification of *Ramularia* species

Some ten years ago five of us who already had an interest in Rusts and Smuts and other phytoparasitic microfungi began to come together and considered attempting a Welsh vice-county census catalogue and a Red Data List for Rusts in Wales. We were conveniently well-spaced throughout Wales, Debbie Evans in the north, Ray Woods in the mid-east, Arthur Chater in the mid-west, Nigel Stringer in the south-west, and Paul Smith in the south-east. We published the book in 2015 (Woods et al. 2015), and followed it up three years later with a similar book on the Smuts (Woods et al. 2018). They were generally welcomed, but our attempts at assigning conservation status to give the books authority as Red Data Lists met with some criticism. The rationale and methodology of assigning such status to phytoparasitic microfungi is still very unsatisfactory, and in our later books we abandoned this aspect and confined them to being census catalogues, and added information to help with identification. In 2019 we published such a book on the Powdery Mildews, with key characters for identification covering all the British and Irish species (Chater & Woods 2019). That year the British Mycological Society gave us their Field Mycology Award for promoting the recording, conservation and taxonomy of parasitic fungi, together with our role in education by holding training sessions, field meetings, giving lectures and publishing articles, scientific papers and our first three books. We were then informally calling ourselves the Welsh Rust Group, but changed our name to the Welsh Phytoparasitic Microfungi Group. Encouraged by this recognition that we were doing something useful, we went on to publish increasingly comprehensive books on Downy Mildews and White Blister-rusts (not actually fungi!) (Chater et al. 2020) and White Moulds, *Ramularia* and *Phacellium* anamorphs (Chater et al. 2021). For this last volume, the British Mycological Society gave us one of their Small Grants, which, along with a grant from the British Society for Plant Pathology, has enabled us to sell the book at a very low price and to distribute many free copies to appropriate organisations and people in Wales and beyond. In addition, all five of our books are freely downloadable from Dr Gareth Griffiths's website https://www.aber.ac.uk/waxcap/links/index.shtml.

Our aim in these books has been to encourage interest in and recording of these important organisms. We have tried to strike a balance between giving the impression that identification of phytoparasitic microfungi is practicable and often comparatively easy (especially because of host specificity), to lure mycologists and more general naturalists in, and then emphasising that microscope work and more advanced literature is usually essential for confirming identifications. Some aspects of the *Ramularia* book, which the Society has supported, illustrate why it is so important to increase interest and recording. *R. collo-cygni*, a very distinctive species, the specific epithet referring to the unique conidiophores curved n the shape of a swan's neck, is a very serious disease of Barley. It is estimated to cause about £10 million in losses a year in Britain, and numerous papers have been written on its importance and control, yet there are no records of it in the Society's *Fungal Records Database of Britain and Ireland*, and none in the *Cate2* database. We had great difficulty in finding actual records for inclusion in the book. *R. asplenii*, occurring on the small fern Wall Rue ,*Asplenium ruta-muraria*, has been recorded recently at nineteen sites in Cardiganshire, as well as in four other Welsh vice-counties, but it too has no records yet in either the *Fungal Records Database* or *Cate2*. It must surely be widespread elsewhere in Britain; on the other hand, it was not seen in Cardiganshire in any of the last three years, so there is clearly much to learn altogether about the species' behaviour as well as its distribution. A conspicuous and unexplained discrepancy between records from Wales and those from the rest of Britain and Ireland which often occurs is illustrated by the two main species occurring on genera of the Buttercup family. *R. didyma* (along with its synonym *R. aequivoca*) has been recorded only 21 times in Wales, but 132 times from

elsewhere, while *R. simplex* has been recorded 86 times in Wales but only 17 times from elsewhere.

Increasingly, taxonomic work relies on DNA sequencing which usually results in the splitting up of species which occur on multiple hosts. This ought to make identifications, or preliminary identifications, easier provided one can identify the host reliably. However, it is often not clear whether the splits occur throughout the distribution of the hosts, or whether they only apply in the area where the samples were taken, and sometimes the morphological features separating the new split species are not definite enough to enable identification without further sequencing. Altogether only some sixteen species of *Ramularia* in Britain and Ireland occur on more than one host genus, and this number will doubtless be reduced with further taxonomic and sequencing research leading to splitting of the species. Sequencing is becoming more practicable and cheap for the field mycologist, but increasingly professional mycologists are lab-based and unfamiliar with how the fungi they study look and behave in the field. We hope and intend that our books should encourage people to see how the fungi fit into the environment.

Our work on *Ramularia* was made practicable largely because of the monograph by Braun (Braun 1995, 1998). There are about 350 species worldwide, 108 in Britain and Ireland and 81 so far frecorded in Wales. Several are important agricultural and horticultural pests in this country. Apart from *R. collo-cygni* on Barley, *R. beticola* on Fodder Beet, *R. deusta* var. *alba* on Sweet Peas, *R. grevilleana* on Garden Strawberries, *R. onobychidis* on Sainfoin, *R. pratensis* on Rhubarb and *R. vallisumbrosae* on Daffodils are of especial economic significance, yet most people, who may be aware of Rusts, Smuts and Mildews, including even some mycologists, are scarcely aware of them and we hope to raise their profile. *Ramularia* species are very common, easy to find and widespread on a wide range of mostly herbaceous plants. Only seven species in Britain and Ireland occur on woody plants (*R. rufibasis* on Bog Myrtle and *R. sambucina* on Elder are perhaps the least rare). Only two species are on ferns, and only three on grasses. It is difficult to comment on how under-recorded the species are, and there is too little information at present to make any strong recommendations about conservation priorities, and too little to allow for much comment on any significance of their apparent distributions. A great deal more recording is needed, and our aim is to encourage this and to give people a sense of the sheer enjoyment of learning and recording a perhaps new group for them like *Ramularia*, the White Moulds.

Arthur Chater
Debbie Evans

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Llwydni Gwyn, Anamorffau *Ramularia* a *Phacellium*, yng Nghymru a Phrydain: Cyfeirydd a Chatalog Cyfrifiad Cymreig. A. O. Chater, Aberystwyth.

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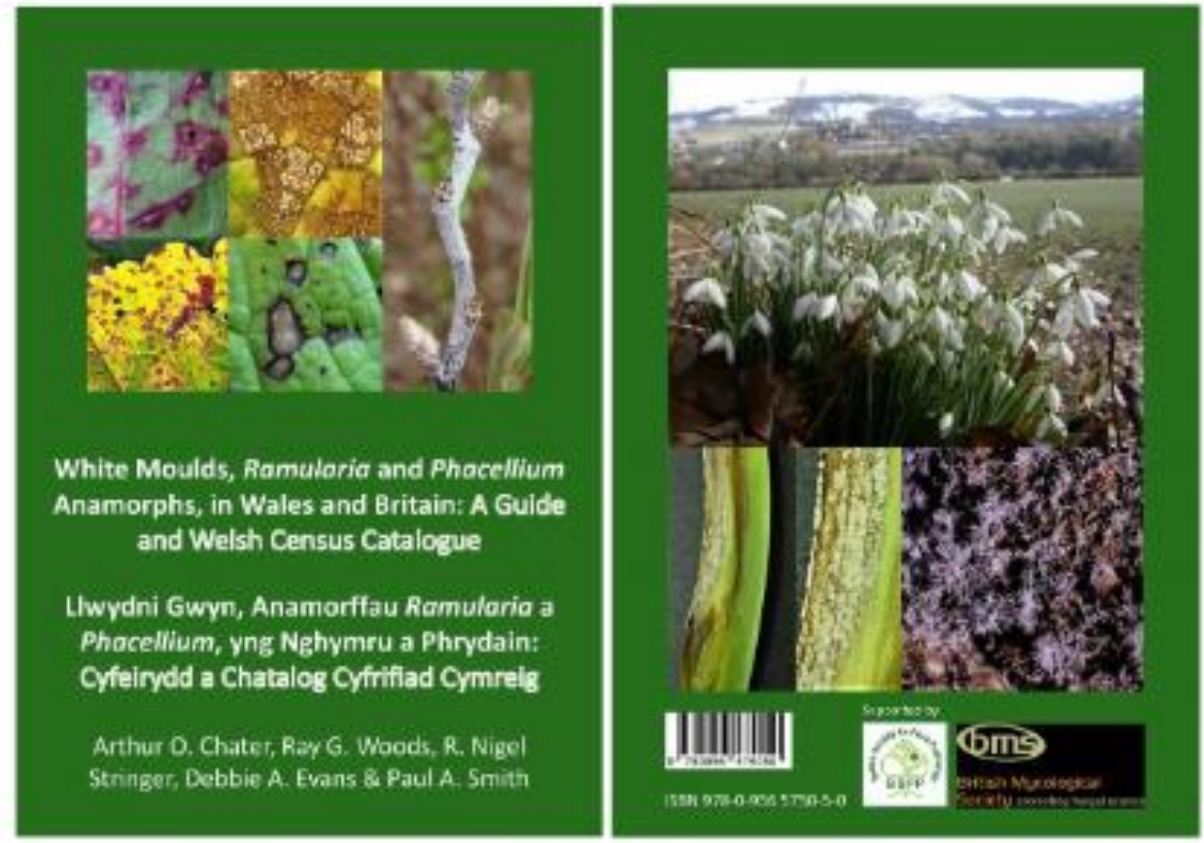

Figure 1: . White Moulds, *Ramularia* and *Phacellium* Anamorphs, in Wales and Britain: a Guide and Welsh Census Catalogue (Chater et al. 2021). Available for free at : https://www.aber.ac.uk/waxcap/links/index.shtml.

2020 Undergraduate Bursary Project Reports

Fungal colonization of voice-prosthesis biofilms and its use as a predictor of device longevity in total-laryngectomy patients

I am a 4th year physics student studying for an MPhys at the University of Manchester. Last summer, I was given the great opportunity to undertake a BMS-funded summer project in the groups of Dr Alexandra Brand and Dr David Richards at the University of Exeter.

Dr Brand's group in the MRC Centre for Medical Mycology had already undertaken a study of the organisms that form biofilms on voice prostheses, devices that enable head and neck cancer patients who have undergone total laryngectomies to speak. These devices are made from soft polymer and so can easily become compromised by the formation of a biofilm. In particular, infestation by fungi can cause them to swell and stiffen, contributing to the mechanical failure of the device (Figure 1). Frequent changes of these devices are both taxing on the patient and costly to the health service.

The purpose of my project was to use a computational approach to analyse the existing dataset of over 800 fungi and bacterial isolates from voice prostheses donated by a cohort of total-laryngectomy patients. The aim was to identify positive and negative relationships between the isolates and probe the dataset for indictors that would act as a predictor of device longevity in these patients.

The study involved a cohort of 14 study participants who submitted both their voice prostheses and oral rinse samples over a period of 13 months. Participant factors included in the analysis included whether the participant used dentures, antacids, nystatin (an antifungal) or antibiotics. From the 66 voice prostheses and 61 oral rinse samples, 885 microbial isolates were identified, representing 11 species of fungi and 70 species of bacteria.

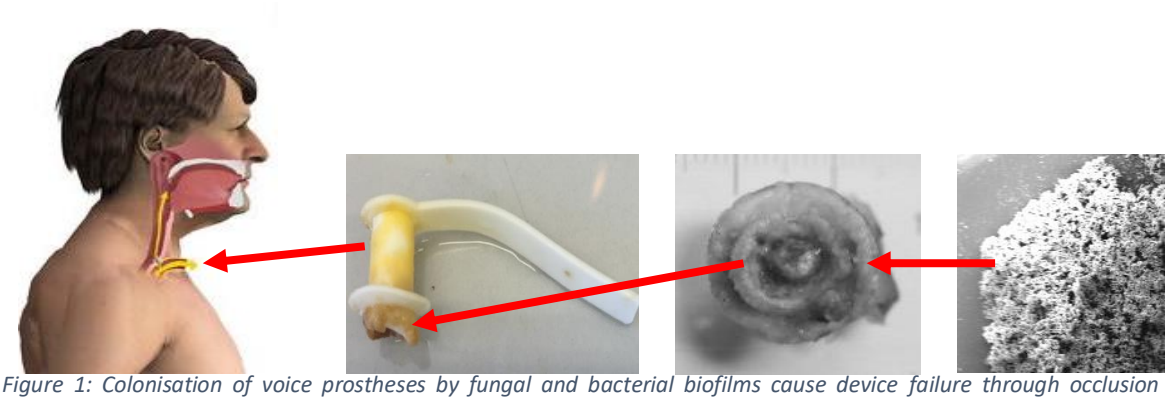

Figure 1: Colonisation of voice prostheses by fungal and bacterial biofilms cause device failure through occlusion and stiffening, leading to the need for frequent replacement by total-laryngectomy patients.

My first task was to identify a core profile of microbes for each participant and to investigate whether this was consistent throughout the participant cohort. After trying various options, I found that the most useful definition of a core profile were those organisms that were present in more than half of the samples. My analysis showed that participants carried a core profile over time that was specific to each individual.

With guidance from Dr Richards, I then used MATLAB (a computer programming environment) to carry out a number of statistical tests between both the participant factors and the organisms themselves. Although the sample size was relatively small, by analysing data over time from both voice prosthesis and oral rinse samples, my analysis revealed a number of associations between microbes and patient

factors that can be investigated in future studies.

I then calculated the phi coefficient (a measure of the correlation between pairs of organisms) for all pairs of organisms, with a colour-map used to translate the coefficient to a colour for ease of visualisation. Finally, the organisms with the most positive and most negative coefficients were selected to be included in a correlation network figure. This showed which organisms were likely to be found together, such as, for example, co-colonisation of voice prostheses by *Candida krusei* and *C. tropicalis*.

I would like to thank the BMS for the opportunity of a Summer Bursary, particularly during this time when Covid-19 has made traditional biology projects difficult to pursue (Figure 2). The award has contributed to a manuscript soon to be submitted for publication by the Brand group and, excitingly, the experience in MATLAB programming and data analysis with Dr Richards has enabled me to obtain a PhD position in computational biology at the University of Exeter that will start this October. I would also like to acknowledge the work of Dr Ijeoma Okoliegbe, who collected the dataset during her PhD with Dr Brand, and the ENT Clinic staff at Aberdeen Royal Infirmary through whom the study was conducted.

Figure 2: Research during lockdown! From left to right: Dr Alexandra Brand, Alaina Cockerell, Dr David Richards.

Alaina Cockerell
University of Exeter

***In silico* analysis of genomic variants influencing titanisation ability in *Cryptococcus neoformans* in response to fluconazole**

During the summer, I was fortunate enough to do some research with members of the Ballou lab to investigate *Cryptococcus neoformans* through bioinformatics analysis.

This was done despite lockdown measures as I was working from home, however I was well supported through frequent Zoom meetings with other team members many of whom were still able to carry out lab work. We were investigating *Cryptococcus neoformans*, which is a fungal pathogen that commonly infects immunocompromised individuals and may lead to life-threatening meningitis. Following lung inhalation or *in vitro* induction, some cells transform into a unique titan phenotype, with conversion to large, polyploid cells over >10µm, with a thick cell wall and crosslinked polysaccharide capsule that are believed to play a role in immune evasion and dissemination.

One of the most important drugs for treating cryptococcosis is fluconazole. However, fluconazole resistance is common, with 60-80% of patients experiencing drug resistance during the course of their treatment. This is due to intrinsic heteroresistance (where particular individuals are more resistant than others and are positively selected during drug exposure). It has been shown that resistant cells demonstrate aneuploidy particularly in chromosome 1, with upregulation of genes such as AFR1, a drug efflux pump and ERG11, a fluconazole target enzyme important in conferring resistance. We hypothesised that titanisation is a mechanism that allows particular cells to become resistant and that resistant colonies may have increased tendency to titanise. Since titanisation involves polyploid cells, there may be copy number amplification of genes conferring resistance, and the thickened cell wall and capsule may reduce drug penetration. Moreover, titan cells give rise to aneuploid progeny, which are also FLC resistant (Gerstein et al. 2015). Therefore, we investigated what genetic variants might influence titanisation capacity.

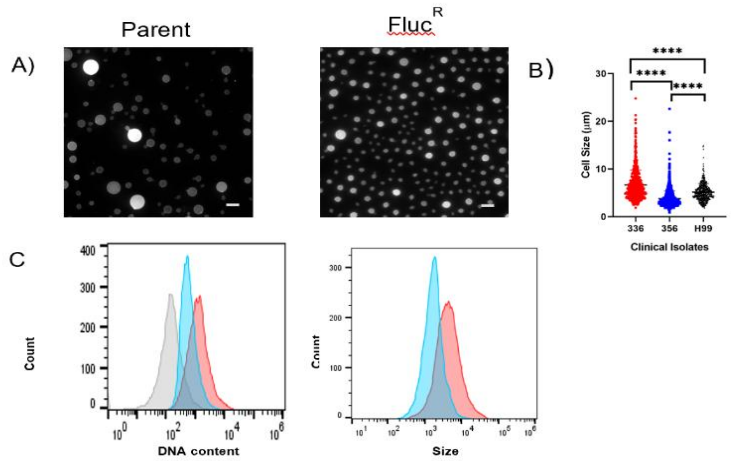

Figure 1: Particular clinical isolates where parental isolate is able to form Titan cells. H99 and clinical isolates were grown in YNB overnight followed by induction of Titan cells in 10% HI-FCS with PBS. A) Microscopy images of clinical isolates representative of 5 technical repeats. Cells were stained for chitin with CFW, scale bar of 10 µM. B) Size of clinical isolates and H99 measured from microscopy images. C) Cells stained for DNA content using DAPI and analysed by flow cytometry. Data is representation of 3 biological repeats. Red represents parent and blue represents Fluc^R. Grey represents unstained H99 control.
Zafar H, 'Screening Tanzanian Clinical Isolates for *in vitro* Titanisation Capacity' [unpublished Phd thesis], Birmingham University (2020)

To do this, we first obtained samples from Tanzanian HIV associated paired patient isolates that were either non-resistant (parental) or resistant *in vitro* when tested by Stone et al (2019). When we tested their ability to titanise, we observed that some resistant samples had slightly increased ability

to titanise, as measured by positive shift in DNA content and increased number of titan cells when measured by flow cytometry and microscopy. However, intriguingly other resistant samples seemed to have reduced DNA content and reduced number of titan cells compared to parental. This reduced ability to titanise we hypothesise to be the result of genetic drift in some samples which may be exacerbated by the formation of reactive oxygen species during fluconazole treatment that may provide increased mutagenic background. Loss of titanisation may not preclude loss of resistance since titan aneuploid progeny continue to be resistant even if titanisation ability is lost in some cells. Mutagenic changes may occur stochastically so in some samples there is no loss of titanisation, but there may be changes in other phenotypes we did not measure such as capsule formation or melanin production.

To investigate potential genetic variants associated change in titanisation ability, we next accessed whole-genome sequenced data for the paired isolates via the EBI database. Variant calling was then done compared to the H99 reference genome using a galaxy workflow, and results sorted and filtered. Bcftools was then used for pairwise analysis of differences between non-resistant and resistant samples and results analysed via Ensembl to find genes associated. Using FungiDB, we found genes common to samples that displayed increased titanisation in resistant samples; and a separate set of genes found in samples with reduced titanisation in resistant samples. Gene enrichment analysis was carried out and we identified particular GO terms associated with cellular stress response, cell wall synthesis and chromatin remodelling that may be linked to titanisation. This was visualised using Revigo.

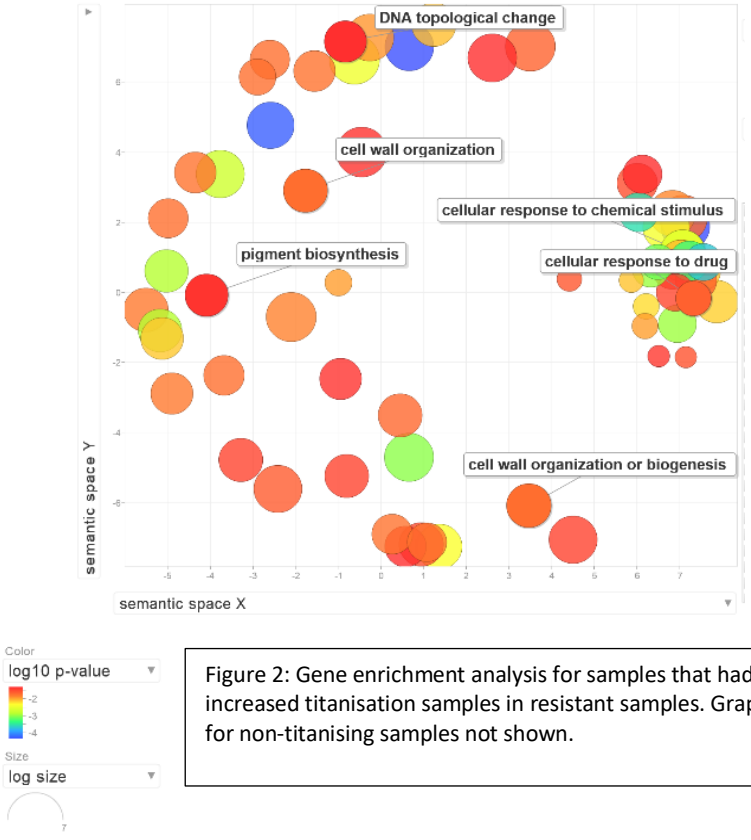

Figure 2: Gene enrichment analysis for samples that had increased titanisation samples in resistant samples. Graph for non-titanising samples not shown.

Next, in order to further explore which genes might have been responsible for altering titanisation ability, we compared my genes with a library of mutants which had particular genes knocked out to screen for qualitative changes in titan cell size and had demonstrated abnormal morphology under

titanising conditions. This yielded a small number of genes shared during *in vitro* and *in silico* analysis which warrant further investigation. In particular, we identified CNAG_05292, found in titanising samples, and CNAG_3765, found in both titanising and non-titanising samples. Both encode enzymes involved in the trehalose biosynthesis pathway, *tps1* and *tps2* respectively.

Under titanising conditions, tps1 mutants could not titanise and had reduced cell density, whereas tps2 mutants displayed extremely large cells many of which had lysed (Figure 3).

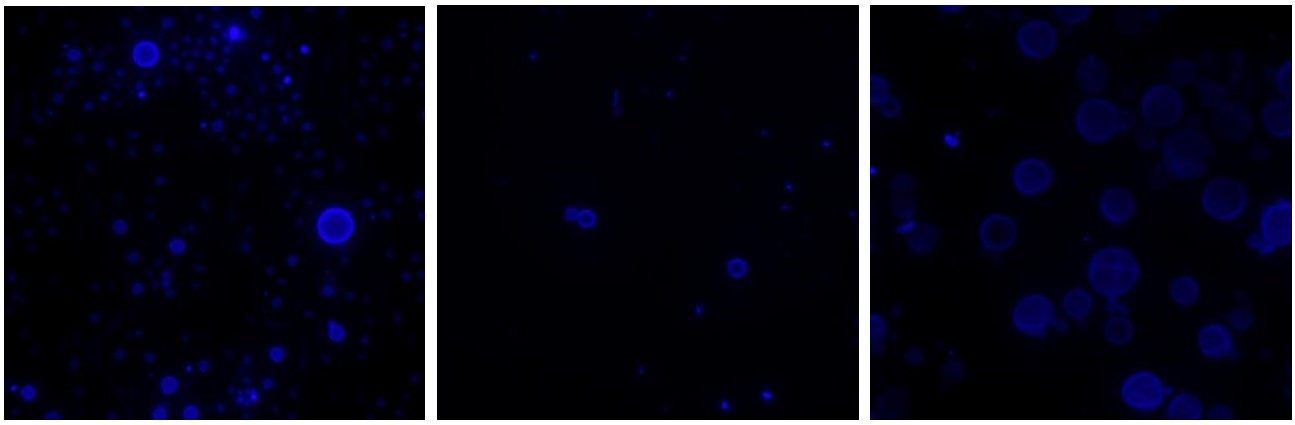

Figure 3. Left: H99, Centre: Tps1 mutant, Right: Tps2 mutant. Cells stained with calcofluor white, which stains cell wall chitin. Cells grown in YNB followed by Titan induction in 10% FCS with PNB. Titan cells appear large as shown in left image but no titan cells are seen in Tps1 mutants. Tps2 mutants display abnormally large titan cells.

In the literature, trehalose has been shown to be important in protecting against both external and internal stresses in fungi, such as osmotic or heat stress. It is also important in virulence, with *tps1 null* mutants exhibiting avirulence in animal models, and also demonstrating increased susceptibility to antifungal drugs that increase oxidative stress. It remains to be seen whether it has a causal role in fluconazole resistance through its possible contribution to titanisation in *Cryptococcus neoformans*; studies in *Cryptococcus gatti* have shown *tps1* mutants have cell wall defects and reduced melanin and capsule synthesis, processes central to titanisation, however these defects have yet to be observed in *Cryptococcus neoformans (*Thammahong et al. 2017*).* Our mutants suggest trehalose biosynthesis does affect titanisation characteristics although the precise mechanisms of why Tps1 and Tps2 mutants display different phenotypes remains to be characterised. We hope that by identifying pathways regulating titanisation, in the future drugs could be selectively targeted to these pathways to combat fluconazole resistance.

My research has been a preliminary exploration into potential genes involved in titanisation, however more research would be needed to further characterise the possible pathways involved. Although my research experience has undoubtedly been unusual since I was working from home, I have definitely learnt a lot about what research is really like and have experienced first-hand both the frustrations of waiting to download massive amounts of data and sense of fulfilment when finally understanding how to analyse it! I have also learnt many skills relating to bioinformatics and genome analysis which I wouldn't have done if I had worked in the lab instead as originally planned. I am deeply grateful to my supervisor and other team members that supported me throughout and made this project both challenging and enjoyable.

Bryan Chang
University of Birmingham

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2021 Summer Project Awards

Each year, the British Mycological Society offers a number of bursaries for students to assist with projects within UK or Ireland universities or research institutes. As well as supporting mycology researchers with their investigations, the bursaries enable undergraduates nearing the end of their studies to spend a summer gaining experience and learning, and help encourage and promote appreciation and interest in fungal research. This year, six bursaries have been awarded to projects in medical mycology and plant pathology.

Dr Liz Beal, Senior Plant Pathologist, RHS.

Hazel Irving will be working with **Dr Liz Beal**, **Royal Horticultural Society**, to investigate the effect of the environment on disease in plants with high susceptibility to powdery mildew. The project will look at severity of disease from powdery mildew fungi under varying conditions of water/drought, light/shade and ventilation. It will also include a study of the effect of different plant protection products on mycelial growth. The findings will contribute to the advice RHS gives to members and other gardeners on limiting and controlling powdery mildew diseases.
Liz's profile

Emma Ann Platt will be working with **Dr Estrella Luna-Diez, University of Birmingham,** to study the effect of elevated CO_2 on resistance to the fungal plant pathogen *Erysiphe alphitoides*. Although it is speculated that elevated CO_2 may increase plant productivity there is also evidence that increased CO_2 affects fungal resistance, which could exacerbate disease outbreaks. Emma Ann will investigate this in mature oak trees and seedlings, providing the groundwork for the translation of research into a set of guidelines for woodland owners, policy makers and the general public on how to establish new forests, now and into the future.
Estrella's profile

Dr Estrella Luna-Diez, Lecturer in Plant Pathology, University of Birmingham

Dr Andy Bailey, Reader in Molecular Mycology, University of Bristol

Armillaria mellea (honey fungus) causes devastating disease on a range of woody trees and shrubs. In lab studies, Trichoderma soil fungi taken from the roots of healthy plants have been shown to have antagonistic or eradicative properties against *A. mellea*. Jude Turner will be working with **Dr Andy Bailey, University of Bristol** to assess the range of plants in which this occurs, helping to investigate the potential for using such endophytic fungi for biological control of honey fungus.
Andy's profile

Dr Alexandra Brand, Associate Professor, MRC Centre for Medical Mycology, University of Exeter

Emily Rowlands will be working with **Dr Alex Brand, University of Exeter** on *Candida auris*, an inherently drug-resistant fungal pathogen of humans. The Brand lab has previously found one of the four clades of *C. Auris,* the South American strain, to be sensitive to myriocin, a metabolite produced by five known species of unrelated fungi. Emily's project will extend this study to the other *C. auris* clades to understand how myriocin works, providing the preliminary data for future studies of these mechanisms.
Alex's profile

The yeast *Candida albicans* is known to associate with the bacterium *Staphylococcus aureus* in human infections, increasing the pathogenicity of *S. aureus* and enabling antibiotic resistance. However, little is known about reciprocal effects. Working with **Dr Ryan Kean, Glasgow Caledonian University,** Willemijn Kuiters will be investigating the effect of co-infection with the bacterium *S. aureus* on the ability of *C. albicans* to form biofilms (a key infection mechanism in many fungal pathogens) to help establish whether co-infection with *S. aureus* increases *C. albicans* pathogenicity and antifungal tolerance.
Ryan's profile

Dr Ryan Kean, Lecturer in Clinical Microbiology, Glasgow Caledonian University

Dr Carolina Coelho, Lecturer in Biosciences, MRC Centre for Medical Mycology, University of Exeter

Dmytro Prasolov will be working with **Dr Carolina Coelho, University of Exeter,** on the yeast *Cryptococcus neoformans*. In mammals, *C. neoformans* infection usually occurs in the lungs and usually in 24mmune-deficient or immune-compromised individuals. Recent studies have shown that deletion of certain *C. neoformans* genes leads to growth defects; this project will further characterise the defects and measure the impact of genetic deletion on virulence in wax moths, a model organism. The findings will provide data to support funding applications for further research into the impact in mammalian hosts.
Carolina's profile

The students' reports from these projects will be published in future newsletters.

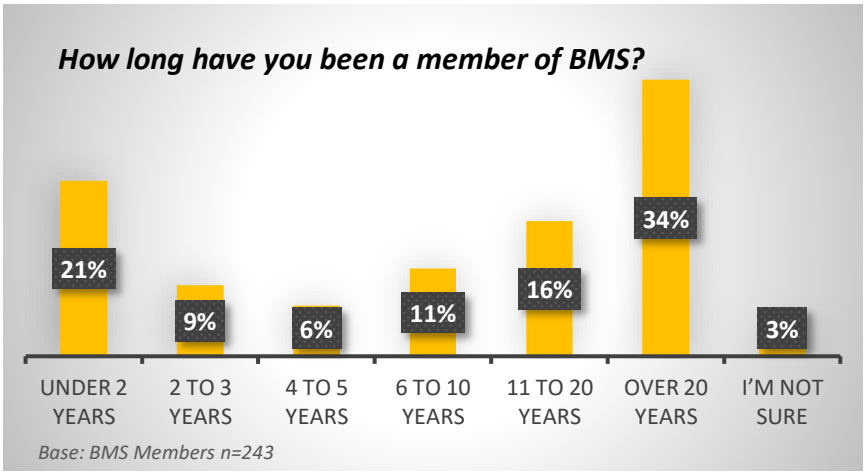
Dr Emma Thompson , BMS Scientific Communications & Development Officer

BMS Survey 2021 – the results

The British Mycological Society carried out some research during May and June of this year to find out about the interests of members and others in the mycology community. We were also keen to receive feedback on BMS events, resources and activities, gather information to help the Society become more relevant and engaging, and understand how the Society is perceived.
Current BMS members and others aware of the BMS - through events, social media or friends and colleagues - were invited to complete a survey, to share their thoughts on the benefits of being a member of the Society, what they value and would like from the BMS, what the Society does well and what could be done better, and where they would like to see the Society in 10 years' time.

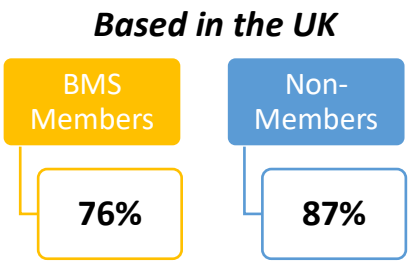
A total of 363 people took part: 243 BMS members and 120 non-members. The response from BMS members is around 43% of the total membership at the time.

Those who have joined the BMS within the last 3 years, have mostly done so to keep up to date with the most recent understandings of fungal ecology, take part in BMS events (workshops, conferences, symposia, forays) and network or meet other, likeminded members.



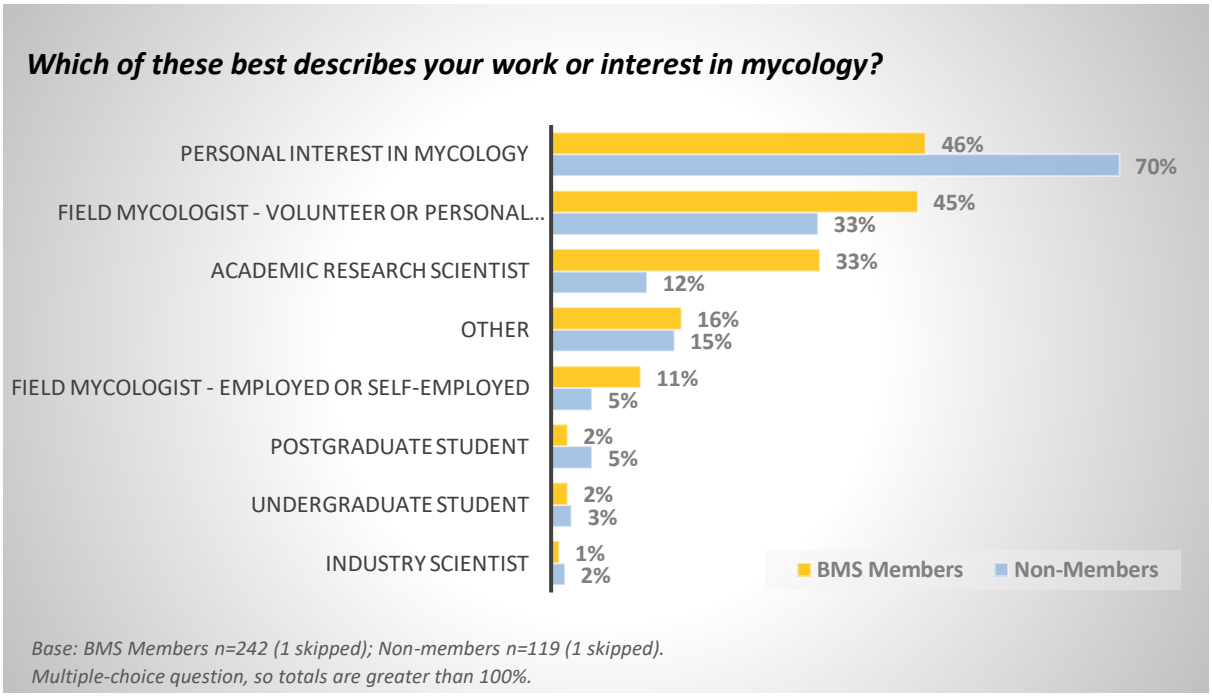
For longer-term members, receiving the BMS journals, taking part in events, and supporting the BMS in raising the profile and awareness of mycology are the key drivers for membership.

A main reason for not joining the BMS is not knowing enough about membership, along with not seeing the benefit of membership, and being able to access what they need without being a member. A fifth of non-members taking part in the survey used to be a member, but are not currently.



The BMS is most commonly seen as **Respected**, **Expert** and **Professional** by its members, and also as **Informative** by non-members. The BMS is also seen by members as being somewhat **old-fashioned**, and **needing to modernise**. In terms of the Society's roles, members and non-members think the Society is most effective at producing journals for the national and international community, and organising conferences, workshops and other activities supporting mycology.

All those taking part in the survey feel the BMS is least effective at *encouraging those interested to join the Society and participate in activities*. Additionally, non-members feel the BMS is not so effective at *promoting the recognition and understanding of all areas of mycology to the public and in the media*.



For those members working or volunteering as Field Mycologists, the most valued BMS events and meetings are the *field meetings and workshops*, and *Local Recording Group events*. Members working as Research Scientists most value the *BMS Annual Scientific Conference*, and *International workshops or symposia*. Non-members most value *UK Fungus Day* and *Local Recording Group events*, and all those taking part in the survey placed high value on *BMS's online lectures and talks*.
Of the BMS's information and resources, members most value the *BMS journals.* Most valued by non-members are the *BMS Facebook Group* and *Resources for identification and taxonomy* (e.g. Keys, English Names). Many survey participants provided helpful feedback on areas of the website they find most useful and there were numerous constructive and practical suggestions for ways in which the members' newsletter could be developed to make the content more relevant and appealing.

For members, the key areas for the BMS to focus on for development and improvement are member engagement and communication, tailoring membership to better match their interests, and raising the Society's profile, through outreach and other activities. Non-members also identified the provision of more education and information for beginners, and the Society being more open and connected as other key areas.

When asked what they would like to see the BMS achieve in the next 10 years, the largest number of comments related to an **increase in outreach and activity to raise public awareness and promote mycology**. This was followed by **more inclusion and engagement to encompass all members' interests and the broader aspects of mycology**.

The research has provided valuable insight and detail that will help the Society grow and develop - thank you very much to all those who took part! As well as using the findings to help shape our overall strategy, the BMS Committees are discussing ways to address key points raised by survey participants; we'll keep you updated on these developments.

Dr Emma Thompson, BMS Scientific Communications & Development Officer

Reviews

BMS Talks: Machiel Noordeloos - *Entoloma* revised: What is left of the traditional species concepts?
Available at: https://www.youtube.com/watch?v=bxd_15EaOJg

It was with great interest that I attended the second monthly talk hosted by the British Mycological Society. One rarely gets to see a master at work and so to have Machiel Noordeloos, one of the great names of European mycology, present made sure that I cleared my evening's schedule to tune in to what would certainly be a special event.

Noordeloos, who has worked with the genus since 1975, has long been considered an authority on *Entoloma* and his talk focused on the impact of ITS barcoding on taxonomic concepts in the European representatives of the genus One feels that the project presented was simultaneously the challenge to and the culmination of several decades work. It is no secret that molecular methods, increasingly seeping their way into mycological taxonomy, are totally changing the picture in terms of our understanding of fungal species. Faced with such a challenge, Noordeloos has bravely charged into the fray and sought to re-examine the genus in the cold light of a molecular data.

To highlight the problem, Noordeloos first highlighted eleven morphological species concepts that fell under a single genetic clade. Identifying the three interacting sources this problem—false identification by mycologists, incorrect keys, and false morphological species concept—Noordeloos went on to assess the current status of ITS data in genus. This was an equally sorry story, with 30-50% of the relatively few accessions of *Entoloma* in genetic data banks being misidentifications. Indeed, the number of fungal misidentifications in genetic databases remains a problem across most fungal genera and speaks to the growing disconnect between field mycology and molecular fungal science that serves neither party and contributes to a poorer mycology for all. However, Noordeloos avoids these problems through utilising collections he has access to, allowing morphological reassessment of the specimen, and through collecting his own genetic data. He has also accessed all available type-collections to ensure the validity of his results. Indeed, the project as presented, speaks to a productive marriage of mycology new and old that shows the true potential of mycology in the molecular age.

The remainder of his talk went through various case studies of European *Entoloma* and how our understanding has been impacted through a genetic analysis of their relationship to each other. Suffice to say the examples were illustrative, the results elegant, and the possibilities for future work exciting. I dare not write more for fear of spoiling the talk which is accessible online. I have watched it numerous times since it has been uploaded and find myself learning something new each time.

Noordeloos ended his talk with the promise of a new monograph for *Entoloma*—labelling it a "temptation". If it is as revolutionary as his talk suggests, it is a temptation indeed and one I look forward to reading in due time. Until then, I shall identify my *Entoloma* specimens with an asterisk and retain them for an inevitable reassessment.

Prof N. J. McGinty

BMS Talks: Patricia Fara - Survival of the fittest: The life and struggles of Helen Gwynne-Vaughan.
Available at: https://www.youtube.com/watch?v=jLcd61tVJ2E

For the third talk in the BMS monthly Zoom meeting, Nathan Smith had invited author of the recently published, and well received, 'A Lab of One's Own', historian, Dr Patricia Fara to talk to us. Entitled "Survival of the fittest: the life and struggles of Helen Gwynne- Vaughan". It certainly wetted my appetite as I had a copy of Gwynne- Vaughan's early text book 'Fungi Ascomycetes, Ustilaginales, Uredinales', (1921) and the later 'The Structure and Development of the Fungi.' H.C.I Gwynne- Vaughan and B. Barnes. (1927).

Dr Fara began by explaining she was not a mycologist, but was interested in the struggles of women in their fight for equality with men. She began with a brief introduction of Gwynne -Vaughan's life, her privileged background, her insistence on attending Kings college London rather than Oxford University (women were not awarded degrees until 1920) She achieved her degree in 1904 and her doctorate three years later. A brief marriage to a fellow academic and, following a number of posts at universities, she succeeded her husband, following his death in 1909, to the post of Professor of Botany at Birkbeck College London.

Her readiness to sign up for the war effort would suggest that her active duty in the first world war for two years, first in the Women's Army Auxiliary Corps, and then commandant of the WRAF was more important than her academic career. This was replicated in 1939 when she was made Chief controller of the Auxiliary Territorial Service. Was this because the firm army discipline and ridged thinking suited her temperament? or was she wanting to show women could be as good as or better than men?

Gwynne -Vaughan was a supporter of suffrage, but not an activist, despite this she and her friend Louisa Garrett Anderson established the London University Suffrage Society. What prevented her activism? Was it her privileged conservative background? Would there have been repercussions to her academic career? She was a parliamentary candidate for the unionist party in 1922, but failed to get elected three times.

An intriguing photo was shown of her post war, in the lab dressed in a tie and looking very manly amongst her predominantly male students. Did Gwynne- Vaughan feel the need to dress like a man to gain academic respect? Was this photo included in the presentation as a hint to her sexuality? This was not touched on, nor more importantly was her work or influence on other women that might have followed her into mycology.

Gwynne-Vaughan it appeared to me from the talk seemed very keen to climb the hierarchical ranks of male dominance and it seemed those years in military service may have meant more to her than her academic career.

Disappointingly Gwynne-Vaughan did not have seemed to inspire others, but appeared rather opportunistic and more concerned on her own success. Her words—"The discipline, the comradeship, the co-operation, the concentration on the service of the community…are as important, and as necessary, for girls as for boys"—perhaps sum up her limited approach to equality, being like a man, rather than equal to them, which was perhaps fashioned by the old-fashioned male dominated ideas which were typical of the Victorian England she was born into.

Carol Hobart

BMS Talks: Dr Sydney Glassman - A tale of two megafires: fire effects on fungi.
Available on request from the BMS Office. Email: admin@britmycolsoc.info

Field mycologists get excited when they come across old bonfire sites in the hope that they will find pyrophilous fungi – and they often do. The fruiting bodies of pyrophilous fungi appear after burning, often occurring in no other habitat. Their apparently miraculous appearance gives rise to their alternative name of phoenicoid fungi. But Dr Sydney Glassman, Assistant Professor at the University of California, Riverside, studies not bonfire sites but the aftermath of mega-fires, wildfires that affect areas of over 100,000 acres. Alarmingly these are becoming increasingly frequent. In her recent BMS on-line lecture, organised by Nathan Smith, she spoke on *The Impact of Fire on Fungal Diversity*.

Dr. Glassman had been studying soil fungi using DNA barcodes to estimate species diversity when two of her experimental sites experienced mega-fires, the first, in 2013, burnt over 250,000 acres of pine forest on the edge of Yellowstone National Park; the second occurred in a redwood-tanoak forest nearer the coast. It may surprise some that before the fire over a thousand species of soil fungi could be detected in the pine forest samples, predominantly ectomycorrhizal basidiomycetes; *Inocybe* spp. were especially abundant. This number dropped by 50% in samples taken one month after the fire and there was a shift toward ascomycetes, with species of *Pyronema* becoming especially abundant, but the basidiomycete truffle *Rhizopogon olivaceotinctus* also prospered. In the less well-studied tanoak-redwood forests, fewer species were detected but with a similar fall in number (300 to 100) and switch from basidiomycetes (especially *Hygrocybe* spp.) to ascomycetes, although the basidiomycete yeast *Basidioascus* became very abundant.

Encouraging studies with hyphal ingrowth bags and water spore-traps showed that over 3000 fungal species ‘arrived’ at the fire sites over two years post-fire and that some 50% of these became established. In response to questions, Dr. Glassman outlined some of the strategies used by fungi to survive fires, including resistant spores, sclerotia, persistence of endophytes in roots and migration from deeper levels. She is carrying out laboratory experiments to determine the characteristics of burnt soil that favour subsequent growth and fruiting of pyrophilous fungi.

Through her enthusiasm, Dr Glassman was able to communicate very effectively with us field mycologists, packing in well-presented facts but never overloading us. A positive spin-off of the pandemic restrictions is that neither did we have to travel to California, nor she to us, for us to benefit from this presentation.

Tony Leech

BMS Talks: Greg Mueller - Progress and challenges in advancing fungal conservation.
Available at: https://www.youtube.com/watch?v=korwEXQieuI

Another excellent online lecture arranged by Nathan Smith. This one was of particular interest to me as it looks at fungal conservation – a topic that I have been interested in since the very start of my fungal recording interest.

Greg Mueller works at the Chicago Botanic Garden and his research focuses on the evolution, ecology and conservation of fungi but he has been extensively involved in International fungal conservation efforts: if anybody is in a position to talk about fungal conservation it is Greg!
This talk was an excellent starter to get folk thinking about how we might use the records that are collected. The extensive database that is the FRDBI is a wonderful that we do need to make use of. Greg began his talk by stressing the importance of working in an inter-disciplinary way – the voluntary recording community (ie the citizen scientists) and the scientists – yes surely – but how often do we forget to involve the planners and the politicians? Working to get the importance of fungi into their decision making is vital. This is not an impossible task and, as Greg points out, the rise in awareness of the importance of waxcap grasslands over the last 25 years demonstrates this. Certainly fungi face the same threats as plants and animals – habitat loss, pollution, climate change and in some cases, over-harvesting but it is not possible to lump them in with the other kingdoms as they have particular needs. You can save a forest but without attention to the composition of age structure, species structure, presence of dead wood etc., the woodland may not actually work well for the fungi, especially if the forest is managed, which most are these days. Similarly some fields described as botanically poor can be excellent for waxcap fungi.

Greg went through the current assessment methods for red list production used to determine which species are thriving and which need attention so that conservation action will make the biggest impact. Decision makers need good data and there is a lack of robust data on distribution, population size, population trends etc etc which means that the vast majority of fungal species remain un-assessed.

Recently there have been a number of well managed citizen science projects that have made a start in addressing this problem including our own excellent 'Lost and Found' project. These projects, although based on observational data only, do provide robust data which can be used to encourage mycological conservation researchers and enable them to find funding (enter policy makers and politicians) for their work.

We are all well aware of the difficulties of working with fungi – their functioning presence often only accessible through research involving DNA. Equally we know that molecular work is in its infancy – something illustrated by a question at the end "Can eDNA (DNA sourced from the environment not mycelia or fruit body so not directly related to a particular individual) be included in conservation assessments?" Greg responded by saying that the current IUCN criteria rely on mature individuals capable of sexual reproduction. DNA picked up in the soil, for example, may never reach that stage. Clearly there is a lot of observation, research and discussion required to take fungal conservation further forward.

Liz Holden

BMS Talks: Ida Dalsgaard Nicolaisen - Standing up for a planet full of Life - Fungi, art and activism.
Available at: https://www.youtube.com/watch?v=EFdpMDo6H0Q

The BMS talk in July was truly something completely different. The speaker of the month—Ida Dalsgaard Nicolaisen—an artist and activist from Denmark, presented a talk on fungal art and activism that was part traditional talk and part art installation. Talking from two-perspectives in the mycological underground and surrounded by hyphal threads, Ida detailed her philosophy of species-focused activism. Beginning with a general introduction, Ida showed how mycorrhizal interactions can allow for a "multi-species conversation" to take place—an idea that sat central to the rest of her talk.

Starting with her artistic work, Ida detailed her interactions with the performance collective *Becoming Species*—a group that, through meditation and play, seeks to erase the human ego to see what they become. A variety of performances were detailed, including Ida as mushroom in a Czech forest connecting a crowd of participants. Despite lacking an artistic impulse myself, I found the performances deeply interesting and with a fascinating conceptual basis. Certainly, it highlighted the potential reach of mycology to audiences beyond our fair society and the potential role of art in facilitating a conversation about the importance of fungi. From previous talks hosted by the BMS, part of last year's UK Fungus Day festival, it appears fungal art is in fashion and I feel that such a trend can bring nothing but benefit in aim of advancing mycology.

The second part of Ida's talk focused on her activism. Of particular interest was her role as a "species ambassador" for the parrot waxcap (*Gliophorus psittacinus* (Schaeff.) Herink)—complete with theatrical costumes—as part of a wider *Embassy of Species* in Copenhagen. Indeed the idea, that an individual takes on the role to advocate for and amplify the voice of a local at-risk species, is one that I'm sure we in Great Britain could adopt—imagine a parliament of mushrooms!—though perhaps we might forgo the outfits for the time being.

The evening finished on a live artistic performance which involved another level of camera trickery. For someone who wanted to challenge the confines of an online talk, Ida certainly did so. Both by its content and its presentation, I left the talk inspired. The bar has certainly been raised!

Prof N. J. McGinty

BMS Contact Information

British Mycological Society
Charles Darwin House
12 Roger St,
London WC1N 2JU
Tel: +44 (0) 330 1330002

For General Enquiries
Email: admin@britmycolsoc.info

For Membership/Journals
Email: membership@britmycolsoc.info

For Newsletter Items
Email: newsletter@britmycolsoc.info

For UK Fungus Day
Email: ukfungusday@britmycolsoc.info

BMS Facebook Group
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www.britmycolsoc.org.uk

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