IMA Fungus full content available in PubMed (2010 onwards)

Since June this year, *IMA Fungus: the global mycological journal* is searchable on PubMed (http://www.ncbi.nlm.nih.gov/pmc/journals/1750/). We trust that this will further enhance the visibility and accessibility of the journal. PubMed comprises more than 21 million citations for biomedical literature from MEDLINE, life-science journals, and online books. Citations may include links to full-text content from PubMed Central and publisher web sites.

IMA Fungus continues to also be available on its own website (www.imafungus.org) and via Ingenta Connect (http://www.ingentaconnect.com/content/ima/imafung).

Fear of Fungi

The global significance of the threats to human well-being and the maintenance of ecosystems posed by fungi are rarely appreciated by policy makers, scientists in general, or the public at large. Now, Fisher *et al.* (2012) have spelled out the threats in a well-researched and extensively referenced review article which made the cover of the 12 April 2012 issue of *Nature*. Seven fungi are highlighted: *Batrachochytrium dendrobatidis* (amphibian decline), *Magnaporthe oryzae* (rice blast), *Geomyces destructans* (white-nose syndrome of bats; see also pp. (3)–(4) below), *Puccinia graminis* (wheat stem rust), *Aspergillus sydowii* (sea-fan aspergillosis of corals), *Nosema* species (colony collapse in bees), and *Fusarium solani* (hatch failure in loggerhead turtle nests). That list is necessarily eclectic, and designed to indicate a range of situations, and some would have included *Phytophthora ramorum* (sudden death of oak) – and a correspondent was quick to add fungal infections of fish to the slate (Gozlan 2012).

The review notes that reports of fungal Emerging Infectious Diseases (EIDs) are increasing worldwide as a proportion of all EID reports, considers dynamics that can lead to host extinctions, the evolution of virulence, and environmental change as a driver. Among other points it also draws attention to the role or trade and transport in the globalization of fungi, and stresses the risk fungi prose to both food security and ecosystem health.

In order to mitigate the threats, there needs to be much more attention paid to monitoring fungal inocula in wild populations, tighter control of trade, and understanding of the interactions between a host, its pathogens, and the environment. The authors conclude with a call for scientists in disparate research fields to be involved in global discussions to work towards strategies for the prevention and timely control of fungal diseases. It is a call-to-arms, and the issues raised must start to be addressed by appropriate agencies at the intergovernmental and governmental levels. At least no-one will now be able to claim that they was no alert as to the risks and global impacts of fungal diseases.

Anyone in doubt as to the importance of fungi in world affairs today, should be immediately directed to this important review.

Fisher MC, Henk DA, Briggs CL, Brownstein JS, Madoff LC, McCraw SL, Gurr SJ (2012) Emerging fungal threats to animal, plant and ecosystem health. *Nature* **484**: 186–194.

Gozlan R (2012) Monitoring fungal infections in fish. *Nature* **485**: 446.

White-nose fungus kills around six million bats

The US Fish and Wildlife Agency issued a press release on 17 January 2012[1] stating that there was a growing trend in the numbers of bats across the USA which were being killed by the white-nose syndrome fungus, *Geomyces destructans*. The mortality rates in colonies ranged from 70–90 %, and have been reported to be as much as 100 %

[1]http://us.vocuspr.com/Newsroom/Query.aspx?SiteName=FWS&Entity=PRAsset&SF_PRAsset_PRAssetID_EQ=129322&XSL=PressRelease&Cache=True

and between 5.5 and 6.7 million bats were estimated to have been killed since 2006, when the first cases were recognized in a cave in New York State. The disease has now spread to 16 states in the US and four Canadian provinces.

Conclusive experimental proof that *Geomyces destructans* was the causal agent was published on 15 December 2011 (Lorch *et al.* 2011). That study established that direct exposure of bats to the fungus caused the disease, and the fungus was recovered from diseased bats, so fulfilling Koch's Postulates. The authors also demonstrated that the disease could be transferred directly from infected to healthy bats. Previous uncertainty as to whether the fungus was the primary cause of the disease had arisen as the fungus occurs on the skin of European bats but is not associated with mortality in the region. It now seems probable that the fungus was transported into North America from Europe, where the bats are resistant to the disease, into North America where the native bats had no such resistance to a fungus they had never previously encountered.

For further information and to follow this developing situation, which poses a huge threat to the continuance of many bat species in North America, consult postings on the Bat Conservation International website (http://batcon.org/).

Lorch JM, Meteyer CU, Behr M, Boyles JG, Cryan PM, Hicks AC, Ballmann AE, Coleman JTH, Redell DN, Reder DM, Blehert DS (2011) Experimental infection of bats with *Geomyces destructans* causes white-nose syndrome. *Nature* **480**: 376–378.

The Top 10 fungal pathogens in molecular plant pathology

Ascomata of *Zymoseptoria tricti* (syn. *Mycosphaerella graminicola*) on infected wheat leaves.

The journal *Molecular Plant Pathology* conducted a poll amongst fungal pathologists associated with the journal to determine which species were of the most scientific or economic importance. The species selected, in rank order, on the basis of 495 votes, were:

1	*Magnaporthe oryzae*
2	*Botrytis cinerea*
3	*Puccinia* spp.
4	*Fusarium graminearum*
5	*Fusarium oxysporum*
6	*Blumeria graminis*
7	*Mycosphaerella graminicola*
8	*Colletotrichum* spp.
9	*Ustilago maydis*
10	*Melampsora lini*

Phakopsora pachyrhizi and *Rhizoctonia solani* were the runners-up. The announcement of this result includes observations on each species and its significance (Dean *et al.* 2012) and os intended to stimulate debate amongst the plant mycology community.

Dean R, van Khan JAL, Pretorius ZA, Hammond-Kosack KE, Di Pietro A, Spanu PD, Judd JJ, Dickman M, Kahmann R, Ellis J, Foster GD (2012)The top ten pathogens in molecular pathology. *Molecular Plant Pathology* **13**: 414–430.

Botrytis cinerea on *Leucadendron* flower head.

Fungus makes the Top 10 species 2012

Spongiforma squarepantsii: Surface view and section of basidiome. Scale in mm. Photo courtesy Tom D. Bruns.

On 23 May 2012, the Spongebob Squarepants Mushroom, *Spongiforma squarepantsii,* a gasteroid bolete discovered in the Lambir Hills National Park in Sarawak, and described by Desjardin *et al.* (2011) was announced as one of the ten top species to be described in 2011. The selection is made by an international committee established by the International Institute for Endangered Species based at Arizona State University. The species are selected because they attract the attention of the committee for a variety of reasons, though perhaps the common and scientific names selected played a role in this case. The name recalls a resemblance to a North American Cartoon character, Spongebob Squarepants, who lives in a pineapple –

and the basidiome apparently has a fruity smell. Other organisms on the 2012 list include a monkey, jellyfish, nematode, orchid, wasp, poppy, millipede, cactus, and tarantula; all are figured on the Institute's website (http://species.ascu.edu/top10).

Two agarics made it into the 2011 list, as reported in *IMA Fungus* **2**: (2), 2011.

Perhaps *IMA Fungus* should run a parallel annual competition? If you would like to do that for the Association, please contact the Editor-in-Chief.

Desjardin DE, Peay KG, Bruns TD (2011) *Spongiforma squarepantsii,* a new species of gasteroid bolete from Borneo. *Mycologia* **103**: 1119–1123.

2013 CBS Spring Symposium – One Fungus : Which Gene(s) (1F = ?G)

The two important and successful CBS Spring Symposia, One Fungus = One Name (2011), and One Fungus = Which Name (2012) had great impacts on the mycological community. The CBS-KNAW Fungal Biodiversity Centre is now planning the 2013 Spring Symposium, One Fungus = Which Gene(s), now fixed for Wednesday-Thursday 10-11 April 2013. The main topic of the symposium will be to extend the concept of DNA barcoding to define how best to classify and identify fungi. Although a general consensus on the ITS barcode region has now been reached, it is important to clarify what additional gene(s) need to be targeted for specific fungal groups. Furthermore, best practices for obtaining and designating ex-type or ex-epitype isolates for whole genome analysis need to be addressed. The impact of fungal genome projects on fungal taxonomy and their utility for discovering new barcoding genes will be a focus, and the possible application of phylogenomic information to inform functional genomic annotation will also be discussed.

Contributed papers are welcome, and they will be selected for either oral or poster presentations.

The venue, as for the previous two symposia, will be Trippenhuis, home of the Royal Netherlands Academy of Arts and Sciences, Amsterdam, and the registration fee is € 250 (which includes includes coffee/tea, lunches and a cocktail party). It is anticipated that on Friday 12 April meetings of the IMA Executive Committee, and of several ICTF and IUMS commissions and working groups will be held at the CBS in Utrecht, which will be concluded with a fungal barbeque.

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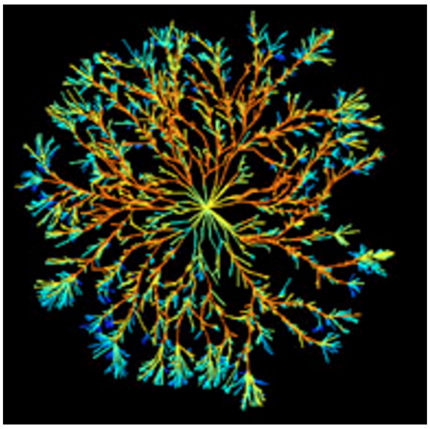
Special issues of journals

Hyphal networks

The hyphal systems of fungi never cease to amaze in their complexity and adaptability. *Fungal Biology Reviews* **26**(1), April 2012, includes four review articles under the title "Hyphal networks: mechanisms, modeling and ecology". These address the self-fusion between conidial anastomosis tubes, analysis of fungal networks developed from block inocula, modeling of hyphal networks, and mycorrhizal networks. All contributions are by leading research groups in the field, and superbly illustrated. I also found the tabulation of the diverse mechanisms by which mycorrhizal networks may affect plant communities of value, and can see that being adapted for various taught courses. There is much to fascinate in the remarkable way these networks develop and function, and this read is a way of getting up-to-speed on this cutting edge research area in fungal biology,.



Phanerochaete velutina mycelium digitized and colour-coded to represent thicknesses of the major cords. From Boddy *et al.* (*Fungal Genetics and Biology* **47**: 522–530, 2010). Photo courtesy Mark Fricker.

Tropical fungi

The tropics are an immense store of unusual and undiscovered fungi, but our knowledge of them remains fragmentary. M. Catherine Aime and Francis Brearley have now put together a special issue of *Biodiversity and Conservation*, scheduled to appear as **21** (9) this August. It is anticipated that the issue will contain 12 original papers dealing with a range of groups of fungi, including aquatic fungi, lichen-fungi, mycorrhizal fungi, polypores, rusts, and trichomycetes, and also approaches to inventorying. Two previous special issues of the journal have been devoted to fungal diversity (**6**(5), 1997; and **16**(1), 2007) and these attracted considerable interest, and it is anticipated that this will also be the case with this number. Most papers are already available online-first *via* SpringerLink (www.

Favoleschia sp. nov. One of about 750 species of fungi new to science discovered in the Pakaraima Mountains of Guyana in 2010, and being featured on the cover of all 14 of the 2012 issues of *Biodiversity and Conservation*. Photo M. Catherine Aime.

springerlink.com/), and the possibility of making all open-access and free to download is under discussion at the time of going to press.

Endophytes

Two journals have recently issued special issues on endophytic fungi: *Fungal Diversity* **54**, May 2012, and *Fungal Ecology* **5** (3), June 2012. The *Fungal Diversity* issue has three review articles which concern the mediation of reactive oxygen species and antioxidants, the role of fungi in phytoremediation, and their value as a source of biocatalysts. Nine papers follow, on a wide range of aspects including cold adaptation, studies of particular species and endophytes of particular plants, and systematics. The *Fungal Ecology* issue, "The secret world of endophytes", has ten articles which range considerably in scope, but with an emphasis on the endophytic fungi of grasses in different regions, effects on the host plants, and also the production of alkaloids. The two issues are complementary rather than duplicatory, and are timely in view of the COST initiative recently launched on endophytes (see p. (7)).

Entomopathogenic fungi

Mycosystema **31** (3), May 2012 is devoted entirely to entomopathogenic fungi. It comprises 17 articles, almost all by Chinese authors, with the emphasis on species exploited for medicinal uses (particularly *Cordyceps* s. str. species) and of actual or of potential applications in biocontrol. The fungi considered in the latter category include species of *Beauveria, Metarhizium, Nomuraea, Paecilomyces,* and *Zoophthora*. Aspects covered include pathogenicity testing, marker genes for released strains, gene cloning, screening, optimization of culture methods, and volatile products.

Mycophily, mycophilogy, and insect conservation

The grass *Festuca rubra* (red fescue) probably provides toxicity against predators to the butterfly *Melanargia galathea* (marbled white) by larval ingestion of pyrrolizidine alkaloids produced by the endophytic *Neotyphoidium* sp. Photos Roger Kemp.

The terms "mycophily" and "mycophilogy" have been proposed by Kemp (2010, 2011) for the association of fungi with living plants and animals, and the study of those associations, respectively. The author postulates that the chemicals produced by fungal endophytes in plants are required by or at least beneficial to the larvae of some insects, particularly butterflies and moths, for optimal growth. He then speculates that the declines in butterflies seen in the UK could be due to the loss of endophytic fungi in the host plants. There is clearly scope for the experimental testing of these novel cross-disciplinary ideas, and this could also encourage more entomologists and plant ecologists to take an active interest in the roles of fungi in the systems they investigate.

It should, however, be noted that in introducing the term "mycophily", Roger Kemp was not aware of the two previous uses of "mycophilic" for either a fondness for fungi (usually for food), or organisms growing on fungi.

Kemp RJ (2010) Mycophily – a new science for insect conservation. *Antenna* **34**: 13–15.

Kemp RJ (2011) Mycophily and its possible role in plant micro-distribution within habitats. *Botanical Society of the British Isles News* **118**: 23.

Global Mycology Initiatives

If you are interested in participating in the following project initiatives, please let us know at your earliest convenience. We do not have funding specifically for this, but want to get started anyhow. We have then two years to gather information before we hopefully can meet at IMC10 meeting in Bangkok!

Global Mycology Initiative I: Traditions, Technologies and Science

Topic: Fungal consortia used in food production (e.g. for production of soy sauce, fermented meat etc).

Objectives, Investigations and results: The basics: Description of production process (Starter culture? Enrichment culture? Process conditions? The experimental: characterization of microbial biodiversity, population dynamics, consortium signaling, secretome and transcriptome composition. Right now industrial biotechnology is basically one gene, expressed in one production host to produce one protein which are sold as one product for one specific purpose. In future we will also be able to handle complex consortia to provide solutions for complex problems, e.g. conversion of biowaste materials. Here a comprehensive understanding of consortia would be very beneficial. Let us together move ahead of the business and share the interesting new knowledge, built on traditional cultural practices.

Join the initiative! Describe which system you are working on and what you can contribute with.

Global Mycology Initiative II: Enzymes from edible fungi

Topic: Enzymes, and enzyme expression and secretion, of cultivated, edible or medicinal fungi.

Objectives, Investigations and results: to obtain a more comprehensive understanding of the secreted enzymes from fungi, which can easily be grown on inexpensive substrates (e.g. old newspapers or straw). Edible and easily cultivated fungi with a rich enzyme profile and an efficient secretion systems may locally (in rural or other decentralized localities) be used for on-site production of enzymes for biomass conversion; allowing for low tech production of both feed, fuel, and fertilizer from biological waste or agricultural crop residues.

Join the initiative! Describe which fungal species and substrate you work on and which research technology you use and/or you are interested in using in the future.

Contact me or my science coordinator, Pia Haugaard Nord-Larsen (pnl@bio.aau.dk). with "Global Mycology Initiative" in the subject field of the message, to enabling us to search our mail box specifically for mails on this.

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A network of European scientists investigating endophytic microorganisms: a new COST programme

Plants are associated with micro– and nano-organisms: endophytic bacteria and fungi, which live inter- and intra-cellularly in plants without inducing pathogenic symptoms, while interacting with the host biochemically and genetically. Endophytic microorganisms may function as plant growth and defence promoters by synthesising phytohormones, producing biosurfactants, enzymes or precursors for secondary plant metabolites, fixing atmospheric nitrogen and CO_2, or controlling plant diseases, as well as providing a source for new bioactive natural products with utility in pharmaceutical, agrochemical and other LifeScience applications. The use of these endophytic microorganisms to control plant-pathogenic bacteria and fungi is receiving increased attention as a sustainable alternative to synthetic pesticides and antibiotics. Furthermore, endophytes may be adapted to the presence and metabolism of complex organic molecules and therefore can show useful biodegradation properties. In order to reduce inputs of pesticides and fertilizers and add value to eco-friendly agriculture in Europe, it will be important to develop inocula of biofertilizers, stress protection and biocontrol agents. But there are currently bottlenecks limiting the development of endophytes for use in biotechnology and agriculture.

To increase understanding about these hidden associations between plants, bacteria and fungi, and to identify bottlenecks in the development and implementation of technologies using endophytes, a network of scientists was recently formed. This COST Action: "Endophytes in biotechnology and agriculture" will operate all over Europe during the next four years. COST (European Cooperation in Science and Technology) was founded in 1971 and is one of the longest-running European instruments supporting cooperation among scientists and researchers across Europe. The support of young researchers, scientific conferences and book publications are some of the activities which are organized by COST and paid for by the European Science Foundation. "My stay in Prague, Czech Republic, which was funded by COST, supported my trials very much. I was able to learn methods which I can now implement in my work at home", says Beate Ceipek, a young German researcher about her Short Term Scientific Mission at Czech Academy of Sciences.

This new COST Action will provide a forum for the identification of bottlenecks limiting the use of endophytes in biotechnology and agriculture and ultimately provide solutions for the economically and ecologically compatible exploitation of these organisms within Europe and beyond.

For more information on this Action and how you can become involved, visit the network's website (www.endophytes.eu).

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New funding for Australian medical mycology

The Molecular Mycology Research Laboratory at the Sydney Medical School, Westmead Hospital, University of Sydney, lead by Wieland Meyer has recently received two Australian National Health & Medical Research Council project grants to investigate two fundamental questions in modern mycology: (1) Which DNA region is the most appropriate one for DNA barcoding of human/animal pathogenic fungi, taking into account that there are serious limitations with the currently accepted barcode for fungi the ITS region; and the (2) What is the genetic basis of fungal virulence? The obtained funding, totalling 1 million dollars for three years, funds several postdoctoral and research assistant positions

The first grant is for collaboration between Wieland Meyer's laboratory, Vincent Robert (Bioinformatics Unit, CBS, Utrecht), and David Ellis (Mycology Unit, University of Adelaide). This project aims to identify the most appropriate loci for DNA barcoding by applying comparative bioinformatic genome analyses against all currently available fungal genomes. It will design loci-specific primers and test them against a broad range of fungi. The most informative loci will then be: selected and used to generate DNA barcodes; used to establish a reference barcode database; and applied as a tool in a diagnostic setting. The project's innovation lies in its use of comparative bioinformatics/genomics to determine novel universally applicable barcode regions and the build up of a barcode library, the first of its kind for human/animal pathogenic fungi, as a tool for fungal diagnosis. This has the promise of revolutionising fungal identification in medical diagnostic units, and reducing turn-around-time for species identification. This will allow earlier initiations of targeted antifungal therapy with improved patient outcomes. The barcodes will also be a key in providing border security with a novel tool to safeguard against fungal disease threats.

The second project is for collaboration between Wieland Meyer's laboratory, Gavin Huttley's laboratory working on genome analysis (Australian National University, Canberra), Helena Nevalainen's laboratory for fungal genetics (Macquarie University, Sydney), and June Kwon-Chung's laboratory for Medical Mycology (National Institutes of Health, Bethesda, USA). This project will compare the whole genomes of 16 high and low virulent cryptococcal strains, based on previously identified expression differences, to identify general virulence-associated genes. Knockout and animal virulence studies on a selection of the identified genetic candidate loci to establish the genetic basis of fungal virulence will be conducted, and used to generalise the cryptococcal findings by extending the whole genome comparison to other human/animal pathogenic fungi to establish fungal virulence-associated gene maps. The key knowledge generated in this project will provide the foundation of a greatly improved evidence base for the development of effective management guidelines for better patient outcomes, develop genetic markers to track the spread of fungal agents, and provide new targets for antifungal development.

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China establishes State Key Laboratory of Mycology

October 2011 represented an important milestone in the history of research and development of Mycology in China. After a rigorous review by the Ministry of Science and Technology, the Institute of Microbiology, Chinese Academy of Sciences (IMCAS), has successfully obtained the final approval as the State Key Laboratory of Mycology (SKLM). The "state key laboratory" programme, which began in 1984, is an essential part of the national science and technology innovation system. It covers the major disciplines and has a high entry bar. Establishing this state key laboratory in China means a great deal for mycological studies because it brings with it sustainable funding from central government. This action will significantly increase the quality and quantity of the output of mycological research in China.

The history of the key laboratory can be traced back to the pioneer mycologists Fang-Lan Dai and Shu-Qun Tang, who established the first mycological research group in the Chinese Academy of Sciences (CAS) and trained generations of young scientists dedicated to fungal study. The CAS Key Laboratory of Systematic Mycology & Lichenology was established in 1985. Through 26 years' of development and extension in fields such as fungal systematics, ecology, genetics, metabolites, and other aspects, the CAS Key Laboratory has now been upgraded to the state level. The SKLM currently has 70 scientists including three CAS academicians and 18 principal investigators, and it will be further expanded to host 25 principal investigators in the next few years. The new Key Laboratory will highlight the following research areas: (1) fungal systematics and biodiversity; (2) fungal community and interaction; (3) fungal genetics and morphogenesis; and (4) the discovery, biosynthesis, and regulation of fungal secondary metabolites.

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FungalDC: a database on fungal diversity in genetic resource collections

FungalDC (Fungal Diversity in Culture Collections) assembles data on fungal diversity held in 264 collections of fungal cultures registered in the World Data Center of Microorganisms (WDCM) as well as ones held in individual laboratories around the world where catalogues are available. The database is open access through the All Russian Collection for Microorganisms (VKM) website (www.vkm.ru/fungalDC.htm), and provides current information on species by linking to the particular species/strain pages in sources such as: Index Fungorum (http://www.indexfungorum.org), MycoBank (http://www.mycobank.org), GenBank (http://www.straininfo.net), and StrainInfo (http://www.straininfo.net)

The integration of these resources mobilizes data from different databases, enabling their simultaneous use. FungalDC provides an opportunity to readily compare the diversity of fungal species available from collections and GenBank, to locate collections holding representatives of particular species and/or particular strains (including ex-type and authentic samples), and reveal species either omitted from the aforementioned information sources or not preserved in a collection as a living culture.

The ready availability of this information facilitates the location of living biomaterial for genetic studies. The data analysis shows that the fungal species diversity held in culture collections is represented only to a limited extent in GenBank (Table 1), thus indicating taxa where molecular studies could be rewarding

As the underlying data sources are constantly updated, the database also remains under constant change. A special format was developed to make it possible to perform real-time tracking to determine to what extent diverse fungal groups have been studied by molecular methods, and to identify type material of a particular species among the specimens studied. Each species name in the database is listed using the orthography of *Index Fungorum* and has the corresponding higher rank taxa indicated according to data from *Ainsworth & Bisby's Dictionary of the Fungi* (10th edn; Kirk PM *et al*., 2008, Wallingford: CAB International). Further information is included in *Inoculum* **61** (3): 1–5 (2010).

We appreciated valuable comments from Bert Verslyppe and Peter Dawyndt (Ghent University, Belgium), P. Conrad Schoch (GenBank, National Institutes of Health/NLM/NCBI, Bethesda, MD, USA), Paul M. Kirk (CABI Bioscience, Egham, UK) and Vincent Robert (Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands). The work is supported by the Ministry of Education and Science of the Russian Federation (contract № 16.518.11.7035) and the programme "Molecular and cell biology" of the Russian Academy of Sciences.

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Table 1. Data in FungalDC

	Index Fungorum*	Collections of fungal cultures	GenBank
Number of genera	19 705	3 728	4 087**
Number of species	469 776	24 897	26 035

*www.indexfungorum.org
**2 364 genera are common to the collections and GenBank