

ONE FUNGUS = WHICH NAME ?

The special provisions that permitted asexual morphs of the same species of pleomorphic non-lichenized ascomycete and basidiomycete fungi to have separate names from that of the whole fungus, which was typified by a sexual morph, were ended at the International Botanical Congress in Melbourne in July 2011. These changes, that are embodied in the forthcoming *International Code of Nomenclature for algae, fungi, and plants*¹, followed after extensive debates and consideration by different committees, and in particular The Amsterdam Declaration². The Declaration resulted from the “One Fungus = One Name” symposium organized by the CBS-KNAW Fungal Biodiversity Centre (CBS) under the auspices of the International Commission on the Taxonomy of Fungi (ICTF) and held in Amsterdam on 19–20 April 2011 (see *IMA Fungus* 2: (7), 2011). Summaries of the changes which were introduced have been presented elsewhere^{3,4} and are not repeated here, but it is important that the published version of the *Code* is consulted for the final wordings.

Mycologists now have the tasks of implementing the changes in their own publications, and also contributing to the production of Accepted and Rejected Lists of names. Recognizing the uncertainties some mycologists expressed as how to proceed, and also the need to progress work on the Lists, CBS organized a follow-up symposium on “One Fungus = Which Name?” in the rooms of the Royal Netherlands Academy of Arts and Sciences in Amsterdam on Thursday and Friday 12–13 April 2012. The meeting was attended by 155 mycologists from 29 countries, almost all of whom were thrilled at the ending of the dual nomenclatural system and enthusiastic at the prospect of Accepted Lists which would place mycology at the cutting edge of biological nomenclature as a whole.

Each day of the symposium was organized in the form of a series of presentations in the morning, and discussion groups or debates in the afternoon. In a new venture aimed at making the presentations as widely available as possible, the talks were also videoed and made available *via* the Internet in real-time. Subsequently, a video-archive of the talks was compiled with

a link to this through the CBS home-page to Youtube (<http://www.youtube.com/playlist?list=PLF8BF8F71D5A3AEDC>). It was gratifying that 220 mycologists watched the proceedings *via* the videolink while they were in progress, and that since the meeting there had been hundreds of downloads of presentations at the time this issue went to press. This means that hundreds of individual mycologists have so far been able to benefit from the full talks of the symposium and others still can do so.

There were 12 presentations in total, all of which are freely available in the video-archive:

One fungus which name: how do we proceed? (David L. Hawksworth, Spain/UK)⁵.

Post-Melbourne fungal nomenclature: an overview (Lorelei Norvell, USA; Scott A. Redhead, Canada).

Why hyphomycete taxonomy is now more important than ever (Keith A. Seifert, Canada).

The nomenclature side of fungal databases, registration, etc (Joost A. Stalpers, The Netherlands; Paul M. Kirk, UK).

Single names in Hypocreales and Diaporthales (Amy Y. Rossman, USA).

Applications of old anamorph-typified names of genera and species (Uwe Braun)⁶.

A strategy for fungal names with teleomorph-anamorph connections (Xing-Zhang Liu, China).

The future of fungal biodiversity research (Pedro W. Crous, The Netherlands).

Naming environmental nucleic acid species (ENAS) (John W. Taylor, USA).

The value of epitypification (Kevin D. Hyde, China/Thailand).

An official DNA barcode for fungi (Conrad Schoch, USA).

1000 fungal genomes and beyond (Joey Spatafora, USA).

A series of break-out group discussions, primarily focused on different fungal taxa, was held on the Thursday afternoon, and those groups were charged with reporting at the end of the next day. Prior to the presentation of these reports, which are reproduced below, an open discussion was held to clarify aspects of the new provisions or other matters that some present had found unclear, and further to ascertain the views of those present on various issues that needed to be addressed by those developing Lists and the Nomenclature Committee for

Fungi (NCF) or ICTF; those discussions are also summarized below.

In addition to the formal parts of the symposium, two new books were formally launched at a cocktail party on the first evening. John W. Taylor (IMA President) was presented with copies of the *Taxonomic Manual of the Erysiphales (Powdery Mildews)* by Uwe Braun and Roger A. Cook, and the *Atlas of Soil Ascomycetes* by Josep Guarro, Josepa Gené, Alberto M. Stchigel, and M. José Figueras. Further information about these works is presented in the Book News section of this issue (pp. (35)–(36)).

¹McNeill JM, Barrie FR, Buck WR, Demoulin V, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Marhold K, Prado J, Pruihonne van Reine WF, Smith GE, Wierssema JH, Turland NJ (eds) (2012a) *International Code of Nomenclature for algae, fungi, and plants (Melbourne Code) adopted by the Eighteenth International Botanical Congress Melbourne, Australia, July 2011*. [Regnum Vegetabile, in press.] Ruggell: A.R.G. Ganter Verlag.

²Hawksworth DL, Crous PW, Redhead SA, Reynolds DR, Samson RA, Seifert KA, Taylor JW, Wingfield MJ [& 69 signatories] (2011) The Amsterdam Declaration on Fungal Nomenclature. *IMA Fungus* 2: 105–112; *Mycotaxon* 116: 91–500

³Hawksworth DL (2011) A new dawn for the naming of fungi: impacts of decisions made in Melbourne in July 2011 on the future publication and regulation of fungal names. *Mycosphere* 1: 7–20; *IMA Fungus* 2: 155–162.

⁴Norvell LL (2011) Fungal nomenclature. 1. Melbourne approves a new Code. *Mycotaxon* 116: 481–490.

⁵Hawksworth DL (2012) Managing and coping with names of pleomorphic fungi in a period of transition. *Mycosphere* 3 (2): 52–64; *IMA Fungus* 3: 15–24.

⁶Braun U (2012) The impacts of the discontinuation of dual nomenclature of pleomorphic fungi: the trivial facts, problems, and strategies. *IMA Fungus* 3: 81–86.

The One Fungus = Which Name ? debate

Chair: David L Hawksworth

Rapporteur: John W. Taylor

Issues considered in this part of the meeting fell into two categories, a clarification of

concepts and possibilities, and view on topics where the ICTF and NCF would appreciate guidance.

Clarification of concepts and possibilities

(1) *Names on an Accepted List are NOT conserved, BUT treated as if conserved*

Some speakers had used the term “conserved” for names that would be included on the Accepted Lists of names, but their status will not be identical to that of formally conserved names as, under the new *Code*, names included in the Lists of Conserved Names would have precedence over those on the Accepted Lists. Further, names that are formally conserved cannot be deleted, whereas there is no such restriction for names on the Accepted Lists. The meeting found this confusing, and felt that a different term should be found to replace “treated as if conserved.” One possibility could be refer to names as “White-” or “Black-listed. It had also been suggested by Gams *et al.*⁷, that the terms “prioritization” and “suppression” were preferable to help minimize possibilities of confusion, and that option should be referred to the NCF for consideration.

(2) *What names can be included in the Accepted and Rejected Lists?*

There was uncertainty over the need to include names on Lists where there was no controversy or ambiguity. The Accepted Lists could include all names in use, including those where there was currently no dispute, as that would safeguard them from any earlier names that subsequently came to light. Alternatively, the Lists, could be restricted to cases where dual nomenclature had previously applied and which now had just one name.

It was felt that the Lists should be large enough to justify the time that would be spent on their preparation. The ideal would be a global checklist, though it was recognized that would not be realizable in the immediate future. However, there is no restriction on the ranks of names nor of taxonomic groupings. A List could be confined to all names in a particular rank, such as orders, families, genera or species, within a particular taxon. Alternatively, it could cover names at all ranks in use in a particular taxon. Thus, a List could deal with all accepted generic names of

fungi, or just those in a particular order or family. It is really a matter for mycologists concerned with different groups of fungi to decide what protected Lists would be of most value to them and which should be prepared first. As there is evidently no obstacle to Lists being revised or replaced, unlike the situation with the already existing lists of conserved and rejected names, there could be some advantage in concentrating on generic names first, and adding species names at a later date.

There was almost unanimous and enthusiastic support for first producing a List covering all accepted generic names (including those of lichen-forming fungi, see below), whether or not they exhibited pleomorphism.

There was a strong feeling at the meeting that provisional Lists should be open for consideration by the community as a whole before submission, in order to iron out any controversy. It was suggested that draft Lists be put on the IMA website, with options for comment so as to work towards a consensus.

(3) *Typification of names in Lists*

It is already possible to change the name-bearing type of a name by conservation, and there appears to be no obstacle to this in the new Lists. The new Lists can therefore include replacement types to deal with cases where well-known names have been misapplied, that bear both sexual and asexual morphs of the species when the previously designated type did not, or one has been sequenced and is widely available (for example as ex-type cultures).

(4) *Terminology of specimens and cultures*

There had been some confusion over the terminology used for specimens and cultures other than name-bearing types by different workers. General usage is as follows:

Authentic: One named by the author of the name, generally after it was published, or, if the name is a combination, the author of the basionym.

Voucher: One used in a particular study, either for experimentation or to support an identification, enabling the same material to be used by or verified by later researchers.

Representative: One or more from a large set or specimens or cultures considered to serve as vouchers where it is impractical to preserve all those used or cited in a particular study.

(5) *Continued use of binomials in synonymized genera*

There will be many cases in moving to one name per species in pleomorphic fungi, where it is uncertain whether all species currently under a particular name are congeneric with the type species of the generic name to be adopted. This situation is no different from that already occurring in non-pleomorphic genera where it has not been possible to ascertain the positions of all taxa previously referred to them. The *Code* does not rule on taxonomy, and, if there are no certain grounds to transfer a species from one genus to another, there is no nomenclatural obstacle to the continued use of the current name until the matter is resolved. This matter is discussed further elsewhere in this issue⁸. This situation is pragmatic not ideal, and one option used by some mycologists is to indicate in an informal way that a generic name is being retained in a wide sense, for example by the use of inverted commas, e.g. ‘*Mycosphaerella*’ where it is unclear if the fungus is truly a *Cladosporium* (syn. *Davidiella*) in the new system. Wholesale uncritical transfer of names is to be discouraged.

(6) *Who can prepare and submit Lists?*

There is no restriction on who can produce a draft List, and it could be an individual as well as formal or informal groups of mycologists. In view of the scale of the problem, the input of as many individuals as possible can only be welcomed. If you have information on particular families, genera, etc, prepare the first draft rather than wait and be angered by the content and quality of one someone else produces. However, be sure to inform the ICTF and NCF if you are willing to prepare a draft or contribute to a draft for a particular taxon so that duplication of effort can be avoided wherever possible. List preparation needs to be initiated quickly now to keep to the timetable necessary to achieve formal adoption at the 2017 congress⁹.

⁷Gams W, Humber RA, Jaklitsch W, Kirschner R, Stadler M (2012) Minimizing the chaos following the loss of Article 59: suggestions for a discussion. *Mycotaxon* 119: 495–507.

⁸Braun U (2012) The impacts of the discontinuation of dual nomenclature of pleomorphic fungi: the trivial facts, problems, and strategies. *IMA Fungus* 3: 81–86.

(7) *Operational dates*

There had been some confusion about when the one name for one fungus species system became effective, and in particular whether this was 30 July 2011 or 1 January 2013. The Preface to each edition of the *Code* now explains that all changes are immediately effective unless another date is indicated. This means that the special provisions ended on 30 July 2011, after which date all names of fungi compete on an equal footing, whether they are typified by material with the teleomorph or of the anamorph. The 1 January 2013 date in the new *Code* is there only to provide immunity to names published prior to that date that otherwise might be declared invalid or illegitimate. The use of a later date allows time for the change to be disseminated amongst researchers, and avoids works in press being contrary to the *Code*, i.e. introducing names that otherwise would be contrary to the *Code* and not available for use.

Issues requiring action or guidance

(1) *Epitypes, teleotypes, and anatypes*

Epitypes are specimens selected to supplement a name-bearing type where that type does exist, but does not show the characters necessary to determine the species. An epitype is a formal category recognized in the *Code*, and once selected an epitype cannot readily be displaced. An increasingly common practice amongst mycologists is to designate as epitypes material that has been sequenced when no DNA could be recovered from the name-bearing type.

Redhead¹⁰ had previously proposed the use of the term “teleotype” type as a special category of epitype selected to show the teleomorph when that was missing from the name-bearing type, but the proposal was withdrawn and not adopted at the Melbourne congress. Although Redhead did not propose it, logically the term “anatype” could also have been proposed for material selected to show the anamorph where that was not represented on the name-bearing type. As these two categories would not be epitypes, they could still be designated where there was already an epitype, and their existence would not preclude an epitype being selected subsequently where there was not.

The meeting rejected the idea of separate “teleotype” or “anatype” designations and considered that the type need not exhibit any particular morphology.

(2) *The terms anamorph and teleomorph*

The issue of whether it was desirable or useful, when describing fungi, to continue to use the terms anamorph and teleomorph was also raised. These had been introduced into the *Code* at the Sydney congress in 1981 specifically for fungi that exhibited pleomorphism. The meeting felt that these terms were an unnecessary complexity, especially in teaching, and that they would be better dropped in favour of the familiar terms asexual and sexual, respectively.

(3) *Defining widely used*

This issue was recognized as difficult, and the potential pitfalls in the use of the Google search engine in particular as an estimator of usage made it unreliable. Matches may not be exact for a variety of reasons. Google Scholar was considered probably better, if used critically. However, it was felt that experts in particular groups would have the best ideas of what was in the interests of mycologists as a whole. Those who disagreed, could make their own List for consideration, or comment on any posted. There was a strong view that applied usages and taxonomic usages were both important and neither should dictate.

(4) *Evidence of holomorphy*

This was a matter considered too complex to debate in the session, but one on which guidance would be welcome. It was suggested that the ICTF should consider providing guidance on this matter.

(5) *Using the conserved/rejected mechanism while Lists are in preparation*

The existing mechanisms for the conservation and rejection of names in the ranks of family, genus, and species would continue to operate while Lists were in preparation, revision, and proceeding towards formal adoption. There was therefore the possibility that decisions made on conservation or rejection might not be in accord with the Lists themselves. The NCF made clear that it would nevertheless still entertain conservation proposals, but that it would prefer to see lists with lots of names

rather than proposals dealing with a single taxon.

(6) *Inclusion of lichen-forming fungi*

Under the proposals adopted at the Melbourne congress, lichen-forming and allied fungi were excluded from the Lists. However, many considered this illogical, and the meeting voted unanimously for the deletion of this anomaly. It is clear that a formal proposal should be made to rectify this in the near future so that it can be considered by the NCF and approved by the General Committee in a timely manner so that lichenized taxa can be included where appropriate in the Lists.

(7) *Use of subgeneric names*

The issue of whether mycologists should use the rank of subgenus more frequently, especially in large monophyletic genera, proved very controversial. Some were completely against any subtaxa, whereas others saw good grounds for the use of subgenera in particular cases. The use of subgeneric names was a way of maintaining name stability as the generic and specific names would not be changed. On the other hand, some felt this meant that users might have to learn three names rather than two, were subgeneric names regularly to be inserted in parentheses between a generic name and a species epithet. No consensus emerged, and this may be a situation where the matter is best addressed on a case-by-case basis.

(8) *Registration of typifications and First Revisers*

There was a unanimous view that details of types designated after the original introduction of a new taxon should be deposited in the registering database at the time of typification. At present it was very difficult to locate later epi-, lecto-, or neotypifications. It was considered that

⁹Hawksworth DL (2012) Managing and coping with names of pleomorphic fungi in a period of transition. *Mycosphere* 3 (2): 52–64; *IMA Fungus* 3: 15–24.

¹⁰Redhead SA (2010b) Proposals to define the new term ‘teleotype’, to rename Chapter VI, and to modify Article 59 to limit dual nomenclature and to remove conflicting examples and recommendations. *Taxon* 59: 1927–1929.

this was an issue that the NCF should consider, with a view to requiring accredited repositories to record such information.

The Amsterdam Declaration had included the proposal that the first authors to make a choice of names when uniting anamorph- and teleomorph-typified genera should be registered and accepted, unless that was subsequently challenged – in which case it would have to be considered by the appropriate mandated body, i.e. the NCF. This concept is similar to the principle of the first-reviser in zoological nomenclature, but has not been used outside zoology. This provision was not part of the package adopted at the Melbourne Congress, but some of those present at the meeting did consider the matter nevertheless merited careful consideration, and perhaps could be discussed during IMC10 in Thailand in 2014.

There was also a lengthy discussion and interchanges between representatives of MycoBank and Index Fungorum on the issue of accreditation of repositories of nomenclatural data, which is required for the valid publication of new fungal taxa from 1 January 2013. In particular, there was a debate as to whether more than one repository should be recognized by the NCF. The meeting saw MycoBank as the logical immediate choice, but it also recognized the value of several centres, especially ones operating systems in different languages, such as Chinese. It also recognized the depth of nomenclatural detail in Index Fungorum and the key role that had in underpinning all fungal nomenclatural databases. If a distributed system were eventually developed, the meeting felt it was absolutely essential that there was data-sharing in a timely manner, and ideally in real-time, but at least on a daily basis.

(9) *Proposal by Walter Gams*

Gams and colleagues had recently published a proposal that when a binomial in a prioritized genus had a younger epithet than the corresponding name in the suppressed genus, priority should be granted to existing names in the prioritized genus¹¹. This principle already applies in zoological nomenclature, and had been adopted by some botanists in the past where it became known as the “Kew Rule”¹² – but this practice has not been permitted under the various editions of the botanical *Code*. Some of those present saw some advantages in this

suggestion as a further means of minimizing name changes, but it was recognized that a formal proposal on this matter would have to be prepared for consideration by the NCF and a future congress. Gams indicated that he was encouraged by the comments and would explore this possibility further.

(10) *Desirability of a joint NCF/ICTF/IMA dedicated Lists committee*

The officers of the NCF, ICTF, and IMA present at the symposium did not see the need or value of establishing a dedicated Lists committee. There was a strong dialogue between the parties, and some mycologists were members of more than one of these bodies. It was recognized that the NCF was the body with mandatory responsibility for making recommendations on any Lists prepared, while the ICTF had a role in List preparation, through its various subcommissions.

(11) *Environmental sequences*

The increasingly urgent need to address the issue of the naming of fungal taxa only known from environmental DNA sequences had been considered at the One Fungus = One Name symposium in 2011, and some suggestions were made in the report of that meeting¹³. After some discussion, the ICTF agreed to establish a working group on naming environmental strains.

Working group reports

Basidiomycota

Rapporteurs: Scott A. Redhead and Dominik Bergerow

Participants: 19

The group split into one dealing with heterobasidiomycetes, and the other with homobasidiomycetes (*Agaricomycetes* s.str.). For the heterobasidiomycetes, a web page in which it would be possible to comment on each name separately should be set up, if possible with a voting option. Most of the problems in these fungi were considered to be taxonomic rather than nomenclatural. The real need was for more people writing papers. For example, it is general knowledge that *Cryptococcus* is paraphyletic, but no one was resolving the problem, which in any case should be addressed together with the yeast commission and the group on medicinal fungi. In the rusts, the solution should be close to current practice. I.e. to maintain the use of *Uredo* for species only

known from the uredinal stage and without any current possibility of assigning them to a monophyletic genus. If *Uredo* was to be restricted to its type species, there was a possibility that some would propose names that prove superfluous in an intermediate time-frame; this was not ideal, but an *ad interim* alternative.

In the case of the homobasidiomycetes (agaricomycetes), a working list could be generated shortly. When that was available, invitations to assist in the evaluation should be sent worldwide to all who had expressed interest in helping and an invitation will be sent to them to participate in the decision making process. Initial tables had been provided for the Amsterdam meeting by CBS, but it was recognized these were not complete. Further it was evident that while there were issues, many would be easy to decide on. Taking the first four generic names: one required research (*Abortiporus* vs. *Fibrillklaria*), one had an obvious solution (*Abortiporus biennis* vs. *Sporotrichopsis terrestris*), one no obvious solution (*Aleurodiscus habgallae* vs. *Matula poroniiforme*), and one conservation (*Armillaria* vs. *Rhizomorpha*). As such cases could be resolved during the meeting, the group opted to start an online working group as soon as the logistics could be worked out. In each case the types for each of the generic or species names would need to be confirmed, and the links between the names needed to be questioned or confirmed. It was planned to have a first List available for comment by the end of 2012.

Dothideomycetes

Rapporteur: Kevin D. Hyde

Participants: 18

It was agreed that a web page for *Dothideomycetes* should be set up within a few months, and all proposed committee members would be contacted by email or other social media (e.g. connect website). Of key importance was the type species of

¹¹Gams W, Humber RA, Jaklitsch W, Kirschner R, Stadler M (2012) Minimizing the chaos following the loss of Article 59: suggestions for a discussion. *Mycotaxon* 119: 495–507.

¹²Stevens PF (1991) George Bentham and the “Kew Rule”. *Regnum Vegetabile* 123: 157–168.

¹³Hawksworth DL, Crous PW, Redhead SA, Reynolds DR, Samson RA, Seifert KA, Taylor JW, Wingfield MJ [& 69 signatories] (2011) The Amsterdam Declaration on Fungal Nomenclature. *IMA Fungus* 2: 105–112; *Mycotaxon* 116: 91–500.

generic names, and it is with those than links should be substantiated; if correlations were with species other than the type, this needed to be made clear in a note on any List or in a supporting paper. Linkages should be based on sexuality/phylogeny, and if not the case needed to be well-argued. In general, the group considered that the oldest names should be given priority, regardless of the nature of their types. In cases where a younger name was prepared, the logic in support of the retention needed to be provided. The group considered that initial Lists could be published by September 2012, with a view to submission by January 2013.

Eurotiomycetes

Rapporteur: Robert A. Samson

Participants: 32

The group recognized that many genera in the class were important for applied mycology, so the nomenclature should be simple, stable and not confusing. It was also noted that applied researchers are likely to ignore nomenclatorial changes. The phylogeny of *Trichocomaceae* was now well-established, and the IUMS International Commission on *Penicillium* and *Aspergillus* (ICPA) planned to tackle other genera in the family as well. However, in the case of *Onygenaceae* collaboration with medical mycologists would be sought. It was anticipated that ICPA would produce a list of accepted names in *Penicillium* within a short time, but it was recognized the case of *Aspergillus* would require more discussion with users. In *Aspergillus*, there were several options: retaining the name for all aspergillae, splitting the genus and re-naming the groupings according to their teleomorph names, changing the type of the genus to *A. niger* so that did not change in a splitting, or to use *Aspergillus* with an optional descriptor. It was also pointed out in open discussion that there was in addition the possibility of using subgeneric names, which could be those of the teleomorph-typified names if adopted in the Accepted List; it while names at the rank of subgenus or section could not be conserved under the *Code*, the Lists had no such rank restriction. sa noted that names in indicator. These matters would be discussed at a meeting of ICPA scheduled for the Saturday after the symposium, and open o all through the commission's website (www.aspergilluspenicillium.org).

Medical mycology

Rapporteurs: Sybren de Hoog and Vishnu

Chaturvedi

Participants: 9

It was considered that the International Society for Human and Animal Mycology (ISHAM) should implement a democratic procedure to achieve a stable result, which would be adopted quickly by the entire community. There was a consensus for a practical approach, taking the needs of the user as the starting point. The community of medical mycologists must first decide which names we without doubt want to keep: for example, *Candida albicans* and *Aspergillus fumigatus* should be maintained, and *Trichophyton* used rather than *Arthroderma*. There could also be many other classical pathogens and opportunists that we wish to keep the current names for and which should be proposed for inclusion on an Accepted List. An important criterion over the choice of a name will be how frequently it has been used. However, "widely used" is an unclear criterion. How does one establish whether *Scedosporium* is more current than *Pseudallescheria*? For each name put forward, the reasons for the proposed retention should be specified. In cases where no single name was strongly favoured, the oldest name (whether anamorph- or teleomorph-typified) should have priority. For example: *Aspergillus* is older than *Neosartorya*, and therefore the *Neosartorya* species should be termed *Aspergillus* in the future.

Reclassifications can be phenotypic or molecular phylogenetic, but the key criterion of a group is the monophyly. The clade determines the group meriting a genus name, preferably the oldest available for that group is used, as for *Aspergillus*. Molecular taxonomy may reveal groups where all experts agree that they are clearly monophyletic, and also share essential characteristics such as pathogenicity or antifungal susceptibility, as in the yeasts. However, there are also groups where so many new data – often of environmental relatives – are being added, that the phylogeny is highly unstable, as in the rapidly developing black yeast taxonomy. The group felt it could be prudent to propose that for the time being we leave names as they are, even if some "genera" are polyphyletic. In the case of established but poorly differentiated genera, such as *Acremonium*, some may be highly polyphyletic and thus phylogenetically ambiguous. There was a proposal to abandon such generic names, but an

alternative would be to redefine them in a modern sense on the basis of accessible type material.

The community of medical mycologists, including the ISHAM membership, is requested to propose Lists of preferred names on the basis of the above criteria. The names of many fungal pathogens have an ancient history and have become a source of confusion over the years. We therefore urge taxonomists, if necessary, to (re)define the groups of fungi they are working with by the deposition of (new) type material that can be protected in the Lists. As a first step, an *ad hoc* group has decided to provide a list of fungal names in current use based on the *Atlas of Clinical Fungi*¹⁴ for the ISHAM membership to comment on (comments to be sent to: s.hoog@cbs.knaw.nl). The group hoped to have active involvement of as many medical mycologists as possible.

Sordariomycetes

Rapporteur: Joey Spatafora

Participants: ca 30

In discussing the criteria to be used to choose between two generic name options, considerations should include: taxonomic clarity (i.e. the genus name should be well circumscribed), the morphology most commonly encountered, names used in plant pathology and industry (etc), quarantine issues, stability, and relevance. The credentials of a particular taxonomist needed to be made clear when making a decision on a particular group. The strength of an argument should consider the number of name changes, monophyly, that names represented clades not morphologies, distinguish taxonomic and nomenclatural issues, consilience, and historical uses, and the possibility of retaining genera but with a different type species. Should there be a preference for names that commemorated the history of a taxon (e.g. *Cordyceps*) or ones that were history (e.g. *Tolpocladium*). It was felt that several subgroups would be needed: *Xylariales*; *Magnaporthales*/*Diaporthales*; *Fusarium*; *Hypocreales* I (*Bionectriaceae*, *Nectriaceae*, *Hypocreaceae*, and *Niessliaceae*); *Hypocreales* II (*Cordycipitaceae*, *Clavicipitaceae*, and *Ophiocordycipitaceae*); *Sordariales* and allies; and *Colletotrichum*.

¹⁴de Hoog G S, Guarro J, Gené J & Figueras MJ (2000) *Atlas of Clinical Mycology*. 2nd edn. Utrecht: Centraalbureau voor Schimmelcultures.



Scenes from the One Fungus = Which Name symposium held in the Trippenhuys, headquarters of the Royal Netherlands Academy of Arts and Sciences, Amsterdam, on 12–13 April 2012.



Scenes from the One Fungus = Which Name symposium held in the Trippenhuys, headquarters of the Royal Netherlands Academy of Arts and Sciences, Amsterdam, on 12–13 April 2012; the launch and presentation of the *Atlas of Soil Ascomycetes* and *Taxonomic Manual of the Erysiphales (Powdery Mildews)* to John W. Taylor (IMA President); and the sun drenched Fungal BBQ at the CBS, following committee meetings on Saturday 14 April 2012.

IMA Executive Committee Meeting



should reach all mycologists, worldwide, on a regular basis and information should be widely distributed in the age of the internet and free information exchange. Beside the issues of *IMA Fungus* volumes, the Executive wishes to enhance the Newsletter, and the option to subscribe will be highlighted much more often than has been the case before. In addition, we ask all members to contribute to the content of the IMA Newsletter and also to *IMA Fungus* to further increase the international visibility of global mycology.

Finally, the Executive Committee acknowledged the progress being made in the organization of IMC 10, which is to take place in Bangkok in 2014. Leka Manoch reported on progress made during the last year. Most exciting was the change of venue to the Queen Sirikit National Convention Center, which will allow a great congress in Thai style. The Organizing Committee is already hard at work, with Leka Manoch and Morakot Tantichareon as co-chairs. The call for symposia will be made soon, and the Executive Committee suggested that there should be seven concurrent sessions per day, two for fungal diversity, and one for each of the following themes: fungal cells, fungal genomes, fungal ecology, fungal pathogenesis and fungal biological technology. In addition there would be nomenclature sessions held on three days, as at IMC9. The congress aims to reflect the best of international mycology, and the needs of our communities.

During the intensive discussions by the Executive Committee, a Skype conference was arranged to facilitate the participation of members who could not attend in person, so broadening the basis for discussions and decisions. Mycology is global, and the Executive Committee would like to get all of you who read this involved in discovering the future.

Dominik Begerow
(Secretary-General, IMA)
(dominik.begerow@rub.de)

In mid-April 2012, The Netherlands again turned into an international centre for mycology and the IMA Executive Committee met on 14 April 2012 in Utrecht parallel to meetings of the International Commission on the Taxonomy of Fungi (ICTF) and the International Commission on *Penicillium* and *Aspergillus* (ICPA). This was the largest Executive Committee meeting ever held between IMC congresses, and illustrated the amount and importance of activities organized by the Association, under the presidency of John Taylor. The meeting covered all aspects of advancing mycology on a global scale, and here I just wish to highlight a few of the points, which were discussed and decided.

First, the Executive Committee congratulates the winners of our young mycologist awards, which were finally completed with announcements on the two outstanding. The Elias Magnus Fries Medal was awarded to Cécile Gueidan (nominated by the European Regional Mycological Member Organization) and the Carlos Luis Spegazzini Medal to Luís Fernando Pascholati Gusmão (nominated by the Latin American Regional Mycological Member Organization; for further information see p. (25) in this issue. While the young mycologist awards are designated to

the early years of a career and honours outstanding mycological research by young scientists from our regional member organizations, the Executive Committee also searches for ways of acknowledging substantial support of mycology by others. The introduction of a category of IMA Fellows as a midcareer award received great support from the Executive Committee, and guidelines will be available soon, so that a first round of mycologists can be recognized in this way during IMC10 in Bangkok.

Although the finances of the IMA are robust, we seek further external funding to increase our capabilities. While there is quite substantial support from external funding during our congresses, the IMA would like to attract companies and institutions to become patrons of the IMA for a yearly fee. The profits of several large international companies are based on fungi or fungal products, and the IMA supports the development of a closer link between research and economy. Mycology will become a big business in the future, and financial support to our work is highly appreciated.

To increase visibility and to provide better support for mycology worldwide, the Executive Committee agreed on the further development of our IMA Newsletter and the redesign of our webpage. IMA

International Commission on the Taxonomy of Fungi (ICTF). 2012 General Meeting

The International Commission on the Taxonomy of Fungi (ICTF) held a

general meeting at the CBS-KNAW Fungal Biodiversity Centre, Utrecht,

The Netherlands on Saturday, 14 April 2012 following the "One Fungus : Which



Keith Seifert (standing) and Andrew Miller (seated) at the ICTF meeting in Utrecht.

Name?” symposium held in the Royal Dutch Academy of Arts and Sciences in Amsterdam. Eleven members of the Commission attended the meeting, an unusually high turnout for this group at a meeting outside an IMC. Approximately 20 observers also attended, some of them taking an active role. With an ambitious programme of work already in front of it, the added expectation that the ICTF and its subcommissions will play active roles in the nomenclatural exercises currently developing made this meeting particularly relevant.

The ICTF website (www.fungaltaxonomy.org), has been hosted at the Technical University of Vienna by Irina Druzhinina and her colleagues since IMC7 in Oslo in 2002. Andrew Miller offered to host the website at the Illinois Natural History Survey (INHS) at the University of Illinois, and this transition is now complete. The ICTF plans to extend the contents of the website considerably, with a view to making it more attractive. The mandate of the ICTF is both to support fungal taxonomists and to provide information and tools that will be useful to those wishing to learn more about this subject. Until now, the website has primarily been a repository for

content.

The need to coordinate information on nomenclatural working groups addressing the changes in the International Code of Nomenclature (ICN) is discussed elsewhere in this issue of *IMA Fungus*. Some of these working groups will conduct their operations and post their draft lists of protected or rejected names on the ICTF website. Our intention is that links to all such working groups who develop their own websites, or those operating from the MycoBank website, will be listed on an ICTF webpage, allowing it to function as a starting point for taxonomists wishing to participate in these exercises.

The relationship between the ICTF, with its focus on promoting fungal taxonomy, and the Nomenclature Committee for Fungi (NCF), with its focus on nomenclature, was the topic of much discussion in Amsterdam and still seems to be a source of some confusion. For the nomenclatural exercises, the two bodies are cooperating as much as possible. While the ICTF envisions assisting in the coordination of the nomenclatural working groups in their preparation of lists, the NCF is the ultimate authority who will be making the final recommendations

the minutes of the Commission, links to the websites of subcommissions, and a small amount of other information. Plans are now being implemented to enhance the website with more visual information, to develop and make available information on good taxonomic practices (such as the article “How to describe a fungus”, *IMA Fungus* 1(2): 109–111, 2010), news items of general interest to fungal taxonomists, and other similar

on the acceptance of these lists to the General Nomenclature Committee, a body appointed by the Melbourne International Botanical Congress in 2011. The existing subcommissions of the ICTF on *Penicillium* and *Aspergillus*, *Fusarium*, and *Trichoderma* and *Hypocrea*, are already actively leading the nomenclatural activities on these genera. We are particularly excited at the formation of new subcommissions on *Colletotrichum* (initiated by Cai Lei and Bevan Weir), and on rusts (initiated by Cathy Aime and José Dianese). Other nomenclatural working groups being formed will interact with the ICTF and the NCF as appropriate during their work.

One of the duties of the ICTF is to organize symposia and sessions at international meetings that will promote advances in fungal taxonomy to a broader scientific audience, as well as promote standards within the fungal community. For the 2014 IUMS congress in Montreal, Canada, we intend to organize a session addressing the changes to the names of economically important fungi resulting from the application of the new ICN. Further, we will propose a symposium on the interaction of genomics and taxonomy, which we hope will include presentations by bacteriologists, and virologists, as well as mycologists. The IMC10 in Bangkok, Thailand, will be held only a few days after the IUMS meeting, but will undoubtedly attract a larger but different crowd of mycologists. For IMC10, more detailed presentation and discussion of the nomenclatural lists will be organized by the ICTF, in collaboration with the NCF as appropriate. The ICTF will also offer a series of after lunch workshops on “Good Practice in Fungal Taxonomy”, presenting information on microscopy, culturing, molecular methods, data analysis and other aspects of fungal taxonomy that would lead to a useful set of publications or exercises on the ICTF website.

Acknowledgement: We appreciate financial support from the IUMS Executive Board, which enabled Andrew Miller to attend the 2012 meetings in The Netherlands.

Seifert KA, Rossman AY (2010) How to describe a fungal species. *IMA Fungus* 1(2): 109–116.

Keith A. Seifert (*Chair ICTF*),
Andrew N. Miller (*Secretary ICTF*)
(amiller@inhs.illinois.edu)

An international CBS Course on “Medical

CBS Course Medical Mycology – Chinese edition



"Mycology" was organized in Nanjing, China, on 19–27 November 2011. The course was a joint effort of the Chinese Society for Microbiology (CSM), the Chinese Society of Dermatology, and the

CBS-KNAW Fungal Biodiversity Centre. The *Atlas of Clinical Fungi*¹⁵ was used as the laboratory manual. This book is now also available in the Chinese language on a CD-ROM. A dedicated practical software

was developed on fungal terminology, in order to assist Chinese participants in learning how to pronounce English and Latin names correctly. Eight specialist speakers from all over China were invited, while Sybren de Hoog gave presentations on biodiversity. The 70 participants that attended the course came from many parts of China, Taiwan, Hong Kong, and Indonesia. Their current positions were in hospital laboratories as clinicians, medical microbiologists, and medical technicians. The course was devoted to the identification of pathogenic and opportunistic moulds and yeasts. A large and representative set of organisms was offered for practical work and to introduce the participants to fungal diversity.

Sybren de Hoog
(s.hoog@cbs.knaw.nl)

A very successful meeting of the ISHAM-

Hidden Danger, Bright Promise: 4th Meeting of the ISHAM Working Group on Black Yeasts



affiliated Working Group on Black Yeasts was held in Curitiba, Brazil, on 1–4 December 2011. Themes included new concepts on symbiotic interactions of black yeasts, bioremediation, extremophiles, and current overviews of diseases in humans and animals. There was much time for debate among scientists and clinicians, particularly on human diseases with significant impact such as chromoblastomycosis, a disease with impressive records in Brazil and China. Novel data on the lethargic crab disease in the *Uca* crab population at the northeastern

Brazilian coast were also presented. A Brazilian Black Yeast Network was also introduced.

The presentations were organized in themes. The opening speech was by Sybren de Hoog with an overview of the latest achievements and future questions, followed by Flávio Queiroz-Telles who introduced the Brazilian Network. Sanjay Revankar reported on his recent experience on the MSG Phaeohyphomycoses Network, in cooperation with the ISHAM Working Group Fungiscope. Other themes, such as the biotechnological

potential and biodiversity of melanized fungi, recent progress in melanin research, and the development of compounds with antifungal activity were debated. The workshop updated knowledge on treatment of diseases caused by black yeast infections.

A visit to the hospital of the Paraná State Federal University was part of the programme. Live patients with chromoblastomycosis and mycetoma were shown and discussed. On the last day a visit to a mangrove area was organized in order to draw the participants' attention to the natural habitat of edible crabs where currently a black yeast epizootic is taking place.

The meeting had 73 full participants from 11 countries, and comprised 43 speeches and 18 posters, with a broad diversity of topics showing recent results in taxonomy, molecular techniques, identification and diagnosis of clinical and environmental agents, besides genome analysis data. Electronic abstracts and lectures in PDF format

¹⁵de Hoog G S, Guarro J, Gené J & Figueras MJ (2000) *Atlas of Clinical Mycology*. 2nd edn. Utrecht: Centraalbureau voor Schimmelcultures.

are available on the website (<http://www.blackyeast.org/Curitiba/report.html>) and a film of the entire meeting can be viewed on YouTube.

From this event, new doors were opened for international and intercontinental cooperation involving both clinicians and scientists. At the end of the workshop a list was

presented with all (about 20) full genomes that are currently being sequenced and annotated by different consortia, and plans were made for experimental reproduction and detection of agents of chromoblastomycosis in environmental sources.

The next meeting of the Black Yeast Working Group will be a symposium at

the ISHAM Congress in Berlin on 12 June 2012, and a full meeting is planned in 2013 in Guangzhou, China.

Vania Vicente, Sybren de Hoog, Derlene Attili de Angelis, and Flávio Queiros Telles
(s.hoog@cbs.knaw.nl)

Following the great success of the meeting

International cooperation in zygomycete research

of the ECMM-ISHAM Working Group Zygomycoses in Athens, Greece, in May 2010, a Special Interest Group meeting was organized in conjunction with IMC9 in Edinburgh in August 2010. Kerstin Voigt and Sybren de Hoog were privileged to organize this pre-conference meeting that was attended by 20 mycologists from seven countries (Egypt, Germany, Japan, Poland, Taiwan, The Netherlands, and the United Kingdom). The aim of the meeting was to bring together mycologists working in various areas of the zygomycetes, to share recent discoveries, to establish an international network for discussion, and to exchange materials and sequences. The plan is to build up a database allowing rapid and reliable identification of species, leading to understanding of ecology, routes of infection, and food safety.

Five presentations demonstrated divergent themes in research on morphology, systematics, phylogeny, physiology, and etiology of zygomycetes, and underlined their growing importance as agents of disease. An alarming rise in the incidence of zygomycosis was noted worldwide, especially in Asia and South America. Tropical climates seem to favour the manifestation of mucoralean infections. The percentage of cases of zygomycoses increased over the past seven decades from 0 % to above 70 %, as documented by cultures (Roden *et al.* 2005). However, during the same period mortality decreased from almost 100 % to below 40 % due to improved diagnostics (Roden *et al.* 2005). Therefore, correct identification and reliable diagnostics were major themes in the SIG meeting. It became evident that the taxonomy and phylogenetic reconstruction of the zygomycetes is changing fundamentally with the application of molecular methods, particularly ones involving the ITS and the D1/D2 domain of the large subunit (LSU) nuclear ribosomal DNA as barcoding and phylogenetic markers. The ITS domain is

the preferred region for species distinction.

In the first presentation, Sybren de Hoog (CBS-KNAW Fungal Biodiversity Centre, Utrecht, The Netherlands) pointed out that ITS and LSU sequences do not fully determine the species level, because significant intraspecific variability is observed. Generic circumscription is also difficult, with ITS dissimilarities of up to 30 % observed between species of the same genus. *Mucorales*, the most prominent order of zygomycetes, was recently raised to the rank of subphylum, underlining the molecular divergence of these organisms. De Hoog advocated a multigene approach which also utilizes protein-coding genes and their diagnostic power hidden in the introns, supplemented with classical mating experiments. Members of *Mucorales* are ubiquitous in homes, bath- and bedrooms, as well as in refrigerators and pantries. They are known to have an ecological “hit-and-run-strategy”, which means that they arrive on virgin food sources prior to most other microbes, eat fast, grow fast, and get away before competing microorganisms arrive. This strategy leads to rapid spoilage of unattended food batches by abundant production of extracellular enzymes. Within hours, they form a disgusting hairy felt on fruits, vegetables, and cereal products alike. Humans have learnt to manipulate the decomposition process. Especially in Asia a wide variety of mucoralean fungi is applied for pre-digestion of fermented foods, such as soy sauce or Indonesian tempeh. However, de Hoog drew the attention to a possible downside to the use of *Mucorales* in food preparation, since the order also harbours confirmed causative agents of mycoses. Human infections tend to produce severely disfiguring and often fatal symptomatology. These infections have been encountered particularly in patients with severe underlying disease, such as ketoacidotic diabetes or leukemia, but recently a species was found consistently causing chronic skin infections in

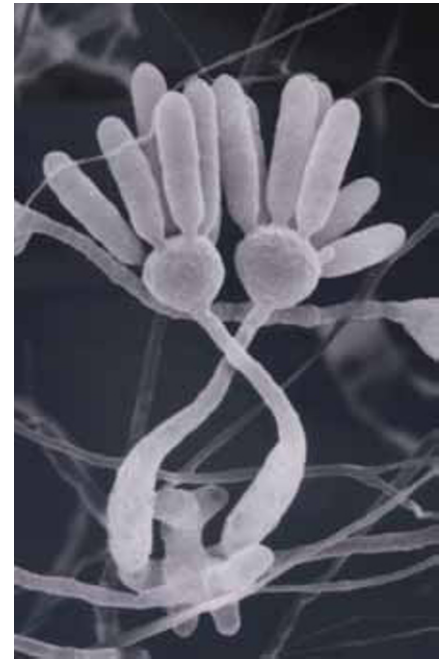


Fig. 1. *Syncephalis parvula* (Piptocephalidaceae, Zoopagales), SEM micrograph. Photo courtesy Hsiao-Man Ho.

otherwise healthy patients in East Asia. Inappropriate therapy of such lesions due to poor diagnostics of the causative agent of the infection may lead to fulminant growth and severe mutilation. Agents of these destructive infections in part belong to the same species that are used for food preparation. An example is *Rhizopus microsporus*, where the varieties classically maintained for food preparation and those responsible as agents of severe disease appear to be identical. Further research is needed to establish whether pathogens are consistently being used to prepare food.

The status of zygomycete research in Taiwan outlined from historical and contemporary points of view was presented by Hsiao-Man Ho (National Taipei University of Education, Taiwan). Special emphasis was placed on thermotolerant species in *Mucorales* with a potential to cause human infections. The study of

zygomycetous fungi in Taiwan started in the 1920s, and since that period a number of local mycologists recorded 38 genera with 123 species. The fungi comprise the following nine families, with their most prominent genera between parentheses: *Chaetocladiaceae* (*Chaetocladium*), *Dimargaritaceae* (*Dispira*), *Kickxellaceae* (*Coemansia*, *Linderina*, *Ramicandelaber*), *Lichtheimiaceae* (*Lichtheimia*), *Mortierellaceae* (*Mortierella*), *Mucoraceae* (*Absidia*, *Gongronella*, *Cunninghamella*), *Pilobolaceae* (*Pilobolus*, *Utharomyces*), *Piptocephalidaceae* (*Piptocephalis*, *Syncephalis*), and *Thamniaceae* (*Thamnidium*, *Thamnostylum*). The morphological beauty of the zygomycetes is demonstrated exemplarily for *Syncephalis parvula* (Fig. 1) and *Zygorhynchus moelleri* (Fig. 2). At present, most of the zygomycete research is carried out in the mycology laboratory of Hsiao-Man at the National Taipei University of Education. Species identification is based on morphological characters combined with ITS, LSU-D1/D2, SSU data for most of the taxa.

Kerstin Hoffmann (Jena Microbial Resource Collection, Department of Microbiology and Molecular Biology, Institute of Microbiology, Jena, Germany) gave an overview of the zygomycetes as emerging pathogens in recent years. Traditionally, the phylum *Zygomycota* has been divided into two classes, *Zygomycetes* and the *Trichomycetes* (Alexopoulos *et al.* 1996). However, since the *Zygomycota* appeared to be polyphyletic, multi-gene based phylogenies suggested the elimination of the classical *Zygomycota* as a separate phylum and its subdivision into five distinct subphyla: *Mucoromycotina*, *Entomophthoromycotina*, *Kickxellomycotina*, *Zoopagomycotina* (Hibbett *et al.* 2007) and the newly described *Mortierellomycotina* (Hoffmann *et al.* 2010). Members of *Entomophthoromycotina* produce indolent subcutaneous and mucocutaneous infections in immunocompetent hosts, whereas the *Mucoromycotina* mostly cause rapidly progressing, fatal and often systemic infections in immunocompromised or severely debilitated hosts (Voigt *et al.* 1999, Ribes *et al.* 2000). Members of *Mucorales* are very significant in hospital settings. Of a total of 205 known species in the order, 25 species, belonging to the genera *Apophysomyces*, *Cunninghamella*, *Lichtheimia*, *Mucor*, *Rhizomucor*, *Rhizopus*, and *Saksena* have been reported to be pathogenic, whereas only 4 four out

of a total of 277 species described in *Entomophthorales* are reported as causing infection. Within *Mortierellales*, only a single species was found to be clinically relevant, *Mortierella wolffii*, causing abortion in cattle. Infection routes are variable, including inhalation, ingestion or direct inoculation into pre-damaged tissue. Ketoacidotic diabetes, burns, major surgery, severe trauma and immune disorders trigger the establishment of mucoromycoses. Roden *et al.* (2005) listed malignancy, organ transplantation, desferoxamine therapy, injection drug use, bone marrow transplantation, renal failure, and malnutrition as additional risk factors, in order of decreasing significance. A relationship between predisposing factors and type of infection was reported, demonstrating that diabetes, malignancy, and desferoxamine therapy predispose for rhinocerebral, pulmonary, and disseminated infections, respectively. Differences between entomophthoromycoses and mucormycoses can be shown in virulence tests using a hen egg model (Fig. 3). While the mucoralean fungus *Rhizopus oryzae* produces a 40 % mortality at day six in hen egg embryos, infection with the entomophthoralean fungus *Conidiobolus coronatus* resulted in 60 % mortality of the embryos within one day, using comparable spore concentrations.

The hen egg model for testing virulence appears to be particularly suitable for large scale assessments of the pathogenic potential of zygomycetes. Ilse D. Jacobsen

(Department of Microbial Pathogenicity Mechanisms, Leibniz Institute for Natural Product Research and Infection Biology - Hans-Knöll-Institute, Jena, Germany) gave a summary of embryonated eggs as an alternative infection model to study virulence. She emphasized that zygomycetes are increasingly recognized as pathogens in both humans and animals. However, relatively little is known of their pathogenesis and virulence. Infection models for zygomycetes have only been described in a very few species. Based on her experience with embryonated eggs as alternative infection model for *Candida albicans* and *Aspergillus fumigatus* (Jacobsen *et al.* 2010, Olias *et al.* 2010), Jacobsen elucidated the suitability of this model for species of *Lichtheimia* (formerly *Absidia*; Hoffmann *et al.* 2009, Alastruey-Izquierdo *et al.* 2010), using *L. corymbifera* as the reference species. Eggs were infected on developmental day 10 on the chorioallantoic membrane (CAM) with 10^6 to 10^2 spores ($n = 20$ per dose and experiment). Survival was determined daily by candling, a standard method which allows visualization of embryonic structures and movement by applying a strong light source to the surface of eggs. Mortality upon infection with the reference strain was dose-dependent, with infectious doses of 10^6 to 10^4 spores per egg resulting in 95–100 % mortality within two days. 10^3 spores per egg killed 70–80 % of infected eggs, and the LD₅₀ was found to be 10^2 spores per egg. These results were



Fig 2. *Zygorhynchus moelleri* (*Mucoraceae*, *Mucorales*), SEM micrograph. Photo Martin Eckart and Kerstin Hoffmann.

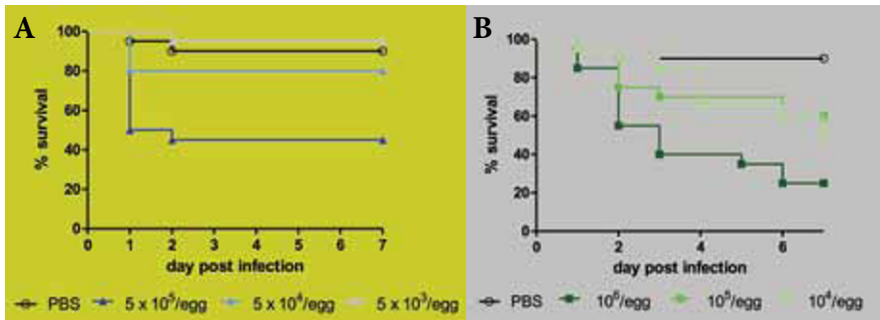


Fig. 3. Virulence tests in the hen egg model. Survival of embryos by application of *Conidiobolus coronatus* (A) and *Rhizopus arrhizus* (syn. *R. oryzae*) (B). Courtesy Ilse Jacobsen and Volker Schwartze.

highly reproducible (2–4 experiments per infectious dose). *Lichtheimia corymbifera* could readily be re-isolated from the CAM of infected eggs, while the CAM of PBS-mock infected controls remained sterile. The three clinically relevant *Lichtheimia* species complexes, *L. ramosa*, *L. corymbifera*, and *L. ornata*, displayed a comparable virulence potential in embryonated eggs. In contrast, the *L. sphaerocystis* and *L. hyalosporea* complexes were significantly attenuated in comparison to *L. corymbifera*. The embryonated egg model is reproducible, inexpensive, easy to handle and does not require specialized facilities. It could serve as alternative model to analyse the virulence potential of different zygomycetes and to directly compare the virulence potential between species, strains and isolates. As the model allows determination of fungal burden, histological analyses and measurement of the host's cytokine response, it can also be used to assess potential pathogenicity mechanisms.

Guido Fischer (Arbeitsmedizin, Umweltbezogener Gesundheitsschutz, Landesgesundheitsamt Baden-Württemberg, Stuttgart, Germany) introduced “Fungiscope - a Global Rare Fungal Infection Registry” and its services for the scientific community. The registry is supported by the pharmaceutical industry as well as by scientific communities (as an ISHAM working group) and is hosted at the University of Cologne (www.fungiscope.net). While the registry focuses on the detailed documentation of cases of rare infectious fungi from different taxa, a number of zygomycete infections have been included. Of 41 recently published cases of zygomycete infections (Rüping *et al.* 2009), 63.4 % occurred in patients with malignancies, 17.1 % in patients with diabetes mellitus, and 9.8 % in patients having undergone transplantation. Diagnosis of zygomycete infection was

made by culture in 68.3 % and/or histology in 63.4 % of the cases. The sites of infection were: lung (58.5 %), soft tissue (19.5 %), rhino-sinuorbital region (19.5 %), and brain (14.6 %). In 82.9 %, a targeted treatment against zygomycetes was applied and the overall survival rate of patients was 51.2 % (Rüping *et al.* 2009). All strains collected within Fungiscope are stored in the collection of the mycology laboratory of the State Health Office Baden-Württemberg (LGA-BW, Germany) and were re-identified by morphology-based methods to cross-check the initial identification in the hospital. In addition, all strains were sequenced at CBS. 29 % (4 of 14) of the identifications carried out in the respective centers were incorrect at the genus level; 50 % of the strains had only been identified to that level. *Lichtheimia corymbifera* was the most frequent infectious agent (6 of 14) with a preference for lung infection, followed by *Rhizopus microsporus* and *R. oryzae* (each 3 of 14), and two single isolates of *Mucor racemosus* and *M. circinelloides*. From these findings, two questions could be raised: (1) how reliable is the statistics on clinical cases reported in the literature for different fungal taxa?; and (2) does the correct identification have any implication for therapy? For the cases reported here, application of liposomal amphotericin B was associated with a higher survival rate (*cf.* Rüping *et al.* 2009). For *Rhizopus microsporus/oryzae* infections, the ratio of fatal outcomes tended to be higher than that of *Lichtheimia corymbifera* infections. In general, antimycotic therapy of zygomycetes is difficult because: (a) clinical and microbiological diagnosis of zygomycete infections is difficult in practice, while species may have different susceptibility profiles; (b) zygomycetes grow very quickly causing fulminant infections; and (c) zygomycetes are resistant to some azoles, except posaconazole, and may show reduced

susceptibility to amphotericin-B. Exposure prophylaxis may be relevant to high-risk patients, as infectious zygomycetes occur ubiquitously in the environment. Effective risk assessment is based on knowledge of fungal concentrations in the environment and of possible sources of infection.

Quantitative data were presented at the SIG meeting from Fischer's preliminary studies. The concentration of *Rhizopus* species lies below 1 cfu m⁻³ air in natural environments, and is thus one order of magnitude lower compared to *Aspergillus fumigatus*. Concentrations can be higher due to human activities, such as waste-handling. *Lichtheimia* species are associated with composting facilities (up to 4×10^2 cfu m⁻³), and are rarely encountered in air in natural habitats. A study in a suburban area showed that *R. pusillus* was the most frequently encountered species, followed by *R. oryzae* and *R. microsporus*; *L. corymbifera* was encountered infrequently. It was concluded that knowledge on distribution and habitats of potentially infectious zygomycetes may help to improve risk assessment and infection prophylaxis for immuno-compromised patients.

All participants came to the conclusion that networking of scientists with research interests in zygomycetes on a global basis is necessary to exchange and calibrate materials and data. A platform for future collaboration was created with an expansion of the clinically oriented ECMM-ISHAM Working Group of Zygomycetes by a section on biodiversity and ecology. A follow-up meeting, on “The dynamics of zygomycete research in a changing world”, was held at the CBS-KNAW Fungal Biodiversity Centre in Utrecht, The Netherlands, on 3–5 March, 2011. That workshop was organized by Kerstin Voigt (Jena, Germany), Anna Skiada (Athens, Greece), and Sybren de Hoog (Utrecht, The Netherlands). The keynote speakers were Mary Berbee (University of British Columbia, Canada), Hsiao-man Ho (National University of Taipei, Taiwan), Ashraf Ibrahim (Los Angeles Biomedical Research Institute at Harbor-UCLA Medical Center, Torrance and David Geffen School of Medicine at UCLA, Los Angeles, USA), Ilse D. Jacobsen (HKI, Jena, Germany), and Paul M. Kirk (CAB International, Egham, UK). Topics covered all areas of zygomycete biodiversity, including genomic, phylogenetic, morphological, physiological and ecological aspects. Participants were able to present their latest research data on the many

beautiful and bizarre members of these fungi. The meeting will culminate soon in a special issue on zygomycete phylogeny in the journal *Persoonia*, scheduled for publication in December 2012.

Mycologists, food and nutrition scientists, medical microbiologists, infection and immune biologists, molecular biologists, and bioinformaticians, are welcome to join the Working Group in any of its upcoming initiatives. For more information please consult the Group's web page (www.zygomycota.eu).

Alastruey-Izquierdo A, Hoffmann K, Hoog GS de, Rodriguez-Tudela J-L *et al.* (2010) Species recognition and clinical relevance of the zygomycetous genus *Lichtheimia* (syn.

Absidia p.p., *Mycocladius*). *Journal of Clinical Microbiology* **48**: 2154–2170.

Alexopoulos CJ, Mims CW, Blackwell M (1996) *Introductory Mycology*. 4th edn. New York: John Wiley & Sons.

Hibbett DS, Binder M, Bischoff JF, Blackwell M *et al.* (2007) A higher-level phylogenetic classification of the *Fungi*. *Mycological Research* **111**: 509–447.

Hoffmann K, Walther G, Voigt K (2009) *Mycocladius* vs. *Lichtheimia*, a correction (*Lichtheimiaceae* fam. nov., *Mucorales*, *Mucoromycotina*). *Mycological Research* **113**: 277–278.

Ribes JA, Vanover-Sams CL, Baker DJ (2000) Zygomycetes in human disease. *Clinical Microbiological Reviews* **13**: 236–301.

Roden MM, Zaoutis TE, Buchanan WL, Knudsen TA *et al.* (2005) Epidemiology and outcome

of zygomycosis: a review of 929 reported cases. *Clinical Infectious Diseases* **41**: 634–653.

Rüping MJGT, Heinz WJ, Kindo AJ, Rickerts V *et al.* (2010) Forty-one recent cases of invasive zygomycosis from a global clinical registry. *Journal of Antimicrobial Chemotherapy*. **65**: 296–302.

Voigt K, Cigelnik E & O'Donnell K (1999) Phylogeny and PCR identification of clinically important zygomycetes based on nuclear ribosomal-DNA sequence data. *Journal of Clinical Microbiology* **37**: 3957–3964.

Kerstin Voigt, Sybren de Hoog, Hsiao-Man Ho, Kerstin Hoffmann, Ilse D. Jacobsen, and Guido Fischer
(kerstin.voigt@uni-jena.de)