Chapter 2
Recent Changes in Fungal Nomenclature and Their Impact on Naming of Microfungi

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The Previous Situation

As documented in the *International Code of Botanical Nomenclature* (the ICBN, Article 59, latest edition by McNeill et al. 2006), fungal nomenclature had an unusual situation for several decades: the often very different forms of sporulation (morphs) of a fungus could have different valid and legitimate names in different genera, which were either teleomorph or anamorph typified. The name attached to the teleomorph had precedence over older anamorph-based names. The basic idea behind this rule was that only with the knowledge of the teleomorph could a fungus be inserted in a natural taxonomic system while that of anamorphs was deemed to remain more or less artificial (e.g., Gams 1995). The most complete compilation of anamorph–teleomorph connections is presented for hyphomycete anamorph genera by Seifert et al. (2011). Another comparable compilation was provided by Wijayawardene et al. (2012).

This situation of dual nomenclature was in conflict with the time-honored principle IV of the *Code*: one organism–one name. It was also abnormal because a quality was demanded for the type: presence of a (sexual) teleomorph in the diagnosis and specimen to make it acceptable as a teleomorph name; otherwise it was anamorphic. In the era of molecular work, this abnormality appeared inappropriate, although the dual system had many advantages for the (morphological) identification of a fungus. A change toward unification was postulated mainly by molecular phylogeneticists, while other taxonomists were afraid of a flood of name changes inevitably following such a change.

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Preparations for a Unification

In *Studies in Mycology* 45 (Seifert et al. 2000), several authors explored how molecular studies affected the classification of *Ascomycetes* and showed how far the discrepancy between anamorph and teleomorph taxonomy still persisted. This incongruence of anamorph-defined and teleomorph-defined genera was in fact one of the major obstacles toward a unification. Grégoire Hennebert, in a philosophical text published temporarily on the CBS website, outlined several scenarios for a possible change, according to which the nomenclatural changes might be reduced to a bearable minimum. Keith Seifert and Paul Cannon convened a symposium at the Oslo IMC (Seifert et al. 2003), during which two teams, defending either unification or the conservative side, debated heavily. The audience then was requested to vote, resulting in a majority of 121:84 for retaining the dual system.

Since 2000 the molecular-based classification of fungi has made dramatic progress. The Genealogical Concordance Phylogenetic Species Recognition (GCPSR) concept introduced by Taylor et al. (2000) has become broadly recognized and allows an almost final phylogenetic reconstruction, only inferior to an entire genome-based classification. In contrast to plant species, some 95 % of fungal species are estimated to be undescribed (Hawksworth 2004b). Less than 20 % of the known fungal species are represented with sequences in GenBank (Hawksworth 2004b). Only ca. 15.5 % of the known (<3 % of the estimated) species have known ITS sequences which are considered as universal barcodes (Schoch et al. 2012), although they lack resolution in some species-rich groups such as *Colletotrichum*, *Fusarium*, or *Trichoderma*. The largely varying quality of available DNA data is not sufficiently considered in molecular-based classification. Up to 20 % of fungal ITS sequences in GenBank are labeled with wrong species names (Nilsson et al. 2006). The different technical quality of sequencing (reading errors, ambiguous positions, simple reads vs. double reads, chimeric sequences) also leads to ambiguity of data interpretation. Sequences available in GenBank are often used without checking whether they have undergone a review process or are unpublished. Sequences derived from vouchers identified by other (primary) means than comparisons with DNA data are obviously superior to sequences only identified (secondarily) by comparison with other already available sequences. Schoch et al. (2014) are making laudable efforts to select and re-annotate a set of marker reference sequences that represent each currently accepted order of fungi.

At the International Botanical Congress at Vienna in 2005, just one issue was resolved toward unification: A proposal (Hawksworth 2004a) was passed that allowed epitypification of a previously anamorphic taxon with teleomorphic material in order to avoid unnecessary name changes. For this procedure Redhead (2010b) introduced the term teleotypification. Gams et al. (2010a, b) discussed some problems associated with the procedure and wanted to restrict the mechanism to cases where no appropriate teleomorph genus was yet available.

At the Vienna Congress, a Special Committee on the Nomenclature of Fungi with a Pleomorphic Life History, headed by Scott Redhead, was established and given the mandate of finding solutions for the problems surrounding Article 59.

The members of this committee were rather evenly distributed from both opposing camps and did not reach a conclusion (Redhead 2010a), in contrast to the permanent Nomenclature Committee for Fungi (NCF), which in a ballot reached a majority favoring unification. Redhead (2010b) then prepared a set of alternative proposals to be presented and voted on at the forthcoming International Botanical Congress (IBC18) in Melbourne.

Pedro Crous, for a long time one of the strongest defenders of the dual system, became converted to the unifying camp under the influence of David Hawksworth, John Taylor, Keith Seifert, and others. Rossman and Seifert (2011) edited a further volume 68 of *Studies in Mycology* with contributions honoring the retirement of Gary J. Samuels. The contributors experimented with various modes of moving toward a unified nomenclature, and some of them introduced genera for holomorphs typified by anamorphic species. In April 2011, Crous convened a symposium in Amsterdam "*One fungus–one name*." At this occasion the *Amsterdam Declaration* (Hawksworth et al. 2011) was signed by some 80, mainly practically oriented mycologists as a strong plea for immediate unification. The opponents, who regarded the time for unification as not yet ripe, were no less active and published cogent opposed arguments (Gams et al. 2011) in a paper signed by some 70 mycologists, mainly those involved in morphological taxonomy. All this was done to prepare for the crucial decisions at the IBC in Melbourne in July 2011.

The Crucial Sessions at Melbourne

In the week preceding the main part of the Melbourne Congress, the nomenclature delegates convened and discussed 338 proposals to modify the *Code*. Hawksworth's proposal (Hawksworth et al. 2009) and lively discussions intended to do justice to mycology in the title of the *Code* resulted in the new name: *International Code of Nomenclature for algae, fungi, and plants* (the ICN, McNeill et al. 2012), in which the fungi and algae (in the broadest sense) appear for the first time in the title. A further important decision concerned a compulsory registration of all nomenclatural novelties for their validity (Hawksworth et al. 2010). Any fungal specimen can now serve as type material (including permanently preserved, inactivated fungal cultures). But environmental samples (in spite of Hibbett et al. 2011) and DNA material alone (in spite of Reynolds and Taylor 1992) remain unacceptable as types of formal fungal names. Norvell (2011), McNeill and Turland (2011), Gams (2013), and for phytopathogenic fungi Zhang et al. (2013) have surveyed the major results of this congress.

To introduce the most contentious item, Article 59, Scott Redhead, chair of the Special Committee dealing with Article 59, had prepared a set of proposals to be presented in succession. He started with the most drastic one, which implied the complete abolition of dual nomenclature and precedence of teleomorph-based names over those for anamorphs. A short presentation of pros and cons was permitted before the vote. Expecting that this drastic step would fail, some less drastic procedures would then be presented subsequently. To the great surprise of all

participants, the first vote ended immediately in an overwhelming yes result. The botanical majority of voters did not seem sufficiently aware of the intricacies of the situation and simply voted for a simple and drastic solution. This caused great consternation among the many mycologists who had opposed the move and regarded this step as premature, while too few fungi were still sufficiently characterized in the phylogenetic system. Others (Hawksworth 2011; Wingfield et al. 2012) did afterwards not hide their triumph.

The new situation briefly implies the following: Names introduced independently for different morphs of a pleomorphic fungus remain legitimate but a choice must be made for one of them.

> *59.1.* A name published prior to 1 January 2013 for a taxon of non-lichen-forming *Ascomycota* and *Basidiomycota*, with the intent or implied intent of applying to or being typified by one particular morph (e.g. anamorph or teleomorph), may be legitimate even if it otherwise would be illegitimate under Art. 52 on account of the protologue including a type (as defined in Art. 52.2) referable to a different morph. If the name is otherwise legitimate, it competes for priority (Arts. 11.3 and 11.4; see also Art. 57.2).

On or after 1 Jan 2013, the introduction of a name for a morph different from that previously named for the same species is illegitimate, at least if the later-named morph includes in its protologue the type (or name) of the earlier-named morph. This ruling does therefore not preclude the possibility that two morphs of one fungus inadvertently receive two different legitimate names also after 2012 (Braun 2012). When two names for different morphs pertaining to the same new fungus are simultaneously introduced, neither is validly published (Art. 36.2). Quite generally the principle of priority prevails, no matter whether the original type of a taxon was teleomorphic or anamorphic. The present *Code* still contains the clause:

> *57.2.* In pleomorphic fungi (including lichenicolous fungi, but excluding lichen-forming fungi and those fungi traditionally associated with them taxonomically, e.g. *Mycocaliciaceae*), in cases where, prior to 1 January 2013, both teleomorph-typified and anamorph-typified names were widely used for a taxon, an anamorph-typified name that has priority is not to displace the teleomorph name(s) unless and until a proposal to reject the former under Art. 56.1 or 56.3 or to deal with the latter under Art. 14.1 or 14.13 has been submitted and rejected.

This is a remnant of the previous time-honored rule of precedence for teleomorph-based names; it now finds little appreciation and may soon be abolished (Hawksworth 2014).

Whatever the implementation is, the new ruling has started to bring about drastic nomenclatural changes. To avoid complete chaos, two new additions were made to Articles 14 and 56:

> *14.13.* In the interest of nomenclatural stability, for organisms treated as fungi (including lichenicolous fungi, but excluding lichen-forming fungi and those fungi traditionally associated with them taxonomically, e.g. *Mycocaliciaceae*), lists of names may be submitted to the General Committee, which will refer them to the Nomenclature Committee for Fungi (see Div. III) for examination by subcommittees established by that Committee in consultation with the General Committee and appropriate international bodies. Accepted names on these lists, which become Appendices of the *Code* once reviewed and approved by the Nomenclature Committee for Fungi and the General Committee, are to be listed with their types together with those competing synonyms (including sanctioned names) against which they are treated as conserved (see also Art. 56.3).

> *56.3.* In the interest of nomenclatural stability, for organisms treated as fungi (including lichenicolous fungi, but excluding lichen-forming fungi and those fungi traditionally associated with them taxonomically, e.g. *Mycocaliciaceae*), lists of names to be rejected may be submitted to the General Committee, which will refer them to the Nomenclature Committee for Fungi (see Div. III) for examination by subcommittees established by that Committee in consultation with the General Committee and appropriate international bodies. Names on these lists, which become Appendices of the *Code* once reviewed and approved by the Nomenclature Committee for Fungi and the General Committee, are to be treated as rejected under Art. 56.1 and may become eligible for use only by conservation under Art. 14 (see also Art. 14.13).

These paragraphs imply that the previous, entirely rule-dominated nomenclature is now changed to a committee- and list-based classification and nomenclature (Hawksworth 2012b). Suggestions to minimize the effects were presented by Gams et al. (2012) and Braun (2012).

The Committee-dominated Era

For several major groups of pleomorphic fungi, ad hoc working groups of experts began to establish themselves or were convened at the 2012 and 2013 CBS spring symposia or commissioned by the ICTF. Hawksworth (2012a) proposed a time schedule for this work in order to promote the activity of various committees in view of the International Mycological Congress in Bangkok in 2014 and the International Botanical Congress in China in 2017, when the outcome of this work should be vetted.

The International Commission on the Taxonomy of Fungi (ICTF) is strongly involved in coordinating these efforts (Seifert and Miller 2012, 2013), and most of the discussion papers listed below are also located on the ICTF site www.fungaltaxonomy.org/lists, where they will be most easily found. The lists resulting from these efforts will subsequently remain freely accessible through the Internet.

The committees work with the terms *accepted* names (which are *protected*) and *suppressed* names. There is an important difference from the other system of conserved vs. rejected names, which are irreversible and universally binding. The new lists will remain open for additions and possibly changes. This system is also different from the previously proposed and then defeated system of "*Names in current use*" (Hawksworth and Greuter 1998), where only current use would determine a rather arbitrary selection of names to be retained and protected.

Several groups of mycologists have already done their work. The guiding principles for the choice of genera are well-supported monophyletic clades which comprise morphologically and ecologically rather homogeneous taxa. Normally the priority of names, no matter whether teleomorph- or anamorph-based, decides the choice. But deviations are proposed in some cases in the spirit of nomenclatural parsimony (Seifert and Miller 2012; Rossman 2014). The frequency of usage of a name may also be taken into account, but a more important criterion is the number of necessary name changes when a particular name is given preference.

A problem is whether in cases where the oldest epithet for a species was given in the suppressed genus, this epithet must be recombined, replacing a well-known binomial in the accepted genus. Thus *Trichoderma reesei* would have to be replaced by a newly combined *T. jecorinum* and *T. citrinoviride* by a new *T. schweinitzii*. This was not done by Jaklitsch and Voglmayr (2014), and Gams et al. (2012) also advised against it. Subsequently Samuels (2014) prepared formal proposals for conservation of these younger names and a few similar cases and all recognized *Trichoderma* names were listed by Bissett et al. (2015). For preferential genera of the *Leotiomycetes* Johnston et al. (2014), quite generally made the new combinations for the oldest available epithet.

Discussion Papers

Discussion papers (published or unpublished) with lists of preferred generic names are now available for the following groups of ascomycetes (*Pezizomycotina*) dealing mainly with *genera*, while the phylogenetic delimitation of *species* would deserve priority (Braun 2012).

Orbiliomycetes

Debates are ongoing concerning the *Orbiliales* (Baral et al. 2016). A generic segregation of the nematode trapping, so far mainly anamorph-based species from the large genus *Orbilia*, would be possible in the narrowest of the generic concepts discussed.

Pezizomycetes

Tedersoo et al. (2013) and for the largest family, the *Pyronemataceae*, Hansen et al. (2013) provide phylogenetic insights, and in spite of the occurrence of anamorphs, teleomorph classification clearly dominates.

Dothideomycetes

An account of preferential names for pleomorphic genera of the class was compiled by Rossman et al. (2015b).

Dothideales

Thambugala et al. (2014) delimit the *Dothideaceae* (including the *Dothioraceae*) against the newly coined *Aureobasidiaceae*, a family now comprising seven genera.

Pleosporales

In the review by Hyde et al. (2013) and complete table by Wijayawardene et al. (2014), some genera are still controversial, e.g., the speciose and still heterogeneous *Pleospora* vs. the well-delimited *Stemphylium*. The genus *Alternaria* will have to comprise species of so far separate genera like *Ulocladium*, *Embellisia*, *Nimbya*, etc. (Woudenberg et al. 2013), when only phylogeny counts.

Capnodiales

Crous et al. (2009a, b), Crous (2010). The family name *Cladosporiaceae* is resurrected and *Cladosporium* obviously deserves preference over the associated teleomorph genus *Davidiella*. Species of *Mycosphaerella* s. str. are placed in *Ramularia*, whereas a bulk of species still remains in the teleomorph genus.

Botryosphaeriales

Phillips et al. (2013) place the *Phyllostictaceae* in this order and give preference to *Phyllosticta* over *Guignardia*. In the *Botryosphaeriaceae* Slippers et al. (2013) recognize 17 genera on a phylogenetic basis, among which *Diplodia*, *Neodeightonia*, *Lasiodiplodia*, *Sphaeropsis*, *Macrophomina*, *Neoscytalidium*, and *Neofusicoccum* are all sufficiently distinct and keyed out based on anamorph features. Teleomorph features are insufficient to distinguish phylogenetically significant genera morphologically.

Eurotiomycetes

Chaetothyriomycetidae, *Chaetothyriales*

Réblová and Untereiner (2013) introduce the new anamorph-based family *Cyphellophoraceae* for the expanded genus *Cyphellophora*, which now comprises species with septate and nonseptate conidia. Two new genera are introduced for some former *Cyphellophora* species. Gueidan et al. (2014) include four orders, *Celotheliales* ad int., *Chaetothyriales*, *Pyrenulales*, and *Verrucariales*, and ten

families (*Adelococcaceae*, *Celotheliaceae*, *Chaetothyriaceae*, *Cyphellophoraceae*, *Epibryaceae* fam. nov., *Herpotrichiellaceae*, *Pyrenulaceae*, *Requienellaceae*, *Trichomeriaceae*, and *Verrucariaceae*) to the subclass. To resolve the very difficult complex of *Capronia–Exophiala–Rhinocladiella–Phialophora* in the *Herpotrichiellaceae*, no solution is yet offered.

Eurotiales

The *Aspergillaceae* are now distinguished from the *Trichocomaceae* (Samson et al. 2011). *Penicillium* (including the teleomorph genus *Eupenicillium* and anamorphs previously classified in *Eladia*, *Torulomyces*, and *Thysanophora*) is clearly separated from *Talaromyces*, which now also incorporates anamorphic taxa (formerly *Penicillium* subgen. *Biverticillium*) (Samson et al. 2011). Debates are going on between a majority of members of the *Penicillium–Aspergillus* working group who prefer recognizing one large genus *Aspergillus* (so far linked to over ten teleomorph genera) and other mycologists who prefer several, mostly teleomorph-linked and ecologically very distinct genera, among which *Aspergillus* s. str. would have to retain a conserved type that represents the former section *Circumdati* and not the original genus in the sense of *Eurotium* (Pitt and Taylor 2014). Another debatable case is the choice between *Byssochlamys* and *Paecilomyces*.

Leotiomycetes

In a voluminous survey Johnston et al. (2014) propose several cases of preferential teleomorph names that are younger than the associated anamorph names, such as *Ascocoryne* over *Coryne*, *Dematioscypha* over *Haplographium*, *Dermea* over *Sphaeronaema*, *Diplocarpon* over *Entomosporium*, *Gremmeniella* over *Brunchorstia*, *Monilinia* over *Monilia*, *Neofabraea* over *Phlyctema*, and *Pyrenopeziza* over *Cylindrosporium*, but they retain the older *Hyphodiscus* over *Catenulifera*, *Pezicula* over *Cryptosporiopsis*, *Phacidium* over *Ceuthospora*, *Phialocephala* over *Phaeomollisia*, *Pilidium* over (*Disco-*)*Hainesia*, *Rhytisma* over *Melasmia*, and *Vibrissea* over *Anavirga*.

Erysiphales

Braun (2013) proposes conservation of the teleomorph-based name *Blumeria* over the older anamorph-based *Oidium* and several more teleomorph-based epithets over correlated older anamorph names. Thus the names of powdery mildew genera are now consistently teleomorph-based, although anamorph features also contribute to genus delimitation.

Phacidiales

Crous et al. (2014) raise the family *Phacidiaceae* to ordinal level, segregated from the formerly paraphyletic *Helotiales* and synonymize the younger anamorph genus *Ceuthospora* with *Phacidium*.

Sordariomycetes

Xylariomycetidae, *Xylariales*

In the *Xylariales* the teleomorph-based taxonomy is quite clearly the guiding rule of generic classification negating that of anamorphs (Stadler et al. 2013). The authors are retaining teleomorph-generic names throughout the order (exception *Virgaria* preferred over *Ascovirgaria*), while certain anamorph features also correlate with generic delimitation. Debatable cases include *Arthrinium* vs. *Apiospora*, *Monographella* vs. *Microdochium*, *Seiridium* vs. *Eutypa*, and a few others.

Hypocreomycetidae

Hypocreales

Rossman et al. (2013) list several genera of *Hypocreales* as candidates for protection while avoiding many hot irons in this group. *Nectria* clearly deserves preference over *Tubercularia*. The so far vaguely defined genus *Cylindrocarpon* (although a nomen conservandum) is sacrificed in favor of several associated teleomorph-based genera. *Gliocladium* s.str. is replaced by *Sphaerostilbella*, but the morphologically similar *Clonostachys* will outlive the associated older teleomorph name *Bionectria*. The very important genus *Fusarium* cannot be sacrificed for its teleomorph *Gibberella* (Geiser et al. 2013), but how many clades will remain in this genus is still uncertain, while some of them were already excluded and transferred to other genera by Gräfenhan et al. (2011). The controversy over the taxonomic identity of the speciose *F. solani* clade and the appropriate name for such a clade, if it were to be recognized as distinct from *Fusarium*, remain to be solved. Lombard et al. (2015) propose the name *Neocosmospora* for this clade and follow a narrow generic concept.

In *Hypocrea*, according to the former rule of teleomorph precedence, several species have been described recently, some of which lacked an anamorph altogether or had deviating anamorphs, but all of them are now transferred to the broadly preferred anamorph-based genus *Trichoderma* (Jaklitsch and Voglmayr 2014) as listed for the whole genus by Bissett et al. (2015). The introduction of a teleomorph genus for *Volutella* by Luo and Zhuang (2012) obviously becomes redundant after the work by Gräfenhan et al. (2011), but its publication in 2012 does not render the

name *Volutellonectria* illegitimate. For the difficult complex of *Acremonium–Emericellopsis–Stilbella–Gliomastix* (Summerbell et al. 2011), no workable solution is yet in sight.

The *Clavicipitaceae* s. l. are treated in several papers: In the *Clavicipitaceae* s. str., the teleomorph-based genus *Epichloë* is older than *Neotyphodium* for associated anamorphs, and these taxa can easily be merged (Leuchtmann et al. 2014). Kepler et al. (2013) broaden the concept of *Polycephalomyces* and Kepler et al. (2014) create a large genus *Metarhizium* including former *Nomuraea* and, although strongly deviating, some paecilomyces-like species. Dealing with the *Ophiocordycipitaceae*, Quandt et al. (2014) give preference to the younger teleomorph name *Ophiocordyceps* over several older anamorph-based generic names. *Tolypocladium* is now conceived in a wider frame that required numerous new combinations, including some from a teleomorph genus.

The genera to be distinguished in the *Cordycipitaceae* are the most controversial. Cladistically minded mycologists wish to recognize no more than 11 rather widely defined monophyletic genera, while the morphology-trained and ecologically oriented mycologists demand a much finer distinction of genera.

Microascales

For the medically relevant genera around *Pseudallescheria*, Lackner et al. (2014) recognize the generic names *Parascedosporium*, *Lomentospora*, *Petriella*, *Petriellopsis*, and *Scedosporium* (displacing *Pseudallescheria*, but still debated). For the mainly phytopathogenic taxa around *Ceratocystis*, de Beer et al. (2014) distinguish several genera, *Ceratocystis sensu stricto*, *Chalaropsis*, *Endoconidiophora*, *Thielaviopsis*, and *Ambrosiella*, and the new genera, *Davidsoniella* and *Huntiella*, most of which have chalara-like anamorphs.

Glomerellales

The older genus name *Colletotrichum* is to be protected against the teleomorph genus *Glomerella* (Cannon et al. 2012).

Sordariomycetidae

Diaporthales

In the *Magnaporthaceae* Luo et al. (2014) distinguish three major lines: (1) *Ophioceras*, (2) *Pyricularia* (suppressing *Magnaporthe*, but still debated), (3) *Gaeumannomyces* (*Harpophora*), *Magnaporthiopsis*, and distinct anamorph-based genera *Nakataea* and *Pseudophialophora*. A survey of preferential names in pleomorphic genera of the order was compiled by Rossman et al. (2015a).

Ophiostomatales

De Beer et al. (2013, see Conclusions below) give a nomenclature of all presently recognized ophiostomatoid taxa.

Some of these lists were briefly presented at the 10th International Mycological Congress in Bangkok during three nomenclature sessions (Redhead et al. 2014), which were too short for a detailed discussion. The lists still have to be scrutinized by the Nomenclature Committee for Fungi before being published in their final form in the Internet and presented to and sanctioned by the next Botanical Congress in China (Hawksworth 2012b). Thus the present years can only be regarded as a transitional period (Zhang et al. 2013), but it is likely that the examples listed here will be fixed as described.

Conclusions

The unification of fungal nomenclature has been pushed through in order to provide for the *Fungi* a natural system just like for plants and animals. Sooner or later this move had to come, ideally at a time when a majority of fungal species is known to science. The most urgent task of mycology—discovery and careful description of new species—is now placed into second place by raising the issue of unified nomenclature to the top. At this moment phylogenetic knowledge is not sufficiently developed throughout the fungal system to provide clear-cut solutions for problematic cases. The present hectic activity at least enforces a useful stocktaking of what is so far known.

Mycologists are making enormous efforts to minimize the chaos ensuing from the somewhat prematurely introduced unification by generating meaningful lists of names. Lists of protected names are being produced and will become established. They are not the last word in fungal taxonomy, and mycologists cannot be forced to adopt a particular taxonomy when they do not agree with it. It is presently impossible to effectively squeeze all known species into recognized, available, and strictly monophyletic genera. Braun (2012) rightly emphasizes the permanent legitimacy of "suppressed" generic names as long as for many species evidence for their affinity with a list-accepted genus is missing. In addition I wish to emphasize that recognition of paraphyletic genera as being a natural phenomenon will do much more justice to a classification based on morphological and ecological criteria.

Unification was expected to facilitate the study of fungal systematics by students. However, this is not the case, as the knowledge of both sexual and asexual morphs of a fungus (and associated names) remains indispensable, even when only one generic name is recognized and the alternative one retains the role of a morphological descriptor and often also is the basis for the names of higher taxonomic ranks. As suggested by Seifert et al. (2000), some of these presently suppressed names will continue to be used as descriptive adjectives or nouns. We will just have phialophora-like and acremonium-like, but not phaeoacremonium-like or simplicillium-like

because the latter two are recognized genera. Thus a certain duality of names for one genus is bound to persist after this move.

A complete move to unified nomenclature will require the recombination of all included species into a single recognized genus for a particular group. This has so far only been achieved consistently in *Trichoderma* (Jaklitsch and Voglmayr 2014; Bissett et al. 2015) and in *Tolypocladium* (Quandt et al. 2014). It has also been done for *Penicillium* and *Talaromyces* (Samson et al. 2014), but for *Aspergillus* remains controversial (Pitt and Taylor 2014). An interesting solution is chosen by de Beer et al. (2013) for ophiostomatoid fungi, where the authors list the species of monophyletic clades but leave them with their original binomial; e.g., in *Ophiostoma* they retain species of *Sporothrix*, *Raffaelea*, and even "*Leptographium*," although that genus phylogenetically belongs to a different clade. This procedure has much to recommend it, especially when not all fungi in question have yet been revised phylogenetically. This is preferable to imposing countless new generic combinations for controversial cases which at present can hardly be satisfactorily resolved.

A debatable proposal concerns morph pairs with identical epithets, for which Hawksworth et al. (2013) suggest a mechanism by which newly discovered alternate morphs are generally to be declared as new combinations based on the type of the older name. This would replace the hitherto compulsory introduction of a new species in the appropriate genus for the newly discovered morph, which created heterotypic names for contiguous morphs. However, this heterotypic situation has the advantage that the connection can be viewed critically in each case and need not always be recognized (Braun 2012); a global adoption of the proposed mechanisms has little chance of stabilizing names.

Taxonomic decisions can never be made by rules of nomenclature. If a name is placed on a list for suppression, this does not mean that it cannot be used when required. This is the important difference of the other system of officially conserving vs. rejecting names that is universally binding and irreversible (also Seifert and Miller 2012). These subtle differences are, however, not easily understood by authors, editors, and reviewers, not to say students, and may cause unnecessary conflicts about how to proceed. Presently, lists of names to be protected are prepared, and parallel official conservation proposals are published often by members of the same team (e.g., Samuels 2014), which further confuses these two different ways of formalizing names.

Publication of new names is now facilitated by eliminating the hurdles of Latin diagnoses and print publication so that the number of validly but qualitatively poorly published names is increasing. Some knowledge of Latin does remain indispensable for understanding the old literature and correctly coining new names for new taxa.

Taxonomic knowledge of numerous fungal groups is still quite inadequate and often does not yet allow decisions about the delimitation of natural taxa. The tendency by many mycologists to ignore morphological characters when introducing fungal taxa is not helpful when striving for a natural classification. The morphological knowledge gathered by older workers and that to be gathered for recent material remains an indispensable basis for establishing a natural system for fungi

that guarantees stability and allows predictions of properties of related taxa. A careful morphological analysis and permanent preservation of the material studied are indispensable prerequisites to assure that a sequence obtained really applies to the fungus in question. Do not forget that genotype and phenotype are two sides of the same coin. Much more material needs to be collected and thoroughly studied to enhance mycological knowledge. Are the taxonomists of the future prepared to meet this challenge in all of its dimensions? The fungal world remains alive in its native environment, awaiting discovery. Conditions must urgently be created to enable mycologists to get out of the boardrooms and back into the field.

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