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## Managing and coping with names of pleomorphic fungi in a period of transition<sup>+</sup>

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An explanation is provided of the recent changes in the *International Code of Nomenclature for algae, fungi and plants* relating to the ending of the separate naming of different states of fungi with a pleomorphic life-cycle. Issues relating to their implementation are discussed, including problems of defining "widely used", author citations, proofs of holomorphy, typification, the preparation of "Lists of accepted and rejected names" (with a possible timetable), relationship to the existing processes of sanctioning and conservation or rejection, and steps to be considered for the future. This material is presented here to stimulate debate on the actions that should be taken by individuals, and responsible committees, in the current period of transition to a system of fungal nomenclature fit for the 21<sup>st</sup> century.

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"The whole situation is evolving, slower than some would like, and too fast for others."  
(Scott A. Redhead, 26 January 2012)

### Introduction

On 30 July 2011, the long-established practice of allowing separate names to be used for different morphs of the same fungus, dual nomenclature, was ended. On that day, the XVIII<sup>th</sup> International Botanical Congress, meeting in Melbourne, Australia, adopted a resolution accepting the decisions of the Nomenclature Section of the Congress that had been reached on 18–22 July 2011 (McNeill et al. 2011). Decisions became immediately effective from the date the resolution was

adopted, unless a date on which particular provisions become effective was included in the decisions of the Nomenclature Section. These are the effective dates, and not the date of publication of the *International Code of Nomenclature for algae, fungi, and plants* (ICN); the final edited version of the new *Code* is expected in mid-2012 (McNeill et al. 2012a). Summaries of the changes relevant to mycologists have, however, been provided elsewhere (Hawksworth 2011, Lendemer 2011, Norvell 2011).

<sup>+</sup> Dedicated to the memory of the numerical taxonomist and bacteriologist Peter H A Sneath (1923–2011), one of my mentors while a student at the University of Leicester in 1964–69, who already tried to convince me in the 1980s that the "approved lists" model was that to follow for fungal and plant names; he died on 9 September 2011, but probably unaware that the first steps along that route had just been approved.

The issue of permitting dual nomenclature for non-lichenized ascomycete and basidiomycete fungi has been a source of continuing controversy, especially since the 1950s. As a consequence, changes in the system have been made at several of the subsequent International Botanical Congresses, the most dramatic being at the Sydney Congress in 1981. However, it was in the early 1990s, when molecular methods were just becoming available, that some mycologists realized that molecular phylogenetic methods could render the dual system redundant. A fungus could be placed in its appropriate phylogenetic position, regardless of the kind of spore-producing structure expressed – even if it were sterile with no spores of any kind being produced. The desirability, and inevitability, of reaching a position of "one name for one fungus" became increasingly recognized amongst mycologists, and the way in which that might be achieved with a minimum of pain started to be discussed. At the same time some mycologists, impatient with a lack of common assent as to what should be done, started to adopt different practices. Debates and discussions ensued during recent International Mycological Congresses (e.g. Seifert 2003, Norvell et al. 2010). The matter was also considered by various committees (e.g. Redhead 2010a). Now, stimulated by a special meeting, held under the auspices of the International Commission on the Taxonomy of Fungi (ICTF) in Amsterdam in April 2011 (Hawksworth et al. 2011), decisive action was taken at the Melbourne Congress.

As a result of the Melbourne decision, the nomenclature of non-lichenized, pleomorphic fungi has entered a phase of transition. We are now in a period when the actual name to be used, in each case, needs to be unequivocally resolved. Furthermore, when made, the decisions on those names need to be promulgated throughout the mycological community, and indeed to all who use fungal names.

The issue has moved on from "One Name = One Fungus", to "One Fungus = Which Name?"

The number of generic and species names that might be affected is unclear. However, I suspect it may prove necessary to reassess around 2,000–3,000 names of genera, and

10,000–12,000 names of species. In many cases, and probably most, the reassessments will not necessitate changes to familiar well-established names. Recognizing the need to minimize the potential disruption that could ensue, the Congress made some special provisions to mitigate the possible effects of the changes. However, the agreed procedures will take some years to implement fully as, in some cases, deciding on which names to adopt is likely to require protracted discussions. The issue then arises as to what mycologists should do in this period of transition? The aim of this note is to: (1) explain what can be done immediately; (2) detail the changes that come into effect on 1 January 2013; (3) discuss the proposed mechanism to move towards "Lists of accepted and rejected names"; and (4) suggest some options on how to proceed.

### **The new situation**

The separate nomenclatural status afforded to anamorph-typified and teleomorph-typified names ended on 30 July 2011. Regardless of the life-history state represented by their types, all legitimate fungal names are now treated equally for the purposes of establishing priority. The special rules permitting dual nomenclature no longer apply. This has two major consequences:

(1) The correct name is now the earliest published legitimate name; i.e. the principle of priority applies regardless of the sexual stage represented by the name-bearing type (but see also below).

(2) The removal of the special provision for dual nomenclature means that, where names had been introduced for different morphs of a single taxon, those names would strictly be either (a) alternative names (and so not validly published, if proposed at the same time), or (b) nomenclaturally superfluous and illegitimate (if proposed for a taxon where one morph already had a legitimate name). In view of the potential disruption this would cause, names in those two categories are ruled as validly published and legitimate – provided they were published before 1 January 2013 (Art. 59.1).

In some instances, generic names with type species typified by an anamorphic state, and names of genera, species, and infraspecific taxa with anamorphic name-bearing types, will

have priority over currently used teleomorph-typified names. There will be cases where anamorph-typified names will have priority of publication, but be little used, so adopting them could be disruptive. Consequently, mycologists are instructed under Art. 57.2 not adopt anamorph-typified names in cases where either name was "widely used for a taxon . . . until retention of the teleomorph-typified name has been considered by the General Committee and rejected" (see below). This is necessarily a lengthy procedure and, in instances where both names are not widely used, mycologists are not constrained from immediately adopting older anamorph-typified names. Even in cases of widespread usage of dual nomenclature, where the anamorph name is much used, some mycologists are already adopting anamorph-typified names as the correct ones for taxa. While that may not be considered good practice under the *Code*, in some cases it may be pragmatic; there are no nomenclatural penalties proscribed for such actions.

The converse situation, is not mentioned as requiring consideration by the General Committee (GCN). This case is where a little used teleomorph-typified name has priority over a more widely used anamorph-typified name of later date. This should not be interpreted as a general approval of taking such actions. Indeed, the responsible approach in such cases would be to propose either the less used teleomorph name for rejection in favour of the anamorph-typified name, or the anamorph name to be included on the "Lists of accepted names" (see below). Any decision involving the General Committee is likely to take a considerable time.

For submitted cases, the key guidance is to maintain "existing usage as far as possible", pending the decision (Rec. 56A.1). However, when a recommendation for either conservation or rejection has been announced by the Committee, that should be followed – even though formal ratification would not occur until the Committee's report was accepted at the next International Botanical Congress (Arts. 14.6 and 56.4), due to be held in China in 2017.

Some publications, introducing separate new names for different states of the same fungus, may already have been in advanced stages of preparation, or in press, when the

decision to end the dual nomenclatural system was taken. Art. 59.1 protects those appearing before 1 January 2013 from either being ruled as not validly published (as alternative names), or illegitimate (as superfluous names). Without that safeguard, application of the rules that apply to all other fungal names would mean that such names would not be available for use (without special proposals for their conservation; see below). After 1 January 2013, different names proposed for morphs of a single species no longer have such protection but, until that date, names introduced for different morphs will not be ruled as nomenclaturally invalid or illegitimate on that basis.

In summary: (1) Scientific names of pleomorphic ascomycetes and basidiomycetes published on or after 1 May 1753, whether anamorph-typified or teleomorph-typified, compete on an equal footing in determining the nomenclaturally correct name for a fungus; and (2) Names proposed for different states, prior to 1 January 2013, which would otherwise be ruled as invalid or illegitimate by the application of the general provisions for fungal names, continue to be available for use.

### Defining "widely used"

Whether cases where a single taxon has both anamorph-typified and teleomorph-typified names should be submitted for consideration through the mandated Committees, under Art. 57.2 (see above), relies on the phrase "widely used". There is currently no formal guidance on how "widely used" should be defined or interpreted, although two examples of what the Editorial Committee for the Melbourne *Code* considered to be good practice, are being incorporated into the body of the *Code* itself<sup>1</sup>:

*Ex. 2.* The teleomorph-typified generic name *Eupenicillium* F. Ludw. (1892) and five other teleomorph-typified generic names were treated as synonyms of the anamorph-typified generic name *Penicillium* Link (1809) by Houbraken & Samson (in Stud. Mycol. 70: 24. 2011), *Penicillium* being the oldest and the most widely used generic name. However, in order to remove any controversy and stabilize

<sup>1</sup> This wording may still be subject to some final editorial changes before the new edition of the *Code* is released.

this nomenclature, it could be appropriate to propose the rejection of the five teleomorph-typified generic names to the General Committee.

*Ex. 3.* The anamorph-typified generic name *Polychaeton* (Pers.) Lév. (1846) was not taken up by Chomnunti & al. (in Fungal Div. 51: 116.2011) in preference to the later teleomorph-typified generic name *Capnodium* Mont. (1849) as the latter is in widespread use, and the authors suggest that the teleomorphic name be considered for inclusion in the planned lists of accepted names to be approved by the General Committee under Art. 14.13.

It would be helpful if mycologists involved in making the changes were provided with further guidance on this matter. This would expedite the necessary changes being made, and would need to be borne in mind when preparing draft lists of accepted or rejected names. This is an issue which the Nomenclature Committee for Fungi (NCF) appointed by the International Botanical Congress, and the IUBS/IUMS International Commission on the Taxonomy of Fungi (ICTF), may wish to address.

In reaching a decision as to whether each of a competing pair of state names is “widely used” or not, it will be important to consider the wider community of biologists who use fungal names, and not only fungal taxonomists. In this connection, it is fortunate that web-based search engines are available. A simple *Google* search on a word, such as a generic name, will give the largest number of “hits”, but these may contain duplicates. *Google Scholar* is more restrictive in being confined to scholarly publications, rather than usages in general, but both these will not weed-out non-fungal usages of the same word, or its use at a different rank. For example, a search of *Coryne* resulted in 671,000 hits in *Google* and 13,700 in *Google Scholar* due to the inclusion of coryneform bacteria and coryne-bacteria, whereas *Ascocoryne* yielded 133,000 and 1,070 respectively; *Sphaerellopsis*, without the additional search word “rust”, had 70,500 hits in *Google* but only 4,800 with “rust” due to problems of an orthographically identical algal genus; and for an unqualified *Polymorphum*, there were 126,000 hits in *Google* and 3,380 in *Google Scholar*, mainly from the use of

“*polymorphum*” as a species epithet in diverse organisms. These are very rough and, in some cases, potentially misleading bibliometrics, but they have merit in being broader in their coverage than databases such as *Web of Science* or *Scopus* which catch only a subset of the scientific output, and so are starting to attract more attention as tools in the biblioinformatics community (e.g. Alcaraz & Morais 2012, Krell 2012). In principle, a better guide for usage in fungal taxonomy would be the *Bibliography of Systematic Mycology*, but in that the detailed indexing of genera only started in 1986. Examples of numbers of hits obtained for 25 genera in three datasets are included in Table 1.

Whatever search is conducted, three problems appear to be impracticable to address: (1) usages of names prior to the advent of widespread computerization of bibliographic databases in the mid-1970s and 1980s will only be picked-up occasionally, but could be very numerous; (2) the commonplace situation where both state names of a pleomorphic fungus are cited in a single work (either as accepted names for the different states, or where one is mentioned as a synonym); and (3) the levels of indexing in the databases themselves, for example, if they are based on a search of the entire text, as words in an abstract, or only as keywords.

While some of the caveats discussed in the previous two paragraphs might be overcome with the help of biblioinformatics specialists, others are unlikely to be surmountable in the foreseeable future. Even if the *Biodiversity Heritage Library* and *CyberLiber* were eventually to cover all the systematic mycology publications since 1753, there would be the so-pertinent usage in applied biological journals, patents, and semi-popular magazines, to address. Nevertheless, the numbers of mentions of generic names recovered by search engines or bibliographic databases may serve as a rough-and-ready indication as to what is “widely used”, but only with an awareness of both caveats noted above, and a familiarity with current practices in the group of fungi concerned.

If in doubt whether one or both names of a pleomorphic fungus fall into the “widely used” category, it would be prudent to follow the committee route (see below) before

committing to a decision in print. If that is not done, an author may face the prospect of embarrassment if the decision is reversed in one of the protected lists of accepted names, not to mention being responsible for additional confusion in the literature, and for perplexing and frustrating all users of the name(s).

### Author citation corrections

The pre-Melbourne editions of the *Code* included a special provision that meant, if a teleomorph of an anamorph-typified taxon were discovered, and the anamorph-typified name were transferred to a teleomorph-typified generic name, the combination was to be treated as the name of a new species, and not as a new combination, if, and only if, a valid diagnosis or description were provided. It was then to be attributed to the author making the connection. If no valid diagnosis of the teleomorph were provided, the binomial would remain as a validly published combination, typified by the anamorphic type of the basionym<sup>2</sup>. This situation did not arise very often but, in those cases where it did, the combinations are now again to be treated as just that, and the author citations changed accordingly. An example of this situation is included in the Melbourne *Code*:

*Ex. 3. Mycosphaerella aleuritidis* (Miyake) S. H. Ou (1940), when published as a new combination, was accompanied by a Latin diagnosis of the newly discovered teleomorph corresponding to the anamorph on which the basionym *Cercospora aleuritidis* Miyake (1912) was typified. Under previous editions of this *Code*, *M. aleuritidis* was considered to be the name of a new species with a teleomorph type, dating from 1940, and with authorship attributed solely to Ou. Under the current *Code*, the correct citation is as originally published, i.e. as *M. aleuritidis* (Miyake) S. H. Ou, typified by the type of the basionym.

In cases of this type, the correction can simply be made without any formal actions or even a publication though, when encountered, it would be helpful to inform the compilers of *Index Fungorum* that a correction should be made in the database.

<sup>2</sup> In several editions of the *Code* prior to that adopted by the Sydney Congress in 1981, the epithet in a binomial placed in a teleomorph-typified genus was also ruled as illegitimate if the type did not represent the teleomorphic state.

### Proofs of holomorphy

One of the key drivers for the end of the dual nomenclatural system for pleomorphic fungi was the realization that, on the basis of sequence data alone, even a fungus not forming any spores could be placed with confidence in the sexual system (Reynolds & Taylor 1992). The kind of spores produced by a fungal specimen or culture are irrelevant to its placement in the phylogenetic system for the fungi as a whole. While molecular results can be expected to be definitive in this regard, and have enabled even fungi known only in a non-sporing state to be incorporated into the sexual system, many of the connections reported in the literature have, as yet, not been examined by molecular methods.

An enormous number of connections between anamorphs and teleomorphs were made in the pre-molecular era, and these were painstakingly compiled in Kendrick (1979); this work remains a remarkable resource today. From the mid-19<sup>th</sup> century, these connections were largely based on detailed observations of the fungi in nature and, most spectacularly, by Tulasne & Tulasne (1861-65). Later, connections seen in culture, the development of sporocarps in or from one only with conidial states, were used as evidence (e.g. de Bary 1887). During the 20<sup>th</sup> century, increased rigour was used, with the emphasis on establishing connections by examination of the anamorphic fungi developed from single ascospores. Notwithstanding such careful approaches, a considerable number of the reported connections in the literature remain based only on co-occurrences in nature.

When uniting names, typified by different states under the new rules to provide the correct name for a species, particular care should be taken to ensure that the evidence is sound. That is especially so when basing decisions on co-occurrences, particularly as fungicolous fungi have sometimes been misinterpreted as anamorphs of their hosts. The *Code* itself provides no guidance as to proofs of holomorphy, and this remains a taxonomic decision parallel to that of treating any two names as synonyms. Similarly, it is a taxonomic decision whether to describe a conidial fungus in the same genus as one in which a teleomorph is known; in that case, the judgment has to be

**Table 1** Results of searches on 25 pairs of potentially competing generic names in *Google*, *Google Scholar*, and the *Bibliography of Systematic Mycology* (BSM, 1986 on) on 21 February 2012, and possible actions. Generic names in: **bold** = names suggested to be used, *italic* = names suggested for treatment as synonyms, and normal = names suggested for consideration by committees; v. = versus.

Anamorph-typified	Search results			Teleomorph-typified	Search results		
	Google	Google Scholar	BSM		Google	Google Scholar	BSM
<b>(1) ACCEPT PRIORITY ?</b>							
<i>Basipetospora</i> G.T. Cole & W.B. Kendr. 1968	4,170	184	12	v. <b>Monascus</b> Tiegh. 1884	1,670,000	10,500	72
<b>Cladosporium</b> Link 1816	586,000	30,900	555	v. <i>Davidiella</i> Crous & U. Braun 2003	31,300	258	37
<b>Cryptococcus</b> Vuill. 1901 nom. cons.	4,950,000	72,800	815	v. <i>Filobasidiella</i> Kwon-Chung 1976	151,000	2,000	156
<i>Chrysonilia</i> Arx 1981	89,200	433	24	v. <b>Neurospora</b> Shear & B.O. Dodge 1927	1,100,000	107,000	323
<i>Endothiella</i> Sacc. 1906	5,100	139	16	v. <b>Cryphonectria</b> (Sacc.) Sacc. & D. Sacc. 1905	172,000	7,070	194
<b>Dendryphiopsis</b> S. Hughes 1953	13,200	74	21	v. <i>Kirschsteiniothelia</i> D. Hawksw. 1985	482	155	45
<b>Histoplasma</b> Darling 1906	1,910,000	28,200	226	v. <i>Ajellomyces</i> McDonough & A.L. Lewis 1968	216,000	1,010	66
<i>Monocillium</i> S.B. Saksena 1955	4,480	691	15	v. <b>Niesslia</b> Auersw. 1869	28,700	145	41
<i>Oidium</i> Link 1824	324,000	14,200	287	v. <b>Erysiphe</b> R. Hedw. ex DC. 1805	1,080,000	32,600	505
<b>Penicillium</b> Link 1809	682,000	210,000	940	v. <i>Eupenicillium</i> F. Ludw. 1892	64,500	3,160	121
<b>Sepedonium</b> Link 1809	40,200	1,440	55	v. <i>Apiocrea</i> Syd. & P. Syd. 1921	10,700	125	9
<b>Trichoderma</b> Pers. 1794	1,500,000	129,000	486	v. <i>Hypocrea</i> Fr. 1825	362,000	4,640	262
<i>Uredo</i> Pers. 1801	146,000	5,020	212	v. <b>Puccinia</b> Pers. 1794	819,000	54,400	1,067
<b>(2) ACCEPT LATER NAME ?</b>							
<i>Cladobotryum</i> Nees 1816	12,100	549	63	v. <b>Hypomyces</b> (Fr.) Tul. & C. Tul. 1860	189,000	2,330	142
<b>Hansfordiellopsis</b> Deighton 1960	8,460	13	4	v. <i>Koordersiella</i> Höhn. 1909	410	8	5
<b>Phomopsis</b> (Sacc.) Bubák 1905 nom. cons.	585,000	16,200	376	v. <i>Diaporthe</i> Nitschke 1870	269,000	7,300	256
<i>Polychaeton</i> (Pers.) Lév. 1846	3,300	70	14	v. <b>Capnodium</b> Mont. 1849	26,300	1,340	53
<b>Scopulariopsis</b> Bainier 1907	215,000	6,130	127	v. <i>Microascus</i> Zukai 1885	9,640	898	79
<i>Sphaerellopsis</i> Cooke 1883	4820 <sup>1</sup>	260 <sup>1</sup>	22	v. <b>Eudarluc</b> a Speg. 1908	14,300	190	21
<i>Ugloa</i> Adans. 1763	0	0	0	v. <b>Asterophora</b> Ditmar 1809	95,200	868	72
<b>(3) REFER TO COMMITTEE ?</b>							
<i>Cylindrocladium</i> Morgan 1892	93,100	3,890	195	v. <i>Calonectria</i> De Not. 1867	89,400	2,220	137
<i>Hormoconis</i> Arx & G.A. de Vries 1973	26,900	533	10	v. <i>Amorphotheca</i> Parbery 1969	29,300	233	12
<i>Hypocrella</i> Sacc. 1878	31,200	842	53	v. <i>Aschersonia</i> Mont. 1848	24,800	1,450	60
<i>Stemphylium</i> Wallr. 1833	89,400	9,500	176	v. <i>Pleospora</i> Rabenh. ex Ces. & De Not. 1863	168,000	4,630	276
<i>Polymorphum</i> Chevall. 1822	44,700	549	3	v. <i>Ascodichaena</i> Butin 1977	31,200	93	7

<sup>1</sup>Due to confusion with the algal genus *Sphaerellopsis* Koschikov 1925, searches were for *Sphaerellopsis* + rust; acceptance of *Eudarluc*a would facilitate conservation of the algal generic name.

based on the similarity of that conidial fungus to ones already established as being members of the same genus.

In discussion, I have heard it suggested that molecular evidence should be required for proof of holomorphy. I would concur that either molecular sequence data or evidence from single ascospore cultures must be the “gold standard”. However, in reality this is not going to be achievable in any conceivable time-frame for the majority of fungi. While desirable, I would also question if that were necessary at all in certain cases, for instance, when there was evidence from physical connections seen in nature (e.g. in many sooty-moulds), or regular co-occurrences (e.g. *Vouauxiomyces* anamorphs of *Abrothallus* species). The burden of presenting cases “beyond reasonable doubt” will remain that of authors who have to satisfy their peer reviewers, editors, and ultimately the mycological community at large; a situation no different from that which already exists when taxonomic novelties are proposed.

There will be many instances where it is uncertain if a particular species should be transferred to a particular anamorph-typified or teleomorph-typified genus, and I would caution against wholesale uncritical transfers in such cases – especially as it is becoming clear that so many fungal genera are polyphyletic. This will also have to remain an issue for taxonomic judgement, either by individuals or committees, but it is to be expected that there will be numerous “orphaned” species names, i.e. ones under generic names now synonymized with others. While this is an undesirable situation, it is no different from numerous names already in the literature under generic names such as *Mycosphaerella*, *Phoma*, *Sphaeria*, and *Sporidesmium*.

While not ideal, it must not be forgotten that the placement of a taxon under a particular generic name is no impediment to the use of the name in identification or inclusion in artificial diagnostic keys, other identification aids, or use in publications. When using a generic name I recognize as probably being wrong for a species, but not having enough evidence to make a transfer, or introduce a new generic name, my personal practice is to place the generic name in quotation marks (e.g. “*Sporidesmium*” *lichenicola*). The late Martin

B. Ellis drilled into me, when a neophyte mycologist in the early 1970s, that the important thing was to give the taxon a label with a good description so that it could be recognized by others and discussed.

### Typification

An epitype is essentially an interpretative type; a specimen or illustration designated to fix the precise application of a name where the name-bearing type lacks characters necessary for its identification. For example, molecularly-sequenced epitypes are increasingly being designated to fix the application of names where DNA cannot be recovered from the name-bearing types. As an interim step towards the ending of dual nomenclature, the Vienna Congress of 2005 extended the original concept further, and authorized the designation of teleomorph-types as “epitypes” for names already typified by anamorphic material (McNeill et al. 2006). This particular extension of the epitype concept was introduced in order to avoid having to introduce a new scientific name when the teleomorph of a species, previously known only in the anamorphic state, was discovered. The term “teletype” was proposed for this special category of epitypes by Redhead (2010b), but the special terminology was not adopted by the Melbourne Congress in 2011. Nevertheless, with the changes effected at that Congress, there are likely to be numerous instances where it will be desirable to designate epitypes exhibiting a state not evident on the name-bearing type of a name. Epitypes designated for this purpose can represent the anamorph or the teleomorph; there is no longer any restriction of such actions to teleomorphic material.

### Names of families and orders

Some mycologists have expressed concern that by allowing anamorph-typified and teleomorph-typified names to compete on an equal basis, this will lead to the loss of some very familiar and long-established suprageneric names, particularly those of families and orders. However, while family names must be based on a legitimate generic name (Art. 18.3), that generic name does not have to be that currently accepted as the correct name for a genus. For example, the treatment of *Eurotium* as a

synonym of *Aspergillus* does not in itself prevent the use of *Eurotiaceae* and *Eurotiales*, nor would the adoption of *Trichoderma* as the correct name for *Hypocrea* preclude the continued use of either *Hypocreaceae* or *Hypocreales*. However, while the principle of priority does not apply to higher categories such as order, class, or subphylum, it does to that of family. Consequently, *Cladosporiaceae* Nannizi 1934 would have priority over *Davidiellaceae* C.L. Schoch et al. 2007 and, in order to retain *Hypocreaceae* de Not. 1844, that name would have to be conserved (see below) against the earlier *Trichodermataceae* Fr. 1825 to remain in use.

### Informal designations

Some mycologists have expressed concern over the loss of data that can be of practical importance, for example, in referring to a particular state that is the causal agent of a plant disease. This was already recognized by Seifert et al. (2000) who proposed the adoption of lower-case non-italic names, such as "acromonium-anamorph" and "trichodermaanamorph". I can see no objection to these or similar phrases being included in the titles of publications or associated with species names, either outside or inside brackets, where it is appropriate to refer to a particular state. However, in such expressions, it might be simpler to use "morph" rather than "anamorph" or "teleomorph" as the last two terms are not familiar to non-mycologists. In due time, I would like to see a recommendation to encourage this practice included in a future edition of the *Code*, even though such a proposal made to the Vienna Congress in 2005 (Hawksworth 2004) was not accepted.

### Lists of accepted and rejected names

The *Code* has various appendices dealing with lists of conserved and rejected names and suppressed publications, and also accords special protection to names adopted in certain mycological works that are deemed to be "sanctioned" (see below). Prior to the Melbourne Congress, there was no mechanism whereby additional lists of names might be adopted for protection or rejection *en bloc*. This changed for all non-lichenized fungi on 30 July 2011 when procedures for the adoption of lists

of accepted (Art. 14.13) or rejected names (Art. 56.3) were approved. In the case of names on the new Accepted Lists, the competing synonyms over which another is preferred would remain available for use in a different taxonomy (Art. 14.6), provided that they do not compete with the accepted name. However, in the case of the Rejected Lists, the names cannot be resurrected except by conservation (Art. 56.3; see below). For this reason, I suspect that many mycologists will embrace the concept of Accepted Lists more favourably than that of the Rejected Lists.

It is important to be aware that while the motivation of the concept of these Lists was the changes in the former special rules relating to the names of pleomorphic fungi, the Lists can cover any fungal names except those of "lichen-forming fungi and those fungi traditionally associated with them taxonomically, e.g. *Mycocaliciaceae*". Reasons for this exception, which I personally find unconvincing, are addressed by Lendemer (2011).

There is no restriction on who might produce a List, its taxonomic scope, or the ranks that can be covered. Initial Lists for consideration can be prepared by individuals or small groups, as well as formally constituted committees or subcommittees of international or national mycological organizations. However, when a List has been produced, the *Code* requires it to be submitted to the General Committee on Nomenclature (GCN). The GCN will pass it to the Nomenclature Committee for Fungi (NCF), who in turn will refer it to a subcommittee, which it has established in consultation with the GCN "and appropriate international bodies". It is anticipated that the "appropriate international bodies" will include the International Commission on the Taxonomy of Fungi (ICTF) as well as similar bodies, such as the International Commission on Yeasts (ICY), and their subcommittees. Where possible, the sub-committees should include users of names other than taxonomists for reasons noted below.

Following review and refinement of a List by the subcommittee tasked with this work, it is then to be submitted to the NCF. After a period of discussion within the NCF, a vote would be taken; a 60 % majority is adopted by the NCF when considering individual name

conservation and rejection proposals but, the NCF would have to consider whether it wished to follow that system for these special Lists. When approved by the NCF, the List will in turn pass to the GCN. Following approval by the GCN, the List would await formal adoption by the following International Botanical Congress.

The Melbourne *Code* does not require a period of open consultation, but it is anticipated that a procedure, parallel to that already well established for the conservation and rejection of particular names (see below), would be followed, i.e., the Lists would be published and open for comment prior to any voting by the NCF. The Lists would ideally be made available through a particular website, with a commenting facility, as that would maximize the involvement of mycologists at large. It is imperative that the process is transparent, and open to inputs from those working in applied and non-taxonomic aspects of mycology, as well as to taxonomists. This is necessary in order to avoid the mycological community as a whole feeling Lists have been imposed upon them, for if they are not seen to be to the benefit of the entire subject, there will be those who decide not to follow what they consider the dictates of some clique.

It is imperative that Lists are meticulously prepared, and the bibliographic details and type information are verified. Names on the Accepted Lists "are to be listed with their types together with those competing synonyms (including sanctioned names) against which they are to be treated as conserved" (Art. 14.13). While every effort should be made to make even the earliest drafts as accurate as possible, this is not critical. When preparing the *Lists of Names in Current Use* for genera of all groups of organisms covered by the *Code*, experience was that if "quick and dirty" drafts were first drawn up and widely circulated, numerous mycologists would critically assess and correct entries for groups in which they had a particular interest. That procedure took five years (Greuter et al. 1993), but does mean that a considerable amount of checking has already been done for fungal names at the rank of genus. In addition, there is a variety of other substantial data sets that also are available for use in compiling entries for Lists. These include

the *Outline of Ascomycota* (Lumbsch & Huhndorf 2010), *Ainsworth & Bisby's Dictionary of the Fungi* (Kirk et al. 2008), the *Species Fungorum* database ([www.species-fungorum.org/Names/Names.asp](http://www.species-fungorum.org/Names/Names.asp)), *The Genera of Hyphomycetes* (Seifert et al. 2011), compilations of reported anamorph-teleomorph connections in Kendrick (1979) and, most significantly, the listing of 739 non-teleomorph-typified generic names linked to teleomorph genera by Hyde et al. (2011).

Allowing an adequate period of consultation will be imperative, as the Lists will become a cornerstone of fungal nomenclature for the future. One possible time-line that could be achievable, at least for generic names, would be to:

- (1) Release "quick and dirty" (hopefully not too dirty!) drafts for comment on the internet by the end of 2012.
- (2) Invite mycologists to express interest in either serving on or helping committees or subcommittees mandated by the NCF, with preparing Lists by the end of 2012.
- (3) Encourage comments and corrections on the Lists by the end of June 2013, and have the NCF mandated committees and subcommittees consider inputs received, and prepare a revision of the Lists.
- (4) Issue revised versions of the Lists by the end of December 2013, after consideration by committees or subcommittees mandated by the NCF to perform that task.
- (5) Debate and conduct a poll on acceptance of the Lists open to all participants during the 10<sup>th</sup> International Mycological Congress (IMC10) in August 2014.
- (6) Have the NCF mandated committees and subcommittees make further revisions and corrections by December 2014, place the updated versions on the internet, and submit them to the NCF for approval.
- (7) Discuss and approve the Lists within the NCF by December 2015 and submit them to the GCN.
- (8) Have the GCN consider and approve the Lists by January 2016.

- (9) Present the Lists for formal adoption at the International Botanical Congress in 2017.
- (10) Include the Lists as Appendices in the 2018 edition of the *International Code of Nomenclature for algae, fungi, and plants*.

What is imperative is that the NCF, in consultation with the ICTF and other international bodies, determines and publicizes the schedules. Species lists for some families or genera (e.g. *Saccharomycetaceae*, *Trichocomaceae*), where much work has already been done, could well be integrated into this time-scale, but others would undoubtedly take much longer. Particular time-lines would need to be developed and advertised on an ordinal, familial, or generic basis for species names, depending on how mandated infrastructure is developed by the NCF. I suspect that it will be difficult to have all in a sufficiently mature state for adoption by 2017 Congress.

The Lists are not restricted to names affected by the changes in the rules relating to pleomorphic fungi. The preparation of these Lists will consequently also provide an opportunity for larger scale protection of currently accepted non-lichenized fungal names whether pleomorphism is known or not. Lists could, therefore, cover all accepted taxa within particular orders, families, or genera. This is an issue for consideration by those involved in the preparation and revisions of particular Lists, and the matter merits serious consideration at the "One Fungus = Which Name?" symposium to be held under the auspices of the ICTF in Amsterdam on 12–13 April 2012.

That the process will inevitably be lengthy will be found frustrating by some but, as the consequences will have to be embraced by future generations of mycologists, this seems unavoidable. In the case of the preparation of the *Approved Lists of Bacterial Names*, which includes around 300 generic and 1,800 specific names, the first draft was made available in 1976, the revised List was published in 1980, and this was formally accepted at the 1982 International Congress of Bacteriology (Sneath 1986). That process took six years, which is similar to the time-line suggested above. However, in mycology, there are many more names to be handled, although the precise

numbers on which decisions will be necessary are unknown. Fortunately, today, we have the huge advantage of the internet and nomenclatural databases which were not available to the bacteriologists of the 1970s.

The actual format of entries in the Lists will need to follow that used in the current Appendices of the *Code* which list conserved and rejected names. In the case of species names, it will also be advantageous, wherever possible, to cite references to deposited molecular sequence data when available for the name-bearing type; in some cases, it could be helpful to designate a sequenced epitype in the List.

Once approved by the GCN and the subsequent International Botanical Congress, the extent to which a List may be added to or revised is not made explicit in the Melbourne *Code*. Indeed, it seems to be somewhat ambiguous on this point. While listed names are to be "treated as conserved" (Art. 14.13) and "entries of conserved names may not be deleted" (Art. 14.14.), the accepted names on the Lists are not in the same category as conserved names. This matter will need to be considered by the NCF, but it would clearly be advantageous to have the Lists open. This would enable them to be added to as detailed treatments of families and genera become available.

The issue of how to prepare approved lists of names, which have specially protected status, is currently a matter undergoing discussion in the zoological community, and it is anticipated that proposals from the International Commission on Zoological Nomenclature (ICZN) will be released for general discussion shortly. It will be important for mycologists to monitor those discussions as they may be helpful in suggesting how best to develop and seek approval for fungal Lists.

### Sanctioned names

The inclusion of a fungal name on an Accepted List over-rides the specially protected status of the sanctioned names of ascomycetes and basidiomycetes (Art. 15). This is evident as sanctioned names are mentioned as "competing synonyms" to be included in the Lists in Art. 14.13. However, a sanctioned status should be one issue for those preparing lists to take into

account when deciding which of two competing names should be commended for acceptance.

### Conservation and rejection

The long established system for the conservation and rejection of names of families, genera, and species is independent from that of the new Lists. The system provides a mechanism for avoiding the displacement of well-established names for purely nomenclatural reasons, such as priority of publication, and also permits typification with a type other than that previously designated. Guidance on preparing proposals under these provisions is provided by McNeill et al. (2012b).

In the new Lists, the names are "treated as conserved" (Art. 14.13) or "treated as rejected" (Art. 56.3), but are not formally conserved or rejected. This is an important distinction as conservation and rejection procedures grant a more final solution, since names once ruled upon cannot be deleted and, in the case of rejected names, are not to be used (Art. 56.1). Names listed as not to be used in favour of conserved names, however, are still available for use in a different taxonomy provided they do not compete with a conserved name.

Conservation and rejection over-ride inclusion in the new Lists but, at the same time, some names that now compete are already conserved, for example *Cryptococcus* and *Phomopsis* (Table 1). Were such already conserved names not to be those preferred in the Accepted Lists, formal proposals for the conservation of the preferred name, over that which had been previously conserved, would have to be made.

Where the adoption of the earliest legitimate generic name or species name for a pleomorphic fungus would result in the change of long-established and widely used names, the mechanisms for the conservation and rejection of names are available for use now. Such proposals would strictly be independent from the planned Lists of accepted and rejected names (see above). However, whether the NCF, established by the Melbourne Congress, would wish to vote on them separately, and pre-empt any treatment in an adopted List, is uncertain. It would be helpful if the NCF could provide guidance on its approach to such proposals. However, for particularly controversial cases,

as the Lists will take a considerable time to prepare and be approved, use of these procedures may be the most expedient course of action to remove uncertainties in a timely manner, especially for fungi of particular economic or medical importance.

### Next steps

Here, to provide some background for the discussions now commencing regarding their implementation, I have endeavored to explain what is involved in the new arrangements for the naming of pleomorphic fungi adopted at the Melbourne Congress in 2011. I have also suggested a possible timetable of actions as a basis for wider discussion – and without prejudice to the result of the decisions of the NCF.

The new provisions are already in force, and mycologists preparing their work for publication will need to make decisions on what names to use while the preparation of Accepted and Rejected Lists of names progresses. This is already recognized in the *Code* through the examples given in Art. 14.13 (see above) and not only is, but was, already happening prior to the Melbourne Congress. To make a decision now over competing names is not contrary to the *Code*, provided its general provisions for all names are met – except that where an anamorph-typified name has priority by date over a widely used teleomorph-typified name. However, it would be unwise to rush into making any formal nomenclatural changes that may prove controversial until at least draft Lists have been made available. In Table 1, I have indicated some examples of different situations and actions that might be taken in those cases as a basis for discussion.

The problem over the large numbers of cases that would need to be addressed in mycology, and the appreciation that many would not be controversial, led to the inclusion in the Amsterdam Declaration on Fungal Nomenclature (Hawksworth et al. 2011: para 5) of the Principle of the First Reviser, a concept borrowed from the International Code of Zoological Nomenclature (ICZN 1999: Art. 24.2). This is essentially that the author(s) first making a choice between generic names should be followed, and that those choices should be registered in a nomenclatural depository (e.g.

*MycoBank, Index Fungorum*). It was suggested that such cases only needed referral to an internationally mandated committee if a case to overturn the choice of the first reviser was prepared. This provision was not, however, amongst the proposals presented to the Melbourne Congress, but may merit consideration as a way of expediting decisions on numerous cases. This is a topic which could merit discussion at the upcoming "One Fungus = Which Name?" symposium.

Transition can be a painful process, but this new dawn of fungal nomenclature promises to deliver a system truly fit-for-purpose for mycology in the 21<sup>st</sup> century. I trust that all mycologists will work constructively towards the realization of that goal.

### Caveats

The interpretations and views presented here are personal, and those involved in fungal nomenclature should consult the *International Code of Nomenclature for algae, fungi and plants* (McNeill et al. 2012a) when it becomes available. Information on the procedures to be used for the development of Lists of accepted and rejected names, or other guidance, prepared by the Nomenclature Committee for Fungi, or the International Commission on the Taxonomy of Fungi, should also be consulted as they become available. The suggestions made as to actions that might be considered appropriate in the particular cases included in Table 1 are presented here merely as a basis for discussion, and are without prejudice to final decisions on those cases.

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### References

Alcaraz C, Morais S. 2012 – Citations: results differ by databases. *Nature* 483, 36.

- de Bary A. 1887 – *Comparative Morphology and Biology of the Fungi, Mycetozoa and Bacteria*. Clarendon Press, Oxford.
- Greuter W, Brummitt RK, Farr E, Killian N, Kirk PM, Silva PC. 1993 – NCU-3: names in current use for extant plant genera. [Regnum Vegetabile no. 129.] Koeltz Scientific Books, Königstein.
- Hawksworth DL. 2004 – Limitation of dual nomenclature for pleomorphic fungi. *Taxon* 53, 596–598.
- Hawksworth 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. *MycoKeys* 1, 7–20; *IMA Fungus* 2, 155–162.
- Hawksworth 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.
- Hyde KD, McKenzie EHC, KoKo TW. 2011 – Towards incorporating anamorphic fungi in a natural classification – checklist and notes for 2010. *Mycosphere* 2, 1–88.
- International Commission on Zoological Nomenclature (ICZN). 1999 – *International Code of Zoological Nomenclature*. 4<sup>th</sup> edn. International Trust for Zoological Nomenclature, London.
- Kendrick B (ed.) 1979 – *The Whole Fungus: the sexual-aseexual system*. 2 vols. National Museums of Canada, Ottawa.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008 – *Ainsworth & Bisby's Dictionary of the Fungi*. 10<sup>th</sup> edn. CAB International, Wallingford.
- Krell F-T. 2012 – The journal impact factor as a performance indicator. *European Science Editing* 38, 3–5.
- Lendemer JC. 2011 – Changes to the International Code for Botanical Nomenclature passed in Melbourne: a lichenological perspective. *Opuscula Philolichenum* 10, 6–13.
- Lumbsch HT, Huhndorf SM. 2010 – *Outline of Ascomycota – 2009*. *Fieldiana, Life and Earth Sciences* 1, 1–42.

- McNeill J, Barrie FR, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J Silva PC, Skog JE, Wiersema JH, Turland NJ (eds). 2006 – International Code of Botanical Nomenclature (Vienna Code) adopted by the Seventeenth International Botanical Congress Vienna, Austria, July 2005. [Regnum Vegetabile no. 146.] A.R.G. Ganter Verlag, Ruggell.
- McNeill J, Turland NJ, Monro A, Lepschi BJ. 2011 – XVIII International Botanical Congress: preliminary mail vote and report of Congress action on nomenclature proposals. *Taxon* 60, 1507–1520.
- McNeill J, Barrie FR, Buck WR, Demoulin V, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Marhold K, Prado J, Pruhomme van Reine WF, Smith GE, Wiersema 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.] A.R.G. Ganter Verlag, Ruggell.
- McNeill J, Redhead SA, Wiersma JH. 2012b – Guidelines for proposals to conserve or reject names. *Taxon* 61, 248–251.
- Norvell LL. 2011 – Fungal nomenclature. 1. Melbourne approves a new Code. *Mycotaxon* 116, 481–490.
- Norvell LL, Hawksworth DL, Petersen RH, Redhead SA. 2010 – IMC9 Edinburgh Nomenclature Sessions. *Mycotaxon* 113, 503–511; *IMA Fungus* 1, 143–147; *Taxon* 59, 1867–1868.
- Redhead SA. 2010a – Report on the Special Committee on the Nomenclature of Fungi with a Pleomorphic Life Cycle. *Taxon* 59, 1863–1866.
- Redhead 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.
- Reynolds DR, Taylor JW. 1992 – Article 59: reinterpretation or revision? *Taxon* 41, 91–98.
- Seifert KA (ed.). 2003 – Has dual nomenclature for fungi run its course? The Article 59 debate. *Mycotaxon* 88, 493–508.
- Seifert KA, Gams W, Crous PW, Samuels GJ (eds). 2000 – Molecules, morphology and classification: towards monophyletic genera in the ascomycetes. *Studies in Mycology* 45, 1–230.
- Seifert KA, Morgan-Jones G, Gams W, Kendrick B. 2011 – The Genera of Hyphomycetes. [CBS Biodiversity Series no. 2.] CBS-KNAW Fungal Biodiversity Centre, Utrecht.
- Sneath PHA. 1986 – Nomenclature of bacteria. In: *Biological Nomenclature Today* (eds WDL Ride, T Younés). [IUBS Monograph no. 2.] IRL Press, Eynsham, Oxford, 36–48.
- Tulasne LR, Tulasne C. 1861–65 – *Selecta Fungorum Carpologia*. 3 vols. Imperial Press, Paris.