7 The Shifting Sands of Fungal Naming Under the ICN and the One Name Era for Fungi

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CONTENTS

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I. Introduction

The accumulated knowledge about fungi and funguslike organisms is linked to names, and communication of this knowledge relies upon the use of these names. Naming of these organisms can be thought of simply as involving two principal components, taxonomy and nomenclature. Taxonomy is how a fungal entity is defined and grouped with other fungal entities into a system of classification. Although there is no universally agreed upon right or wrong way to do this, mycologists today generally base taxonomic concepts and classifications of fungi on evolutionary relationships inferred from phylogenetic analyses. Nomenclature includes the rules for formally establishing a name, determining which is correct, and establishing a standard to determine the application of a name, i.e., the type. The formal rules of nomenclature that govern the naming of fungi and funguslike organisms, excluding Microsporidia, are found in the current version of the International Code of Nomenclature for algae, fungi and plants, or ICN (Melbourne Code) (McNeill et al. 2012). New taxonomic concepts often lead to name changes, and newly recognized taxa are added as mycologists document the enormous quantity of fungi and funguslike organisms, estimated to include as many as 5.1 million fungal species (Blackwell 2011). Name changes also result from the application of and changes to the rules of the ICN.

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Though the name of a fungus might change, the fungus itself remains the same. Thus, tracking the different names used for a specific fungus allows all of the accumulated knowledge about it to be pooled, and in some cases misidentifications and changing concepts can be evaluated and information that is no longer clearly applicable to a specific fungus can be identified and reconsidered. The value of fungal naming and following the ICN thus lies in having one correct name for each fungus and funguslike organism that can be used for precise communication and an associated standard for determining what organism that name represents.

In the first edition of *The Mycota*, Hawksworth (2001) provided a scholarly and detailed summary of fungal naming that provided guidance for using the version of the International Code of Botanical Nomenclature (Tokyo Code) (Greuter et al. 1994) that was in effect at that time and integrated information about potential proposals for changes to fungal naming, some of which were never adopted, e.g., the BioCode. Subsequent to the completion of the original text of Hawksworth's (2001) publication, three different Codes have been used for fungal naming, and major changes to the procedures for naming fungi have been adopted, especially changes found in the current ICN (McNeill et al. 2012). Rather than restate the historical aspects and basics of fungal naming summarized by Hawksworth (2001), this chapter will provide an update and supplement to the previous version. Much has been written on the topic of fungal naming in recent years, and all of this will not be covered in detail here. The present chapter will focus on the transition to a one-name-per-fungus system of classification, other major changes to how fungi are named found in the ICN, and how to perform frequently used nomenclatural procedures correctly. Some attention will also be given to a number of current proposals and ideas on changes to fungal naming that may be adopted in the future.

II. International Code of Nomenclature for Algae, Fungi, and Plants (ICN)

The ICN is a set of rules for naming the organisms traditionally treated as algae, fungi, or plants (McNeill et al. 2012). Modifications of and additions to the rules are considered, and new Codes are adopted via a democratic process every 6 years at an International Botanical Congress (IBC), the next of which will occur in 2017 in Shenzhen, China. The Code may be thought of as a sort of gentlemen's agreement since it has no legal status; hence, it depends on users' willingness to voluntarily follow its rules, which has largely been done over the years. The Code itself is divided into a number of parts, and the organization and numbering of these in the current ICN has changed substantially from earlier Codes. Its language is complicated, and the finer details of the rules take a while to learn and appreciate; a single read is insufficient for most mycologists to gain anything close to a basic degree of mastery. Typically, nomenclatural experts must read and reread and reinterpret the Code depending on what nomenclatural procedures, some little used, and areas of interest have emerged during a taxonomic project. Unfortunately, many mycologists do not have time to learn the Code because the rigors of keeping up with other scientific matters in a quickly changing world take up a lot of time. It is hoped that the present chapter will serve mycologists as an elementary guide to the basic essentials of nomenclature.

Following a preface summarizing the changes found in the current Code, a key to the renumbering of parts, and a list of important dates in the Code, the ICN begins with a preamble that defines its purpose and the organisms it covers and summarizes its parts, among other items. Next comes the first of three divisions of the ICN, Principles. This single page contains the six major principles that form the basis of nomenclature, not the least of which are determining the application of names by nomenclatural types, priority of publication, and that each taxon may only bear one correct name, with a few exceptions.

The second division, Rules and Recommendations, contains nine chapters, some of which have additional sections. These chapters contain rules, which are set out in articles and sometimes clarified with notes, and recommendations, and examples are added occasionally for illustrative purposes. Rather than detail

all of these, a brief summary of important concepts and parts that should be useful for most mycologists follows. Chapter I covers taxa and their ranks. The principal ranks include kingdom, phylum, class, order, family, genus, and species, which we have all learned and loved. A bevy of secondary ranks are also presented for those inclined to produce complicated classifications. None of these ranks is a level, so studies that use the term "level," such as species level or level at other ranks, reflect the authors' nomenclatural ignorance. Such usage is best avoided by employing the term rank rather than level because there is no such thing as the latter (at least under the Code).

Chapter II covers status, typification, and priority of names. Effective publication (getting the word out) is defined as per the articles of Chapter IV, and this simply means that the name of a taxon has been presented to the world by appropriate means, for example, in a printed book or journal that is widely distributed rather than on a note left in a single university herbarium specimen. Valid publication, which produces a valid name, means that the articles of Chapter V, hybrids ignored herein, were followed during the naming process. To be a name, a name must be valid, and valid simply means meeting the basic requirements to exist or have status under the Code and be recognized by the scientific community. An invalid name does not have status (exist) under the Code and should not be recognized by the scientific community because it does not meet the basic requirements of the ICN. The terms valid and invalid are misused by a number of authors, often as a way of indicating disagreement with a particular taxonomic concept of someone else. A legitimate name is a valid name that is in accordance with the rules, while an illegitimate name is a valid one that is defined as such by the articles listed in ICN Art. 6.4. There are two common ways in which a name may be illegitimate. The first is by being a later homonym, or the same name validly published at a later date, like the imaginary cases of "*Amanita hibbettii* Vilgalys 2011" and the illegitimate "*Amanita hibbettii* J.W. Taylor 2013." The second is by being superfluous, which can be thought of as simply renaming an already named fungus, for example, I have "*Amanita hibbettii* Vilgalys 2011," but I call it "*Amanita justoi* Minnis 2014." The terms legitimate and illegitimate are also often misused by authors despite being clearly defined in the various Codes.

Typification is one of the most important principles of the Code because a type is a standard used to determine the application of a name, i.e., answer the question: what is this fungus? An analogous standard is the International Prototype Kilogram (IPK), which is used to ascertain the base unit of mass if and when questions about it arise (BIPM 2006). Needless to say, the IPK is rarely handled and protected from damage for good reason. A nomenclatural type functions similarly for the name of a fungus. As a single standard, a type may not encompass all of the variation of a biological entity, and it may not be the most representative element. A type is typically a specimen, but illustrations may serve as types in some cases. There are a large number of different kinds of types and terminology, and some of them are reviewed later in this chapter. The name of a genus is typified by the type of name of a species, and this may be indicated by citation of the species name. The name of a family is typified by the same type as the generic name on which it is based, and this may be indicated by citing the name of the genus. Above the rank of family, typification does not apply unless the name is based on a generic name, in which case the type is automatically the same as that of the genus. Thus, the Agaricomycetes has the same type as that of the genus *Agaricus*, the type of *Agaricus campestris* L.

Priority applies to names at the rank of family and below where each name may bear only one correct name, with a few exceptions. Names do not have priority outside of the rank at which they were published, and the correct name is the legitimate name that was effectively published first. Priority does not operate above the rank of family. Generally speaking, there are three major ways that the principle of priority may be limited for fungal names. For fungi, the valid publication of names is treated as beginning on 1 May 1753 with *Species Plantarum*, a work of Linnaeus, and fungal names that may

have existed before this date have no status under the Code. However, this has not always been the case, and the starting point for rusts, smuts, and gasteromycetes used to be Persoon's *Synopsis Methodica Fungorum*, while that of other fungi (excluding slime molds) was Fries' *Systema Mycologicum*. Because of the change in starting point for these groups and the resulting and unfortunate need to change many names, sanctioning was adopted to give priority against earlier names to names adopted in the works that used to be the former starting point for fungi; additional information relating to sanctioning and its history was summarized by Hawksworth (2001). Conservation via ICN Article 14 is another procedure that limits priority and is employed when strict application of the rules results in disadvantageous changes. Names may be conserved to have priority over competing names or to have a different type that preserves usage in order to serve stability. Rejection via ICN Article 56 is another procedure that limits priority. It is similar to conservation in some ways, but a rejected name may not be used and can be thought of as being taken out of play permanently, unless later conserved. Additional limitations to priority involve the transition to a one-name-per-fungus system of classification, which will be covered in more detail subsequently in this chapter.

Chapters of Division II not previously mentioned in detail include Chapter III, which shows how to construct names at the various ranks, Chapter VI, which shows how to give author citations that credit the appropriate authors of names, Chapter VII, which covers all forms of name rejection, Chapter VIII, which deals with the names of anamorphic fungi or those with a pleomorphic life cycle (discussed under the transition to one name per fungus below), and Chapter IX, on the orthography and gender of names, which simply means spelling and grammar issues. Division III, the last one of the Code, includes matters relating to governance of the Code. The last items of the Code appear as Appendix I on the names of hybrids, a glossary, and a couple of indexes. Seven additional appendices are to be published separately and will be available in print and electronically. For additional information on the ICN and matters not summarized herein, refer to the complete ICN (McNeill et al. 2012) and the earlier chapter by Hawksworth (2001).

A. Transition to One Name Per Fungus

Perhaps the most significant change to the naming of fungi found in the current ICN (McNeill et al. 2012) is the elimination of provisions that allowed multiple names for the same taxa of non-lichen-forming ascomycetous and basidiomycetous fungi, sometimes referred to as dual nomenclature. The following sections consider historical aspects and how the transition to a one-name-per-fungus system of classification was implemented as well as the specific rules of the ICN and how they will be used to make the transition happen. Terms such as anamorph, teleomorph, and holomorph, though still present in the ICN, are abandoned as much as possible in accordance with the preferences of mycologists including Hawksworth (2013) and Amy Y. Rossman, my recent mentor. Seifert (2014), however, has made a good case for the continued use of these terms. It would be hard for new students of mycology to understand the historical mycological literature without these terms and knowledge of earlier Codes of nomenclature.

1. History and Enactment of Rule Changes

Many fungi possess complicated life cycles that include a number of different states, both asexual and sexual. These states may look completely different, some may be found rarely or seemingly not at all, and sometimes they occur at different times and/or places. Thus, mycologists have not always known whether or not the variously observed states of fungi represent the same organism, and multiple names for the same fungus inevitably accumulated in the literature. During the formalization of the earliest Codes of nomenclature, mycologists were already linking the different states of a number of fungi. Nevertheless, and with less than universal agreement, multiple names were

allowed for certain ascomycetous and basidiomycetous fungi with so-called pleomorphic life cycles in early Codes for the sake of convenience of communication. Weresub and Pirozynski (1979) presented a historical account of pleomorphic fungi and fungal naming. Over the years, a number of modifications and clarifications to the rules of naming pleomorphic fungi and fungi known only from asexual states were adopted. These changes included rules regarding, for example, the invalidation of species names if the state of a genus differed from the state of a newly described species that was included in that genus, which changed to the mere illegitimacy of species names under the same circumstances, and went to legitimacy of species names but incorrect classification in the wrong genus. Terms like imperfect and perfect that describe asexual and sexual states, respectively, were replaced by terms like anamorph (asexual state), teleomorph (sexual state), and holomorph (fungus in all of its morphs) in formalized Codes. Because of the frequency of rule changes and their increasing complexity, many problems involving the names of fungi with pleomorphic life cycles were associated with the rules that had been in place when a significant amount of work was being performed on certain groups of fungi and how rules changes affected this work. Oftentimes, rules changed again before mycologists were able to address issues associated with the names of groups of fungi that were not receiving substantial attention. A study of rust nomenclature is particularly enlightening when it comes to understanding the impacts of variously changing Codes, for example, Judith and Rossman (2014).

As DNA sequence data became more readily obtainable and used in fungal taxonomy, a small but vocal group of mycologists came to the conclusion that multiple names for the same fungus were no longer convenient (Hawksworth 2011; Hawksworth et al. 2011; Taylor 2011). The debate about whether or not to transition to a one-name-per-fungus system of classification and how to do it went on for a number of years with the small but vocal group slowly increasing in numbers but never quite reaching a substantial majority of mycologists, as evidenced by the results of the nomenclature questionnaire from the International Mycological Congress (IMC 9) in Edinburgh (Norvell et al. 2010). In 2010, as the next IBC in Melbourne was approaching, Redhead (2010b) reported on the efforts of the latest group to formally consider the matter in a representative way, the Special Committee on Nomenclature of Fungi with a Pleomorphic Life Cycle. Redhead (2010b) summarized an ideological impasse in which no agreement could be reached on a course of action and noted the anarchy that was occurring in mycological publications regarding the naming of pleomorphic fungi. Following the report by Redhead (2010b), proponents of a one-name-per-fungus system of classification felt an immediacy to act on nomenclatural reform. This act came in the form of the "Amsterdam Declaration on Fungal Nomenclature" (Hawksworth et al. 2011). Early versions of the declaration were circulated to mycologists to garner their support, and despite significant support, a number of proponents for one name per fungus chose not to support the Amsterdam Declaration due to its general lack of details and the inclusion of unrelated issues, such as governance of the Code and the naming of environmental sequences. The published version of the Amsterdam Declaration (Hawksworth et al. 2011) made a strong statement on the principle of moving to a one-name-per-fungus system of classification, but the rule changes by which this was to occur were not detailed, and the aforementioned unrelated rider issues were excluded from the formal declaration but put up for future consideration. With knowledge that this issue was to be brought up on the floor of the IBC in Melbourne, "A Critical Response to the Amsterdam Declaration" was circulated to gain support by advocates of a continuation of multiple names per fungus who strongly opposed a transition to a one-name-per-fungus system of classification, but because of a lack of time before the IBC, it was not published formally by Gams and Jaklitsch (2011) until after the IBC, where the response was presented as a handout. The IBC itself was attended by a small number (13) of representative mycologists and a large number of botanists

(nearly all of the remaining 201 attendees). Following an inconclusive discussion and presentation of the competing principles on naming fungi with a pleomorphic life cycle, Redhead prepared to circulate the first of his three proposals that were hastily developed and not seen or considered by more than a handful of mycologists, some of whom were consulted in making them (Milius 2014; Norvell 2011b). The three Redhead proposals were arranged from the most extreme to a moderate proposal that was in line with the majority of mycologists on the Special Committee on Nomenclature of Fungi with a Pleomorphic Life Cycle (Redhead 2010b). The mostly botanists and other attendees at the IBC passed the first and most extreme proposal without even considering the latter two (Milius 2014; Norvell 2011b). A number of additional proposals for and against dual nomenclature with varying degrees and often involving a term called teleotypification had been made and considered prior to the IBC in Melbourne (McNeill and Turland 2011a; McNeill et al. 2011; Norvell 2011a), but these were not seriously considered at the IBC because most were withdrawn (McNeill et al. 2011). In this way, well over 100 years of fungal naming involving multiple names for fungi with pleomorphic life cycles passed into history, and the transition was made to a one-name-per-fungus system of classification.

2. How One Name Per Fungus Will Happen Under the New Rules

In the International Code of Botanical Nomenclature (Vienna Code), or ICBN (McNeill et al. 2006), immediately preceding the ICN (Melbourne Code) (McNeill et al. 2012), separate names for asexual and sexual states of non-lichen-forming ascomycetes and basidiomycetes were allowed by a number of rules that governed the naming of fungi, and Art. 59 of that ICBN included most of these rules. Redhead's floor proposal at the IBC in Melbourne and subsequent editorial modifications have more or less replaced Art. 59 and related provisions in their entirety, and separate names for the asexual and sexual states of non-lichen-forming ascomycetes and basidiomycetes are no longer allowed. Understanding how the transition to a one-name-per-fungus system of classification will occur, perhaps best thought of as the continuing taxonomic process, requires examination of basic nomenclatural mechanisms, special provisions for stability, and considerations on how to decide which names will be correct. Links are provided to articles of the Code for the sake of convenience, and the associated explanatory text is best considered concurrently with the text of the Code. Hawksworth (2012) and Rossman (2014) offer additional guidance on dealing with and understanding the rule changes. Braun (2012) does so as well using powdery mildews as an example.

The previous Art. 59 has been replaced in the ICN by the new Art. 59 (McNeill et al. 2012) in Chapter VIII, "Names of anamorphic fungi or fungi with a pleomorphic life cycle": http://www.iapt-taxon.org/nomen/main.php?page=art59.

The first thing to note about the new Art. 59 is that the changes are retroactive via ICN Principle VI. This means that all previous mycological literature must be interpreted as if these rules had been in place at the time they were published. Of course, they had not been, and the mycologists of other times were doing their best to follow whichever rules were in place at their respective times. This also means that all previous literature must be reconsidered to see how this will affect the fungal names. Indexes of names and other databases will take some time to update because the task is enormous, so scientists will have to check names on which they would like to publish themselves, and little existing literature involving pleomorphic fungi can be taken for granted as being nomenclaturally accurate.

For names of newly described taxa, authors should not publish more than one name for a fungus regardless of the number of states in its life cycle. This is because simultaneously published names that are alternative names for asexual and sexual states are invalid if published on or after 1 January 2013. Additionally, multiple state names published for named species, regardless of whether the named taxon at the same rank was typified by a sexual state or

asexual state, will be illegitimate as superfluous in most cases if published on or after 1 January 2013. Such a fungal name would be superfluous as defined by the ICN since an already named fungus would be renamed.

For names published prior to 1 January 2013 when multiple names were allowed for certain fungi and there was an intent or implied intent of their applying to or being typified by a particular morph or state, these may be valid and legitimate, and if so, they will compete for priority. If proposed at the same time, the names for the different states are not alternative names and are heterotypic. Priority (typically being validly published first), except when this is limited, will determine the correct name of taxa at the ranks of family and below, and this can be thought of as the basic default mechanism that requires no action. Regardless of the type of the state of the fungus, all names are treated equally, and this is a departure from earlier Codes that gave precedence to names associated with the sexual state when the whole fungus in all of its forms was considered. The following examples will illustrate how this works.

The Amsterdam Declaration (Hawksworth et al. 2011) and most mycologists currently working on the transition to one name per fungus primarily focus on the rank of genus. If a taxonomic study concludes that the following genera represent the same genus, and even if these were used for separate asexual and sexual states historically, priority determines the correct generic name, except when this principle is limited:

Competing names	Correct name
Chloridium Link 1809 (asexual) *Melanopsamella* Höhn. 1929 (sexual)	***Chloridium* Link 1809**

Though little considered prior to enactment of the new rules, a number of familial names apply separately to asexual and sexual states. In recent history, most authors gave priority to those typified by sexual states, and they were used widely in accordance with previous Codes. If a taxonomic study concludes that the following families represent the same family, and even if these were used for separate asexual and sexual states historically, priority determines the correct familial name, except when this principle is limited:

Competing names	Correct name
Chloridiaceae Nann. 1932 (asexual) Chaetosphaeriaceae Réblová, M.E. Barr & Samuels 1999 (sexual)	**Chloridiaceae Nann. 1932**

The situation at the rank of species is perhaps the most complicated because a large number of possibilities might occur, especially owing to the existence or potential creation of homonyms. In general, a taxonomic study looking at a fungus with existing names for multiple states should look to determine the correct name for each state and then use this to determine the correct name for the species. If a taxonomic study concludes that the following species represent the same species, and even if these were used for separate asexual and sexual states historically, priority determines the correct species name, except when this principle is limited:

Competing names	Correct name?
Chloridium virescens (Pers.) W. Gams & Hol.-Jech. 1976 (asexual) *Melanopsamella vermicularioides* (Sacc. & Roum.) Réblová, M.E. Barr & Samuels 1999 (sexual) **Four possibilities:** *Chloridium virescens*, based on the basionym, *Dematium virescens* Pers. 1797	

(continued)

Competing names	→	Correct name?
Chloridium vermicularioides *Melanopsamella virescens* *Melanopsamella vermicularioides*, based on the basionym, *Eriosphaeria vermicularioides* Sacc. & Roum. 1883 In this case, we know that *Chloridium* has priority at the rank of genus, and the species epithet comes from *Dematium virescens*, which has priority at the rank of species:	→	*Correct name* ***Chloridium virescens*** (Pers.) W. Gams & Hol.-Jech. 1976

In this simple case, no new combination was required. But this may not always be the case.

The principle of priority does not operate above the rank of family. Suppose only the ordinal name Chaetoshaeriales Huhndorf, A.N. Mill. & F.A. Fernández 2004 is available. An author could publish an additional name, for example, Chloridiales Minnis 2014, and use this as the correct name at that rank if it was desirable.

Author citations and types of names associated with pleomorphic fungi may be changed as a result of the deletion of various provisions of Art. 59.6 found in the previous ICBN (McNeill et al. 2006) found here: http://www.iapt-taxon.org/icbn/main.htm.

In some instances, like Example 6 of the previous Art. 59.6 (McNeill et al. 2006), the Code would automatically create a new name based on a type that matches the appropriate morph or state. This would effectively change the supposed new combination *Mycosphaerella aleuritidis* (Miyake) S.H. Ou based on *Cercospora aleuritidis* Miyake into a new species name, for example, *Mycosphaerella aleuritidis* S.H. Ou, with a different author citation, and the type would change from an old specimen with conidia to a newly created type that is a different specimen with asci and ascospores. *Cercospora aleuritidis* would remain typified by the specimen bearing conidia and only apply to the asexual state, and *M. aleuritidis* would apply to the sexual state and have precedence for the name of the whole fungus in all of its states. Under Art. 59 of the ICN (McNeill et al. 2012), Example 2 shows how in this situation the new species name reverts to a new combination, *Mycosphaerella aleuritidis* (Miyake) S.H. Ou, and the type changes from a specimen with asci and ascospores to the older specimen with conidia that typifies the basionym, a process I refer to as **detypification and retypification**. The specimen with asci and ascospores is no longer a type. It has been suggested (Hawksworth 2012) that this situation has not occurred very often. In my work updating the fungal databases at the U.S. National Fungus Collections (Farr and Rossman 2014, and ongoing), however, I found this situation to be more common than easily overlooked because of its rarity, especially for rust fungi. Authors addressing taxonomy and nomenclature should be aware of this phenomenon because it would be especially significant if the different types did not represent the same fungus, which seems to happen from time to time in the era of molecular splitting.

Universal recognition of one aspect of transitioning to a one-name-per-fungus system of classification was given to the need to provide some means for having stability of fungal names when the basic nomenclatural mechanisms did not allow for a smooth transition to a one-name-per-fungus system of classification. Along with typical conservation against competing synonyms via ICN Article 14.1 and rejection of names via ICN Article 56.1, additional provisions for the stability of fungal names were included in the ICN. The three major provisions follow.

The first of these is ICN Art. 14.13 (McNeill et al. 2012): http://www.iapt-taxon.org/nomen/main.php?page=art14.

Under this rule, fungal names, excluding lichen-forming fungi, may be added to lists of accepted names and treated as if conserved following submission of these lists to the General Committee (GC) of the International Association of Plant Taxonomists (IAPT) and subsequent review and approval by both the Nomenclature Committee for Fungi (NCF) and the GC. Accepted names on approved lists

are then added to Appendices of the Code along with competing names against which they are conserved. Subcommittees and international groups established by and in support of the NCF are to aid in the assembly of lists and make recommendations regarding their approval. Fortunately, proposals by Redhead (2010a) on having an option to publish some of the Appendices of the ICN separately and/or in electronic format only were approved at the IBC in Melbourne (McNeill and Turland 2011b; McNeill et al. 2011) since the Appendices are likely destined to become rather large during the transition to one name per fungus!

The second of the provisions is ICN Art. 56.3 (McNeill et al. 2012): http://www.iapt-taxon.org/nomen/main.php?page=art56.

Under this rule, fungal names, excluding those of lichen-forming fungi, may be added to lists and treated as if rejected under ICN Art. 56.1. The approval process is the same as the one that applies to Art. 14.13. Names on approved lists are also added to the Appendices of the Code. Names to be treated as rejected may become eligible for use only by subsequent conservation via ICN Art. 14.

The third provision is ICN Art. 57.2 (McNeill et al. 2012): http://www.iapt-taxon.org/nomen/main.php?page=art57.

This rule addresses pleomorphic fungi, excluding lichen-forming fungi, that have both widely used anamorph-typified and widely used teleomorph-typified names prior to 1 January 2013. In such cases, anamorph-typified names with priority are not to take precedence over teleomorph-typified names unless and until either a proposal to reject the anamorph-typified names via Art. 56.1 or to put them on a list to be treated as rejected via Art. 56.3 **or** a proposal to conserve the teleomorph-typified names via Art. 14.1 or to put them on a list to be treated as conserved via Art. 14.13 has been submitted and rejected. This rule is perhaps one of the most difficult to interpret because no guidance is given as to what it means to be widely used. In any case, the benefit of this is that any major revision of groups, where either both asexual and sexual state names were frequent and where sexual state names were given priority because of their state over older asexual state names, will have to proceed by a more democratic process that involves the mycological community. Historical precedence of teleomorph-typified names is also continued to some degree by default. It is worthwhile noting that the existing Example 3 involves two genera, *Magnaporthe* and *Pyricularia*, that are no longer considered to be congeneric (Luo and Zhang 2013), and ICN Art. 57.2 does not apply. The downside is that a liberal interpretation of the phrase "widely used" will create a lot of work for mycologists and the appropriate committees.

Though several options are available to protect against undesirable changes, ICN Arts. 56.1 and 56.3 should be employed judiciously and only after careful consideration since rejected names may not be used later if taxonomic revisions create a reason to do so without the names first being conserved under ICN Art. 14.

The NCF of the International Association for Plant Taxonomy (IAPT) plays a major role in reviewing and approving lists of accepted and rejected names, and the International Commission on the Taxonomy of Fungi (ICTF; http://www.fungaltaxonomy.org/) is assisting with the coordination of working groups on specific fungal groups that are charged with making these lists. Since it is desirable to make the transition to one name per fungus a community-wide and inclusive effort, authors are encouraged to contact the NCF and/or the ICTF before publishing major revisions of important taxonomic groups of pleomorphic fungi affected by the changes to a one-name-per-fungus system of classification.

In determining whether to accept the basic nomenclatural mechanisms or employ one of the tools allowing for the stability of fungal names, it is difficult but necessary to remain without prejudice because it is often easy to prefer certain names for arbitrary or personal reasons. A number of considerations on name choice are listed in what follows.

Should genus choice be correlated with higher ranks?

Trichoderma Pers. 1794 versus *Hypocrea* Fr. 1825

Trichodermataceae Fr. 1825 versus Hypocreaceae De Not. 1844
Hypocreales, Hypocreomycetidae

In this example, *Trichoderma* and Trichodermataceae have priority at their respective ranks, but higher rank classification is based on the name *Hypocrea*. Rossman et al. (2013a) recently proposed the use of *Trichoderma*, an asexual genus with priority, instead of *Hypocrea*, a sexual genus used as the correct name for the whole fungus under the previous Code, when both were widely used. Rossman et al. (2013a) also favored the name Hypocreaceae, though it lacks priority. In this case, the accepted name of the genus does not correlate with higher ranks, and *Hypocrea* will not be used at the rank of genus or below.

What if I don't like the familial name for these fungi?

Planistromellaceae M.E. Barr 1996
Kellermania Ellis & Everh. 1885
= *Piptarthron* Mont. ex Höhn. 1918
= *Alpakesa* Subram. & K. Ramakr. 1954
= *Planistroma* A.W. Ramaley 1991
= *Planistromella* A.W. Ramaley 1993

In this example, if all of these genera are treated as synonyms, as was done by Minnis et al. (2012), the only available familial name is Planistromellaceae, which is not based on an accepted generic name. Alternatives include living with this or describing the new family Kellermaniaceae Minnis 2014 and using one of the tools for fungal name stability such as ICN Arts. 14.1, 14.13, 56.1, and 56.3 to make the later name correct.

What results in the fewest changes or maximum stability?

Which genus has more species names in it?

Which genus appears most in the literature and in the most significant literature?

What morph or state is found most commonly in nature?

All four of these are worthy considerations. The case of *Cochliobolus* Drechsler 1934 versus *Bipolaris* Shoemaker 1959, as noted by Rossman et al. (2013b), is one in which going with the later name based on an asexual state results in the fewest changes, *Bipolaris* has more names, and the asexual state is found more commonly in nature. Significant literature regarding genetics and genomics, unfortunately, uses the name *Cochliobolus* (Rossman et al. 2013b).

Should we prioritize priority?

Scientific discovery is typically credited to the first person to find something new and publish on it. One of the six major principles of the ICN is the principle of priority, which means that names that were validly published first shall be correct in most instances and the author citations of these names are those of the authors that should receive credit. One of the issues with lists of accepted and rejected names of fungi is that such lists totally disregard the principle of priority and the authors who originally discovered and described fungi are not credited for this work. For this reason, some might not prefer to liberally or arbitrarily use the lists of accepted and rejected names at all or for a large number of cases. Others may feel it is not necessary to give credit where credit is due since other factors are believed to be more important.

What do users of fungal names such as plant pathologists and medical mycologists prefer and how do we get the word out?

Users of fungal names in more applied fields are often frustrated by frequent name changes associated with scientific progress. Perhaps it would be wise to consider how to make the transition to one name per fungus that resulted from philosophical differences in naming to be as painless as possible for users in these fields. Wingfield et al. (2012) and Zhang et al. (2013) have provided valuable explanations of the transition to one name per fungus and the benefits of doing this to the community of plant pathologists. Hoog et al. (2014) have provided a similar resource for the medical community.

Some general observations and thoughts on the transition to one name per fungus:

- Taxonomic revisions and new species descriptions are hardly justifiable without looking at the whole fungus in all of its morphs or states, for example, all of those existing names, and taxonomic integration is essential.
- Mycologists must value the discovery and description of the other morphs or states for named species as key taxonomic and mycological contributions because the recognition for doing so may not be the same as in the past.
- We will have what I refer to as "The rise of the anamorphs" since, in general, asexual states for many groups are more common and conspicuous than sexual states and generic concepts for them were elaborated more quickly [except when later discovered to be polyphyletic hodgepodges, e.g., *Acremonium* (Summerbell et al. 2011)] and asexual state names will tend to be favored by the basic nomenclatural mechanisms.
- Mycologists need to work together to make the transition to one name per fungus. Individuals should be discouraged from taking matters into their own hands and enforcing their preferences on others from positions of power, for example, a journal editor.
- Some groups will require significant study before a wise choice can be made. In rusts, for example, we have yet to phylogenetically place the type of the genus *Uredo*, *Uredo betae*. Crous et al. (2014) have provided suggestions for addressing types of genera and a call to address them.
- Obscure groups may not be dealt with as quickly.
- Groups such as the NCF and the International Commission on the Taxonomy of Fungi will make the process more democratic.

B. Other Major and Minor Changes in the ICN

A number of other significant changes to the naming of fungi are found in the current ICN (McNeill et al. 2012), and these have been reported by McNeill et al. (2011) and summarized variously by Hawksworth (2011), McNeill and Turland (2011b), and Norvell (2011b). The following sections consider the most significant changes.

1. Effective Publication via Electronic Publication

Earlier versions of the Code did not allow for effective publication via electronic formats since only printed matter was available for most of the time that a formal Code has been in existence. An urgent need to update the Code resulted from high costs associated with producing printed formats, the proliferation of electronic-only publications, and the issuance of material in both printed and electronic matter, not always at the same time, for the same publication. The Special Committee on Electronic Publication carefully considered the issue and presented a series of proposals to address effective publication via electronic publication (Chapman et al. 2010), and these were accepted at the IBC in Melbourne (McNeill et al. 2011) and implemented in the ICN. The relevant changes regarding effective publication by electronic means are found in Chapter IV of the ICN and are summarized in what follows. Knapp et al. (2011) provide additional guidance.

Electronic material distributed on or after 1 January 2012 in Portable Document Format (PDF) in an online publication with an International Serial Number (ISSN) or an International Standard Book Number (ISBN) is effectively published, a key component of valid publication. Electronic material distributed before this date is not effectively published. Online is defined as being accessible via the World Wide Web. Only the final version of an electronic publication is effectively published. In press or preliminary versions that may be subsequently altered and are not considered as being the final versions by the publisher are not yet effectively published. The content of electronic publications must not be altered after effective publication, and any such changes are not effectively published. Content in external sources, such as something accessed via a hyperlink, is not part of the publication. Content is that which stands alone as what the

publisher considers to be final, and preliminary page numbers or a lack of them does not prevent a publication from being effectively published, even if page numbers are added or altered later. This can be confusing in some cases because it must be determined which version is considered final by a publisher and what must be cited as the correct page numbers and date of effective publication. The date of effective publication is when the printed matter or electronic matter became available, and this dictates the date used to determine priority of names. When both electronic and printed materials are issued for the same publication, the date of effective publication is treated as being the **same** and is that of **whichever form comes first**.

2. Latin or English for Valid Publication of Names of New Taxa

ICN Art. 38.1 states, with a few exceptions and among other things, that valid publication of the name of a new taxon requires a description and/or diagnosis of the taxon or a reference to an effectively published description and/or diagnosis. In earlier versions of the Code, one of the other requirements was that the description or diagnosis of new fungal taxa must be in Latin, and the Preface of the ICN provides a brief history of this requirement and how its effective date was set to 1 January 1935. This requirement has not always been unanimously supported, and several attempts to modify or remove this requirement, some with success, were made in subsequent years (Hawksworth 2011; Smith et al. 2011). Like others who flouted the rules of the Code they did not like, Dearness (1941) refused to describe new species of fungi in Latin because it was a dead language and would take up too much valuable space in Mycologia. This particular instance of open disregard for the rules was noted during routine updating of the SMML Fungal Databases (cited currently as Farr and Rossman 2014), and Braun et al. (2009) validly published the previously invalid species of interest to them in accordance with the rules. Many mycologists continued to detest the Latin requirement, and there was substantial support for modifying this requirement at the International Mycological Congress (IMC 9) in Edinburgh (Norvell et al. 2010). Demoulin (2010) subsequently acted on the support at the IMC 9 and proposed that Latin or English be acceptable for naming of new fungal taxa. A number of additional and related proposals were made, including that any language be allowed (McNeill and Turland 2011a; Smith et al. 2011), which was not supported by the NCF (Norvell 2011a) and was rejected in the preliminary mail vote for the IBC in Melbourne (McNeill et al. 2011; Smith et al. 2011). At the IBC in Melbourne, the Demoulin (2010) proposal was adopted and modified so that the Latin or English requirement was broadened to include all organisms covered by the Code and set to take effect on 1 January 2012 (Hawksworth 2011; McNeill et al. 2011; Norvell 2011b; Smith et al. 2011). New names described from 1935 up until this date in 2012 must still have descriptions and/or diagnoses in Latin in order to be valid.

3. Registration of Fungal Names

The mycological literature has always been scattered, and taxonomists must be collectors if they are to be scholars. In the earliest days, relatively few copies of mycological publications were made, and their distribution relied upon relatively primitive means of transportation. Due to the slowness in getting the word out, species were often described multiple times. Early indexes of fungal names like Saccardo's *Sylloge Fungorum* gathered lists of described names, their place of publication, and relevant information about the fungi in one place. Hawksworth (2001) provided a list of many of the historical fungal indexes and noted in particular the value of the Index of Fungi. Index Fungorum (http://www.indexfungorum.org/), closely allied with the Index of Fungi, has and continues to be a valuable source as an online global fungal nomenclator. As with the issue of effective publication via electronic publication, the proliferation of large numbers of journals and in numerous formats provided challenges to mycologists, in

this case in the assembly and awareness of published fungal names. I remember having trouble with a conservation proposal due to not knowing about a recent article in a regional faculty journal, the *Revista Facultad Nacional de Agronomía Medellín*. As related challenges grew, financial support of existing indexes began to wane, and the necessary personnel for upkeep became increasingly challenged by the volume of work. The idea of a formal registration of names as a component of valid publication has been around for a while, but many attempts to implement it were not successful (Hawksworth et al. 2010; Hawksworth 2011). In recognizing the problem, the large number of undescribed fungi, and the need to have help in assembling the kind of index that mycologists need, MycoBank was launched as an experimental and voluntary repository for newly published fungal names and associated data on these fungi (Crous et al. 2004). A key component for success was requiring that the authors themselves be responsible for entering names and data. Use of MycoBank increased rapidly, and several mycological journals required that authors of fungal names employ it (Hawksworth et al. 2010; Hawksworth 2011). Significant support for formally requiring the registration of fungal names received support at IMC 9 in Edinburgh (Norvell et al. 2010). As a result, Hawksworth et al. (2010) formally proposed changing the Code so that key information would be entered into an approved repository and that the identifier provided during this process must be included in the publication of fungal names as a requirement for valid publication. The NCF recommended approval (Norvell 2011a), and registration of fungal names was formally approved at the IBC in Melbourne (Hawksworth 2011; McNeill and Turland 2011b; McNeill et al. 2011; Norvell 2011b). Article 42 of the ICN (McNeill et al. 2012) is the relevant article on the registration of fungal names (http://www.iapt-taxon.org/nomen/main.php?page=art42). Thus, all fungal names published on or after 1 January 2013 must cite an identifier issued by a recognized repository; otherwise, it is not valid. Identifiers are issued when minimum elements, for example, those necessary for valid publication of a fungal name, are given to repositories by the authors. The NCF officially approved three repositories, Fungal Names, Index Fungorum, and MycoBank, that had agreed to coordinate their efforts, and the NCF noted that a number of details would need further consideration (Redhead and Norvell 2013).

4. Minor Changes

The Code gets a name change. Botany has historically included the study of more than just plants and was inclusive of, for example, algae and fungi. As the phylogenetic differences between these groups became more and more emphasized and understood, botany tended to become more restricted to just plants, and some major departments even went so far as to change their name from Department of Botany to Department of Plant Biology. Mycologists, wondering where they might be included and feeling slighted, began to think that the name International Code of Botanical Nomenclature might be misleading. Rambold et al. (2013) have also discussed the importance of fungi and the need for more recognition of the field of mycology. To address this matter, Hawksworth et al. (2009) made a series of proposals to amend the ICBN that would include mycology in the title, add fungus-related terms throughout, and transfer some aspects of governance of fungal naming from the International Botanical Congress to the International Mycological Congress. Hawksworth et al. (2009) also noted that some mycologists preferred to break off and establish an independent code for mycology. At the nomenclature session of IMC 9 in Edinburgh, mycologists generally did not support an independent code, provided the name of the current ICBN was changed, but did support transfer of governance to an IMC (Norvell et al. 2010). The NCF recommended approval of a name change, the addition of fungal terminology, and the election of members of the NCF at an IMC, but the NCF did not support transfer of governance (Norvell 2011a). Proposals on a name change and adding fungal terminology were so well supported at the IBC in Melbourne that algae were also included in the title, and the

Code was renamed the International Code of Nomenclature for algae, fungi, and plants via a floor proposal (Hawksworth 2011; McNeill and Turland 2011b; McNeill et al. 2011; Norvell 2011b). Proposals on governance for fungal names were withdrawn on the understanding that a subcommittee would examine the issue at a future date (Hawksworth 2011; McNeill et al. 2011; Norvell 2011b). Mycologists did seem to get everything they really wanted or needed at the IBC and did benefit from having assistance from numerous experts in nomenclature who happen to study plants. As for the new title of the Code, apologies are extended to those who study slime molds and other funguslike organisms; lowercase fungi is the best that could be done to cover these organisms (Hawksworth 2011)!

Microsporidia excluded from ICN. Microsporidia are intracellular parasites that invade host cells via injection by polar filaments (see Didier et al., Chap. 5, Vol. VII, Part A). These organisms are medically important and have been studied historically by zoologists. It turns out that they are fungi, and Redhead et al. (2009) discussed the nomenclatural issues resulting from this realization. Basically, Microsporidia had been described under the rules of the International Code of Zoological Nomenclature (ICZN). This was problematic because Latin diagnoses were not provided, as was required for fungal descriptions, which meant that names of numerous Microsporidia would be invalid. Under the ICBN (Vienna Code) (McNeill et al. 2006), rules were put into place to address this situation, and these stated that if an author of a fungal name thought the organism was something covered by the rules of another code, then the name was validly published as long as that other code was followed, even if the organism was a fungus. This seemed to solve the problem, and a large number of names of Microsporidia were saved from being declared invalid, except that those working with Microsporidia began to say that they were fungi and still kept using the ICZN. Those researching Microsporidia subsequently asked for them to be excluded from the ICBN and covered by the ICZN, which could already do so under one of its articles. Redhead et al. (2009) discussed this and made formal proposals to modify the ICBN to do just that, and Demoulin (2010) provided another proposal to extend this idea to other organisms historically treated under other codes. These proposals passed at the IBC in Melbourne (Hawksworth 2011; McNeill and Turland 2011b; Norvell 2011b). Practically speaking for mycologists, if you want to examine nomenclatural issues of Microsporidia and/or describe new taxa, learn to use the ICZN (International Commission on Zoological Nomenclature 1999).

Typification of sanctioned names. Under the ICBN (Vienna Code) (McNeill et al. 2006), typification of sanctioned names was confusing, and sanctioned names could be typified "in the light of anything associated with the name in that work," meaning the sanctioning work. The protologue or original description of a sanctioned name often predated the sanctioning work, and other rules of the Code stated that a lectotype is to be chosen and designated from the original material (material associated with the protologue) used originally to describe a taxon if no holotype exists. However, material associated with the sanctioning work may not have been part of the original material, and it was unclear as to what such a type, if designated with later material, should be called and which of the potentially conflicting rules should be followed when typifying a sanctioned name. Other complications related to this matter are not discussed here, but Redhead et al. (2010) proposed a set of rule changes to address this matter that would either delete the rule about typifying in light of anything associated with the name in that sanctioning work (ICBN Art. 7.8) (McNeill et al. 2006) or modify a number of rules to create a new kind of type called the sanctiotype for sanctioned names. Perry (2011) provided competing proposals that would not employ the term sanctiotype. The NCF recommended Redhead's proposals relating to the introduction of the sanctiotype (Norvell 2011a). At the IBC in Melbourne, the proposers of these competing options and a few others met to resolve differences, and when it became apparent that the term sanctiotype was hated enough by most at the IBC to be rejected, a compromise was reached (Norvell

2011b). Under the ICN, **a sanctioned name may be typified by an element associated with the protologue and/or the sanctioning work, and this is a lectotype**. Several works (Hawksworth 2011; McNeill et al. 2011; Norvell 2011b) provide more details on the compromise and the changes to the typification of sanctioned names.

Problems with fungal cultures as types. Living fungal cultures may not serve as types of fungal names, and if they are proposed as the type of a new fungal name, that name is invalid. Cultures of fungi permanently preserved in a metabolically inactive state, however, are acceptable as types. Having read a number of publications, I have found it depressing to note how many fungal names are invalid because authors overlooked this requirement of valid publication. Additionally, many authors fail to note the preservation status of cultures, which requires subsequent investigation. Nakada (2010) noted this problem and several other issues such as culture collections periodically reviving cultures and cultures not being deposited in an inactive state. To help clarify matters related to valid publication, Nakada (2010) proposed that a recommendation be added to the Code that the phrase "permanently preserved in a metabolically inactive state" be given when a culture is designated as a type. This proposal was adopted at the IBC in Melbourne (Hawksworth 2011; McNeill et al. 2011; Norvell 2011b). It is often easiest to **dry a culture and deposit it in a herbarium as the type of a taxon and submit a subculture obtained prior to drying to culture collections as the ex-type**.

C. Practical Notes on Using the ICN

The following notes on how to perform frequently used nomenclatural procedures are taken and modified from a document prepared by A.M. Minnis, K.A. Seifert, S.A. Redhead, and R.E. Halling for Mycologia (http://www.mycologia.org/site/misc/FAQvers2.xhtml).

Nomenclatural Procedures FAQ (ICN/Melbourne Code): Help and Checklist for Authors.

This document is designed to help authors avoid common mistakes in frequently used nomenclatural procedures. For questions not covered here, please consult an expert and/or the current version of the International Code of Nomenclature for algae, fungi, and plants (ICN) at http://www.iapt-taxon.org/nomen/main.php?page=title. Following several changes that were adopted at the IBC in Melbourne in July 2011, this FAQ has been modified from earlier versions.

Note: In several examples that follow, the symbol ≡ is used to indicate a homotypic (sometimes called a nomenclatural or obligate) synonym, which is a synonym based on the same type. The symbol = should be used to indicate a heterotypic (sometimes called a taxonomic or facultative) synonym, which is a synonym based on a different type.

1. How Do I Describe New Taxa at the Rank of Species?

a) Validation

Ensure that the new name is in Latin (or is acceptably Latinized). Construct the name according to ICN Arts. 23 and 60. Make sure that the epithet conforms to recommendations and conventions if dedicating the name to a person or place or referring to growth on a substrate or host. Pay special attention to the gender of generic names and corresponding adjectival species epithets. (However, this rule does not apply to epithets that are nouns; they retain their own gender and never change their endings.)

Provide an English or Latin description or diagnosis for your taxon (or provide a full and direct reference to a previously published English or Latin description or diagnosis uniquely applicable to your fungus). Have the diagnosis/description checked by an expert in the language that is used.

- You may use a single English or Latin description or diagnosis (i.e., *a descriptio generico-specifica*) for both a new genus **and** a new species if there is a single species in the new genus and **both are new**.

Designate a holotype (authors must use the word "holotypus" or "holotype," alternatively

"typus" or "type") and cite the **single herbarium** or place the specimen is housed. See Index Herbariorum or other biorepository for proper institutional codes. The phrase "hic designatus" (designated here) is not required.

- Designate a single collection made at one place and time represented as a single specimen in a single institute (list the collector, date, and collection number);
- or a permanently metabolically inactive culture or tissue (e.g., frozen, dried, or pickled) designated by a unique reference and in a single institute (write "permanently preserved in a metabolically inactive state" and indicate the method of preservation to ensure that readers know the type is not a living culture or one that is in a temporarily inactive state);
- or an effectively published illustration (concurrently or previously published) **if and only if** there are technical difficulties preserving a collection of a microfungus. If previously published, a full and direct reference to the place of prior publication is required.

Do not indicate that the "holotype" is in several institutes. Duplicates of the holotype collection are isotypes when deposited elsewhere or are otherwise separate from the holotype. Cultures derived from the holotype, or used to generate the holotype, are themselves not types. Because preserved cultures can serve as "type," do not indiscriminately cite both a specimen and a culture as type. Ensure one is specifically designated as holotype and specifically state where that single type is located. (Otherwise the name will be invalid.)

Do not provide **alternative** Latin names for the same taxon. (Otherwise all will be invalid unless allowed by ICN Art. 59 for pleomorphic fungi until the end of 2012.)

Do not suggest that your new scientific name is tentative, provisional, a temporary fix or express any other doubt about accepting a name for a new taxon. (Otherwise it is invalid.)

You must register your name with MycoBank, obtain a MycoBank registration number, and present it in the protologue. Registration with another of two repositories, Fungal Names or Index Fungorum, that have been officially approved for this purpose (Redhead and Norvell 2013) and the listing of the identifier provided by that repository in the protologue is also acceptable for valid publication.

b) Legitimization

Ensure that you do not publish a later homonym, a name spelled exactly like an earlier valid name (regardless of whether this is legitimate or illegitimate), or one confusingly closely spelled. Later homonyms are illegitimate.

You can and should use MycoBank and Index of Fungi or Index Fungorum to check for earlier potential fungal homonyms and Index Kewensis and other sources via the International Plant Names Index or Tropicos or AlgaeBase for many "botanical" (covered by the ICN) names. Check Index Nominum Genericorum to ensure that the generic name in which you are publishing your species is uniquely fungal. If there are other valid "botanical" homonyms at the generic rank, consider that there is the potential for you to create a later homonym at the species rank to a species in that other genus. You should check GenBank and the World Wide Web for any such uses regardless of whether they are valid or legitimate.

Homonyms for Bacteria and Archaea and for animals (including protozoa) are **covered by other codes**. You may create homonyms, but **this should be avoided**.

Example (fictional; not intended for valid publication):
Lodgea pini E.E. Sm., sp. nov.
MycoBank MB9876543
English diagnosis: this species is distinguished from others in the genus by its brown pileus and yellow pore surface.
Typus: USA: Idaho, Valley Co., near McCall, on soil associated with stands of *Pinus* sp., 07/17/1910, coll. *E. E. Smith*, *E.E. Smith 22* (F).

Seifert and Rossman (2010) have provided some additional guidance on describing new fungal species.

2. How Do I Describe New Taxa at the Rank of Genus?

Construct the name according to ICN Arts. 20 and 60. Follow recommendations 20A.1(h) and 60B when dedicating the name of the genus to a person. Check databases (see earlier discussion) to make sure the generic name has not been used already. A MycoBank, Fungal Names, or Index Fungorum registration number must be obtained and listed for all new names.

An English or Latin diagnosis or description must be supplied when describing a new genus or any other taxon. Have the diagnosis/description checked by an expert in the language that is used.

Designate the type of the genus by citing the name of one previously or concurrently validly published species. Use the word "typus" or "type."

Example (fictional; not intended for valid publication):
Lodgea E.E. Sm., gen. nov.
MycoBank MB457896
Latin diagnosis: *Similis* Hygrocybe *sed hymenio poroso differt.*
Typus: *Lodgea pini* E.E. Sm.

3. What Is an Ex-type?

A living culture obtained from a type may be referred to as an ex-type (see ICN Article 8 for more information). It is linked to the type, but it is not the same as the type. Depending on the nature of the type, it may be called, for example, an ex-holotype, an ex-neotype, or an ex-epitype. Such cultures, as well as the place where the living culture is preserved, should be indicated in publications, especially for new taxa. This information is often listed next to the type designation.

Example (fictional; not intended for valid publication):
Lodgea pini E.E. Sm., sp. nov.
MycoBank MB457896
Latin diagnosis: *Pileo brunneo. Poris luteis.*
Typus: USA: Idaho, Valley Co., near McCall, on soil associated with stands of *Pinus* sp., 07/17/1910, coll. *E. E. Smith*, *E.E. Smith 22* (F); ex-type CBS 4567493.

4. How and When Do I Designate a Lectotype for a Species?

A lectotype is designated when there was no holotype in the original description or if it has been lost or destroyed. Rarely, a lectotype may be designated when the holotype belongs to more than one taxon (see ICN Art. 9 for more information).

A lectotype is a designated specimen or illustration that is part of the original material. Simply speaking, original material consists of specimens and published or unpublished illustrations that were definitely used in the original description of a name. For sanctioned fungal names, the former material and/or any element associated with the name in the sanctioning treatment (equivalent to original material) may be used for lectotypification (see ICN Articles 9.2, 9.3, and 9.10).

When designating a lectotype for a name that is not sanctioned, priority must be given to the following types of materials in the order given:

1. Isotype (see ICN Art. 9.4);
2. Syntype (also possibly an isosyntype) (see ICN Art. 9.5);
3. Paratype (see ICN Art. 9.6);
4. Uncited specimen, uncited illustration, cited illustration.

On or after 1 January 1990, the herbarium housing the specimen or unpublished illustration must be cited, and on or after 1 January 2001, the term "lectotypus" or "lectotype" must be given along with the phrase "hic designatus" or "designated here." A full and direct reference to the place of publication of previously published illustrations should be given, and it is ideal if the illustration can be reproduced in the current work. Lectotypification is only achieved through effective publication. In the case of accepted names based on a basionym (legitimate, previously published name on which a new combination or name at a new rank is based and that provides the final epithet or stem of such a name) or replaced synonym

(valid name on which a replacement name is based and that does not provide the final epithet, etc.), the basionym or replaced synonym should be the name that is lectotypified.

Example (fictional):

Pseudocercospora nyssicola (Peck) Peck, Mycologia 3: 377. 1911.

≡ *Cercospora nyssicola* Peck, Mycologia 1: 100. 1909.

Lectotypus of *Cercospora nyssicola* (hic designatus): USA: Louisiana, near LSU, on leaves of *Nyssa*, 07/12/1907, coll. *Peck, Peck 1239* (BPI).

5. How and When Do I Designate a Neotype for a Species?

A neotype is designated when no original material (specimens and published or unpublished illustrations that were definitely used in the original description of a name) exists. See earlier notes on sanctioned fungal names. With rare exception, a lectotype designated from original material supersedes a neotype. Thus, it is important not to overlook any original material when considering a neotype designation.

A neotype is a specimen or illustration, preferably the former. Special consideration should be given so that the designated neotype matches the material described in the protologue in nearly every regard. For example, a *Puccinia* on *Rosa* from China should not be chosen as a neotype specimen for a *Puccinia* species described on *Potentilla* from Ireland since there is a significant risk that they may not represent the same taxon.

On or after 1 January 1990, the herbarium housing the specimen or unpublished illustration must be cited, and on or after 1 January 2001, the term "neotypus" or "neotype" must be given along with the phrase "hic designatus" or "designated here." A full and direct reference to the place of publication of previously published illustrations should be given, and it is ideal if the illustration can be reproduced in the current work. Neotypification is only achieved through effective publication. In the case of accepted names based on a basionym or replaced synonym, the basionym or replaced synonym should be the name that is neotypified.

Example (fictional):

Amanita nyssae (Peck) Peck, Mycologia 5: 9. 1913.

≡ *Agaricus nyssae* Peck, Mycologia 2: 39. 1910.

Neotypus of *Agaricus nyssae* (hic designatus): USA: Louisiana, near Baton Rouge, scattered, associated with *Nyssa sylvatica*, 10/25/2001, coll. *Tulloss, Tulloss 2211* (NYS).

6. How and When Do I Designate an Epitype for a Species?

An epitype is designated when the existing nomenclatural type (holotype, lectotype, or neotype) or all the original material is not sufficient to allow for precise application of a name. An example of this would be an agaric species where the stipe of the holotype is missing but the stipe is critical for species recognition. In this case, an epitype with a stipe displaying the critical features may be designated to support the existing holotype. Many mycologists working with culturable fungi designate epitype specimens associated with a separate living culture so that DNA data and cultural characters needed to recognize a species are associated with the type of a name. Others use the epitype to link asexual and sexual states of the same fungus.

An epitype is a specimen or illustration, but a specimen should nearly always be employed. Only one epitype is allowed per name. Thus, it must be carefully chosen, and authors should ensure that the epitype represents the same taxon as the type it supports.

For an epitypification to be effected, the herbarium housing the specimen or unpublished illustration must be cited or, in the case of a published illustration, a full and direct bibliographic reference must be given, and on or after 1 January 2001, the term "epitypus" or "epitype" must be given along with the phrase "hic designatus" or "designated here." Additionally, the nomenclatural type (holotype, lectotype, or neotype) that the epitype supports must be explicitly cited. Epitypification is only achieved through effective publication. In the case of accepted names based on a basionym or replaced synonym,

the basionym or replaced synonym should be the name that is epitypified.

Example (fictional):

Amanita nyssae (Peck) Peck, Mycologia 5: 9. 1913.

≡ *Agaricus nyssae* Peck, Mycologia 2: 39. 1910.

Neotypus of *Agaricus nyssae* (designated by R.E. Tulloss, Mycotaxon 82: 54. 2002): USA: Louisiana, near Baton Rouge, scattered, associated with *Nyssa sylvatica*, 10/25/2001, coll. *Tulloss*, *Tulloss 2211* (NYS).

Epitypus of *Agaricus nyssae* (hic designatus): USA: Louisiana, near Baton Rouge, solitary, associated with *Nyssa sylvatica*, 10/31/2007, coll. *Methven*, *ASM 55891* (EIU).

Notes: The stipe of the neotype is missing and its preservation in chemicals prevents PCR amplification. Here, we designate a supporting epitype with stipe that is associated with DNA sequence data.

7. How Do I Validly Publish New Combinations?

The rules for publishing new combinations are covered in large part and in more detail in ICN Arts. 35, 37, and, especially, 41. The basionym must be cited with a clear and direct reference to its place of valid publication. For this, authors making new combinations must include the journal and volume or book title, the page where the protologue begins (be sure not to cite the entire pagination of the whole publication that includes the protologue), and the date. Authors should make sure that adjectival species epithets agree grammatically with the genus in making new combinations (e.g., *Agaricus americanus* becomes *Lepiota americana* instead of *Lepiota americanus*). A MycoBank, Fungal Names, or Index Fungorum registration number must be obtained and listed for new combinations.

Examples (both fictional):

Alternaria nyssicola (Peck) E.G. Simmons, comb. nov.

MycoBank MB124578

≡ *Stemphylium nyssicola* Peck, Mycologia 3: 375. 1911 (basionym).

≡ *Ulocladium nyssicola* (Peck) Minnis, Mycologia 100: 22. 2008.

Pseudocercospora nyssicola (Peck) A.H. Sm., comb. & stat. nov.

MycoBank MB654826

≡ *Cercospora apii* var. *nyssicola* Peck, Mycologia 3: 376. 1911 (basionym).

In the second example, the new combination also changes the rank from variety to species.

8. How Do I Validly Publish a Replacement Name Also Known as a Nomen Novum?

Replacement names are similar to new combinations, but they are made in cases where there is an illegitimate later homonym or when the epithet of the basionym is already occupied in the genus where a new combination is required. The replaced synonym (not a basionym since the epithet is not being used in the new name) must be cited with a clear and direct reference to its place of valid publication. For this, authors making replacement names must include the journal and volume or book title, the page where the protologue begins (be sure not to cite the entire pagination of the whole publication that includes the protologue), and the date. Authors should make sure that species epithets agree grammatically with the genus of their new name. It is also suggested that authors include a citation including a full and direct reference for the earlier homonym or species name already occupying a genus that necessitates the replacement name. A MycoBank, Fungal Names, or Index Fungorum registration number must be obtained and listed for replacement names.

Examples (both fictional):

Nectria peckii Rossman, nom. nov.

MycoBank MB124669

≡ *Nectria cinnabarina* Peck, Mycologia 3: 377. 1911 (replaced synonym), non *Nectria cinnabarina* (Tode : Fr.) Fr., Summa vegetabilium Scandinaviae 2: 388. 1849.

In the preceding example, there is an illegitimate later homonym (Peck's "*cinnabarina*") and a cited earlier legitimate homonym (Fries' "*cinnabarina*").

Phoma braunii Rossman, nom. nov.

MycoBank MB222223

≡ *Phyllosticta cinnabarina* Peck, Mycologia 5: 123. 1913 (replaced synonym), non *Phoma cinnabarina* Fr., Summa vegetabilium Scandinaviae 2: 390. 1849.

In the preceding example, the epithet "*cinnabarina*" is already occupied in *Phoma*. The new combination "*Phoma cinnabarina*" based on Peck's species would create a later homonym.

9. How Do I Correctly Give Author Citations for Taxa?

Complete details about author citations for taxa are found in ICN Arts. 46–50. For existing fungal names, correct author citations may be found (usually) in Index Fungorum and MycoBank. In detailed taxonomic studies, authors should attempt to carefully verify that these databases are correct since they are not perfect. For new names, including new combinations, authors should include author citations for such taxa. These author citations are not necessarily the same as the authorship for the whole publication. Abbreviations for authors of fungi and plants should follow the standards established by the International Plant Names Index (IPNI), and in cases where a standardized abbreviation does not yet exist, authors should still attempt to conform to IPNI practices. Authors should be linked by the use of an "&" and the serial comma is not employed.

Example (fictional):
Chaetomium oregonense T.C. Harr., H.Y. Su & Spatafora, sp. nov.

III. Potential Changes to Nomenclatural Rules

A number of possible modifications to the ICN are currently being considered, and some of these may be implemented in the future. In the following text, some of these ideas and background information are given, but in general, details from cited works are not because the proposals are preliminary and have not yet been adopted in the Code.

More changes relating to Art. 59 and the transition to one name per fungus: During the debate about whether or not to transition to a one-name-per-fungus system of classification, strong feelings about philosophical principles of maintaining dual nomenclature or abandoning it were voiced. Unfortunately and in general, relatively little attention was given to the actual details of potential rules to make a transition to one name per fungus happen, and numerous experts of nomenclature that really know the Code well, but opposed the transition, did not assist the voices calling loudly for change. Gams et al. (2012a, b) brought up a number of considerations, challenges, and needed clarifications about the adopted rules for the transition shortly after it was passed, and many of the finer details may have to be addressed through additional modification of the ICN (Hawksworth 2014).

A number of possible proposals that would tinker with the current transition to a one-name-per-fungus system of classification have already been presented. Hawksworth et al. (2013) have suggested that if a new species name were erected for a morph or state of an already existing species name having the corresponding morph or state under dual nomenclature and the two species names shared the same epithet, the later name should be treated as a new combination rather than a new species name and share the same type as the earlier species name. The later type would then have no standing under the ICN. This approach may be overly complicated since it requires an understanding of old rules that have been deleted from the Code. There is a danger that the two species names do not represent the same fungus, and the application of the name based on the later type might be more prevalent in the literature. In noting existing confusion about terminology associated with lists of fungal names to be treated as conserved via ICN Art. 14.13 or treated as rejected via ICN Art. 56.3, Hawksworth (2014) has proposed that the term "**protected**" be introduced for the former situation and "**suppressed**" for the latter. Hawksworth (2014) has also proposed that fungal names listed via ICN Art. 14.13 be protected

against all unlisted names. Informal discussion of the NCF also suggests that the term "widely used" and Art. 57.2 in general are likely to be modified in the next Code.

Registration of typifications of existing names: The same problems of scattered mycological literature and the proliferation of numerous journals that make it valuable to construct a fungal index through required registrations of fungal names also plague later typifications, such as lectotypification, neotypification, and epitypification, of existing names. Shortly after Hawksworth et al. (2010) proposed registration of fungal names as a requirement for valid publication, Gams (2010) proposed that a similar type of registration be required for typification of existing names. The NCF recommended that this proposal be adopted (Norvell 2011a), but it was rejected at the IBC in Melbourne (McNeill et al. 2011). Hawksworth (2014) has since then suggested draft proposals for registration of typifications of existing names, and MycoBank now has a utility for just such an action.

Naming of environmental sequences: With the emergence of new DNA sequencing technologies, the accumulation of large amounts of DNA sequence data from environmental samples in a short time has outpaced the speed at which taxonomists address the multitude of undescribed fungi, some of which are seemingly known only from environmental data. As a result, a few mycologists have proposed that these sequences be formally named and have proposed some possible mechanisms by which this might happen (Hawksworth et al. 2011; Hibbett and Taylor 2013; Hibbett et al. 2011; Taylor 2011). Challenges include sequencing errors, incomplete sampling of named taxa, and intragenomic variation of markers like the ITS, among others (Hibbett and Taylor 2013; Hibbett et al. 2011; Lindner and Banik 2011; Lindner et al. 2013; Taylor 2011). It has also been proposed that fungal naming be completely automated by computer programs (Hibbett and Taylor 2013; Taylor 2011). Typification of taxa known only from environmental samples remains a problem because it is not clear whether such material or data obtained from it would qualify as a type under the ICN, and many mycologists object to the idea that a gram of soil or piece of cow manure filled with large numbers of organisms, some as a spore or two, can serve as a suitable standard for the application of a name or names. Nevertheless, some authors have begun to explore the following questions: What is the absolute minimum that is required to publish a new fungal name? And can this be done with only DNA sequence data? The NCF is currently debating many complicated aspects brought up by these questions in deliberations on whether or not some recently and minimally described fungi are valid names (Tripp and Lendemer 2012). The online serial publication provided by Index Fungorum (http://www.indexfungorum.org/Names/IndexFungorumRegister.htm) has other similar examples. Large-scale naming of fungi based on environmental sequences will likely require modification of the ICN. Given that next-generation sequencing technology is advancing rapidly, the field of molecular ecology is still in its relative infancy, and many taxonomists feel that ITS data alone are entirely inadequate, it may be hasty to rush into the formal description and naming of a large number of environmental sequences based on one marker at this time.

Other changes being considered: Hawksworth (2014) has offered a grab bag of possible proposals for consideration that include issues such as extension of sanctioning to additional works, extending conservation to additional ranks, and more. These will not be considered in detail herein. Kirk et al. (2013) have shown an interest in expanding the coverage of the lists for dealing with the transition to a one-name-per-fungus system of classification to a protected list for all fungal genera via existing rules of the ICN, even though this was not the intent of Redhead's proposal.

IV. Conspectus and the Future of Fungal Naming

Precise communication about fungi and funguslike organisms relies upon the use of names, and the application of a name is determined by means of a nomenclatural type, i.e., a standard. This chapter provides a basic treat-

ment of changes to fungal nomenclature as implemented by the current International Code of Nomenclature for algae, fungi, and plants (Melbourne Code), or ICN. The transition to a one-name-per-fungus system of classification has begun. Several working groups or subcommissions have already organized in loose association with the International Commission on the Taxonomy of Fungi, and a number of them have made progress on lists of names, such as that offered by the Leotiomycetes Working Group (Johnston et al. 2014). The NCF is currently in the process of beginning to look at the lists of names recommended by these groups. It remains to be seen how much progress will be made before the next International Botanical Congress in Shenzhen in 2017. Additionally, essential and basic nomenclatural rules and terminology and notes on how to perform frequently used nomenclatural procedures correctly are covered in this chapter. Most nomenclature must be self-taught because of the lack of courses and experts, and this chapter attempts to provide guidance in its use.

What is the future of fungal naming? Although some mycologists (Money 2013) feel that we should give up on the naming of fungi, fungal names will continue to provide an essential tool for communicating everything that is known about these important organisms. With the incredibly large number of undescribed fungi, the prospects of cataloging this diversity are certainly exciting and daunting for those who are willing and able to do so. Names will be needed to discuss critical ecological questions on how environmental change affects major ecosystems and human welfare. Names will be needed to put together the Fungal Tree of Life and to fill in missing clades as well as help understand fungal evolution and the origins of structural and biochemical diversity (McLaughlin et al. 2009). We mycologists have learned over the years that modifications to the Code create more work and instability of names, but it is hoped that completing the transition to a one-name-per-fungus system of classification will make it easier to communicate about fungi for generations to come. Samuels (2011) provided valuable insights as to his own intellectual struggles regarding a possible transition to a one-name-per-fungus system of classification, and perhaps his most valuable lesson for fungal systematists is to make sure that the most productive times in a career are spent doing exciting and worthwhile mycology. In the words quoted by Walter J. Sundberg, my sorely missed doctoral advisor, are we having fun yet? As for the future of fungal naming, I guess we will find out what we make of it.

References

Blackwell M (2011) The fungi: 1,2,3. . .5.1 million species? Am J Bot 98:426–438

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

Braun U, Farr DF, Minnis AM (2009) Nomenclatural notes on some cercosporoid hyphomycetes. Schlechtendalia 19:81–84

Bureau International des Poids et Mesures (BIPM) (2006) Le Système international d'unités (SI), 8th edn. STEDI Media, Paris

Chapman AD, Turland NJ, Watson MF (2010) Report of the special committee on electronic publication. Taxon 59:1853–1862

Crous PW, Gams W, Stalpers JA, Robert V, Stegehuis G (2004) MycoBank: an online initiative to launch mycology into the 21st century. Stud Mycol 50: 19–22

Crous PW, Giraldo A, Hawksworth DL, Robert V, Kirk PM, Guarro J, Robbertse B, Schoch CL, Damm U, Trakunyingcharoen T, Groenewald JZ (2014) The genera of Fungi: fixing the application of type species of generic names. IMA Fungus 5:141–160

Dearness J (1941) New species of Tennessee fungi. Mycologia 33:360–366

Demoulin V (2010) (185–190) Proposals to amend Articles 15, 36 and 45. Taxon 59:1611–1612

Farr DF, Rossman AY (2014) Fungal Databases, Systematic Mycology and Microbiology Laboratory, ARS, USDA. http://nt.ars-grin.gov/fungaldatabases. Cited 19 Jun 2014

Gams W (2010) (183–184) Proposals to require deposition of information concerning typification of names of fungal taxa, with an associated recommendation. Taxon 59:1610–1611

Gams W, Jaklitsch W (2011) Fungal nomenclature 3. A critical response to the 'Amsterdam Declaration'. Mycotaxon 116:501–512

Gams W, Baral HO, Jaklitsch WM, Kirschner R, Stadler M (2012a) Clarifications needed concerning the new Article 59 dealing with pleomorphic fungi. IMA Fungus 2:175–177

Gams W, Humber RA, Jaklitsch W, Kirschner R, Stadler M (2012b) Minimizing the chaos following the loss

of Article 59: suggestions for a discussion. Mycotaxon 119:495–507
Greuter W, Barrie FR, Burdet HM, Chaloner WG, Demoulin V, Hawksworth DL, Jørgensen PM, Nicolson DH, Silva PC, Trehane P, McNeill J (eds) (1994) International Code of Botanical Nomenclature (Tokyo Code) adopted by the Fifteenth International Botanical Congress Yokohama, August–September 1993. Regnum vegetabile no. 131. Koeltz Scientific Books, Königstein
Hawksworth DL (2001) The naming of fungi. In: McLaughlin DJ, McLaughlin EG, Lemke PA (eds) The mycota, vol VII, Systematics and evolution, Part B. Springer, Berlin, pp 171–192
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. IMA Fungus 2:155–162
Hawksworth DL (2012) Managing and coping with names of pleomorphic fungi in a period of transition. IMA Fungus 3:15–24
Hawksworth DL (2013) Mycospeak and biobabble. IMA Fungus 4:1
Hawksworth DL (2014) Possible house-keeping and other draft proposals to clarify or enhance the naming of fungi within the International Code of Nomenclature for algae, fungi, and plants (ICN). IMA Fungus 5:31–37
Hawksworth DL, Crous PW, Dianese JC, Gryzenhout M, Norvell LL, Seifert KA (2009) (016–020) Proposals to amend the Code to make clear that it covers the nomenclature of fungi, and to modify its governance with respect to names of organisms treated as fungi. Taxon 58:658–659
Hawksworth DL, Cooper JA, Crous PW, Hyde KD, Iturriaga T, Kirk PM, Lumbsch HT, May TW, Minter DW, Misra JK, Norvell LL, Redhead SA, Rossman AY, Seifert KA, Stalpers JA, Taylor JW, Wingfield MJ (2010) (117–119) Proposals to make the pre-publication deposit of key nomenclatural information in a recognized repository a requirement for valid publication of organisms treated as fungi under the Code. Taxon 59:660–662
Hawksworth DL, Crous PW, Redhead SA, Reynolds DR, Samson RA, Seifert KA, Taylor JW, Wingfield MJ, Abaci O, Aime C, Asan A, Bai FY, de Beer ZW, Begerow D, Berikten D, Boekhout T, Buchanan PK, Burgess T, Buzina W, Cai L, Cannon PF, Crane JL, Damm U, Daniel HM, van Diepeningen AD, Druzhinina I, Dyer PS, Eberhardt U, Fell JW, Frisvad JC, Geiser DM, Geml J, Glienke C, Gräfenhan T, Groenewald JZ, Groenewald M, de Gruyter J, Guého-Kellermann E, Guo LD, Hibbett DS, Hong SB, de Hoog GS, Houbraken J, Huhndorf SM, Hyde KD, Ismail A, Johnston PR, Kadaifciler DG, Kirk PM, Kõljalg U, Kurtzman CP, Lagneau PE, Lévesque CA, Liu X, Lombard L, Meyer W, Miller A, Minter DW, Najafzadeh MJ, Norvell L, Ozerskaya SM, Öziç R, Pennycook SR, Peterson SW, Pettersson OV, Quaedvlieg W, Robert VA, Ruibal C, Schnürer J, Schroers HJ, Shivas R, Slippers B, Spierenburg H, Takashima M, Taşkn E, Thines M, Thrane U, Uztan AH, van Raak M, Varga J, Vasco A, Verkley G, Videira SIR, de Vries RP, Weir BS, Yilmaz N, Yurkov A, Zhang N (2011) The Amsterdam declaration on fungal nomenclature. IMA Fungus 2:105–112
Hawksworth DL, McNeill J, de Beer ZW, Wingfield MJ (2013) Names of fungal species with the same epithet applied to different morphs: how to treat them. IMA Fungus 4:53–56
Hibbett DS, Taylor JW (2013) Fungal systematics: is a new age of enlightenment at hand? Nat Rev Microbiol 11:129–133
Hibbett DS, Ohman A, Glotzer D, Nuhn M, Kirk P, Nilsson RH (2011) Progress in molecular and morphological taxon discovery in fungi and options for formal classification of environmental sequences. Fungal Biol Rev 25:38–47
Hoog GS de, Chaturvedi V, Denning DW, Dyer PS, Frisvad JC, Geiser D, Gräser Y, Guarro J, Haase G, Kwon-Chung K-J, Meiss JF, Meyer W, Pitt JI, Samson RA, Taylor JW, Tintelnot K, Vitale RG, Walsh TJ, Lackner M (2014) Name changes in medically important fungi and their implications for clinical practice. J Clin Microbiol. doi:10.1128/JCM.02016-14
International Commission on Zoological Nomenclature (1999) International Code of Zoological Nomenclature, 4th edn. International Trust for Zoological Nomenclature, London
Johnston PR, Seifert KA, Stone JK, Rossman AY, Marvanová L (2014) Recommendations on generic names competing for use in Leotiomycetes (Ascomycota). IMA Fungus 5:91–120
Judith C, Rossman A (2014) Revised scientific names of the genus *Hemileia* (Pucciniales) based on the new ICN. MycoKeys 8:1–10
Kirk PM, Stalpers JA, Braun U, Crous PW, Hansen K, Hawksworth DL, Hyde KD, Lücking R, Lumbsch TH, Rossman AY, Seifert KA, Stadler M (2013) A without-prejudice list of generic names of fungi for protection under the International Code of Nomenclature for algae, fungi, and plants. IMA Fungus 4:381–443
Knapp S, McNeill J, Turland NJ (2011) Changes to publication requirements made at the XVIII International Botanical Congress in Melbourne: what does e-publication mean for you? Taxon 60: 1498–1501
Lindner DL, Banik MT (2011) Intragenomic variation in the ITS rDNA region obscures phylogenetic relationships and inflates estimates of operational taxonomic units in genus *Laetiporus*. Mycologia 103:731–740
Lindner DL, Carlsen T, Nilsson RH, Davey M, Schumacher T, Kauserud H (2013) Employing 454 amplicon pyrosequencing to reveal intragenomic

divergence in the internal transcribed spacer rNDA region in fungi. Ecol Evol 3:1751–1764
Luo J, Zhang N (2013) *Magnaporthiopsis*, a new genus in Magnaporthaceae (Ascomycota). Mycologia 105:1019–1029
McLaughlin DJ, Hibbett DS, Lutzoni F, Spatafora JW, Vilgalys R (2009) The search for the fungal tree of life. Trends Microbiol 17:488–497
McNeill J, Turland NJ (2011a) Synopsis of proposals on botanical nomenclature—Melbourne 2011: a review of the proposals concerning the International Code of Botanical Nomenclature submitted to the XVIII International Botanical Congress. Taxon 60:243–286
McNeill J, Turland NJ (2011b) Major changes to the Code of Nomenclature—Melbourne, July 2011. Taxon 60:1495–1497
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. Gantner, Ruggell
McNeill J, Turland NJ, Monro AM, 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, Prud'homme van Reine WF, Smith GF, Wiersema JH, Turland NJ (eds) (2012) International Code of Nomenclature for algae, fungi, and plants (Melbourne Code) adopted by the Eighteenth International Botanical Congress Melbourne, Australia, July 2011. Regnum vegetabile no. 154. Koeltz Scientific Books, Königstein
Milius S (2014) The name of the fungus: genetic advances spur mycologists to put their kingdom in order. Sci News 185:22–26
Minnis AM, Kennedy AH, Grenier DB, Palm ME, Rossman AY (2012) Phylogeny and taxonomic revision of the Planistromellaceae including its coelomycetous anamorphs: contributions towards a monograph of the genus *Kellermania*. Persoonia 29:11–28
Money NP (2013) Against the naming of fungi. Fungal Biol 117:463–465
Nakada T (2010) (138) A proposal on the designation of cultures of fungi and algae as types. Taxon 59: 983
Norvell LL (2011a) Report of the nomenclature committee for fungi: 17. Taxon 60:610–613
Norvell LL (2011b) Fungal nomenclature. 1. Melbourne approves a new Code. Mycotaxon 116:481–490
Norvell LL, Hawksworth DL, Petersen RH, Redhead SA (2010) Fungal nomenclature. 1. The IMC9 Edinburgh Nomenclature Sessions. Mycotaxon 113: 503–511
Perry G (2011) Comments on proposals for the Melbourne Congress dealing with original material and the typification of sanctioned names. Taxon 60:916–919
Rambold G, Stadler M, Begerow D (2013) Mycology should be recognized as a field in biology at eye level with other major disciplines—a memorandum. Mycol Prog 12:455–463
Redhead SA (2010a) (098–100) Proposals to limit hard-copy publication of Appendices II–V. Taxon 59: 311
Redhead SA (2010b) Report on the special committee on the nomenclature of fungi with a pleomorphic life cycle. Taxon 59:1863–1866
Redhead SA, Norvell LL (2013) Report of the nomenclature committee for fungi 19: official repositories for fungal names. Taxon 62:173–174
Redhead SA, Kirk PM, Keeling PJ, Weiss LM (2009) (048–051) Proposals to exclude the phylum Microsporidia from the Code. Taxon 58:669
Redhead SA, Norvell LL, Pennycook SR (2010) (223–232) Proposals to amend articles regulating the typification of names in sanctioning works. Taxon 59: 1910–1913
Rossman AY (2014) Lessons learned from moving to one scientific name for fungi. IMA Fungus 5:81–89
Rossman AY, Seifert KA, Samuels GJ, Minnis AM, Schroers HJ, Lombard L, Crous PW, Põldmaa K, Cannon PF, Summberbell RC, Geiser DM, Zhuang W-Y, Hirooka Y, Herrera C, Salgado-Salazar C, Chaverri P (2013a) Genera in Bionectriaceae, Hypocreaceae, and Nectriaceae (Hypocreales) proposed for acceptance or rejection. IMA Fungus 4:41–51
Rossman AY, Manamgoda DS, Hyde KD (2013b) Proposal to conserve the name *Bipolaris* against *Cochliobolus* (Ascomycota: Pleosporales: Pleosporaceae). Taxon 62:1331–1332
Samuels G (2011) Some thoughts about naming anamorphs and teleomorphs. MycoAfrica 4(2):11–14
Seifert KA (2014) In defence of the terms holomorph, teleomorph, and anamorph. IMA Fungus 4:55–56
Seifert KA, Rossman AY (2010) How to describe a new fungal species. IMA Fungus 1:109–116
Smith GF, Figueiredo E, Moore G (2011) English and Latin as alternative languages for validating the names of organisms covered by the International Code of Nomenclature for algae, fungi, and plants: the final chapter? Taxon 60:1502–1503
Summerbell RC, Gueidan C, Schroers H-J, de Hoog GS, Starink M, Rosete YA, Guarro J, Scott JA (2011) *Acremonium* phylogenetic overview and revision of *Gliomastix*, *Sarocladium*, and *Trichothecium*. Stud Mycol 68:139–162
Taylor JW (2011) One fungus=one name: DNA and fungal nomenclature twenty years after PCR. IMA Fungus 2:113–120

Tripp EA, Lendemer JC (2012) (4–5) Request for binding decisions on the descriptive statements associated with *Mortierella sigyensis* (fungi: Mortierellaceae) and *Piromyces cryptodigmaticus* (fungi: Neocallimastigaceae). Taxon 61:886–888

Weresub LK, Pirozynski KA (1979) Pleomorphism of fungi as treated in the history of mycology and nomenclature. In: Kendrick B (ed) The whole fungus; the sexual-asexual synthesis. National Museums of Canada, Ottawa, pp 17–30

Wingfield MJ, de Beer ZW, Slippers B, Wingfield BD, Gronewald JZ, Lombard L, Crous PW (2012) One fungus, one name promotes progressive plant pathology. Mol Plant Pathol 13:604–613

Zhang N, Rossman AY, Seifert K, Bennett JW, Cai G, Cai L, Hillman B, Hyde KD, Luo J, Manamgoda D, Meyer W, Molnar T, Schoch C, Tadych M, White JF Jr (2013) Impacts of the International Code of Nomenclature for algae, fungi, and plants (Melbourne Code) on the scientific names of plant pathogenic fungi. Online. APSnet Feature. American Phytopathological Society, St. Paul, MN. http://www.apsnet.org/publications/apsnetfeatures/Pages/Melbourne.aspx. Cited 19 Jun 2014