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ARTICLE

Genera in *Bionectriaceae*, *Hypocreaceae*, and *Nectriaceae* (*Hypocreales*) proposed for acceptance or rejection

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Abstract: With the recent changes concerning pleomorphic fungi in the new *International Code of Nomenclature for algae, fungi, and plants* (ICN), it is necessary to propose the acceptance or protection of sexual morph-typified or asexual morph-typified generic names that do not have priority, or to propose the rejection or suppression[1] of competing names. In addition, sexual morph-typified generic names, where widely used, must be proposed for rejection or suppression in favour of asexual morph-typified names that have priority, or the latter must be proposed for conservation or protection. Some pragmatic criteria used for deciding the acceptance or rejection of generic names include: the number of name changes required when one generic name is used over another, the clarity of the generic concept, their relative frequencies of use in the scientific literature, and a vote of interested mycologists. Here, twelve widely used generic names in three families of *Hypocreales* are proposed for acceptance, either by conservation or protection, despite their lack of priority of publication, or because they are widely used asexual morph-typified names. Each pair of generic names is evaluated, with a recommendation as to the generic name to be used, and safeguarded, either through conservation or protection. Four generic names typified by a species with a sexual morph as type that are younger than competing generic names typified by a species with an asexual morph type, are proposed for use. Eight older generic names typified by species with an asexual morph as type are proposed for use over younger competing generic names typified by a species with a sexual morph as type. Within *Bionectriaceae, Clonostachys* is recommended over *Bionectria*; in *Hypocreaceae, Hypomyces* is recommended over *Cladobotryum, Sphaerostilbella* over *Gliocladium*, and *Trichoderma* over *Hypocrea*; and in *Nectriaceae, Actinostilbe* is recommended over *Lanatonectria*, *Cylindrocladiella* over *Nectricladiella*, *Fusarium* over *Gibberella*, *Gliocephalotrichum* over *Leuconectria*, *Gliocladiopsis* over *Glionectria*, *Nalanthamala* over *Rubrinectria*, *Nectria* over *Tubercularia,* and *Neonectria* over *Cylindrocarpon*.

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INTRODUCTION

The International Code of Nomenclature for algae, fungi and plants (ICN) states that "…for a taxon of non-lichen-forming *Ascomycota* and *Basidiomycota*… [all names] compete for priority" regardless of their particular morph (Article 59.1, McNeill *et al*. 2012). This stipulates that only one scientific name be used for each species of fungi, contrary to previous editions of the *International Code of Botanical Nomenclature* and its predecessors. The preceding *Code* "…provided for separate names for mitotic asexual morphs (anamorphs) of certain pleomorphic fungi …" (Note 2. McNeill *et al*. 2006, 2012; Norvell 2011). As a result, the nomenclature of fungi must now conform to the principle of priority that applies to other groups of organisms governed by this *Code*. This change came into effect on 30 July 2011, when the decisions of the Nomenclature Section were ratified by the plenary session of the Melbourne Congress, although the application of some aspects was delayed until 1 January 2013.

In determining which binominal to use for a fungal species, it is necessary first to give priority to the oldest generic name when different sexual morph-typified and asexual morph-typified names apply to the same taxon. For example, the sexual morph-typified name *Calonectria* De Not. 1867 (type: *C. pyrochroa* (Desm.) Sacc. 1878) and asexual morph-typified name *Cylindrocladium* Morgan 1892 (type: *Cyl. scoparium* Morgan1892) circumscribe the same group of species. Following the principle of priority, *Calonectria* is the older name and thus should be used for this genus. The genus *Cylindrocladium* is considered a synonym of *Calonectria*. All species names that belong to this genus, whether or not their type species exhibits the sexual or asexual morph, must be placed in *Calonectria* (Lombard *et al*. 2010). Even species that do not show evidence of a sexual morph, but are recognized as congeneric with the type species, are placed in that genus. Within a single genus, all species names now compete for priority regardless of their morph, and thus the oldest species epithet should be placed in the genus that has priority.

In some cases it may be useful to make an exception to the principle of priority allowing the use of a generic name or species epithet that is not the oldest. For example *Cladobotryum varium* Nees 1816, the type species of the genus, is the asexual morph of *Hypomyces aurantius* (Pers.) Tul. & C. Tul. 1860. *Cladobotryum* Nees 1816 is older than *Hypomyces* (Fr.) Tul. & C. Tul. 1860, typified by *H. lactifluorum*. Thus, the ICN stipulates that *Hypomyces* is considered a later synonym of *Cladobotryum*. However, because *Hypomyces* is far more commonly used than *Cladobotryum,* it is preferable to preserve the younger name. Such exceptions could be made, for example, in the case of long established scientific names of fungi judged to be important in some respect. The ICN allows for this in several ways, as described in Arts 14 and 56. As for all organisms covered by this *Code*, generic and/or species names may be conserved by writing a conservation proposal that is published in *Taxon* and eventually approved or rejected by the Nomenclatural Committee for Fungi (NCF) and the General Committee (GC) of the International Association for Plant Taxonomy (IAPT). Alternatively, according to Art. 14.13, "…lists of names may be submitted to the General Committee….Accepted names…are to be listed with their types together with those competing synonyms against which they will be treated as conserved…". These lists will be reviewed and approved by the appropriate bodies of the IAPT. Similarly, names may be proposed for rejection under Art. 56.1 or put on a list to be treated as rejected under Art. 56.3, where they are processed in the same manner as Arts 14.1 and 14.13. Rejected names may not be used unless later conserved under Art. 14, thus the use of rejection should be considered seriously.

According to Art. 57.2 "…in cases where…both teleomorph-typified and anamorph-typified names were widely used for a taxon, an anamorph-typified name that has priority is not to displace the teleomorph name(s) unless and until a proposal to reject the former under Article 56.1 or 56.3 or to deal with the latter under Article 14.1 or 14.13 has been submitted and rejected." This requires that use of an asexual morph-typified generic or species name must be approved or at least the use of the sexual morph-typified name rejected prior to the use of the asexual morph-typified name for the taxon.

A number of criteria have been suggested for determining the accepted status of a generic name (Hawksworth 2011). These include the number of name changes required when one generic name is used over another. For example, in the case of *Cochliobolus* Drechsler 1934 *versus Bipolaris* Shoemaker 1959, *Cochliobolus* is the older generic name, but most of the species were described in *Bipolaris*. If the older name *Cochliobolus* is used, many of the species described in *Bipolaris* would have to be transferred into *Cochliobolus*, while if *Bipolaris* were protected over *Cochliobolus*, only one scientific name would have to be changed (Manamgoda *et al.* 2012).

Another important criterion concerns the clarity of the generic concept. Some fungi have a reduced morphology, such as yeast fungi or those having simple phialides and non-septate hyaline conidia (i.e an acremonium-like morphology). Generic names have been applied that refer only to the morphology rather than to a well-defined genus. Thus the name *Acremonium* Link 1809 has been used for a range of species that are phylogenetically diverse with species now placed in *Leotiomycetes* and at least 12 orders of *Sordariomycetes* (Summerbell *et al*. 2011). Noting the critical and careful work of Gams (1971) in collecting cultures compatible with the well preserved type specimen of the type species, *Acremonium alternatum* Link 1809, Summerbell *et al*. (2011) designated an epitype that places that species, and so the generic name *Acremonium,* in the core group of medically and phytopathologically important species. This group has no well established contending names.

[1]The terms "conservation" and "rejection" are used here for names ruled as *nomina conservanda* or *nomina rejicienda* under the ICN (Arts 14.1, 56.1). In contrast, "protected" and "suppressed" are terms used here for names to be placed on lists of fungal names under Arts 14.3, 56.3). The terms "list-accepted" and "list-demoted" proposed by Gams *et al.* (2012) are equivalent to "protected" and "suppressed", respectively, as used in this article

Therefore, it is recommended that this name remain in active biosystematic use despite the reduced morphology. On the other hand, the generic name *Uredo* Pers. 1801 has been used for a diverse range of asexual morphs of rust fungi and will most likely be abandoned. Names such as uredo-like can be maintained for use as a descriptor of common but phylogenetically uninformative characters. That format separates such terms from classification or formal binominals and is not regulated by the ICN.

The relative frequencies of use of each generic name in the scientific literature has been mentioned as a criterion for deciding the most appropriate generic or species name for protection (Hawksworth 2012). A comprehensive evaluation of peer-reviewed scientific literature allows the context of name usage to be determined. For example, the generic name *Botryotinia,* with a type species typified by a sexual morph, is frequently used in the literature but almost always in direct association with the much more broadly used name *Botrytis*, which has a type species typified by an asexual morph. Similarly, for generic concepts that are not precisely defined, high numbers of citations can arise because the name has been widely applied but very imprecisely. In another case, and if using the inaccurate number of Google "hits", the name may have more than one meaning such as for *Valsa* in which Google hits include those that refer to the Valsavar maneuver. Searches of scholarly databases are useful indicators if the scientific name is widely known in the literature, such as a scientific name that refers to a common plant disease as for *Venturia inaequalis*, cause of apple scab, or *Clonostachys rosea*, a widely reported biocontrol agent. If a comprehensive literature review is not possible, searches of scholarly databases such as *Scopus*, *Biological Abstracts*, or *CAB Abstracts* are likely to be far more robust than Google.

Another approach is to request input from the community of scientists interested in a particular name and discuss the advantages/disadvantages of the adoption of each name. This may result in agreement on the best choice with a straw poll or voting on the issue. For some of the genera discussed here, such as *Hypocrea* vs. *Trichoderma*, considerable discussion has taken place. In cases where the number of votes for each name are about equal, it would seem expedient to apply the principle of priority, provided that those voting include users of names and not only systematists.

Here we discuss 12 genera from three families of *Hypocreales*, namely *Bionectriaceae*, *Hypocreaceae*, and *Nectriaceae*, that are proposed for acceptance either because they are typified by a sexual morph and do not have priority, or have priority but are asexual morph-typified. Some asexual morph-typified genera that have priority and will displace a sexual morph-typified genus are proposed for approval, i.e. the sexual morph-typified name is proposed for abandonment. For each genus, the type species is given along with the competing name(s) and rationale for using the proposed generic name. These generic names are summarized in Table 1, and some affected family names are treated in Table 2. We do, however, point out that there is no objection under the ICN to the name of a family based on the stem of a now synonymized generic name being used, as in the case of *Ceratostomataceae* G. Winter 1885 where *Ceratostoma* Fr. 1818 has long been recognized as a synonym of *Melanospora* Corda 1837. These proposed exceptions to the application of the principle of priority will now need to be evaluated by the procedures established by the ICN.

NOMENCLATURAL PROPOSALS

BIONECTRIACEAE

Clonostachys Corda 1839 vs. *Bionectria* Speg. 1919

Clonostachys is an asexual morph-typified genus that has priority over the sexual morph-typified genus *Bionectria*. The type species of *Clonostachys* is *C. araucaria* Corda 1839, now considered a synonym of *C. rosea* (Link) Schroers *et al.* 1999 (basionym *Penicillium roseum* Link 1816), anamorph of *B. ochroleuca* (Schwein.) Schroers & Samuels 1997. The type species of *Bionectria* is *B. tonduzi* Speg. 1919. *Bionectria tonduzi* is not well characterized; it is known only from the type specimen and has not been cultured. According to Schroers (2001), the type specimen of *B. tonduzi* includes a *Clonostachys macrospora*-like asexual morph. Although they have different species as their types, these two genera have consistently been considered congeneric. Neither genus name has a taxonomically or phylogenetically confused history that would confound interpretation of the historical literature. *Clonostachys rosea* (syn. *Gliocladium roseum* Bainier 1907) is a biocontrol agent (Schroers *et al*. 1999) that is commonly isolated from soil and found growing on woody substrates. Its sexual morph is frequently encountered only in tropical regions, and mainly on recently dead woody hosts. The name *Clonostachys rosea* has a well defined species concept, is well established in the literature, and is of importance to applied mycologists. *Bionectria* has seldom been used outside the taxonomic literature. Based on the monograph of *Bionectria* and *Clonostachys* by Schroers (2001), no matter which generic name is used, the number of required name changes is equal, specifically 16; however, not all of the 43 names in *Bionectria* nor the 67 names in *Clonostachys* were considered in that study. Because the name *Clonostachys rosea* is commonly used in biocontrol studies, we propose the protection of the older asexual morph-typified name *Clonostachys* for this genus.

Bionectria typifies the fungal family *Bionectriaceae* Samuels & Rossman 1999, which has been frequently cited. By contrast the family name *Spicariaceae* Nann. 1934, based on *Clonostachys solani* (Harting) Schroers & W. Gams 2001 (basionym *Spicaria solani* Harting 1846), has hardly been used in literature. We suggest protecting this family name, despite the synonymy of *Bionectria* and *Clonostachys,* and maintaining the use of the name *Bionectriaceae* for the family.

HYPOCREACEAE

Hypomyces (Fr.) Tul. & C. Tul. 1860 vs. *Sepedonium* Link 1809 vs. *Mycogone* Link 1809 vs. *Cladobotryum* Nees 1817 vs. *Stephanoma* Wallr. 1833

Hypomyces is typified by *H. lactifluorum* (Schwein.) Tul. & C. Tul. 1860, a species growing on basidiomes of *Russulaceae* that has no known asexual morph. Most conidial morphs of

Table 1. Proposals for protected or suppressed generic names and their type species in *Hypocreales*[1]. Names to be protected are in **bold** type[2].

Bionectriaceae	
Clonostachys Corda, *Pracht-Fl. Eur. Schimmelbild.*: 31 (1839)	(=) *Bionectria* Speg. in *Boln Acad. nac. Cienc. Córdoba* **23**: 563 (1919)
Typus: *C. rosea* (Link) Schroers *et al*. (1999) (*C. araucaria* Corda (1839), now considered a synonym of basionym *Penicillium roseum* Link (1816)	Typus: *B. tonduzi* Speg.
Hypocreaceae	
Hypomyces (Fr.) Tul. & C. Tul. in *Annls Sci. Nat.*, Bot., sér. 4 **13**: 11 (1860) (*Hypocrea* subg. *Hypomyces* Fr., *Syst. orb. veg.* (Lundae) **1**: 105 (1825).	(=) *Cladobotryum* Nees, *Syst. Pilze* (Würzburg): 56 (1816) 1817.
Typus: *H. lactifluorum* (Schwein.) Tul. & C. Tul. (*Sphaeria lactifluorum* Schwein.)	Typus: *C. varium* Nees
	(=) *Gliocladium* Corda, *Icon. fung.* (Prague) **4**: 30 (1840)
Sphaerostilbella (Henn.) Sacc. & D. Sacc., *Syll. fung.* (Abellini) **17**: 778 (1905) (*Sphaerostilbe* subgen. *Sphaerostilbella* Henn. in *Bot. Jb*. 30: 40 1901)	
Typus: *S. lutea* (Henn.) Sacc. & D. Sacc. (*Sphaerostilbe lutea* Henn.)	Typus: *G. penicillioides* Corda
	(=) *Hypocrea* Fr., *Syst. orb. veg.* (Lundae) 1: 104 (1825)
Trichoderma Pers., in *Neues Mag. Bot.* 1: 92 (1794)	
Typus: *T. viride* Pers.	Typus: *H. rufa* (Pers.) Fr. (*Sphaeria rufa* Fr.)
Nectriaceae	
Actinostilbe Petch in *Ann. R. bot. Gdns Peradeniya* **9**: 327 (1925).	(=) *Lanatonectria* Samuels & Rossman in *Stud. Mycol.* **42**: 137 (1999) .
Typus: *A. vanillae* Petch	Typus: *L. flocculenta* (Henn. & E. Nyman) Samuels & Rossman (*Nectriella flocculenta* Henn. & E. Nyman)
Cylindrocladiella Boesew. in Can. J. Bot. **60**: 2289 (1982).	(=) *Nectricladiella* Crous & C.L. Schoch in *Stud. Mycol*. **45**: 54 (2000).
Typus: *C. parva* (P.J. Anderson) Boesew.	Typus: *N. camelliae* (Shipton) Crous & C.L. Schoch
Fusarium Link in *Mag. Gesell. naturf. Freunde, Berlin* **3**: 10 (1809).	(=) *Gibberella* Sacc. in *Michelia* **1**: 43 (1877).
Typus: *F. roseum* Link, synonym of *F. sambucinum* Fuckel, nom. cons.	Typus: *G. pulicaris* (Fr.) Sacc.
Gliocephalotrichum J.J. Ellis & Hesselt. in *Bull. Torrey bot. Club* **89**: 21 (1962). Typus: *G. bulbilium* J.J. Ellis & Hesselt.	(=) *Leuconectria* Rossman & al. in *Mycologia* **85**: 686 (1993). Typus: *L. clusiae* (Samuels & Rogerson) Rossman & al. (*Pseudonectria clusiae* Samuels & Rogerson)
Gliocladiopsis S.B**.** Saksena in *Mycologia* **46**: 663 (1954).	(=) *Glionectria* Crous & C.L. Schoch in *Stud. Mycol*. **45**: 58 (2000).
Typus: *G. sagariensis* S.B. Saksena	Typus: *Gn. tenuis* Crous & C.L. Schoch
Nalanthamala Subram. in *J. Indian Bot. Soc.* **35**: 478 (1956).	(=) *Rubrinectria* Rossman & Samuels 1999 in *Stud. Mycol.* **42**: 164 (1999).
Typus: *N. madreeya* Subram.	Typus: *R. olivacea* (Seaver) Rossman & Samuels (*Macbridella olivacea* Seaver)
Nectria (Fr.) Fr., *Summa veg. Scand.*, Section Post. (Stockholm): 387 (1849).	(=) *Tubercularia* Tode, *Fung. mecklenb. sel.* (Lüneburg) **1**: 18 (1790). Typus: *T. vulgaris* Tode
(*Hypocrea* sect. *Nectria* Fr. *Syst. orb. veg*. (Lundae) 1: 105 (1825).	
Typus: *N. cinnabarina* (Tode : Fr.) Fr. (*Sphaeria cinnabarina* Tode : Fr.)	
Neonectria Wollenw. in *Annls mycol.* **15**: 52 (1917).	(=) *Cylindrocarpon* Wollenw. in *Phytopathology* **3**: 225 (1913).
Typus: *N. ramulariae* Wollenw.	Typus: *C. cylindroides* Wollenw.

[2]The entries are formatted here as in the Appendices of the Vienna Code (McNeill *et al*. 2006) except that dates of publication are placed in parentheses.

Table 2. Proposals for protected or suppressed familial names and their type genera in *Hypocreales.* Names proposed for protection are in bold.

Bionectriaceae Samuels & Rossman in *Stud. Mycol.* **42:** 15 (1999). Typus: *Bionectria* Speg.	(=) *Spicariaceae* Nann. in *Repert. Mic. Uomo:* 451 (1934). Typus: *Spicaria* Harting
Hypocreaceae De Not. in *G. Bot. Ital.* **2**: 48 (1844) as "Hypocreacei". Typus: *Hypocrea* Fr.	(=) *Trichodermataceae* Fr., *Syst. Orb. Veg. (Lundae)* **1**: 144 (1825) as "*Trichodermacei*". Typus: *Trichoderma* Pers. : Fr.
Nectriaceae Tul. & C. Tul., *Select. Fung. Carpol. (Paris)* **3**: 3 (1865) as "*Nectriei*". Typus: *Nectria* (Fr.) Fr.	(=) *Tuberculariaceae* Fr., *Syst. Orb. Veg. (Lundae)* **1**: 169 (1825) as "*Tuberculariini*". Typus: *Tuberculariа* Tode : Fr.

Hypomyces and related species without sexual morphs are classified in *Cladobotryum* typified by *C. varium* Nees 1816, the anamorph of *H. aurantius* (Pers. : Fr.) Tul. & C. Tul. The type species of *Cladobotryum* is closely related to and considered congeneric with the type species of *Hypomyces,* thus *Cladobotryum* has priority over *Hypomyces*. *Hypomyces* is a well-known genus with 197 names, of which 68 have been included in monographic studies over the past three decades (Rogerson & Samuels 1985, 1989, 1993, 1994, Põldmaa *et al*. 1997, Põldmaa 2003, 2011, Põldmaa & Samuels 1999, 2004). *Cladobotryum* includes 67 names, with a majority applying to species without a known sexual morph. Based on the usage and familiarity of the names, we propose that *Hypomyces* be protected against *Cladobotryum*.

No comprehensive phylogenetic analysis of most species of *Hypomyces* exists, but species in the genus have diverse asexual morphs that tend to be restricted to specific groups of host fungi. Published results reveal that the genus is most likely paraphyletic (Põldmaa 2000, Põldmaa & Samuels 2004) or may be too broadly circumscribed. The asexual morph of *Hypomyces cervinigenus* Rogerson & Simms 1971 has been described in *Mycogone* Link 1809, typified by *M. rosea* Link 1809, a species lacking a known sexual morph. Another genus typified by an asexual morph, *Sepedonium* Link 1809 based on *S. mycophilum* (Pers.) Link 1809, has been connected with species of *Hypomyces* growing exclusively on *Boletales*. *Stephanoma* Wallr. 1833, typified by *S. strigosum* Wallr. 1833, is connected with *H. stephanomatis* Rogerson & Samuels 1985. These three asexual morph-typified genera are more distantly related to the type species of *Hypomyces* than most members of *Cladobotryum,* and thus may not be congeneric. In its current circumscription, the generic name *Hypomyces* should also be protected against the other asexual morph-typified genera *Mycogone, Sepedonium,* and *Stephanoma*.

Sphaerostilbella (Henn.) Sacc. & D. Sacc. 1905 vs. *Gliocladium* Corda 1840

The genus *Sphaerostilbella* is based on *S. lutea* (Henn.) Sacc. & D. Sacc. 1905 and produces an asexual morph referred to as *Gliocladium aurifilum* (Gerard) Seifert *et al*. 1985 (basionym *Stilbum aurifilum* Gerard 1874). The genus *Gliocladium* is based on *G. penicillioides* Corda 1840, the asexual morph of *Sphaerostilbella aureonitens* (Tul. & C. Tul.) Seifert *et al.* 1985, a parasite of *Stereum* (Seifert 1985). Phylogenetic analyses indicate that *Sphaerostilbella lutea* and *G. penicillioides* are congeneric (Rehner & Samuels 1994), and it presently seems unlikely that these two species would ever be classified in different genera. Although *Gliocladium* has priority over *Sphaerostilbella, Gliocladium* was used historically for species with penicillate conidiophores and slimy aseptate conidia that are now known to be phylogenetically diverse. Among the 63 named species, the most commonly cited species are *G. roseum* (see discussion of *Clonostachys* above) and *G. virens* Miller *et al*. 1958, both involved in research on the biological control of soil borne plant diseases. *Gliocladium roseum* is now regarded as *Clonostachys rosea*, the asexual morph of *Bionectria ochroleuca* (*Bionectriaceae*; see above). *Gliocladium virens* is placed in *Trichoderma* as *T. virens* (Miller *et al*.) Arx 1987, the asexual morph of *Hypocrea virens* Chaverri & Samuels 2011 (Chaverri *et al*. 2001). *Gliocladium deliquescens* Sopp. 1912 (syn. *G. viride* Matr. 1893, non *T. viride* Pers. 1794) is the asexual morph of *Hypocrea lutea* (Tode) Petch 1937. Other species of *Gliocladium* are now known to be species of *Cephalotheca*[3] (*G. prolificum), Clonostachys, Gliocephalis (Gliocladium pulchellum), Metarhizium (M. viridicolumnare), Myrothecium, Nalanthamala, Nectriopsis broomeana* (*G. microspermum), Tolypocladium,* or *Trichoderma*. The majority of *Gliocladium* species have not been re-evaluated in modern terms but, apart from those accepted by Seifert (1985), are unlikely to be species of *Sphaerostilbella*. Although the morphological concept of *Gliocladium* was useful for identification, the polyphyletic distribution of the included species and its frequent use in the historical literature in a form-genus sense, calls into question its continued use. From a taxonomic perspective, it has been used in a phylogenetically consistent sense for the past 25 years, but this has not been true in the applied literature, where the form-genus concept still predominates.

Sphaerostilbella was an obscure sexual morph-typified genus until reintroduced by Seifert (1985). *Sphaerostilbella* has therefore appeared much less often in the mycological literature and is a name recognizable to far fewer applied mycologists than *Gliocladium*. However, since 1985, this name has been used for a consistent morphological and biological concept that molecular data confirm is monophyletic. Presently, there are seven named species, five with named and one with unnamed *Gliocladium* morphs,

[3]Author citations and dates are not provided for names of fungi mentioned in this article unless pertinent to the issues of priority and typification under discussion.

and one with a verticillium-like anamorph. Among the nine species known in this clade, seven have known sexual morphs. Adoption of either name for this clade would require four new combinations. We suggest that the continued use of the generic name *Gliocladium* will lead to confusion interpreting the literature and function as a "persistent source of error". Because use of the younger name *Sphaerostilbella* would favour clarity of communication, we propose to protect *Sphaerostilbella* against *Gliocladiium.*

Trichoderma 1794 vs. *Hypocrea* Fr. 1825

Trichoderma Pers. 1794 typified by *T. viride* Pers. 1794 is an asexual morph-typified name and has priority over *Hypocrea* Fr. 1825 typified by *H. rufa* (Pers.) Fr. 1825, a sexual morph-typified name. Over the past ten years, considerable systematic research has been conducted on *Trichoderma* and *Hypocrea* (Bissett 1984, 1991a, b, Chaverri *et al*. 2003, Degenkolb *et al*. 2008a, Jaklitsch 2009, 2011, Samuels *et al*. 2012). Both *Trichoderma* and *Hypocrea* are in one monophyletic clade. *Trichoderma* includes a number of species that have proven useful in the biocontrol of fungal diseases and biotechnology as a source of industrial enzymes and species are frequently isolated as endophytes (Harman & Kubicek 1998, Kubicek & Harman 1998, Evans *et al*. 2003, Degenkolb *et al*. 2008b). Commercially available biocontrol products such as SoilGard (*T. virens*); and Rootshield (Bioworks Inc., *T. harzianum)* are based on named *Trichoderma* species and several US patents have been issued for *Trichoderma* species in diverse projects, including cellulose production, biofuels production, inhibition of nematodes, plant growth stimulation, and biopesticides to name a few. Specimens of *Hypocrea* are macroscopic, frequently collected on rotting wood, and thus are often included in fungal surveys (Dingley 1957, Doi 1972, Jaklitsch 2009, 2011).

Against the selection of *Trichoderma* over *Hypocrea* is that far more names of *Hypocrea* (approximately 1000) have been proposed than in *Trichoderma* (approximately 215), potentially necessitating considerable nomenclatural disruption if *Trichoderma* is accepted. A second reason for not preserving *Trichoderma* over *Hypocrea* is that, while *Hypocrea* as a genus is morphologically conservative and easily recognized, the asexual morphs of several species are morphologically unlike the type species, *Trichoderma viride,* or other divergent species such as *T. polysporum.* They would not be immediately recognized as *Trichoderma* despite their phylogenetic inclusion in the genus. Moreover, some holomorphic species, such as *H. peltata* Jungh. and *H. spinulosa,* are not known to have asexual morphs.

In the case of *Trichoderma* vs. *Hypocrea,* considerable disruption will result regardless of which genus is given priority. If *Hypocrea* is adopted, there will be relatively few nomenclatural changes, but the impact on the user communities will be tremendous and the morphological concept of the phylogenetic *Trichoderma* will be greatly modified. On the other hand, if *Trichoderma* is selected, a potentially daunting number of transfers from *Hypocrea* into *Trichoderma* are possible, but the impact on the user communities will be minimal. For several months of 2011–2012 a vote was organized by the International Subcomission on *Trichoderma* and *Hypocrea* taxonomy (www.isth.info) to determine the will of the *Trichoderma*/*Hypocrea* user communities as regards adoption of *Trichoderma*. As of 30 Nov. 2012, 75 people had voted, of whom 54 favored *Trichoderma* and 22 favored *Hypocrea*. Thus the clear preference of the *Trichoderma* user communities is for adoption of *Trichoderma* rather than *Hypocrea.* Although *Hypocrea* typifies the family *Hypocreaceae* and order *Hypocreales*, these familial and ordinal names are retained despite the synonymy of *Hypocrea* with *Trichoderma* (Art. 11). Given the preponderance of *Trichoderma* usage in the applied literature, and given that few *Hypocrea* species have been reported more than once, we recommend that the use of the name *Hypocrea* be discontinued in favour of *Trichoderma*.

NECTRIACEAE

Actinostilbe Petch 1925 vs. *Lanatonectria* Samuels & Rossman 1999

The sexual morph-typified genus *Lanatonectria* was established for nectria-like species having red ascomata with distinct yellow, curly hairs, and *Actinostilbe* asexual states (Rossman *et al*. 1999). The type species of *Actinostilbe, A. vanillae* Petch 1925, has distinctive yellow hairs, although no sexual state is known for this species. The type species of *Lanatonectria, L. flocculenta* (Henn. & E. Nyman) Samuels & Rossman 1999, is the asexual state *A. macalpinei* (Agnihothr. & G.C.S. Barua) Seifert & Samuels 1999. Five species have been placed in *Lanatonectria*, two of which have *Actinostilbe* asexual states; these species are relatively common in the tropics. Given the relative obscurity of these genera, the recent date of the sexual morph generic name, and the few names involved, we propose to that the name *Lanatonectria* be abandoned in favour of the older and more widely used asexual morph-typified generic name *Actinostilbe*. Three new combinations are required and made below[4].

Cylindrocladiella Boesew. 1982 vs. *Nectricladiella* Crous & C. L. Schoch 2000

The generic name *Cylindrocladiella* Boesew. 1982 was proposed by Boesewinkel (1982) to accommodate cylindrocladium-like species with small conidia and aseptate stipe extensions with *C. parva* (P.J. Anderson) Boesew.

[4]**Actinostilbe flocculenta** (Henn. & E. Nyman) Rossman, Samuels & Seifert, **comb. nov**.
MycoBank MB802534
Basionym: *Nectriella flocculenta* Henn. & E. Nyman, in Warburg, *Monsunia* **1**:160 (1899).
Actinostilbe flavolanata (Berk. & Broome) Rossman, Samuels & Seifert, **comb. nov**.
MycoBank MB802535
Basionym: *Nectria flavolanata* Berk. & Broome, *J. Linn. Soc., Bot*. **14**: 114 (1873).
Actinostilbe oblongispora (Y. Nong & W.Y. Zhuang) Rossman, Samuels & Seifert, **comb. nov.**
MycoBank MB802536
Basionym: *Lanatonectria oblongispora* Y. Nong & W.Y. Zhuang, *Fungal Diversity* **19**: 98 (2005).

1982 as type species. Although Peerally (1991) contested the placement of several *Cylindrocladium* species in *Cylindrocladiella*, Schoch *et al*. (2000) were able to confirm the separate generic status of *Cylindrocladiella*. The sexual morph-typified genus *Nectricladiella* Crous & C.L. Schoch 2000 was introduced with *N. camelliae* (Shipton) Crous & C.L. Schoch 2000 as type species. Recently, Lombard *et al* (2012) were able to show that *N. infestans* Boesew. 1982 was incorrectly linked to the asexual morph-typified species *C. infestans,* and therefore introduced the name *C. pseudoinfestans* L. Lombard & Crous 2012 as a replacement for *N. infestans* auct. Currently there are 26 names accepted in *Cylindrocladiella* and only one name in the genus *Nectricladiella* (*N. camelliae* linked to *C. microcylindrica* Crous & D. Victor 2000), and therefore we propose to that the generic name *Cylindrocladiella* be protected over *Nectricladiella*.

Fusarium Link 1809 vs. *Gibberella* Sacc. 1877

The genus *Fusarium* Link 1809 : Fr. is typified by *Fusarium roseum* Link 1809, now considered to be *F. sambucinum* Fuckel 1870 nom. cons. The genus *Gibberella* Sacc. 1877 is typified by *Gibberella pulicaris* (Fr.) Sacc. 1887 having an asexual state referred to as *Fusarium sambucinum*, an important pathogen on potatoes. The genus *Fusarium* includes many important plant pathogens. *Fusarium oxysporum* Schltdl. 1824 has no known sexual state, but has been shown to belong in *Fusarium* in the strict sense including those species that have *Gibberella* sexual states. There is no question that the genera *Fusarium* and *Gibberella* are synonyms. The genus *Fusarium* is well characterized phylogenetically and can be considered as one large genus (Geiser *et al*., 2012) or as several major clades some of which have sexual morph-typified generic names (Rossman *et al*. 1999, Schroers *et al*. 2011). None of these names compete with *Fusarium* in the narrow sense. They include *Albonectria* Rossman & Samuels 1999, *Cyanonectria* Samuels & Chaverri 2009, *Geejayessia* Schroers *et al.* 2011, and *Neocosmospora* E. F. Sm. 1899 (Gräfenhan *et al*. 2011, Schroers *et al.* 2011). Although opinions differ on how to circumscribe the genus *Fusarium*, there is universal agreement that the asexual morph-typified generic name *Fusarium* should be used instead of the sexual morph-typified *Gibberella.* It is proposed here that *Gibberella* be suppressed in favour of *Fusarium*.

Exclusion of the *Fusarium epispheria*-group from the genus *Fusarium* is widely accepted based on the phylogenetic distance of these species from the core species of *Fusarium* mentioned above. These species have sexual states placed in *Cosmospora* Rabenh. 1862 *sensu lato*, although this genus has been divided into additional genera (Gräfenhan *et al*. 2011). Their biology differs from the species of *Fusarium* discussed above in being primarily fungicolous and insecticolous, rather than plant pathogenic.

Gliocephalotrichum J.J. Ellis & Hesselt. 1962 vs. *Leuconectria* Rossman *et al.* 1993

The genus *Gliocephalotrichum* J.J. Ellis & Hesselt. 1962, typified by *G. bulbillium* J.J. Ellis & Hesselt. 1962, includes seven described species. When a sexual state was discovered for the type species, a new genus, *Leuconectria*, was described with the type*, L. clusiae* Samuels & Rogerson) Rossman *et al*. (1993) (basionym: *Pseudonectria clusiae* Samuels & Rossman 1990). Species of *Gliocephalotrichum* have been widely reported from soils. Given the relative obscurity of *Leuconectria,* with only two species, and the need to make name changes if *Leuconectria* were used, we propose that the sexual morph-typified generic name *Leuconectria* be suppressed in favour of the asexual morph-typified name *Gliocephalotrichum,* which has priority by date. Only a single new combination is required by this decision[5].

Gliocladiopsis S.B. Saksena 1954 vs. *Glionectria* Crous & C.L. Schoch 2000

The genus *Gliocladiopsis* S.B. Saksena 1954, based on *G. sagariensis* S.B. Saksena 1954, was introduced by Saksena (1954) to accommodate a fungal isolate from soil that has penicillate conidiophores resembling *Penicillium* and *Gliocladium*. This genus was initially synonymized under *Cylindrocarpon* (Agnihothrudu 1959) and *Cylindrocladium* (Barron 1968), but resurrected by Crous & Wingfield (1993) and characterized by dense, penicillate conidiophores producing aseptate to 1-septate cylindrical conidia and lacking sterile stipe extensions distinguishing it from *Cylindrocladiella* and *Cylindrocladium*. The generic status of *Gliocladiopsis* was further confirmed by Schoch *et al*. (2000), who introduced the generic name *Glionectria* Crous & C. L. Schoch 2000, with the type species *G. tenuis* Crous & C. L. Schoch 2000, the presumed sexual morph of *Gliocladiopsis. tenuis* (Bugn.) Crous & M.J. Wingf. 1993. Lombard & Crous (2012) distinguished *G. sagariensis* from *G. tenius* based on phylogenetic inference. That study also proposed *G. pseudotenuis* as a new name for the asexual morph of *Gliocladiopsis tenuis*, which was shown to be distinct from *G. tenuis*. Therefore we propose the protection of the genus name *Gliocladiopsis* over the generic name *Glionectria.*

Nalanthamala Subram. 1956 vs. *Rubrinectria* Rossman & Samuels 1999

The sexual morph-typified genus *Rubrinectria* was established for nectria-like species having red perithecioid ascomata with “a green-tinged, warted wall, golden-brown, coarsely striate ascospores,…” (Rossman *et al.* 1999) and a complex anamorph including penicillium-like and sporodochial structures bearing conidia in chains and an acremonium-like synanamorph forming conidial heads (Schroers et al. 2005). The type and only species, *R. olivacea* (Seaver) Rossman & Samuels 1999 (basionym: *Macbridella olivacea* Seaver 1910), is a relatively common tropical fungus that occurs on dead woody stems of palms and other woody substrates. The sexual morph of *R. olivacea* was later identified as an unnamed *Nalanthamala* species by Schroers et al. (2005), who included seven species in that asexual morph-typified genus. The type species of *Nalanthamala*, *N. madreeya*

[5]**Gliocephalotrichum grande** (Y. Nong & W.Y. Zhuang) Rossman & L. Lombard, **comb. nov.**

MycoBank MB802537

Basionym: *Leuconectria grandis* Y. Nong & W.Y. Zhuang, *Fungal Diversity* **24**: 349 (2007).

Subram. 1956, is relatively unknown and there is no extant culture, but, based on the original description, Schroers et al. (2005) concluded that three economically important species should be recognized in *Nalanthamala*: *N. diospyri* (Crandall) Schroers & M.J. Wingf. 2005, the persimmon wilt fungus; *N. psidii* (Sawada & Kurosawa) Schroers & M.J. Wingf. 2005, cause of wilt disease of guava; and *N. vermoesenii* (Biourge) Schroers 2005, cause of necrosis and blight of palms. They demonstrated using LSU sequences that this genus belongs in *Nectriaceae* and further, inferred monophyly of six cultured species using ITS and LSU and partial beta-tubulin gene introns and exons. Only one name is currently combined in *Rubrinectria* and, if that name were taked up, it would result in several names changes including the three of economic importance noted above. We therefore proposed that *Rubrinectria* be suppressed in favor of the older and more widely used generic name *Nalanthamala*[6].

Nectria (Fr.) Fr. 1849 vs. *Tubercularia* Tode 1790

For about 150 years, the generic name *Nectria* was used for bright-coloured, uniloculate, perithecial ascomycetes. Following the informal designation of the *N. cinnabarina*-group by Booth (1971) as presumptive type of the genus, the concept of *Nectria* was gradually refined to coincide with that group, and is now restricted to only 29 species (Hirooka *et al*. 2012). Many of the 1104 described names in *Nectria* have been allocated to other genera, including *Bionectria*, *Haematonectria*, *Lanatonectria*, *Leuconectria*, *Neonectria*, and *Sphaerostilbella*; several of these names are considered elsewhere in the present article. *Nectria* is also the nominal genus of the family *Nectriaceae* Tul. & C. Tul. 1865, one of the most economically important families in the *Hypocreales.*

The accepted type species of *Nectria* is the well-known *N. cinnabarina* (Tode) Fr. 1849 , the sexual morph of *Tubercularia vulgaris* Tode 1790, cause of coral spot of hardwood trees. *Tubercularia* is typified by the same species, *T. vulgaris,* the asexual morph of *N. cinnabarina.* Thus these generic names are congeneric and changes in taxonomic concepts or phylogenetic analyses will not alter their synonymy. About 247 species of *Tubercularia* have been described and the form-taxon concept of this genus included pale-coloured, sporodochial fungi with slimy aseptate conidia; it has never been monographed. Thirty asexual morph names associated with the *N. cinnabarina* complex were revised by Seifert (1985); although unpublished, his subsequent revision of additional names uncovered species that would now be classified in *Clonostachys*, *Colletotrichum, Coryne, Fusarium,* and *Hymenella*. *Tubercularia* is the nominal genus of the family name *Tuberculariaceae* Fr. 1825, which is no longer used but is widely associated with Saccardo's sporophore and spore-based taxonomy of conidial fungi. Both *Nectria* and *Tubercularia* have been used in a broad sense historically, and their modern concepts have developed more or less in synchrony over the last 40 years. Both names are well-known to mycologists, though not all may be aware of the nuances that now restrict the generic concept. If the genus *Nectria* in the strict sense were protected against *Tubercularia*, only three species would require name changes. There is a possibility that some of the older asexually typified epithets might supplant the newly described *Nectria* epithets in the segregate species of the *N. cinnabarina* complex proposed by Hirooka *et al.* (2011), but that could perhaps be avoided by their inclusion in a list of suppressed names. If the name *Tubercularia* were used, most of the 29 names accepted by Hirooka *et al.* (2012) would have to be recombined in that genus. We propose that the generic name *Nectria* be protected against *Tubercularia* by suppression of the latter generic name. Further, the important family name *Nectriaceae* Fr. 1849 will need to be protected by suppression of *Tuberculariaceae* Fr. 1825.

Species names in *Nectria*

Nectria cinnabarina based on *Sphaeria cinnabarina* 1791 vs. *Tubercularia vulgaris* 1790.

As noted above, these two names are the types of their respective genera. Although the species is of limited significance as a plant pathogen, it is also well-known by field mycologists. Both names are used in the plant pathology and mushroom-guide literature, often with explicit statements that they are a sexual-asexual pair. Although *T. vulgaris* is an older epithet, the epithet is pre-occupied in *Nectria* by *Nectria vulgaris* Speg. 1881. None of the other asexual-morph synonyms of *T. vulgaris* listed by Seifert (1985) predate *Sphaeria cinnabarina.* Therefore, the name *N. cinnabarina* should be used for this species; it does not need to be protected or conserved against *T. vulgaris.*

We also take the opportunity to clarify the nomenclature of one species, and find a name change is necessary in another:

(1) *Nectria pseudotrichia* Berk. & M. A. Curtis 1854 (based on " *Sphaeria pseudotrichia* Schwein." nom. inval. (Art. 29.1) vs. *Tubercularia lateritia* (Berk.) Seifert 1985 (basionym *Stilbum lateritium* Berk. 1840).

This is the most common tropical species of this genus. Seifert (1985) transferred *Stilbum lateritium* to *Tubercularia,* replacing the name *Stilbum cinnabarinum* Mont. 1837 (syn. *Stilbella cinnabarina* (Mont.) Wollenw.1926), which is listed as a nomen rejiciendum under Art. 56.1. Although *N. pseudotrichia* and *S. cinnabarinum* were frequently used for this species in the historical literature, *T. lateritia* has been used for the asexual morph of this fungus only since 1985. However, as this epithet is pre-occupied in *Nectria* by *N. lateritia* (P. Karst.) Rossman 1983, there is no need for *N. pseudotrichia* to be protected over *S. lateritium*.

(2) *Nectria grayana* (Sacc. & Ellis) Hirooka & Seifert 2013[7] (basionym*: Ciliciopodium grayanum* Sacc. & Ellis 1882) vs *Nectria canadensis* Ellis & Everh. 1884. The name used for

[6]**Nalanthamala olivacea** (Seaver) Rossman, **comb. nov**.
MycoBank MB803882
Basionym: *Macbridella olivacea* Seaver, *Mycologia* 2: 178 (1910).

[7]**Nectria grayana** (Sacc. & Ellis) Hirooka & Seifert, **comb. nov**.
MycoBank MB802538
Basionym: Ciliciopodium grayanum Sacc. & Ellis, *Michelia* **2**: 581 (1882).

this species in the monograph of *Nectria* by Hirooka *et al*. (2012) is *Nectria canadensis.* This poorly known species has an earlier epithet in the genus *Ciliciopodium* Corda 1831. That genus was based on *C. violaceum* Corda 1831, described from dog faeces, and is not congeneric with *Nectria* (Seifert1985). Given the obscurity of this species, it seems acceptable to use the earliest epithet for this species.

Neonectria Wollenw. 1917 vs. *Cylindrocarpon* Wollenw. 1913

The genus *Cylindrocarpon* Wollenw. 1913*,* based on *C. cylindroides* Wollenw. 1913, has been circumscribed in a broad sense to include all species having cylindrocarpon-like conidia. Many of these species are known to have nectria-like sexual states (Booth 1966). Rossman *et al*. (1999) resurrected *Neonectria* Wollenw. 1917 for the sexual state of species of *Cylindrocarpon*. Recently several new genera were segregated from *Neonectria,* all of which have asexual morphs belonging to *Cylindrocarpon* in the broad sense (Chaverri *et al*. 2011). Both the type species of *Neonectria, N. ramulariae* Wollenw. 1917, and *Cylindrocarpon*, *C. cylindroides,* belong to the same genus in the restricted sense (Castlebury *et al*. 2006, Chaverri *et al*. 2011). *Neonectria* in the strict sense includes the cause of European beech bark disease, *N. coccinea* (Pers.) Rossman & Samuels 1999; American beech bark disease, *N. faginata* (M. L. Lohman *et al.*) Castl. & Rossman 2006; and hardwood canker disease, *N. ditissima* (Tul. & C. Tul.) Samuels & Rossman 2006 (Castlebury *et al*. 2006). A number of other important plant pathogenic fungi are included in *Cylindrocarpon* in the broad sense. The most commonly encountered species, previously known as *Cylindrocarpon destructans* (Zinssm.) Scholten 1964 is now placed in a segregate genus as *Ilyonectria radiciola* (Gerlach & L. Nilsson) P. Chaverri & Salgado 2011 (Cabral *et al*. 2012). Given the broad classical concept of the genus *Cylindrocarpon* and the well-circumscribed genus *Neonectria* that includes a number of plant pathogenic species, we recommend that the generic name *Neonectria* be protected against *Cylindrocarpon*.

REFERENCES

Agnihothrudu V (1959) Notes on fungi from north-east India. *Transactions of the British Mycological Society* **42**: 458–462.

Barron GL (1968) *The Genera of Hyphomycetes from Soil*. Baltimore, MD: Williams & Wilkins.

Bissett J (1984) A revision of the genus *Trichoderma*. I. Section *Longibrachiatum*, sect. nov. *Canadian Journal of Botany*. **62**: 924–931.

Bissett J (1991a) A revision of the genus *Trichoderma*. II. Infrageneric classification. *Canadian Journal of Botany* **69**: 235–2372.

Bissett J (1991b) A revision of the genus *Trichoderma*. III. Section *Pachybasium*. *Canadian Journal of Botany* **69**: 237–2416.

Boesewinkel HJ (1982) *Cylindrocladiella*, a new genus to accommodate *Cylindrocladium parvum* and other small-spored species of *Cylindrocladium*. *Canadian Journal of Botany* **60**: 2288–2294.

Booth C (1966) The genus *Cylindrocarpon*. *Mycological Papers* **104**: 1–56.

Booth C (1971) *The Genus Fusarium*. Kew: Commonwealth Mycological Institute.

Cabral A, Rego C, Nascimento T, Oliveira H, Groenewald JZ, Crous PW (2012) Multi-gene analysis and morphology reveal novel *Ilyonectria* species associated with black foot disease of grapevines. *Fungal Biology* **116**: 62–80.

Castlebury LA, Rossman AY, Hyten AS (2006) Phylogenetic relationships of *Neonectria*/*Cylindrocarpon* on *Fagus* in North America. *Canadian Journal of Botany* **84**: 1417–1433.

Chaverri P, Salgado C, Hirooka Y, Rossman AY, Samuels GJ (2011) Delimitation of *Neonectria* and *Cylindrocarpon* (*Nectriaceae*, *Hypocreales*, *Ascomycota*) and related genera with *Cylindrocarpon*-like anamorphs. *Studies in Mycology* **68**: 57–78.

Chaverri P, Samuels GJ, Stewart EL (2001) *Hypocrea virens* sp. nov., the teleomorph of *Trichoderma virens*. *Mycologia* **93**: 1113–1124.

Chaverri P, Castlebury LA, Overton BE, Samuels GJ (2003). Species of *Hypocrea* and *Trichoderma* with green conidia, and conidiophore elongations and related species in sect. *Pachybasium*. *Mycologia* **95**: 1100–1140.

Chen SF, Lombard L, Roux J, Xie YJ, Wingfield MJ, Zhou XD (2011) Novel species of *Calonectria* associated with *Eucalyptus* leaf blight in Southeast China. *Persoonia* **26**: 1–12.

Crous PW (2002) *Taxonomy and Pathology of Cylindrocladium (Calonectria) and allied genera*. St Paul, MN: American Phytopathological Society Press.

Crous PW, Wingfield MJ (1993) A re-evaluation of *Cylindrocladiella*, and a comparison with morphologically similar genera. *Mycological Research* **97**: 433–448.

Degenkolb T, Dieckmann R, Nielsen KF, Gräfenhan T, Theis C, Zafari D, Chaverri P, Ismaiel A., Brückner H, von Döhren H, Thrane U, Petrini O, Samuels GJ (2008a) The *Trichoderma brevicompactum* clade: a separate lineage with new species, new peptaibiotics, and mycotoxins. *Mycological Progress* **7**: 177–219.

Degenkolb T, Döhren H von, Nielsen KF, Samuels GJ, Brückner H (2008b) Recent advances and future prospects in peptaibiotics, hydrophobins, and mycotoxin research, and their importance for chemotaxonomy of *Trichoderma* and *Hypocrea*. *Chemistry & Biodiversity* **5**: 671–680.

Dingley JM (1957) Life history studies in the genus *Hypocrea*. *Transactions and Proceedings of the Royal Society of New Zealand* **84**: 689–693.

Doi Y (1972) A revision of the *Hypocreales* with cultural observations IV. The genus *Hypocrea* and its allies in Japan (2) Enumeration of the species. *Bulletin of the National Science Museum, Tokyo* **15**: 649–751.

Evans HC, Holmes KA, Thomas SE (2003) Endophytes and mycoparasites associated with an indigenous forest tree, *Theobroma gileri*, in Ecuador and a preliminary assessment of their potential as biocontrol agents of cocoa diseases. *Mycological Progress* **2**: 149–160.

Gams W (1971) Cephalosporium-artige Schimmelpilze (Hyphomycetes). Stuttgart: Gustav Fischer Verlag.

Gams W, Baral H-O, Jaklitsch WM, Kirschner R, Stadler M (2012) *Clarifications concerning the new Article 59 dealing with pleomorphic fungi*. *IMA Fungus* **3**: 175–177.

Geiser DM, Aoki T, Bacon CW, Baker SE, Bhattacharayya MB, Brandt M, Burgess LW, Chulze S, Coleman JJ, Correll JC, Covert SF, Crous PW, Cuomo CA, de Hoog GS, Di Pietro A, Elmer WH, Epstein L, Frandsen RJN, Freeman S, Gagkaeva T, Glenn AE, Gordon TR, Gregory NF, Hammond-Kosack KE, Hanson LE,

Jimenez-Gasco MD, Kang S, Kistler HC, Kuldau GA, Leslie JF, Logrieco A, Lu G, Lysoe E, Ma L, McCormick SP, Migheli Q, Moretti A, Munaut F, O'Donnell K, Pfenning LH, Ploetz RC, Proctor RH, Rehner SA, Robert VARG, Rooney AP, Salleh B, Scandiani MM, Scauflaire J, Short DPG, Steenkamp ET, Suga H, Summerell BA, Sutton DA, Thrane U, Trail F, van Diepeningen A, VanEtten HD, Viljoen A, Waalwijk C, Ward TJ, Wingfield MJ, Xu J, Yang X, Yli-Mattila T, Zhang N (2013) One Fungus, One Name: defining the genus *Fusarium* in a scientifically robust way that preserves longstanding use. *Phytopathology*: (in press). DOI 10.1094/PHYTO-07-12-0150-LE.

Gräfenhan T, Schroers H-J, Nirenberg HI, Seifert KA (2011) An overview of the taxonomy, phylogeny, and typification of nectriaceous fungi in *Cosmospora*, *Acremonium*, *Fusarium*, *Stilbella*, and *Volutella*. *Studies in Mycology* **68**: 79–113.

Harman GE, Kubicek CP (eds.) (1998) *Trichoderma and Gliocladium.* Vol. 2. *Enzymes, Biological Control and Commercial Applications.* London: Taylor & Francis

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. *Mycosphere* **2**: 143–155; *IMA Fungus* **3**: 15–24.

Hirooka Y, Rossman AY, Chaverri P (2011) A morphological and phylogenetic revision of the *Necria cinnabarina* species complex. *Studies in Mycology* **68**: 35–56.

Hirooka Y, Rossman AY, Samuels GJ, Lechat C, Chaverri P (2012) A monograph of *Allantonectria, Nectria*, and *Pleonectria* (*Nectriaceae, Hypocreales, Ascomycota*) and their pycndial, sporodochial, and synnematous anamorphs. *Studies in Mycology* **71**: 1–210.

Jaklitsch WM (2009) European species of *Hypocrea* Part I. The green-spored species. *Studies in Mycology* **63**: 1–91.

Jaklitsch WJ (2011) European species of *Hypocrea* part II: species with hyaline ascospores. *Fungal Diversity* **48**: 1–250.

Kubicek CP, Harman GE (eds.) (1998) *Trichoderma and Gliocladium.* Vol.1. *Basic Biology, Taxonomy and Genetics*. London: Taylor & Francis.

Lombard L, Crous PW (2012) Phylogeny and taxonomy of the genus *Gliocladiopsis*. *Persoonia* **28**: 25–33.

Lombard L, Crous PW, Wingfield BD, Wingfield MJ (2010) Phylogeny and systematics of the genus *Calonectria*. *Studies in Mycology* **66**: 31–69.

Lombard L, Polizzi G, Guarnaccia V, Vitale A, Crous PW (2011) *Calonectria* spp. causing leaf spot, crown and root rot of ornamentals in Tunisia. *Persoonia* **27**: 73–79.

Lombard L, Shivas RG, To-Anun C, Crous PW (2012) Phylogeny and taxonomy of the genus *Cylindrocladiella*. *Mycological Progress* **11**: 835–868.

Manamgoda DS, Cai L, McKenzie EHC, Crous PW, Madrid H, Chukeatirote E, Shivas RG, Tan YP, Hyde KD (2012) A phylogenetic and taxonomic re-evaluation of the *Bipolaris - Cochliobolus - Curvularia* complex. *Fungal Diversity* **56**: 131–144.

McNeill J, Barrie FF, Buck WR, Demoulin V, Greuter W, Hawksworth D L, Herendeen PS, Knapp S, Marhold K, Prado J, Prud'homme van Reine WF, Smith GF, Wiersema J, Turland NJ (eds.) (2012) *International Code of Nomenclature for algae, fungi, and plants (Melbourne Code)*. [Regnum vegetabile no. 154.] Königstein: Koeltz Scientific Books.

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).* [Regnum vegetabile no. 146.] Ruggell: A. R. G. Gantner Verlag.

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

Peerally A (1991) The classification and phytopathology of *Cylindrocladium* species. *Mycotaxon* **40**: 323–366.

Põldmaa K (2003) Three species of *Hypomyces* growing on basidiomata of *Stereaceae*. *Mycologia* **95**: 921–933.

Põldmaa K (2011) Tropical species of *Cladobotryum* and *Hypomyces* producing red pigments. *Studies in Mycology* **68**: 1–34.

Põldmaa K, Samuels GJ, Lodge DJ (1997) Three new polyporicolous species of *Hypomyces* and their *Cladobotryum* anamorphs. *Sydowia* **49**: 80–93.

Põldmaa K, Samuels GJ (1999) Aphyllophoricolous species of *Hypomyces* with KOH-negative perithecia. *Mycologia* **91**: 177–199.

Põldmaa K, Samuels GJ (2004) Fungicolous *Hypocreaceae* (Ascomycota: Hypocreales) from Khao Yai National Park, Thailand. *Sydowia* **56**: 79–130.

Rehner SA, Samuels GJ (1994) Taxonomy and phylogeny of *Gliocladium* analyzed by large subunit rDNA sequences. *Mycological Research* **98:** 625–634.

Rogerson CT, Samuels GJ (1985) Species of *Hypomyces* and *Nectria* occurring on discomycetes. *Mycologia* **77**: 763–783.

Rogerson CT, Samuels GJ (1989) The boleticolous species of *Hypomyces*. *Mycologia* **81**: 413–432.

Rogerson CT, Samuels GJ (1993) Polyporicolous species of *Hypomyces*. *Mycologia* **85**: 231–272.

Rogerson CT, Samuels GJ (1994) [1995] Agaricicolous species of *Hypomyces*. *Mycologia* **86**: 839–866.

Rossman AY (1979) *Calonectria* and its type, *C. daldiniana*, a later synonym of *C. pyrochroa*. *Mycotaxon* **8**: 321–328.

Rossman AY, Samuels GJ, Lowen R (1993) *Leuconectria clusiae* gen. nov. and its anamorph *Gliocephalotrichum bulbilium* with notes on *Pseudonectria*. *Mycologia* **85**: 685–704.

Rossman AY, Samuels GJ, Rogerson CT, Lowen R (1999) Genera of *Bionectriaceae*, *Hypocreaceae*, and *Nectriaceae* (*Hypocreales, Ascomycetes*). *Studies in Mycology* **42**: 1–248.

Rossman AY, Seifert KA (2011) Phylogenetic revision of taxonomic concepts in the *Hypocreales* and other *Ascomycota* – A tribute to Gary J. Samuels. *Studies in Mycology* **68**: 1–247.

Saksena SB (1954) A new genus of *Moniliaceae*. *Mycologia* **46**: 660–666.

Samuels GJ, Ismaiel A, Mulaw TB, Szakacs G, Druzhinina IS, Kubicek CP, Jaklitsch WM (2012) The Longibrachiatum Clade of *Trichoderma*: a revision with new species. *Fungal Diversity* **55**: 77–108.

Schoch CL, Crous PW, Wingfield MJ, Wingfield BD (2000) Phylogeny of *Calonectria* and selected hypocrealean genera with cylindrical macroconidia. *Studies in Mycology* **45**: 45–62.

Schroers H-J, Samuels GJ, Seifert KA, Gams W (1999) Classification of the mycoparasite *Gliocladium roseum* in *Clonostachys* as *C. rosea*, its relationship to *Bionectria ochroleuca*, and notes on other *Gliocladium*-like fungi. *Mycologia* **91**: 365–385.

Schroers H-J (2001) A monograph of *Bionectria* (*Ascomycota*, *Hypocreales*, *Bionectriaceae*) and its *Clonostachys* anamorphs. *Studies in Mycology* **46**: 1–214.

Schroers H-J, Geldenhuis MM, Wingfield MJ, Schoeman MH, Yen Y-F, Shen W-C, Wingfield BD (2005) Classification of the guava wilt fungus *Myxosporium psidii*, the palm pathogen *Gliocladium vermoesenii,* and the persimmon wilt fungus *Acremonium diospyri* in *Nalanthamala*. *Mycologia* **97**: 375–395.

Schroers H-J, Gräfenhan T, Nirenberg HI, Seifert KA (2011) A revision of *Cyanonectria* and *Geejayessia* gen. nov. and related species with *Fusarium*-like anamorph. *Studies in Mycology* **68**: 115–138.

Seifert KA (1985) A monograph of *Stilbella* and some allied hyphomycetes. *Studies in Mycology* **27**: 1–234.

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*. *Studies in Mycology* **68**: 139–162.