Genera in Bionectriaceae, Hypocreaeaceae, 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 suppression1 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, Gloeophalotrichum over Leuconectria, Gloiocladiopsis over Gliocentia, Nalanthamala over Rubrinectria, Necdria 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.
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. Mycocgone 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** type².

**Bionectriaceae**

| Name | Proposal Details |
|------|------------------|
| Clonostachys Corda. Pracht-Fl. Eur. Schimmelbild.: 31 (1839) | Typos: C. rosea (Link) Schroers et al. (1999) (C. araucaria Corda (1839), now considered a synonym of basionym Penicillium roseum Link (1816)) |
| | (≈) Bionectria Spec in Boln Acad. nac. Cienc. Córdoba 23: 563 (1919) |
| | Typos: B. tonduzi Spec. |

**Hypocreaceae**

| Name | Proposal Details |
|------|------------------|
| 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). | Typos: H. lactifluorum (Schwein.) Tul. & C. Tul. (Sphaeria lactifluorum Schwein.) |
| | (≈) Cladobotryum Nees, Syst. Pilze (Würzburg): 56 (1816) |
| | Typus: C. rosea (Link) Schroers et al. (1999) (C. araucaria Corda (1839), now considered a synonym of basionym Penicillium roseum Link (1816)) |
| | Typos: C. varium Nees |
| Sphaerostilbella (Henn.) Sacc. & D. Sacc., Sylf. fung. (Abellini) 17: 778 (1905) (Sphaerostilbe subgen. Sphaerostilbella Henn. in Bot. Jb. 30: 40 1901) | Typos: S. lutea (Henn.) Sacc. & D. Sacc. (Sphaerostilbe lutea Henn.) |
| | (≈) Gliocladium Corda, Icon. fung. (Prague) 4: 30 (1840) |
| | Typus: G. penicillioides Corda |
| Trichoderma Pers., in Neues Mag. Bot. 1: 92 (1794) | Typos: T. viride Pers. |
| | (≈) Hypocrea Fr., Syst. orb. veg. (Lundae) 1: 104 (1825) |

**Nectriaceae**

| Name | Proposal Details |
|------|------------------|
| Actinostilbe Petch in Ann. R. bot. Gdns Peradeniya 9: 327 (1925). | Typos: A. vanillae Petch |
| | (≈) Lanatobenctic Samuels & Rossman in Stud. Mycol. 42: 137 (1999) |
| | Typos: L. flocculenta (Henn. & E. Nyman) Samuels & Rossman (Nectriella flocculenta Henn. & E. Nyman) |
| Cylindrocladiella Boesew. in Can. J. Bot. 60: 2289 (1982). | Typos: C. parva (P.J. Anderson) Boesew. |
| | (≈) Nectriadiella Crous & C.L. Schoch in Stud. Mycol. 45: 54 (2000). |
| Fusarium Link in Mag. Gesell. naturf. Freunde, Berlin 3: 10 (1809). | Typos: F. roseum Link, synonym of F. sambucinum Fuckel, nom. cons. |
| | (≈) Gibberella Sacc. in Michelia 1: 43 (1877). |
| Glioccephalotrichum J.J. Ellis & Hesselt. in Bull. Torrey bot. Club 89: 21 (1962). | Typos: G. bulbilium J.J. Ellis & Hesselt. |
| | (≈) Leuconectria Rossman & al. in Mycologia 85: 686 (1993). |
| | Typos: L. clusiae (Samuels & Rogerson) Rossman & al. (Pseudonectria clusiae Samuels & Rogerson) |
| Gliocladiopsis S.B. Saksea in Mycologia 46: 663 (1954). | Typos: G. sagariensis S.B. Saksea |
| | (≈) Gliocladium Crous & C.L. Schoch in Stud. Mycol. 45: 58 (2000). |
| Nalanthamala Subram. in J. Indian Bot. Soc. 35: 478 (1956). | Typos: N. madereya Subram. |
| | (≈) Rubrinectria Rossman & Samuels 1999 in Stud. Mycol. 42: 164 (1999). |
| | Typos: R. olivacea (Seaver) Rossman & Samuels (Macbridella olivacea Seaver) |
| Neonectria (Fr.) Fr., Summa veg. Scand., Section Post. (Stockholm): 387 (1849). (Hypocrea sect. Nectria Fr. Syst. orb. veg. (Lundae) 1: 105 (1825). | Typos: N. cinnabarina (Tode : Fr.) Fr. (Sphaeria cinnabarina Tode : Fr.) |
| | (≈) Tubercularia Tode, Fung. mecklenb. sel. (Lüneburg) 1: 18 (1790). |
| | Typos: T. vulgaris Tode |
| Neonectria Wollenw. in Annls mycol. 15: 52 (1917). | Typos: N. ramulariae Wollenw. |
| | (≈) Cylindrocarpon Wollenw. in Phytopathology 3: 225 (1913). |

²The 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.
Genera in Hypocreales proposed for acceptance or rejection

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

| Taxon               | Type genus                                      | Synonymy                                      |
|---------------------|-------------------------------------------------|------------------------------------------------|
| **Bionectriaceae**  | Samuels & Rossman in Stud. Mycol. 42: 15 (1999). | Types: Bionectria Spec. (≡) Spicariaeae Nann. in Repert. Mic. Uomo: 451 (1934). |
| **Hypocreaceae**    | De Not. in G. Bot. Ital. 2: 48 (1844) as “Hypocreaceae”. | Types: Hypocreca Fr. (≡) Trichodermaeae Fr., Syst. Orb. Veg. (Lundae) 1: 144 (1825) as “Trichodermaeae”. |
| **Nectriaceae**     | Tul. & C. Tul., Select. Fung. Carpol. (Paris) 3: 3 (1865) as “Nectrii”. | Types: Nectria (Fr.) Fr. (≡) Tuberculariaeae Fr., Syst. Orb. Veg. (Lundae) 1: 169 (1825) as “Tuberculariaeae”. |

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, Pöldmaa et al. 1997, Pöldmaa 2003, 2011, Pöldmaa & 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 (Pöldmaa 2000, Pöldmaa & 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, Sepeodium 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. stephanonatis 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, Sepeodium, 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 aureostratum (Gerard) Seifert et al. 1985 (basionym Stilbum aureostratum 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. viride 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 (Bionectrieae; see above). Gliocladium viride is placed in Trichoderma as T. viride (Miller et al.) Arx 1987, the asexual morph of Hypocre viride Chaverri & Samuels 2011 (Chaverri et al. 2001). Gliocladium delicuercens Sopp. 1912 (syn. G. viride Mater. 1893, non T. viride Pers. 1794) is the asexual morph of Hypocre lutea (Tode) Petch 1973. Other species of Gliocladium are now known to be species of Cephalotheca (G. prolificum), Clonostachys, Glucocephalis (Gliocladium pulchellum), Metarhizium (M. viridicolumnare), Myrothecium, Nalanthamala, Nectriopsis broomeana (G. microperum), 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.

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 Gliocladium.

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. viride); 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. pellata 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 Subcommission on Trichoderma and Hypocrea taxonomy (www.isth.info) to determine the will of the Trichodermal/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 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 (Agnihotri. & 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 below4.

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.

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4 Actinostilbe flocculenta (Henn. & E. Nyman) Rossman, Samuels & Seifert, comb. nov.
MycoBank MB802534
Basionym: Nectria 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 Cylindrocladium. The sexual morph-typified genus Nectrianiella 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 Nectrianiella (N. camelliae linked to C. microcylindrica Crous & D. Victor 2000), and therefore we propose to that the generic name Cylindrocladiella be protected over Nectrianiella.

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 piciulis 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 Schldrl. 1824 has no known sexual state, but has been shown to be a pseudogamous anamorph forming conidial heads (Schroers et al. 2005). The type and only species, R. olivacea (Seaver) Rossman 2011, is a relatively common tropical fungus that occurs on dead woody stems of palms and other woody substrates. The sexual morph-typified genus Rubrotrichium was described with the type, L. clusiae Samuels & Rogerson) Rossman et al. (1993) (basionym: Pseudonectria clusiae Samuels & Rossman 1990). Species of Glioccephalotrichum have been widely reported from soils. Given the relative obscurity of Rubrotrichium, 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 Glioccephalotrichum, which has priority by date. Only a single new combination is required by this decision

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

The genus Gliocchiadopsis S.B. Saksena 1954, based on G. sagriensis 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 (Baron 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 Gliocchiadopsis 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 Gliocchiadopsis tenuis (Bgn.) Crous & M.J. Wingf. 1993. Lombard & Crous (2012) distinguished G. sagriensis from G. tenuis based on phylogenetic inference. That study also proposed G. pseudotenuis as a new name for the asexual morph of Gliocchiadopsis tenuis, which was shown to be distinct from G. tenuis. Therefore we propose the protection of the genus name Gliocchiadopsis over the generic name Glionectria.

Nalanthamala Subram. 1956 vs. Rubreinctria Rossman & Samuels 1999

The sexual morph-typified genus Rubreinctria was established for neetria-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 acromonium-like synanamorph forming conidial heads (Schroers et al. 2005). The type and only species, R. olivacea (Seaver) Rossman & Samuels 1999 (basionym: Macbrideilla 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

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

The genus Glioccephalotrichum 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 Glioccephalotrichum 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 Glioccephalotrichum, which has priority by date. Only a single new combination is required by this decision

Glioccephalotrichum 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. psidi* (Sawada & Kurosawa) Schroers & M.J. Wingf. 2005, cause of wilt disease of guava; and *N. vermoosenii* (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 taken 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*.

**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*, *Haematonecctia*, *Lanatonecctia*, *Leuconectria*, *Neonecctia*, 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 asseptate 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-asesexual 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 *Stilbium lateritium* Berk. 1840).

   This is the most common tropical species of this genus. Seifert (1985) transferred *Stilbium lateritium* to *Tubercularia*, replacing the name *Stilbium cinnabarum* Mont. 1837 (syn. *Stilbella cinnabarina* (Mont.) Wollenw.1926), which is listed as a nomen rejiciendum under Art. 56.1. Although *N. pseudotrichia* and *S. cinnabarum* 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 (basionym: *Ciliopodium grayanum* Sacc. & Ellis 1882) vs *Nectria canadensis* Ellis & Everh. 1884. The name used for

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1. *Nalanthamala olivacea* (Seaver) Rossman, *comb. nov.* MycoBank MB803882
   Basionym: *Macbrideilla olivacea* Seaver, *Mycologia* 2: 178 (1910).

2. *Nectria grayana* (Sacc. & Ellis) Hirooka & Seifert, *comb. nov.* MycoBank MB802538
   Basionym: *Ciliopodium grayanum* Sacc. & Ellis, *Michelia* 2: 581 (1882).
this species in the monograph of Nectria by Hirooka et al. (2012) is Nectria canaden
densis. This poorly known species has an earlier epithet in the genus Ciliopi
dodium 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
cadiciola* (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.

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