

New 1F1N Species Combinations in *Ophiocordycipitaceae* (*Hypocreales*)

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Abstract: Based on the taxonomic and nomenclatural recommendations of Quandt *et al.* (2014) new species combinations are made for *Ophiocordycipitaceae*. These new combinations are compliant with recent changes in the *International Code of Nomenclature for algae, fungi, and plants* (ICN) and the abolition of the dual system of nomenclature for fungi. These changes include 10 new combinations into *Drechmeria*, four new combinations into *Harposporium*, 23 new combinations and 15 synonymies in *Ophiocordyceps*, and one new combination into *Purpureocillium*.

Key words:

Cordyceps
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INTRODUCTION

Kirk *et al.* (2013) listed 11 genera of *Ophiocordycipitaceae* for protection as a result of changes in Art. 59 of the *International Code of Nomenclature for algae, fungi, and plants* (ICN; McNeill *et al.* 2012); these include *Chaunopycnis*, *Drechmeria*, *Harposporium*, *Hirsutella*, *Hymenostilbe*, *Ophiocordyceps*, *Paraisaria*, *Podocrella*, *Polycephalomyces*, *Sorospora* and *Tolypocladium*. Informed by multigene phylogenetic analyses, Quandt *et al.* (2014) refined this list and proposed a generic classification for *Ophiocordycipitaceae* comprising six monophyletic genera, including *Drechmeria*, *Harposporium*, *Ophiocordyceps*, *Polycephalomyces*, *Purpureocillium* and *Tolypocladium*. This system was used as part of a natural classification of *Sordariomycetes* (Maharachchikumbura *et al.* 2015) and new species combinations were made for *Polycephalomyces* (Kepler *et al.* 2013) and *Tolypocladium* (Quandt *et al.* 2014), but the species composition of the remaining four genera remained ambiguous. Here we introduce necessary species combinations into the genera *Drechmeria*, *Harposporium*, *Ophiocordyceps* and *Purpureocillium*. These combinations are supported by the reference multigene phylogeny presented in Quandt *et al.* (2014: fig 1) and previous phylogenetic analyses (e.g., Sung *et al.* 2007, Luangsa-ard *et al.* 2011).

***Drechmeria* W. Gams & H.-B. Jansson, *Mycotaxon* 22: 36 (1985).**

Type: *Drechmeria coniospora* (Drechsler) W. Gams & H.-B. Jansson, *Mycotaxon* 22: 37 (1985).

Commentary: *Drechmeria* includes the sexually reproductive species *Cordyceps gunnii*, which parasitizes lepidopteran larvae (*Hepialidae*) buried in soil; it has a known distribution in Australia and New Zealand (Berkeley 1848, Dingley 1953). *Drechmeria* also includes species classified in the asexually typified genus *Haptocillium*, which like *Drechmeria* includes a number of nematode pathogenic fungi. The nematode pathogen ecology of the asexual morphs associated with this clade suggests that nematode associations may also be a frequent trophic mode for sexually reproductive species. Ten new combinations are made here, resulting in a total of twelve names of accepted species in the genus.

Drechmeria bactrospora* (Drechsler) Spatafora & Kepler, **comb. nov.*

MycoBank MB814713

Basionym: *Acrostalagmus bactrosporus* Drechsler, *Phytopathology* 31: 782 (1941).

Synonyms: *Haptocillium bactrosporum* (Drechsler) Glockling, *Mycologist* 19: 3 (2005).

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Verticillium bactrosporium (Drechsler) Subram., *Kavaka* **5**: 98 (1977).

Drechmeria balanoides (Drechsler) Spatafora & Kepler, **comb. nov.**

MycoBank MB814714

Basionym: *Cephalosporium balanoides* Drechsler, *Phytopathology* **31**: 786 (1941).

Synonyms: *Haptocillium balanoides* (Drechsler) Zare & W. Gams, *Nova Hedwigia* **72**: 335 (2001).

Tolypocladium balanoides (Drechsler) Bissett, *Canad. J. Bot.* **61**: 1313 (1983).

Verticillium balanoides (Drechsler) Dowsett et al., *Mycologia* **74**: 690 (1982).

Acronium balanoides (Drechsler) Subram., *Kavaka* **5**: 98 (1977).

Drechmeria campanulata (Glockling) Spatafora & Kepler, **comb. nov.**

MycoBank MB814715

Basionym: *Verticillium campanulatum* Glockling, *Nordic J. Bot.* **17**: 655 (1997).

Synonym: *Haptocillium campanulatum* (Glockling) Zare & W. Gams, *Nova Hedwigia* **73**: 285 (2001).

Drechmeria glocklingiae (Zare & W. Gams) Spatafora & Kepler, **comb. nov.**

MycoBank MB814716

Basionym: *Haptocillium glocklingiae* Zare & W. Gams, *Nova Hedwigia* **73**: 281 (2001).

Drechmeria gunnii (Berk.) Spatafora, Kepler & Quandt, **comb. nov.**

MycoBank MB814717

Basionym: *Sphaeria gunnii* Berk., *London J. Bot.* **7**: 577 (1848).

Synonym: *Cordyceps gunnii* (Berk.) Berk., in Hooker, *Bot. Antarct. Voy.*, III, *Fl. Tasman.* **2**: 278 (1860).

Drechmeria obovata (Drechsler) Spatafora & Kepler, **comb. nov.**

MycoBank MB814718

Basionym: *Acrostalagmus obovatus* Drechsler, *Phytopathology* **31**: 784 (1941).

Synonyms: *Haptocillium obovatum* (Drechsler) Glockling, *Mycologist* **19**: 4 (2005).

Verticillium obovatum (Drechsler) Subram., *Kavaka* **5**: 98 (1977).

Drechmeria rhabdospora (Zare & W. Gams) Spatafora & Kepler, **comb. nov.**

MycoBank MB814719

Basionym: *Haptocillium rhabdosporum* Zare & W. Gams, *Nova Hedwigia* **73**: 288 (2001).

Drechmeria sinensis (K.Q. Zhang et al.) Spatafora & Kepler, **comb. nov.**

MycoBank MB814720

Basionym: *Verticillium sinense* K.Q. Zhang et al., *Micol. Res.* **100**: 1481 (1996).

Synonym: *Haptocillium sinense* (K.Q. Zhang et al.) Zare & W. Gams, *Nova Hedwigia* **73**: 287 (2001).

Drechmeria sphaerospora (Goodey) Spatafora & Kepler, **comb. nov.**

MycoBank MB814721

Basionym: *Verticillium sphaerosporum* Goodey, *Trans. Brit. Mycol. Soc.* **34**: 272 (1951).

Synonym: *Haptocillium sphaerosporum* (Goodey) Zare & W. Gams, *Nova Hedwigia* **73**: 278 (2001).

Drechmeria zeospora (Goodey) Spatafora & Kepler, **comb. nov.**

MycoBank MB814722

Basionym: *Acrostalagmus zeosporus* Drechsler, *Phytopathology* **36**: 216 (1946).

Synonyms: *Haptocillium zeosporum* (Drechsler) Zare & W. Gams, *Nova Hedwigia* **73**: 282 (2001).

Verticillium zeosporum (Drechsler) Glockling, *Nordic J. Bot.* **17**: 658 (1997).

Harposporium Lohde, *Tagebl. Versamm. Dt. Naturf. Ärzte* (Breslau) **47**: 206 (1874).

Type: *Harposporium anguillulae* Lohde emend. Zopf, *Nova Acta Acad. Caes. Leop.-Carol. German. Nat. Cur.* **52**: 339 (1888).

Commentary: *Harposporium* includes the sexually reproductive species of *Podocrella*, which typically parasitize coleopteran larvae buried in wood (Chaverri et al. 2005). The taxonomic history of these fungi has been unstable with species classified in *Cordyceps*, *Ophiocordyceps* and *Wakefieldiomyces*. Like *Drechmeria*, *Harposporium* asexual morphs are pathogens of nematodes suggesting that nematode associations may be a frequent trophic mode for sexually reproductive species, as well. Four new combinations are made here, resulting in a total of 37 names of accepted species in the genus.

Harposporium fuscum (Chaverri & K.T. Hodge) Spatafora & Kepler, **comb. nov.**

MycoBank MB814723

Basionym: *Podocrella fusca* Chaverri & K.T. Hodge, *Mycologia* **97**: 438 (2005).

Harposporium harposporiferum (Samuels) Spatafora & Kepler, **comb. nov.**

MycoBank MB814724

Basionym: *Atricordyceps harposporifera* Samuels, *N.Z. J. Botany* **21**: 174 (1983).

Synonym: *Podocrella harposporifera* (Samuels) Chaverri & Samuels, *Mycologia* **97**: 439 (2005).

Harposporium peltatum (Wakef.) Spatafora & Kepler, **comb. nov.**

MycoBank MB814725

Basionym: *Cordyceps peltata* Wakef., *Bull. Misc. Inf., Kew.* **74** (1916).

Synonyms: *Podocrella peltata* (Wakef.) Chaverri & K.T. Hodge, *Mycologia* **97**: 441 (2005).

Wakefieldiomyces peltatus (Wakef.) Kobayasi, *Bull. Natn. Sci. Mus.*, Tokyo, B 7: 2 (1981); as “*peltata*”.

Ophiocordyceps peltata (Wakef.) Petch, *Trans. Brit. Mycol. Soc.* 16: 74 (1931).

Harposporium poronioides (Seaver) Spatafora & Kepler, **comb. nov.**

MycoBank MB814726

Basionym: Podocrella poronioides Seaver, *Mycologia* 20: 57 (1928).

Ophiocordyceps Petch, *Trans. Brit. Mycol. Soc.* 16: 74 (1931).

Type: Ophiocordyceps blattae (Petch) Petch, *Trans. Brit. Mycol. Soc.* 16: 74 (1931).

Commentary: New combinations are made for species that were recently demonstrated to be members of *Ophiocordyceps* including *Cordyceps annullata*, *Stilbella buquetii* and *Tilachliodopsis nigra* (Quandt *et al.* 2014), as well as species classified in *Hymenostilbe*, *Paraisaria*, *Podonectria* and *Syngliocladium*, which were demonstrated to have a phylogenetic affinity with the genus (Hodge *et al.* 1998, Sung *et al.* 2007, Quandt *et al.* 2014). All anticipated species recombinations are not made for *Podonectria*, because additional sampling of other species is needed to confirm their placement in *Ophiocordyceps*. Similarly, due to the polyphyletic distribution across multiple families of *Hypocreales*, the genus *Hirsutella* will be treated separately elsewhere. Twenty-three new combinations and fifteen synonymies with existing names are made here, resulting in a total of 223 names of accepted species in the genus.

Ophiocordyceps acridiora (H.C. Evans & P.A. Shah) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**
MycoBank MB814728

Basionym: Syngliocladium acridiorum H.C. Evans & P.A. Shah, *Mycol. Res.* 106: 741 (2002).

Ophiocordyceps acridiora var. **madagascariensis** (H.C. Evans & P.A. Shah) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**

MycoBank MB814729

Basionym: Syngliocladium acridiorum var. *madagascariensis* H.C. Evans & P.A. Shah, *Mycol. Res.* 106: 741 (2002).

Ophiocordyceps annullata (Kobayasi & Shimizu) Spatafora, Kepler & Quandt, **comb. nov.**

MycoBank MB814730

Basionym: Cordyceps annullata Kobayasi & Shimizu, *Bull. Natn. Sci. Mus.*, Tokyo, B 8: 91 (1982).

Ophiocordyceps aphidis (Petch) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**

MycoBank MB814731

Basionym: Hymenostilbe aphidis Petch, *Trans. Brit. Mycol. Soc.* 25: 259 (1942) [“1941”].

Ophiocordyceps arachneicola (Kobayasi) G.H. Sung *et al.*, *Stud. Mycol.* 57: 40 (2007).

Basionym: Cordyceps arachneicola Kobayasi, *Sci. Rep. Tokyo Bunrika Daig.*, sect. B 5: 123 (1941)

Synonym: Hymenostilbe kobayasii Koval, *Nov. Sist. Niz. Rast.* 13: 206 (1976).

Ophiocordyceps araneorum (Petch) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**

MycoBank MB814732

Basionym: Syngliocladium araneorum Petch, *Trans. Brit. Mycol. Soc.* 17: 177 (1932).

Ophiocordyceps australiensis (Mains) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**

MycoBank MB814733

Basionym: Hymenostilbe australiensis Mains, *Mycologia* 40: 411 (1948).

Ophiocordyceps blattae (Petch) Petch, *Trans. Brit. Mycol. Soc.* 16: 74 (1931).

MycoBank MB431869

Basionym: Cordyceps blattae Petch, *Trans. Brit. Mycol. Soc.* 10: 35 (1924).

Synonym: Hymenostilbe ventricosa Hywel-Jones, *Mycol. Res.* 99: 1201 (1995).

Ophiocordyceps buquetii (Mont. & C.P. Robin) Spatafora, Kepler & Quandt, **comb. nov.**

MycoBank MB814734

Basionym: Stilbum buquetii Mont. & C.P. Robin, *in* Robin, *Hist. Nat. Végét. Paras. Homme Anim. Viv.*: 640 (1853).

Synonyms: Stilbella buquetii (Mont. & C.P. Robin) Samson & H.C. Evans, *Proc. K. Ned. Akad. Wet.*, ser. C, *Biol. Med. Sci.* 84: 290 (1981).

Stilbella buquetii var. *formicarum* (Cooke & Masee) Samson & H.C. Evans, *Proc. K. Ned. Akad. Wet.*, ser. C, *Biol. Med. Sci.* 84: 290 (1981).

Stilbum formicarum Cooke & Masee, *Grevillea* 18: 8 (1889).
Isaria buquetii (Mont. & C.P. Robin) Lloyd, *Mycol. Writ.* 7: 1119 (1922).

Ophiocordyceps campanoti (Mains) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**

MycoBank MB814735

Basionym: Hymenostilbe campanoti Mains, *Mycologia* 42: 586 (1950); as “*camponoti*”.

Ophiocordyceps cicadellidicola (Kobayasi & Shimizu) Spatafora, Kepler & Quandt, **comb. nov.**

MycoBank MB814736

Basionym: Podonectria cicadellidicola Kobayasi & Shimizu, *Bull. Natn. Sci. Mus.*, Tokyo, B 3: 95 (1977).

Ophiocordyceps citrina (Kobayasi & Shimizu) Spatafora, Kepler & Quandt, **comb. nov.**

MycoBank MB814737

Basionym: Podonectria citrina Kobayasi & Shimizu, *Bull. Natn. Sci. Mus.*, Tokyo, B 3: 97 (1977).

- Ophiocordyceps clavulata** (Schwein.) Petch, *Trans. Brit. Mycol. Soc.* **18**: 53 (1933).
Mycobank MB251478
Basionym: *Sphaeria clavulata* Schwein., *Trans. Am. Phil. Soc.* **4**: 188 (1834) ["1832"].
Synonym: *Xylaria clavulata* (Schwein.) Berk. & M.A. Curtis, *J. Linn. Soc., Bot.* **10**: 380 (1869) ["1868"].
Torrubia clavulata (Schwein.) Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* **28**: 70 (1876).
Cordyceps clavulata (Schwein.) Ellis & Everh., *N. Amer. Pyren.*: 61 (1892).
Isaria lecanicola Jaap, *Verh. Bot. Ver. Prov. Brandenb.* **50**: 49 (1909).
Hymenostilbe lecanicola (Jaap) Mains, *Mycologia* **42**: 582 (1950).
- Ophiocordyceps cleoni** (Wize) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**
Mycobank MB814738
Basionym: *Acremonium cleoni* Wize, *Bull. Int. Acad. Sci. Cracovie, Cl. Sci. Math. Nat.*: 719 (1905) ["1904"].
Synonym: *Syngliocladium cleoni* (Wize) Petch, *Trans. Brit. Mycol. Soc.* **25**: 263 (1942).
- Ophiocordyceps curculionum** (Tul. & C. Tul.) G.H. Sung et al., *Stud. Mycol.* **57**: 41 (2007).
Basionym: *Torrubia curculionum* Tul. & C. Tul., *Select. Fung. Carpol.* **3**: 20 (1865).
Synonyms: *Cordyceps curculionum* (Tul. & C. Tul.) Sacc., *Michelia* **1**: 320 (1879).
Cordyceps bicephala subsp. *curculionum* (Tul. & C. Tul.) Moureau, *Mém. Inst. Roy. Colonial Belge* **7**: 50 (1949).
Isaria melanopus Speg., *Boln Acad. Nac. Cienc. Córdoba* **11**: 616 (1889).
Hymenostilbe melanopoda (Speg.) Petch, *Trans. Brit. Mycol. Soc.* **16**: 209 (1931).
- Ophiocordyceps dipterigena** (Berk. & Broome) G.H. Sung et al., *Stud. Mycol.* **57**: 42 (2007).
Basionym: *Cordyceps dipterigena* Berk. & Broome, *J. Linn. Soc., Bot.* **14**: 111 (1875) ["1873"].
Hymenostilbe dipterigena Petch, *Trans. Brit. Mycol. Soc.* **16**: 212 (1931).
- Ophiocordyceps entomorrhiza** (Dicks.) G.H. Sung et al., *Stud. Mycol.* **57**: 42 (2007).
Basionym: *Sphaeria entomorrhiza* Dicks., *Fasc. Pl. Crypt. Brit.* **1**: 22 (1785).
Synonyms: *Xylaria entomorrhiza* (Dicks.) Gray, *Nat. Arr. Brit. Pl.* **1**: 511 (1821).
Cordyceps entomorrhiza (Dicks.) Fr., *Summa Veg. Scand.* **2**: 567 (1849).
Tilachlidiopsis nigra Yakush. & Kumaz., *Bot. Mag., Tokyo* **44**: 461 (1930).
- Ophiocordyceps forquignonii** (Quél.) G.H. Sung et al., *Stud. Mycol.* **57**: 43 (2007).
Basionym: *Cordyceps forquignonii* Qué., *16th Suppl. Champ. Jura et Vosges*: 6 (1887).
Synonym: *Hymenostilbe muscaria* Petch, *Naturalist (Hull)* **1931**: 101 (1931).
- Ophiocordyceps furcata** (Aung et al.) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**
Mycobank MB814739
Basionym: *Hymenostilbe furcata* Aung et al., *Mycotaxon* **97**: 243 (2006).
- Ophiocordyceps ghanensis** (Samson & H.C. Evans) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**
Mycobank MB814740
Basionym: *Hymenostilbe ghanensis* Samson & H.C. Evans, *Proc. K. Ned. Akad. Wet., ser. C, Biol. Med. Sci.* **78**: 76 (1975).
- Ophiocordyceps gracilis** (Grev.) G.H. Sung et al., *Stud. Mycol.* **57**: 43 (2007).
Basionym: *Xylaria gracilis* Grev., *Scott. Crypt. Fl.*: t. 86 (1824).
Synonyms: *Cordyceps gracilis* (Grev.) Durieu & Mont., in Durieu, *Expl. Sci. Alg.* **1** (12): 449 (1849).
Cordyceps entomorrhiza var. *gracilis* (Grev.) Cooke, *Grevillea* **12**: 102 (1884).
Paraisaria dubia (Delacr.) Samson & B.L. Brady, *Trans. Brit. Mycol. Soc.* **81**: 285 (1983).
- Ophiocordyceps gracilioides** (Kobayasi) G.H. Sung et al., *Stud. Mycol.* **57**: 43 (2007).
Basionym: *Cordyceps gracilioides* Kobayasi, *Sci. Rep. Tokyo Bunrika Daig., sect. B* **5**: 140 (1941).
Synonyms: *Isaria gracilioides* Kobayasi, *Sci. Rep. Tokyo Bunrika Daig., sect. B* **5**: 231 (1941).
Paraisaria gracilioides (Kobayasi) C.R. Li et al., *Mycosystema* **23**: 165 (2004).
- Ophiocordyceps ichneumonophila** (van Vooren & Audibert) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**
Mycobank MB814741
Basionym: *Hymenostilbe ichneumonophila* van Vooren & Audibert, *Bull. Mens. Soc. Linn. Lyon* **74**: 228 (2005).
- Ophiocordyceps intricata** (Petch) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**
Mycobank MB814742
Basionym: *Syngliocladium intricatum* Petch, *Trans. Brit. Mycol. Soc.* **25**: 264 (1942).
- Ophiocordyceps irangiensis** (Moureau) G.H. Sung et al., *Stud. Mycol.* **57**: 43 (2007).
Basionym: *Cordyceps irangiensis* Moureau, *Lejeunia Mém.* **15**: 33 (1961).
Synonym: *Hymenostilbe aurantiaca* Hywel-Jones, *Mycol. Res.* **100**: 617 (1996).
- Ophiocordyceps lloydii** (H.S. Fawc.) G.H. Sung et al., *Stud. Mycol.* **57**: 44 (2007).
Basionym: *Cordyceps lloydii* H.S. Fawc., *Ann. Mag. Nat. Hist.*: 317 (1886).

Synonym: Hymenostilbe formicarum Petch, *Trans. Brit. Mycol. Soc.* **16**: 218 (1931).

Ophiocordyceps longispora (Samson & H.C. Evans) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**
MycoBank MB814743

Basionym: Hymenostilbe longispora Samson & H.C. Evans, *Proc. K. Ned. Akad. Wet., ser. C, Biol. Med. Sci.* **78**: 74 (1975).

Ophiocordyceps lutea (Moureau) G.H. Sung *et al.*, *Stud. Mycol.* **57**: 44 (2007).

Basionym: Cordyceps lutea Moureau, *Mém. Inst. Roy. Colonial Belge* **7**: 41 (1949).

Synonym: Hymenostilbe sulphurea Samson & H.C. Evans, *Proc. K. Ned. Akad. Wet., ser. C, Biol. Med. Sci.* **78**: 76 (1975).

Ophiocordyceps novae-zelandiae (Dingley) B. Shrestha, G.-H. Sung & Spatafora, **comb. nov.**
MycoBank MB814745

Basionym: Cordyceps novae-zelandiae Dingley, *Trans. Roy. Soc. N.Z.* **81**: 337 (1953); as “*novae-zealandiae*”.

Ophiocordyceps nutans (Pat.) G.H. Sung *et al.*, *Stud. Mycol.* **57**: 45 (2007).

Basionym: Cordyceps nutans Pat., *Bull. Soc. Mycol. Fr.* **3**: 127 (1887).

Synonym: Cordyceps bicephala subsp. *nutans* (Pat.) Moureau, *Mém. Inst. Roy. Colonial Belge* **7**: 47 (1949).

Hymenostilbe nutans Samson & H.C. Evans, *Proc. K. Ned. Akad. Wet., ser. C, Biol. Med. Sci.* **78**: 78 (1975).

Ophiocordyceps odonatae (Kobayasi) G.H. Sung *et al.*, *Stud. Mycol.* **57**: 45 (2007).

Basionym: Cordyceps odonatae Kobayasi, *Bull. Natn. Sci. Mus., Tokyo*, **B 7**: 6 (1981).

Synonym: Hymenostilbe odonatae Kobayasi, *Sci. Rep. Tokyo Bunrika Daig., sect. B* **5**: 223 (1941).

Ophiocordyceps paramyrmicarum B. Shrestha, G.H. Sung & Spatafora, **nom. nov.**
MycoBank MB814744

Basionym (replaced name): *Paraisaria myrmicarum* H.C. Evans *et al.*, *Fungal Biology* **114**: 455 (2010).

Non *Ophiocordyceps myrmicarum* D.R. Simmons & Groden, *J. Invert. Path.* **125**: 26 (2015).

Ophiocordyceps pseudogibellulae (Samson *et al.*) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**
MycoBank MB814746

Basionym: Torribiella pseudogibellulae Samson *et al.*, *Stud. Mycol.* **31**: 127 (1989).

Synonyms: Gibellula formicarum Mains, *Mycologia* **41**: 309 (1949).

Pseudogibellula formicarum (Mains) Samson & H.C. Evans, *Acta Bot. Neerl.* **22**: 524 (1973).

Non *Ophiocordyceps formicarum* (Kobayasi) G.H. Sung *et al.*, *Stud. Mycol.* **57**: 43 (2007).

Ophiocordyceps siamensis (Hywel-Jones) Mongkolsamrit & Luangsa-ard, **comb. nov.**
MycoBank MB814747

Basionym: Torribiella siamensis Hywel-Jones, *Mycol. Res.* **99**: 331 (1995).

Ophiocordyceps sobolifera (Hill ex Watson) G.H. Sung *et al.*, *Stud. Mycol.* **57**: 46 (2007).

Basionym: Clavaria sobolifera Hill ex Watson, *Phil. Trans. Roy. Soc. London*: 271 (1763).

Synonyms: Sphaeria sobolifera (Hill ex Watson) Berk., *London J. Bot.* **2**: 207 (1843).

Torribia sobolifera (Hill ex Watson) Tul. & C. Tul., *Select. Fung. Carpol.* **3**: 10 (1865).

Cordyceps sobolifera (Hill ex Watson) Berk. & Broome, *J. Linn. Soc., Bot.* **14**: 110 (1875) [“1873”].

Beauveria sobolifera Zuo Y. Liu *et al.*, *Fungal Div.* **7**: 64 (2001).

Ophiocordyceps spiculata (B. Huang *et al.*) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**
MycoBank MB814748

Basionym: Hymenostilbe spiculata B. Huang *et al.*, *Mycosystema* **17**: 194 (1998).

Ophiocordyceps tetanopsis (K.T. Hodge *et al.*) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**
MycoBank MB814749

Basionym: Syngliocladium tetanopsis K.T. Hodge *et al.*, *Mycologia* **90**: 750 (1998).

Ophiocordyceps verrucosa (Mains) B. Shrestha, G.H. Sung & Spatafora, **comb. nov.**
MycoBank MB814750

Basionym: Hymenostilbe verrucosa Mains, *Mycologia* **42**: 587 (1950).

Purpureocillium Luangsa-ard *et al.*, *FEMS Microbiol. Lett.* **321**: 144 (2011).

Type: Purpureocillium lilacinum (Thom) Luangsa-ard *et al.*, *FEMS Microbiol. Lett.* **321**: 144 (2011).

Commentary: Purpureocillium includes the sexually reproducing species *Cordyceps cylindrica* Petch 1937 which parasitizes trapdoor spiders. This species is linked to the asexual morph *Nomuraea atypicola*, also a spider pathogen. *Purpureocillium* also includes *P. takamizusanense*, and Ban *et al.* 2015 is an asexual morph that has been linked to the sexual morph *Cordyceps ryogamimontana* Kobayasi 1963 (Ban *et al.* 2015). *Nomuraea* Maubl. 1903 included green-spored species, which were classified in *Metarhizium* (Kepler *et al.* 2014); all purple- to lilac-spored species are classified here in *Purpureocillium*. One new combination is made here, resulting in a total of twelve names of accepted species in the genus.

Purpureocillium atypicum (Petch) Spatafora, Hywel-Jones & Luangsa-ard, **comb. nov.**
MycoBank MB814727

Basionym: Isaria atypicola Yasuda, *Bot. Mag.*, Tokyo **29**: 117 (1915).
Synonyms: Nomuraea atypicola (Yasuda) Samson, *Stud. Mycol.* **6**: 84 (1974).
Spicaria atypicola (Yasuda) Petch, *Trans. Brit. Mycol. Soc.* **23**: 140 (1939).
Cordyceps cylindrica Petch, *Trans. Brit. Mycol. Soc.* **21**: 46 (1937).

CONCLUSIONS

We present species combinations for *Ophiocordycipitaceae* that are consistent with the abolition of Art. 59 of the ICN (McNeill *et al.* 2012) and the recommendations of Quandt *et al.* (2014). Six genera are currently recognized within the family and all include at least one species formerly classified in *Cordyceps sensu* Kobayasi (1941) and Mains (1958) and multiple species classified in several asexually typified genera. The principles of monophyly and priority were enforced in all cases and resulted in a total of 38 new combinations and 15 synonymies. We have purposefully reserved the treatment of *Hirsutella* for a subsequent publication; it is a large and complex genus and the genus name has been applied to a broad and heterogenous group of fungi across several families of *Hypocreales* (Sung *et al.* 2007). Many species currently classified in *Hirsutella* will be ultimately transferred to *Ophiocordyceps*, but many will also be accommodated in other genera and more detailed taxonomic and phylogenetic analyses are required.

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REFERENCES

Ban S, Azuma Y, Sato H, Suzuki KI, Nakagiri A (2015) *Isaria takamizusanensis* is the anamorph of *Cordyceps ryogamimontana*, warranting a new combination, *Purpureocillium takamizusanense* comb. nov. *International Journal of Systematic and Evolutionary Microbiology* **65**: 2459–2465.

Berkeley MJ (1848) Decades of fungi, Tasmanian fungi. *London Journal of Botany* **7**: 572–580.

Chaverri P, Samuels GJ, Hodge KT (2005) The genus *Podocrella* and its nematode-killing anamorph *Harposporium*. *Mycologia* **97**: 433–443.

Dingley JM (1953) *Hypocreales* of New Zealand 5. Genera *Cordyceps* and *Torrubiella*. *Transactions of the Royal Society of New Zealand* **81**: 329–343.

Hodge KT, Humber RA, Wozniak CA (1998) *Cordyceps variabilis* and the genus *Syngliocladium*. *Mycologia* **90**: 743–753.

Kepler RM, Ban S, Nakagiri A, Bischoff JF, Hywel-Jones N, *et al.* (2013) The phylogenetic placement of hypocrealean insect pathogens in the genus *Polycephalomyces*: an application of One Fungus One Name. *Fungal Biology* **117**: 611–622.

Kepler RM, Humber RA, Bischoff JF, Rehner SA (2014) Clarification of generic and species boundaries for *Metarhizium* and related fungi through multigene phylogenetics. *Mycologia* **106**: 811–829.

Kirk PM, Stalpers JA, Braun E, Crous PW, Hansen K, *et al.* (2013) A without-prejudice list of generic names of fungi for protection under the *International Code of Nomenclature for algae, fungi, and plants*. *IMA Fungus* **4**: 381–443.

Kobayasi Y (1941) The genus *Cordyceps* and its allies. *Science Reports of the Tokyo Bunrika Daigaku, sect. B* (84) **5**: 53–260.

Luangsa-ard J, Houbraken J, van Doorn T, Hong SB, Borman AM, *et al.* (2011) *Purpureocillium*, a new genus for the medically important *Paecilomyces lilacinus*. *FEMS Microbiology Letters* **321**: 141–149.

Maharachchikumbura SSN, Hyde KD, Jones EBG, McKenzie EHC, Huang SK, *et al.* (2015) Towards a natural classification and backbone tree for *Sordariomycetes*. *Fungal Diversity* **72**: 199–301.

Mains EB (1958) North American entomogenous species of *Cordyceps*. *Mycologia* **50**: 169–222.

McNeill J, Barrie FF, Buck WR, Demoulin V, Greuter W, *et al.* (eds.) (2012) *International Code of Nomenclature for algae, fungi, and plants (Melbourne Code)*. [Regnum Vegetabile no. 154.] Königstein: Koeltz Scientific Books.

Quandt CA, Kepler RM, Gams W, Araújo JPM, Ban S, *et al.* (2014) Phylogenetic-based nomenclatural proposals for *Ophiocordycipitaceae* (*Hypocreales*) with new combinations in *Tolypocladium*. *IMA Fungus* **5**: 121–134.

Sung G-H, Hywel-Jones NL, Sung J-M, Luangsa-ard JJ, Shrestha B, Spatafora JW (2007) Phylogenetic classification of *Cordyceps* and the clavicipitaceous fungi. *Studies in Mycology* **57**: 5–59.