

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

Joseph W. Spatafora¹, C. Alisha Quandt², Ryan M. Kepler³, Gi-Ho Sung⁴, Bhushan Shrestha⁵, Nigel L. Hywel-Jones⁶, and J. Jennifer Luangsa-ard⁷

¹Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331, USA; corresponding author e-mail: joseph.spatafora@oregonstate.edu

²Department of Ecology and Evolutionary Biology, The University of Michigan, Ann Arbor, MI 48109, USA

³USDA-ARS, Systematic Mycology and Microbiology Laboratory, Beltsville, MD 20705, USA

⁴Institutes for Bio-Medical Convergence and Integrative Medicine, International St Mary's Hospital and College of Medicine, Catholic Kwandong University, Incheon 404-834, Korea

⁵Institute of Life Science and Biotechnology, Sungkyunkwan University, Suwon 440-746, Korea

⁶Milton Biotech Co. Ltd, Innovation Cluster 2, Tower D, 141 Moo. 9, Khlong Nueng, Khlong Luang, Pathum Thani 12120, Thailand

⁷Microbe Interaction Laboratory, National Center for Genetic Engineering and Biotechnology (BIOTEC), 113 Thailand Science Park, Phahonyothin Rd, Khlong Nueng, Khlong Luang, Pathum Thani 12120, Thailand

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
Drechmeria
Harposporium
nomenclature
Ophiocordyceps
Purpureocillium

Article info: Submitted: 28 September 2015; Accepted: 23 October 2015; Published: 4 November 2015.

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).

© 2015 International Mycological Association

You are free to share - to copy, distribute and transmit the work, under the following conditions:

Attribution: You must attribute the work in the manner specified by the author or licensor (but not in any way that suggests that they endorse you or your use of the work).

Non-commercial: You may not use this work for commercial purposes.

No derivative works: You may not alter, transform, or build upon this work.

For any reuse or distribution, you must make clear to others the license terms of this work, which can be found at <http://creativecommons.org/licenses/by-nc-nd/3.0/legalcode>. Any of the above conditions can be waived if you get permission from the copyright holder. Nothing in this license impairs or restricts the author's moral rights.

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.*, *Mycol. 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).
Tilachliopsis nigra Yakush. & Kumaz., *Bot. Mag., Tokyo* **44**: 461 (1930).
- Ophiocordyceps forquignonii** (Quel.) 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.

ACKNOWLEDGEMENTS

G H Sung and B Shrestha acknowledge the financial support of the Cooperative Research Program for Agricultural and Technology Development (PJ009241) of Rural Development Administration, Korea. N L H-J would like to thank Morakot Tanticharoen for her continued support of the BIOTEC insect-fungus programme over many years. J W S acknowledges financial support (DEB-1258162) from the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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 *Polycephalomycetes*: 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.