Phytotaxa 181 (1): 001–033
www.mapress.com/phytotaxa/

Article

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

http://dx.doi.org/10.11646/phytotaxa.181.1.1

Roussoellaceae, a new pleosporalean family to accommodate the genera *Neoroussoella* gen. nov., *Roussoella* and *Roussoellopsis*

JIAN-KUI LIU[1,2,3], RUNGTIWA PHOOKAMSAK[2,3], DONG-QIN DAI[2,3], KAZUAKI TANAKA[4], E.B GARETH JONES[5], JIAN-CHU XU[6], EKACHAI CHUKEATIROTE[2,3] & KEVIN D. HYDE[1,2,3]

[1]*Key Laboratory for Plant Diversity and Biogeography of East Asia, Kunming Institute of Botany, Chinese Academy of Sciences, 132 Lanhei Road, Kunming 650201, China.*
[2]*Institute of Excellence in Fungal Research, Mae Fah Luang University, Chiang Rai 57100, Thailand.*
[3]*School of Science, Mae Fah Luang University, Chiang Rai 57100, Thailand.*
[4]*Faculty of Agriculture and Life Sciences, Hirosaki University, Bunkyo-cho 3, Hirosaki, Aomori 036-8561, Japan.*
[5]*Department of Botany and Microbiology, College of Science, King Saud University, Riyadh 11451, Kingdom of Saudi Arabia.*
[6]*World Agroforestry Centre, East and Central Asia, Kunming 650201, Yunnan, China.*
Corresponding author: Jian-Kui Liu (ljiankui@gmail.com) / Kevin D. Hyde (kdhyde3@gmail.com).

Abstract

Roussoella and *Roussoellopsis* species are mostly known from monocotyledons (large grasses, bamboo and palms). Detailed phylogenies for this group are lacking and thus their family placement and relationships with other genera are unclear. Fresh collections of several *Roussoella*-like species, including the type species *Roussoella nitidula* were made from bamboo and palms in Thailand. In order to obtain a phylogenetic understanding of *Roussoella*-like species within the order *Pleosporales*, we carried out the phylogenetic analyses of ITS, LSU, *TEF1α* and *RPB2* loci. The 15 target strains formed a well-supported clade (100% BS/1.00 PP) in phylogenetic reconstructions of individual and combined datasets, supporting the introduction of a new family *Roussoellaceae*. The *Roussoellaceae* clade can be distinguished into three well-supported sections, namely *Roussoella*/*Roussoellopsis* (93% BS/1.00 PP), *Roussoella* (88% BS/1.00 PP) and *Neoroussoella*. Based on both morphology and phylogenetic analyses, we introduce *Neoroussoella* gen. nov., epitypify *Roussoella nitidula* which is the type species of the genus, and introduce the new species *Neoroussoella bambusae*, *Roussoella chiangraina*, *R. japanensis*, *R. neopustulans*, *R. siamensis*, *R. thailandica* and *R. verrucispora*.

Key words: Asexual morphs, Epitype, Phylogeny, Pleosporales, Taxonomy, Type

Introduction

The *Pleosporales* is the largest order in the class *Dothideomycetes*, including 43 families, 332 genera and more than 4 700 species (Kirk *et al.* 2008, Lumbsch and Huhndorf 2009, Schoch *et al.* 2009a, b, Hyde *et al.* 2013). Most taxa were previously included in *Dothideomycetes* based on morphology. Many important taxonomic studies on this large and difficult group of *Ascomycota* incorporating molecular phylogeny have been published (Crous *et al.* 2006, 2009, 2012, Zhang *et al.* 2008, 2009a, 2009b, 2012, 2013, Schoch *et al.* 2009a, 2009b, Tanaka *et al.* 2009, Gruyter *et al.* 2010, 2012, Boonmee *et al.* 2011, Chomnunti *et al.* 2011, Liu *et al.* 2011, 2012, Manamgoda *et al.* 2011, Hyde *et al.* 2013, Woudenberg *et al.* 2013). However, several groups are not well-resolved because of few collections, lack of recent studies, and most importantly lack of molecular sequence data.

Roussoella was introduced with the type species *R. nitidula* Sacc. & Paol., recorded from bamboo in Malacca, Malaysia (Saccardo and Paoletti 1888). Höhnel (1919) proposed *Roussoella hysterioides* as the type species of *Roussoella* as an earlier name was found in *Dothidea hysterioides*; this combination was accepted by Müller and Arx (1962). The latter authors assigned *Roussoella* to *Amphisphaeriaceae*, a family characterized by broad, cylindrical, unitunicate asci, immersed ascostromata, and two-celled, brown ascospores. Aptroot (1995a) described the asci in *Roussoella* as unitunicate and transferred three species to this genus. Aptroot (1995b), however, modified his concept of *Roussoella* and considered the asci to be bitunicate.

Ascomycetes on bamboo and palms are commonly observed with immersed ascomata containing long, cylindrical, thin asci and brown, two-celled, ornamented ascospores; this might have caused the confusion that *Roussoella* belonged *Amphisphaeriaceae*. Hyde *et al.* (1996) discussed these fungi, and two groups with such characteristics were

Accepted by Wen-Ying Zhuang: 1 Jul. 2014; published: 26 Sept. 2014

Acknowledgements

We are grateful to the Directors and Curators of the PAD and YAM herbaria for the loan of specimens in their keeping. The Mushroom Research Foundation, Bandoo District, Chiang Rai Province, Thailand is acknowledged for providing postgraduate scholarship support and facilities to J.K. Liu. The Royal Golden Jubilee Ph. D. Program (PHD/0090/2551) under Thailand Research Fund is gratefully acknowledged for financial support to R. Phookamsak. K. Tanaka would like to thank the Japan Society for the Promotion of Science (JSPS, 25440199) for financial support. KD Hyde thanks The Chinese Academy of Sciences, project number 2013T2S0030, for the award of Visiting Professorship for Senior International Scientists at Kunming Institute of Botany.

Literature Cited

Alves, A., Correia, A. & Phillips, A.J.L. (2006) Multi-gene genealogies and morphological data support *Diplodia cupressi* sp. nov., previously recognized as *D. pinea* f. sp. *cupressi*, as a distinct species. *Fungal Diversity* 23:1−15.

Aptroot, A. (1995a) Redisposition of some species excluded from *Didymosphaeria* (Ascomycotina). *Nova Hedwigia* 60: 325−379.

Aptroot, A. (1995b) A monograph of *Didymosphaeria*. *Studies in Mycology* 37: 1−161.

Ariyawansa, H.A., Camporesi, E., Thambugala, K.M., Mapook, A., Kang, J.C. & Hyde, K.D. (2014) Confusion surrounding *Didymosphaeria*—phylogenetic and morphological evidence suggest *Didymosphaeriaceae* is not a distinct family. *Phytotaxa* 176(1): 102−119.
http://dx.doi.org/10.11646/phytotaxa.176.1.12

Boonmee, S., Zhang, Y., Chomnunti, P., Chukeatirote, E., Tsui, C.K.M., Bahkali, A.H. & Hyde, K.D. (2011) Revision of lignicolous *Tubeufiaceae* based on morphological reexamination and phylogenetic analysis. *Fungal Diversity* 51: 63−102.
http://dx.doi.org/10.1007/s13225-011-0147-4

Cannon, P.F. & Kirk, P.M. (2007) *Fungal families of the world.* CABI, UK, 456 pp.

Chomnunti, P., Schoch, C.L., Aguirre-Hudson, B., Ko-Ko, T.W., Hongsanan, S., Jones, E.B.G., Kodsueb, R., Phookamsak, R., Chukeatirote, E., Bahkali, A.H. & Hyde, K.D. (2011) *Capnodiaceae*. *Fungal Diversity* 51:103−134.
http://dx.doi.org/10.1007/s13225-011-0145-6

Crous, P.W., Braun, U., Hunter, G., Wingfield, M.J., Verkley, G., Shin, H.D., Nakashima, C. & Groenewald, J. (2012) Phylogenetic lineages in *Pseudocercospora*. *Studies in Mycology* 75: 37−114.
http://dx.doi.org/10.3114/sim0005

Crous, P.W., Schoch, CL, Hyde, K.D., Wood, A, Gueidan, C., de Hoog, G.S. & Groenewald, J.Z. (2009) Phylogenetic lineages in the *Capnodiales*. *Studies in Mycology* 64: 17−47.
http://dx.doi.org/10.3114/sim.2009.64.02

Crous, P.W., Slippers, B., Wingfield, M.J., Rheeder, J., Marasas, W.F.O., Philips, A.J.L., Alves, A., Burgess, T.I., Barber, P.A. & Groenewald, J.Z. (2006) Phylogenetic lineages in the *Botryosphaeriaceae*. *Studies in Mycology* 55: 235−253.
http://dx.doi.org/10.3114/sim.55.1.235

De Gruyter, J., Woudenberg, J., Aveskamp, M., Verkley, G., Groenewald, J. & Crous, P.W. (2012) Redisposition of *Phoma*-like anamorphs in *Pleosporales*. *Studies in Mycology* 75: 1−36.
http://dx.doi.org/10.3114/sim0004

De Gruyter, J., Woudenberg, J., Aveskamp, M., Verkley, G., Groenewald, J. & Crous, P.W. (2010) Systematic reappraisal of species in *Phoma* section *Paraphoma*, *Pyrenochaeta* and *Pleurophoma*. *Mycologia* 102: 1066−1081.
http://dx.doi.org/10.3852/09-240

Eriksson, O. (1981) The families of bitunicate Ascomycetes. *Opera Botanica* 60: 1−220.

Eriksson, O (1984) Outline of the ascomycetes-1984. *Systema Ascomycetum* 3: 1−72.

Hall, T.A. (1999) BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *In*: *Nucleic Acids Symposium Series 41* 1999: 95−98.

Hambleton, S., Tsuneda, A. & Currah, R.S. (2003) Comparative morphology and phylogenetic placement of two microsclerotial black fungi from Sphagnum. *Mycologia* 95: 959−975.
http://dx.doi.org/10.2307/3762024

Hillis, D.M. & Bull, J.J. (1993) An empirical test of bootstrapping as a method for assessing confidence in phylogenetic analysis. *Systematic Biology* 42: 182.
http://dx.doi.org/10.2307/2992540

Hino, I. & Katumoto, K. (1954) Illustrationes fungorum bambusicolorum. II. *Bulletin of the Faculty of Agriculture Yamaguchi University* 5: 213−234.

Hino, I. & Katumoto, K. (1965) Notes on bambusicolous fungi (1). *Journal of Japanese Botany* 40: 81−89.

Höhnel, F. (1919) Fragmente zur Mykologie XXIII. *Sitzungsber Akad Wiss Wien, Math-Naturwiss Kl, Abt* 1 128: 535−625.

Hyde, K.D. (1997) The genus *Roussoëlla*, including two new species from palms in Cuyabeno, Ecuador. *Mycological Research* 101: 609−616.
http://dx.doi.org/10.1017/s0953756296003061

Hyde, K.D., Eriksson, O.E. & Yue, J.Z. (1996) *Roussoëlla*, an ascomycete genus of uncertain relationships with a *Cytoplea* anamorph. *Mycological Research* 100: 1522−1528.

http://dx.doi.org/10.1016/s0953-7562(96)80089-x
Hyde, K.D., Jones, E.B.G., Liu, J.K., Ariyawansa, H., Boehm, E., Boonmee, S., Braun, U., Chomnunti, Crous, P.W., Dai, D.Q., Diederich, P., Dissanayake, A., Doilom, M., Doveri, F., Hongsanan, S., Jayawardena, R., Lawrey, J.D., Li, Y.M., Liu, Y.X., Lücking, R., Monkai, J., Muggia, L., Nelsen, M.P., Pang, K.L., Phookamsak, R., Senanayake, L.C., Shearer, C.A., Suetrong, S., Tanaka, K., Thambugala, K.M., Wijayawardene, N.N., Wikee, S., Wu, H.X., Zhang, Y., Aguirre-Hudson, B., Alias, S.A., Aptroot, A., Bahkali, A., Bezerra, J.L., Bhat, D.J., Camporesi, E., Chukeatirote, E., Gueidan, C., Hawksworth, D.L., Hirayama, K., De Hoog, S., Kang, J.C., Knudsen, K., li, W.J., Li, X.H., liu, Z.Y., Mapook, A., McKenzie, E.H.C., Miller, A.N., Mortimer, P., Phillips, A.J.L., Raja, H.A., Scheuer,C., Schumm, C., Taylor, J.E., Tian, Q., Tibpromma, S., Wanasinghe, D.N., Wang, Y., Xu, j.C., Yacharoen, S., yan, J.Y. & Zhang M. (2013) Families of Dothideomycetes. *Fungal Diversity* 63: 1−313.
http://dx.doi.org/10.1007/s13225-013-0263-4
Ju, Y.M., Rogers, J.D. & Huhndorf, S.M. (1996) *Valsaria* and notes on *Endoxylina*, *Pseudothyridaria*, *Pseudovalsaria*, and *Roussoella*. *Mycotaxon* 58: 419−481.
Kirk, P.M., Ainsworth, G.C., Cannon, P.F & Minter, D.W. (2008) *Ainsworth and Bisby's Dictionary of the Fungi.* 10th edition. CABI, UK, 771 pp.
Liu, J.K., Phookamsak, R., Jones, E.B.G., Zhang, Y., Ko-Ko, T.W., Hu, H.L., Boonmee, S., Doilom, M., Chukeatirote, E., Bahkali, A.H., Wang, Y. & Hyde, K.D. (2011). *Astrosphaeriella* is polyphyletic, with species in *Fissuroma* gen. nov., and *Neoastrosphaeriella* gen. nov. *Fungal Diversity* 51: 135−154.
http://dx.doi.org/10.1007/s13225-011-0142-9
Liu, J.K., Chomnunti, P., Cai, L., Phookamsak, R., Chukeatirote, E., Jones, E.B.G., Moslem, M. & Hyde, K.D. (2010) Phylogeny and morphology of *Neodeightonia palmicola* sp. nov. from palms. *Sydowia* 62: 261−276.
Liu J.K., Phookamsak R., Doilom M., Wikee S., Li Y.M., Ariyawansha H., Boonmee S., Chomnunti P., Dai D.Q., Bhat J.D., Romero A.I., Zhuang, W.Y., Monkai, J., Jones, E.B.G., Chukeatirote, E., Ko-Ko, T.W., Zhao, Y.C., Wang, Y. & Hyde, K.D. (2012) Towards a natural classification of *Botryosphaeriales*. *Fungal Diversity* 57: 149−210.
http://dx.doi.org/10.1007/s13225-012-0207-4
Liu, Y.J., Whelen, S. & Hall, B.D. (1999) Phylogenetic relationships among ascomycetes: evidence from an RNA polymerse II subunit. *Molecular Biology and Evolution* 16: 1799−1808.
http://dx.doi.org/10.1093/oxfordjournals.molbev.a026092
Lumbsch, H.T. & Huhndorf, S.M. (2009) Outline of Ascomycota–2009. *Myconet* 14: 1−64.
http://dx.doi.org/10.3158/1557.1
Manamgoda, D.S, Cai, L., Bahkali, A.H., Chukeatirote, E. & Hyde, KD. (2011) *Cochliobolus*: an overview and current status of species. *Fungal Diversity* 51: 3−42.
http://dx.doi.org/10.1007/s13225-011-0139-4
Miller, M.A., Pfeiffer, W. & Schwartz, T. (2010) Creating the CIPRES Science Gateway for inference of large phylogenetic trees. *In*: *Gateway Computing Environments Workshop 2010 (GCE), 2010.* IEEE, pp. 1−8.
http://dx.doi.org/10.1109/gce.2010.5676129
Müller, E. & Arx, J.A. von (1962) Die Gattungen der didymosporen Pyrenomyceten. *Mycologia* 55: 251–253.
http://dx.doi.org/10.2307/3756296
Nylander, J.A.A. (2004) *MrModeltest 2.0. Program distributed by the author.* Evolutionary Biology Centre, Uppsala University.
Page, R.D.M. (1996) TreeView: an application to display phylogenetic trees on personal computers. *Computer applications in the biosciences* 12: 357−358.
Phookamsak, R., Liu J.K., Manamgoda, D.S., Wanasinghe, D.N., Mortimer, P.E. & Hyde, K.D. (2014) Epitypification of two bambusicolous fungi from Thailand. *Phytotaxa* (in press).
Rannala, B. & Yang, Z. (1996) Probability distribution of molecular evolutionary trees: a new method of phylogenetic inference. *Journal of Molecular Evolution* 43: 304−311.
Rehner, S. (2001) *Primers for Elongation Factor 1-alpha (EF1-alpha).* Insect Biocontrol Laboratory: USDA, ARS, PSI rehner@ ba ars usda gov.
Saccardo, P.A. & Paoletti, G. (1888) Mycetes Malacenses. Funghi della penisola di Malacca raccolti nel 1885 dell. *Ab Benedetto Scortechini* 6: 387–428.
Schoch, C.L., Crous, P.W., Groenewald, J.Z., Boehm, E.W.A., Burgess, T.I., de Gruyter, J., de Hoog, G.S., Dixon, L.J., Grube, M., Gueidan, C., Harada, Y., Hatakeyama, S., Hirayama, K., Hosoya, T., Huhndorf, S.M., Hyde, K.D., Jones, E.B.G., Kohlmeyer, J., Kruys, A., Li, Y.M., Lucking, R., Lumbsch, H.T., Marvanova, L., Mbatchou, J.S., McVay, A.H., Miller, A.N., Mugambi, G.K., Muggia, L., Nelsen, M.P., Nelson, P., Owensby, C.A., Phillips, A.J., Phongpaichit, S., Pointing, S.B., Pujade-Renaud, V., Raja, H.A., Plata, E.R., Robbertse, B., Ruibal, C., Sakayaroj, J., Sano, T., Selbmann, L., Shearer, C.A., Shirouzu, T., Slippers, B., Suetrong, S., Tanaka, K., Volkmann-Kohlmeyer, B., Wingfield, M.J., Wood, A.R., Woudenberg, J.H., Yonezawa, H., Zhang, Y. & Spatafora, J.W. (2009a) A class-wide phylogenetic assessment of Dothideomycetes. *Studies in Mycology* 64: 1−15.
http://dx.doi.org/10.3114/sim.2009.64.01
Schoch, C.L., Sung, G.H., López-Giráldez, F., Townsend, J.P., Miadlikowska, J., Hofstetter, V., Robbertse, B., Mathen, P.B., Kauff, F., Wang, Z., Gueidan, C.C., Andrie, R.M., Trippe, K., Ciufetti, L.M., Wynns, A., Fraker, E., Hodkinson, B.P., Bonito, G., Groenewald, J.Z., Arzanlou, M., De-Hoog, G.S., Crous, P.W., Hewitt, D., Pfister, D.H., Peterson, K., Gryzenhout, M., Wingfield, M.J., Aptroot, A., Suh, S.O., Blackwell, M., Hillis, D.M., Griffith, G.W., Castlebury, L.A., Rossman, A.Y., Lumbsch, H.T., Lücking, R., Büdel, B., Rauhut, A., Diederich, P., Ertz, D., Geiser, D.M., Hosaka, K., Inderbitzin, P., Kohlmeyer, J., Volkmann-Kohlmeyer, B., Mostert, L., O'Donnell, K., Sipman, H., Rogers, J., Shoemaker, R.A., Sugiyama, J., Summerbell, R.C., Untereiner, W., Johnston, P.R., Stenroos, S., Zuccaro, A., Dyer, P.S., Crittenden, P.D., Cole, M.S., Hansen, K., Trappe, J.M., Yahr, R., Lutzoni, F.O. & Spatafora, J.W. (2009b) The Ascomycota tree of life: a phylum-wide phylogeny clarifies the origin and evolution of fundamental reproductive and ecological traits. *Systematic Biology* 58: 224−239.
http://dx.doi.org/10.1093/sysbio/syp020

Stamatakis, A. (2006) RAxML-VI-HPC: maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. *Bioinformatics* 22 (21):2688−2690.
http://dx.doi.org/10.1093/bioinformatics/btl446

Sutton, B.C. (1980) *The Coelomycetes.* Commonwealth Mycological Institute. Kew, UK, 696 pp.

Swofford, D.L. (2002) *PAUP: phylogenetic analysis using parsimony, version 4.0 b10.* Sunderland, MA: Sinauer Associates.

Tamura, K., Peterson, D., Peterson, N., Stecher, G., Nei, M. & Kumar, S. (2011) MEGA5: Molecular Evolutionary Genetics Analysis using Maximum Likelihood, Evolutionary Distance, and Maximum Parsimony Methods. *Molecular Biology and Evolution* 28: 2731−2739.
http://dx.doi.org/10.1093/molbev/msr121

Tanaka, K., Hirayama, K., Yonezawa, H., Hatakeyama, S., Harada, Y., Sano, T., Shirouzu, T. & Hosoya, T. (2009) Molecular taxonomy of bambusicolous fungi: *Tetraplosphaeriaceae*, a new pleosporalean family with *Tetraploa*-like anamorphs. *Studies in Mycology* 64: 175−209.
http://dx.doi.org/10.3114/sim.2009.64.10

Taylor, J.E. & Hyde, K.D. (2003) *Microfungi of tropical and temperate palms. vol 12.* Fungal Diversity Press.

Thiessen, F. & Sydow, H. (1915) Die Dothideales. Kritisch-systematische Originaluntersuchungen. *In*: *Annales mycologici* 147−746.

Thompson, J.D., Gibson, T.J., Plewniak, F., Jeanmougin, F. & Higgins, D.G. (1997) The CLUSTAL_X windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research* 25: 4876−4882.
http://dx.doi.org/10.1093/nar/25.24.4876

Vilgalys, R. & Hester, M. (1990) Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several Cryptococcus species. *Journal of Bacteriology* 172: 4238−4246.

White, T., Bruns, T., Lee, S. & Taylor, J. (1990) Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. *In*: Innis, M., Gelfand, D., Shinsky, J. & White, T. (Eds.) *PCR protocols: a guide to methods and applications.* Academic Press, New York, pp. 315−322.

Woudenberg, J.H., Groenewald, J.Z., Binder, M. & Crous, P.W. (2013) *Alternaria* redefined. *Studies in Mycology* 75: 171−212.
http://dx.doi.org/10.3114/sim0015

Zhang, Y., Crous, P.W., Schoch, C.L. & Hyde, K.D. (2012) *Pleosporales*. *Fungal Diversity* 53: 1−221.
http://dx.doi.org/10.1007/s13225-011-0117-x

Zhang, Y., Fournier, J., Phookamsak, R., Bahkali, A. & Hyde, K.D. (2013) *Halotthiaceae* fam. nov. (Pleosporales) accommodates the new genus *Phaeoseptum* and several other aquatic genera. *Mycologia* 105: 603−609.
http://dx.doi.org/10.3852/11-286

Zhang, Y., Fournier, J., Pointing, S.B. & Hyde, K.D. (2008) Are *Melanomma pulvis-pyrius* and *Trematosphaeria pertusa* congeneric. *Fungal Diversity* 33: 47−60.

Zhang, Y., Schoch, C.L., Fournier, J., Crous, P.W., De Gruyter, J., Woudenberg, J., Hirayama, K., Tanaka, K., Pointing, S. & Spatafora, J. (2009a) Multi-locus phylogeny of Pleosporales: a taxonomic, ecological and evolutionary re-evaluation. *Studies in Mycology* 64: 85−102.
http://dx.doi.org/10.3114/sim.2009.64.04

Zhang, Y., Wang, H.K., Fournier, J., Crous, P.W., Jeewon, R., Pointing, S.B.& Hyde, K.D. (2009b) Towards a phylogenetic clarification of *Lophiostoma*/*Massarina* and morphologically similar genera in the Pleosporales. *Fungal Diversity* 38: 225−251.

Zhaxybayeva, O. & Gogarten, J.P. (2002) Bootstrap, Bayesian probability and maximum likelihood mapping: exploring new tools for comparative genome analyses. BMC *Genomics* 3: 4.

Zhou, D.Q., Cai, L. & Hyde, K.D. (2003) *Astrosphaeriella* and *Roussoella* species on bamboo from Hong Kong and Yunnan, China, including a new species of *Roussoella*. *Cryptogamie Mycologie* 24: 191−197.