Phytotaxa 203 (3): 245–253
www.mapress.com/phytotaxa/

Article

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

http://dx.doi.org/10.11646/phytotaxa.203.3.3

Orbilia laevimarginata sp. nov. and its asexual morph

YING ZHANG[1], XIAOXIA HE[1], HANS-OTTO BARAL[2], MIN QIAO[1], MICHAEL WEIβ[3], BIN LIU[4], KE-QIN ZHANG[1] & ZEFEN YU[1*]

[1]*Laboratory for Conservation and Utilization of Bio-resources and Key Laboratory for Microbial Resources of the Ministry of Education, Yunnan University, Kunming 650091, P.R. China*
[2]*Blaihofstraße 42, D-72074 Tübingen (Germany)*
[3]*Department of Biology, University of Tübingen (Germany)*
[4] *Institute of Applied Microbiology, Guangxi University, Nanning 530005, P.R. China*

Abstract

O. laevimarginata is here described as a new species, and also its asexual morph could not be assigned to an existing taxon. Anamorphic strains were obtained from three teleomorph specimens which were collected at different sites and dates. The anamorph is characterized by cylindric-ellipsoid to oblong conidia, mainly 1-septate, growing either singly or mostly from 2–10 denticles in a capitate arrangement on the tip of conidiophores. These morphological characters are similar to those of the nematophagous anamorph genus *Arthrobotrys*, but the present isolates lack the ability to produce any trapping devices when contacting with nematodes. Phylogenetic analysis inferred from ITS rDNA sequences on different groups within *Orbilia* showed that the isolates of *O. laevimarginata* clustered together in a clade separate from *Orbilia crenatomarginata* (= *Hyalinia crystallina*). The two species are close to *O. scolecospora* and an undescribed species, which all have a crenulate to dentate apothecial margin composed of solid glassy processes. The group clustered distant from those species identified within the nematode-trapping anamorph genera *Arthrobotrys*, *Dactylellina* and *Drechslerella*, but also distant from the non-predacious anamorph genus *Dactylella*. By combining morphological and phylogenetic analysis, we conclude that the three isolates belong to a single undescribed holomorph species. The morphological differences among the three isolated anamorphic strains, and phylogenetic divergence of nematode-trapping fungi and related species are discussed.

Key words: anamorph-teleomorph connection, non-predacious fungi, phylogenetic relationships

Introduction

The family *Orbiliaceae* Nannf. was originally recognized as one of the smallest families in the order *Helotiales* (Spooner 1987), which was characterized by small, waxy, often translucent apothecia with an ectal excipulum composed of round to angular or prismatic cells, furcate ascus bases, and swollen paraphysis apices. Traditionally, *Hyalinia* Boud., *Habrostictis* Fuckel and *Orbiliaster* Dennis have been accepted in the *Orbiliaceae* (Nannfeldt 1932). However, Baral (1994) regarded these genera as synonyms of *Orbilia* Fr. Based on combined analysis of morphological characters and existing rDNA data, Eriksson *et al*. (2003) established a new order *Orbiliales* and a new class *Orbiliomycetes* including only one family *Orbiliaceae* with two genera, *Orbilia* and *Hyalorbilia* Baral & G. Marson. A third genus *Pseudorbilia* Zhang *et al.* with morphological characteristics intermediate between these two accepted genera has been reported later (Zhang *et al*. 2007).

The family *Orbiliaceae* had not been known as nematophagous until Pfister (1994) reported that a collection of *Orbilia fimicola* Jeng & Krug produced an anamorph of the form genus *Arthrobotrys* Corda (*A. superba* Corda). Orbiliaceous fungi have received more and more attention in recent years. Up to now, at least nine anamorphic genera were found to be connected with *Orbiliaceae*, including *Anguillospora* Ingold, *Arthrobotrys* Corda, *Dactylella* Grove, *Dactylellina* M. Morelet, *Dicranidion* Harkn., *Drechslerella* Subram., *Dwayaangam* Subram., *Trinacrium* Riess, and *Pseudotripoconidium* Z.F. Yu & K.Q. Zhang (Pfister 1997, Eriksson *et al*. 2003, Yu *et al*. 2011).

Orbilia crenatomarginata (Höhn.) Sacc. & Trotter [= *Hyalinia crystallina* (Quél.) Boud.), non *Orbilia crystallina* Rodway] is one of the widespread species within the *Orbiliaceae* that are found on woody substrate on the forest floor. Although several hyphomycetous species were identified as anamorphs of orbiliaceous teleomorphs, the anamorph

Accepted by Kevin Hyde: 21 Feb. 2014; published: 25 Mar. 2015

Hyalinia does not seem to be closely related to species of nematode-trapping fungi, though the anamorph of *O. laevimarginata* is morphologically somewhat similar to *Arthrobotrys superba* Corda and *A. cladodes* Drechsler var. *cladodes* in the shape of conidia and the node of the conidiophores. As for its inability to trap nematodes, we also tried to find a similar anamorph species in the genus *Dactylella*, but the one with the shortest conidia is *D. polyctona* (12.7–21 × 2.3–2.8 µm), which is longer and narrower than in *O. laevimarginata*.

For one member of clade C (*O. vermiformis*) a similar conidial state was reported: *D. vermiformis* Z.F. Yu *et al.* (Yu *et al*. 2007). However, *D. vermiformis* has distinctly larger conidia (14.5–37 × 4.2–8 µm) than the asexual morph of *O. laevimarginata* (7.6–13 × 2.3–4 µm). Conidial shape in *O. laevimarginata* was very similar among the isolates, but strain YMF1.01869 (from Yuxi) had smaller conidia borne frequently singly at the tip of conidiophores, while the other two have terminal capitate heads of conidia. Contrary to this difference, the ITS divergences between YMF1.01833 (from Kunming) and the two strains from Yuxi is rather high, while any distinguishing morphological character was not found between them, so we regard all three strains as a single species. The record from Xishuangbanna deviates by apothecia with distinct marginal teeth and was originally not included in our concept of *O. laevimarginata*, also since it did not form conidia. Mainly because of its sequence we have included it in our description of *O. laevimarginata*.

Mature apothecia of *O. laevimarginata* developed from the anamorphic cultures in all three isolates, and the microscopic characteristics were in accordance with the apothecia collected on the decayed substrate (Fig. 1). The morphology of teleomorph growing in laboratory conditions validated the anamorph-teleomorph connection.

The highly heterogeneous *Dactylella* complex was emended based on ITS rDNA phylogeny by Chen *et al*. (2007). The authors separated some of the taxa in the new genus *Brachyphoris* J. Chen *et al*., one of which was earlier observed to be the asexual morph of a member of the genus *Hyalorbilia*, *H. brevistipitata* Bin Liu *et al*. (Liu *et al*. 2005). Our results show that some non-predacious species isolated from *Orbilia*-like species, i.e., those of clade C, are phylogenetically still more distant to the other members of form genus *Dactylella*. The position of clade C which include members previously assigned to the genus *Hyalinia*, and is characterized by helicoidally twisted ascospores, could not be resolved in the present analysis because of too low bootstrap values. The four sequences of the *O. luteorubella* complex as represented in clade B concern the recently established anamorphic genus *Pseudotripoconidium* Z.F. Yu & Y. Zhang (teleomorph *O. sinensis**), in which non-septate triangular conidia with short protuberances emerge from conidipohores with multiple denticles similar as in *O. laevimarginata*. Our ITS rDNA phylogeny indicates that the systematics of non-predacious orbiliaceous fungi should take into account the morphological characters of both teleomorph and anamorph. More anamorphs need to be detected to improve an overview on a general pattern of phylogeny of orbiliaceous fungi.

****Orbilia sinensis*** **(**Z.F. Yu & K.Q. Zhang) Baral, Z.F. Yu & E. Weber, *comb. nov.* MycoBank MB809640

Basionym: *Pseudotripoconidium sinense* Z.F. Yu & K.Q. Zhang, in Yu *et al.*, Mycologia 103: 168, figs 1–23 (2011). MycoBank MB510512

Acknowledgements

This work was jointly funded by National Basic Research Program of China ("973" Program: 2013CB127506, 2012CB722208), National Natural Science Foundation Program of PR China (31470147, 31100018, 31160008, 31260007) and Grants from the Young Academic and Technical Leader Raising Foundation of Yunnan Province (2010CI020).

References

Ahrèn, D., Ursing, B.M. & Tunlid, A. (1998) Phylogeny of nematode-trapping fungi based on 18S rDNA sequences. *FEMS Microbiology Letters* 158: 179–184.
http://dx.doi.org/10.1111/j.1574-6968.1998.tb12817.x

Baral, H.O. (1994) Comments on "Outline of the ascomycetes - 1993". *Systema Ascomycetum* 13: 113–128.

Boudier, E. (1885) Nouvelle classification naturelle des Discomycètes charnus. *Socieìteì mycologique de France Bulletin* 1: 91–120.

Chen, J., Xu, L.L., Liu, B. & Liu, X.Z. (2007) Taxonomy of *Dactylella* complex and *Vermispora*. I. Generic concepts based on morphology and its sequences data. *Fungal Diversity* 26: 73–83.

Eriksson, O., Baral, H.O., Currah, R., Hansen, K., Kurtzman, C., Lassoe, T. & Rambold, G. (2003) Notes on ascomycete systematics nos

3580-3623. *Myconet* 9: 91–103.

Guo, J.W., Yu, Z.F., Qiao, M. & Zhang, K.Q. (2009) Effects of carbon and nitrogen sources on sexual reproduction of five strains from the ascomycete *Orbilia*. *Annals of Microbiology* 59: 51–55. http://dx.doi.org/10.1007/BF03175598

Höhnel, F. von (1907) Fragmente zur Mykologie. III. Mitteilung Nr. 92-155. *Sitzungsberichten der Kaiserliche Akademie der Wissenschaften in Wien, Mathematische-Naturwissenschaftliche Klasse, Abt. 1* 116 (3): 83–162.

Jeewon, R., Liew, E. & Hyde, K. (2002) Phylogenetic relationships of *Pestalotiopsis* and allied genera inferred from ribosomal DNA sequences and morphological characters. *Molecular Phylogenetics and Evolution* 25: 378–392. http://dx.doi.org/10.1016/S1055-7903(02)00422-0

Li, Y., Hyde, K., Jeewon, R., Cai, L., Vijaykrishna, D. & Zhang, K.Q. (2005) Phylogenetics and evolution of nematode-trapping fungi estimated from nuclear and protein coding genes. *Mycologia* 97: 1034–1046. http://dx.doi.org/10.3852/mycologia.97.5.1034

Liu, B., Liu, X.Z. & Zhuang, W.Y. (2005) A new species of *Hyalorbilia* and its anamorph from China. *Nova Hedwigia* 81: 145–155. http://dx.doi.org/10.1127/0029-5035/2005/0081-0145

Liu, B., Liu, X.Z. & Zhuang, W.Y. (2006) *Taxonomy and molecular phylogeny of Orbiliaceae from China.* Poster presented at the 8th International Mycological Congress in August 2006 in Cairns, Australia.

Nannfeldt, J.A. (1932) Studien über die Morphologie und Systematik der nichtlichenisierten Inoperculaten Discomyceten. *Nova Acta Regiae Societatis Scientiarum Upsaliensis series* 48: 1–368.

Pfister, D. (1997) Castor, pollux and life histories of fungi. *Mycologia* 89: 1–23. http://dx.doi.org/10.2307/3761168

Pfister, D. (1994) *Orbilia fimicola*, a nematophagous discomycetes and its *Arthrobotrys* anamorph. *Mycologia* 86: 451–453. http://dx.doi.org/10.2307/3760578

Qin, L., Qiao, M., Yang, Y., Yang, G.Z., Lu, K.P., Zhang, K.Q., Xu, J.P. & Yu, Z.F. (2011) *Dactylella pseudobrevistipitata*, a new species from China. *Annals of Microbiology* 61: 591–595. http://dx.doi.org/10.1007/s13213-010-0177-2

Rubner, A. (1996) Revision of predacious hyphomycetes in the *Dactylella-Monacrosporium* complex. *Studies in Mycology* 39: 1–134.

Scholler, M., Hagedorn, G. & Rubner, A. (1999) A reevaluation of predatory orbiliaceous fungi. Ii. A new generic concept. *Sydowia* 51: 89–113.

Spooner, B.M. (1987) Helotiales if Australasia: *Geoglossaceae*, *Orbiliaceae*, *Sclerotiniaceae*, *Hyaloscyphaceae*. *Bibliotheca Mycologica* 116: 1–711.

Tamura, K., Stecher, G., Peterson, D., Filipski, A. & Kumar, S. (2013) MEGA6: Molecular Evolutionary Genetics Analysis version 6.0. *Molecular Biology and Evolution* 30: 2725–2729. http://dx.doi.org/10.1093/molbev/mst197

Thakur, S. & Zachariah, K. (1989) Response of the fungus *Dactylella rhopalota* to bacteria. *Plant and Soil* 120: 87–93. http://dx.doi.org/10.1007/BF02370294

Thompson, J., Gibson, T., Plewniak, F., Jeanmougin, F. & Higgins, D. (1997) The clustal X windows interface: Flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research* 24: 4876–4882. http://dx.doi.org/10.1093/nar/25.24.4876

White, T., Bruns, T., Lee, S. & Taylor, J. (1990) Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. *In*: Innis, M.A., Gelfand, D., Sninsky, J.J. & White, T.J. (Eds.) *PCR protocols: a guide to methods and applications*. Academic, San Diego, pp 315–322. http://dx.doi.org/10.1016/B978-0-12-372180-8.50042-1

Yang, Y. & Liu, X.Z. (2006) A new generic approach to the taxonomy of predatory anamorphic *Orbiliaceae* (ascomycotina). *Mycotaxon* 97: 153–161.

Yu, Z.F., Qiao, M., Zhang, Y., Baral, H.O. & Zhang, K.Q. (2007) *Orbilia vermiformis* sp. nov. and its anamorph. *Mycotaxon* 99: 271–278.

Yu, Z.F., Qiao, M., Zhang, Y., Qin, L. & Zhang, K.Q. (2011) *Pseudotripoconidium*, a new anamorph genus connected to *Orbilia*. *Mycologia* 103: 164–173
. http://dx.doi.org/10.3852/10-102

Zachariah, K. (1983) Ascocarp induction in a natural auxotroph of a predatory fungus. *Canadian Journal of Botany* 61: 3262–3266. http://dx.doi.org/10.1139/b83-363

Zhang, Y., Yu, Z.F., Baral, H.O., Qiao, M. & Zhang, K.Q. (2007) *Pseudorbilia* gen. nov. (*Orbiliaceae*) from Yunnan, China. *Fungal Diversity* 26: 305–312.