



Fungi of the Russian Far East 2. New species and new records of *Marasmius* and *Cryptomarasmius* (Basidiomycota)

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Abstract

During the study of mycobiota in the Russian Far East several interesting collections belonging to the genera *Marasmius* and *Cryptomarasmius* were made. Here we report the first records of *Marasmius* cf. *ochroleucus*, *M. occultatiformis* and *Cryptomarasmius aucubae* for the investigated territory. Two species (*Marasmius macrocystidiosus*, *M. insolitus*) and one variety (*M. cohaerens* var. *mandshuricus*) are described as new. Detailed morphological descriptions and illustrations are given. The relationships of the studied taxa with close species are discussed. Molecular phylogenetic reconstructions based on ITS and nrLSU data sets were conducted.

Key words: new species; new records; *Marasmiaceae*; *Physalacriaceae*; taxonomy; molecular phylogeny; Far East of Russian Federation

Introduction

This paper represents the second part of a series devoted to the Agaricomycetes of the Russian Far East (Malysheva *et al.* 2013). The genus *Marasmius* Fr. is distributed worldwide and composed of 500–600 species (Tan *et al.* 2009, Wannathes *et al.* 2009a, 2009b, Antonín & Noordeloos 2010). As a result of recent phylogenetic studies this genus has been restricted to a monophyletic lineage containing only members of morphological sections *Marasmius*, *Sicci*, *Globulares*, *Neosessiles* and *Leveilleani* which are accepted by the majority of modern mycologists (Wilson & Desjardin 2005, Tan *et al.* 2009, Antonín & Noordeloos 2010). The other sections recognized by Singer (1976, 1986) were segregated and classified into new genera: sect. *Androsacei* in the genus *Setulipes* (Antonín & Noordeloos 1993), currently belonging to the genus *Gymnopus* (e.g. Wilson & Desjardin 2005), sect. *Alliacei* in the genus *Mycetinis* (Wilson & Desjardin 2005). According to Tan and co-authors (Tan *et al.* 2009), sect. *Fusicystides* should be considered as a synonym of *Setulipes* and sect. *Epiphylli* should be segregated in a new genus allied with *Gloiocephala* in the *Physalacriaceae* (Tan *et al.* 2009). Sect. *Hygrometrici*, maintained in the genus *Marasmius* for a long time, has been transferred to *Physalacriaceae* as a new genus *Cryptomarasmius* T.S. Jenkinson & Desjardin only recently (Jenkinson *et al.* 2014). This paper deals with members of the genus *Marasmius* sect. *Sicci* and *Globulares* as well as those of the recent genus *Cryptomarasmius*.

Advanced studies have shown that the largest sections of *Marasmius* in the modern sense, sect. *Globulares* and sect. *Sicci*, form a well-supported single clade (Wannathes *et al.* 2009b, Antonín & Noordeloos 2010). Conventionally, sect. *Sicci* was divided into series *Atrorubentes*, *Haematocephali*, *Leonini* and *Spinulosi* based on micromorphological features (Singer 1976, Desjardin 1989). All these infrasectional ranks were also found to be non-monophyletic and may be considered artificial groups (Antonín & Noordeloos 2010, Wannathes *et al.* 2009b). However a molecular-based

distinctiveness of the new species and variety. However, their phylogenetic relationships with close taxa and their position inside the genus were not elucidated.

The result of ITS data set analyses suggests that none of the conventional morphological sections or series can be definitely accepted. This conclusion is consistent with data obtained previously (Tan *et al.* 2009, Wannathes *et al.* 2009b, Antonín *et al.* 2012a). In preceding papers, it was supposed that the involvement of nrLSU sequences could be useful for an infrageneric delimitation of *Marasmius* s.str. (Tan *et al.* 2009). Our data indicate that this gene has probably a limited ability to resolve infrageneric groups. The existence of species with morphological features intermediate between conventional series, viz. *Marasmius insolitus*, demonstrates the necessity of updating infrageneric ranks.

It is hoped that further molecular analyses of *Marasmius* s.str. collections in the world based not only on ITS but also on more informative markers working at a higher taxonomic level will help to reveal evolutionary relationships within the genus.

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References

- Antonín, V. & Noordeloos, M.E. (1993) *A monograph of Marasmius, Collybia and related genera in Europe. Part 1: Marasmius, Setulipes and Marasmiellus*. Libri Botanici, 229 pp.
- Antonín, V. & Noordeloos, M.E. (2010) *A monograph of marasmiod and collybioid fungi in Europe*. IHW Verlag, Eching, 480 pp.
- Antonín, V., Ryoo, R. & Shin, H.D. (2010a) Marasmiod and gymnopoid fungi of the Republic of Korea. 2. *Marasmius* sect. *Globulares*. *Persoonia* 24: 49–59.
- Antonín, V., Ryoo, R. & Shin, H.D. (2010b) Marasmiod and gymnopoid fungi of the Republic of Korea. 3. Two new taxa of *Marasmius* sect. *Sicci* with caulocystidia and/or setae. *Mycotaxon* 111: 369–377.
<http://dx.doi.org/10.5248/111.369>
- Antonín, V., Ryoo, R. & Shin, H.D. (2012a) Marasmiod and gymnopoid fungi of the Republic of Korea. 4. *Marasmius* sect. *Sicci*. *Mycological Progress* 11(3): 614–638.
<http://dx.doi.org/10.1007/s11557-011-0773-y>
- Antonín, V., Ryoo, R., Ka, K-H. & Shin, H.D. (2012b) Marasmiod and gymnopoid fungi of the Republic of Korea. 5. *Marasmius* sect. *Hygrometrici*. *Mycotaxon* 119: 405–411.
<http://dx.doi.org/10.5248/119.405>
- Antonín, V., Ryoo, R., Ka, K-H. & Shin, H.D. (2014) Marasmiod and gymnopoid fungi of the Republic of Korea. 5. *Marasmius* sect. *Marasmius*. *Mycoscience*, in press.
<http://dx.doi.org/10.1016/j.myc.2013.07.003>
- Capella-Gutierrez, S., Silla-Martinez, J.M., Gabaldon, T. (2009) TrimAl, a tool for automated alignment trimming in large-scale phylogenetic analyses. *Bioinformatics* 25: 1972–1973.
<http://dx.doi.org/10.1093/bioinformatics/btp348>
- Corner, E.J.H. (1996) The agaric genera *Marasmius*, *Chaetocalathus*, *Crinipellis*, *Heimiomyces*, *Resupinatus*, *Xerula* and *Xerulina* in Malesia. *Nova Hedwigia* 111: 1–175.
- Desjardin, D.E. (1989) *The Genus Marasmius from the Southern Appalachian Mountains*. PhD diss., University of Tennessee. Available from: http://trace.tennessee.edu/utk_graddiss/2513

- Desjardin, D.E. & Horak, E. (1997) *Marasmius* and *Gloiocephala* in the south Pacific region: Papua New Guinea, New Caledonia and New Zealand taxa. Part 1: Papua New Guinea and New Caledonia taxa. *Bibliotheca Mycologica* 168: 1–152.
- Desjardin, D.E., Retnowati, A. & Horak, E. (2000) Agaricales of Indonesia: 2. A preliminary monograph of *Marasmius* from Java and Bali. *Sydowia* 52: 92–193.
- Gardes, M. & Bruns, T.D. (1993) ITS primers with enhanced specification of mycorrhizae and rusts. *Molecular Ecology* 2: 113–118.
- Halling, R.E. (1983) A synopsis of *Marasmius* section *Globulares* (*Tricholomataceae*) in the United States. *Brittonia* 35(4): 317–326.
<http://dx.doi.org/10.2307/2805974>
- Jenkinson T.S., Perry, B.A., Schaefer, R.E. & Desjardin, D.E. (2014) *Cryptomarasmius* gen. nov. established in the *Physalacriaceae* to accommodate members of *Marasmius* section *Hygrometrici*. *Mycologia* 106: 86–94.
<http://dx.doi.org/10.3852/11-309>
- Katoh, K. & Toh, H. (2008) Recent developments in the MAFFT multiple sequence alignment program. *Briefings in Bioinformatics* 9: 286–298.
<http://dx.doi.org/10.1093/bib/bbn013>
- Kornerup, A. & Wanscher, J.H. (1978) *Methuen handbook of colour*. Eyre Methuen, London, 252 pp.
- Malysheva, E.F., Svetasheva, T.Yu. & Bulakh E.M. (2013) Fungi of the Russian Far East. I. New combination and new species of the genus *Leucoagaricus* (*Agaricaceae*) with red-brown basidiomata. *Mikologiya i Fitopatologiya* 47(3): 169–179.
- Neda, H. & Doi, Y. (1998) Notes on Agarics in Kyushu District. *Memoirs of the National Science Museum* 31: 89–95.
- Nilsson, R.H., Kristiansson, E., Ryberg, M., Hallenberg, N., Larsson, K.-H. (2008) Intraspecific ITS variability in the kingdom Fungi as expressed in the International sequence databases and its implications for molecular species identification. *Evolutionary Bioinformatics* 4: 193–201.
- Ronquist, F. & Huelsenbeck, J.P. (2003) MrBayes3: Bayesian phylogenetic inference under mixed models. *Bioinformatics* 19: 1572–1574.
<http://dx.doi.org/10.1093/bioinformatics/btg180>
- Singer, R. (1964) *Marasmius* congolais recueillis par Mme Goossens-Fontana et d'autres collecteurs belges. *Bulletin du Jardin botanique de l'État a Bruxelles* 34 (3): 317–388.
<http://dx.doi.org/10.2307/3667322>
- Singer, R. (1976) *Marasmieae* (Basidiomycetes – *Tricholomataceae*). *Flora Neotropica* 17: 1–348.
- Singer, R. (1986) *The Agaricales in modern taxonomy*. 4th ed. Koenigstein, 981 p.
- Swofford, D.L. (2002) *PAUP*: phylogenetic analysis using parsimony (and other methods) 4.0 Beta*. Sinauer Associates, Sunderland (MA, USA).
- 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>
- Tan, Y-S., Desjardin, D.E., Vikineswary, S. & Abdullah, N. (2007) New species and mating studies of *Marasmius* from Malaysia. *Fungal Diversity* 25: 187–217.
- Tan, Y-S., Desjardin, D.E., Perry, B.A., Vikineswary, S. & Noorlidah, A. (2009) *Marasmius* sensu stricto in Peninsular Malaysia. *Fungal Diversity* 37: 9–100.
- Vassilieva, Lj.N. (1973) *Die Blätterpilze und Röhrlinge (Agaricales) von Primorsky Region*. Nauka, Leningrad, 331 pp. [In Russian]
- Wannathes, N., Desjardin, D.E. & Lumyong, S. (2007) Mating studies, new species and new reports of *Marasmius* from Northern Thailand. *Mycological Research* 111: 985–996.
<http://dx.doi.org/10.1016/j.mycres.2007.06.013>
- Wannathes, N., Desjardin, D.E. & Lumyong, S. (2009a) Four new species of *Marasmius* section *Globulares* from Northern Thailand. *Fungal Diversity* 36: 155–163.
- Wannathes, N., Desjardin, D.E., Hyde, K.D., Perry, B.A. & Lumyong, S. (2009b) A monograph of *Marasmius* (Basidiomycota) from Northern Thailand based on morphological and molecular (ITS sequences) data. *Fungal Diversity* 37: 209–306.
- Wilson, A.W. & Desjardin, D.E. (2005) Phylogenetic relationships in the gymnopoid and marasmioid fungi (Basidiomycetes, euagarics clade). *Mycologia* 97: 667–679.
<http://dx.doi.org/10.3852/mycologia.97.3.667>