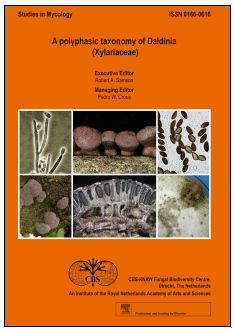
Accepted Manuscript



Cladosporium species in indoor environments

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PII: S0166-0616(18)30009-5

DOI: 10.1016/j.simyco.2018.03.002

Reference: SIMYCO 74

To appear in: *Studies in Mycology*

Please cite this article as: Bensch K, Groenewald JZ, Meijer M, Dijksterhuis J, Jurjevic Ž, Houbraken J, Crous PW, Samson RA, *Cladosporium* species in indoor environments, *Studies in Mycology* (2018), doi: 10.1016/j.simyco.2018.03.002.

Cladosporium species in indoor environments

K. Bensch[1,2*], J.Z. Groenewald[1], M. Meijer[1], J. Dijksterhuis[1], Ž. Jurjevic[3], J. Houbraken[1], P.W. Crous[1,4,5], R.A. Samson[1]

[1]*Westerdijk Fungal Biodiversity Institute, P.O. Box 85167, NL-3508 AD Utrecht, The Netherlands;* [2]*Botanische Staatssammlung München, Menzinger Straße 67, D-80638 München, Germany;* [3]*EMSL Analytical, Inc., 200 Route 130 North, Cinnaminson, NJ 08077, United States;* [4]*Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, Pretoria 0002, South Africa;* [5]*Microbiology, Department of Biology, Utrecht University, Padualaan 8, 3584 CH Utrecht, The Netherlands*

*Correspondence: Konstanze Bensch, k.bensch@westerdijkinstitute.nl

Abstract: As part of a worldwide survey of the indoor mycobiota about 520 new *Cladosporium* isolates from indoor environments mainly collected in China, Europe, New Zealand, North America and South Africa were investigated by using a polyphasic approach to determine their species identity. All *Cladosporium* species occurring in indoor environments are fully described and illustrated. Fourty-six *Cladosporium* species are treated of which 16 species are introduced as new. A key for the most common *Cladosporium* species isolated from indoor environments is provided. *Cladosporium halotolerans* proved to be the most frequently isolated *Cladosporium* species indoors.

Key words: Indoor molds, new species, phylogeny, taxonomy, 16 new taxa.

Taxonomic novelties: New species: *Cladosporium aerium* Bensch & Samson, *C. coloradense* Bensch & Samson, *C. domesticum* Bensch & Samson, *C. europaeum* Bensch & Samson, *C. needhamense* Bensch & Samson, *C. neerlandicum* Bensch & Samson, *C. neolangeronii* Bensch & Samson, *C. parahalotolerans* Bensch & Samson, *C. parasubtilissimum* Bensch & Samson, *C. pulvericola* Bensch & Samson, *C. sinense* Bensch & Samson, *C. sloanii* Bensch & Samson, *C. uwebraunianum* Bensch & Samson, *C. vicinum* Bensch & Samson, *C. westerdijkiae* Bensch & Samson, *C. wyomingense* Bensch & Samson.

INTRODUCTION

The monophyletic genus *Cladosporium* residing in the *Cladosporiaceae* (*Dothideomycetes*) is well circumscribed by having a unique coronate structure of its conidiogenous loci and conidial hila, consisting of a central convex dome surrounded by a raised periclinal rim (David 1997, Braun *et al.* 2003). It has been intensively studied in the last two decades to separate it from cladosporium-like genera (Seifert *et al.* 2004, Heuchert *et al.* 2005, Crous *et al.* 2006, Crous *et al.* 2007b, c, Schubert *et al.* 2007a, Braun *et al.* 2008, Bezerra *et al.* 2017, Crous *et al.* 2017). Three major species complexes are recognised within the genus, mainly based on morphology, and used for practical purposes, viz. the *C. herbarum*, *C. sphaerospermum* and *C. cladosporioides* species complexes. Morphological features describing the three species complexes have been summarised in Bensch *et al.* (2012, 2015) and Marin-Felix *et al.* (2017). Most of the *Cladosporium* species can be referred to one of the three species complexes based on their morphology. The genus previously encompassed more than 772 names (Dugan *et al.* 2004) of which only 170 were recognized as true *Cladosporium* species in a monographic treatment (Bensch *et al.* 2012). Due to continuous isolations from a range of substrates, collected in various continents, this number has increased up to 218 species (Crous *et al.* 2014, Bensch *et al.* 2015, Braun *et al.* 2015, Razafinarivo *et al.* 2016, Marin-Felix *et al.* 2017), including several new species isolated from clinical samples in the United States (Sandoval-Denis *et al.* 2016) and from soil samples in China (Ma *et al.* 2017).

However, little is known about which *Cladosporium* species occur in indoor environments. Besides *Aspergillus*, *Penicillium* and *Talaromyces* (*Trichocomaceae*, *Eurotiomycetes*) *Cladosporium* is considered among the commonest genera found indoors (Flannigan *et al.* 2001, Visagie *et al.* 2014), with some species being predominate under ambient conditions.

Cladosporium species are among the most abundant fungi in outdoor and indoor air (Fradkin *et al.* 1987, Flannigan 2001, Horner *et al.* 2004). In fact, *C. cladosporioides* was reported to be the most predominant fungus in houses in Ontario and Atlanta (Fradkin *et al.* 1987, Horner *et al.* 2004) and the most abundant fungus in outdoor air (Fradkin *et al.* 1987). As the composition of indoor species reflects the composition of outdoor species one would expect to find *C. cladosporioides* as dominant indoors.

In the present study a multilocus DNA sequence typing approach, employing three loci [the internal transcribed spacers of the rDNA genes (ITS), and partial actin and translation elongation factor 1-alpha gene sequences], as well as morphological examinations and cultural charactersitics were used for the identification and delimitation of more than 500 isolates from indoor environments belonging to the genus *Cladosporium*.

MATERIAL AND METHODS

Isolates

Isolates included in this study were obtained from the culture collection of the Westerdijk Fungal Biodiversity Institute (former CBS-KNAW Fungal Biodiversity Centre; CBS), Utrecht, the Netherlands, from the working collection of Pedro Crous (CPC) and from the working collection of the Applied and Industrial Mycology department (DTO), both housed at the Westerdijk Institute. Isolates were inoculated onto 2 % potato-dextrose agar (PDA), synthetic nutrient-poor agar (SNA), 2 % malt extract