



## *Agaricus* section *Brunneopicti*: a phylogenetic reconstruction with descriptions of four new taxa

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### Abstract

*Agaricus* is a genus of saprobic basidiomycetes including species of nutritional and medicinal interest. Historically the temperate species have been grouped into eight classical sections. Recent phylogenetic analyses however, revealed that two-thirds of the tropical taxa do not cluster in these sections, but form exclusively tropical clades. Seven (TR I to TR VII) strongly supported tropical clades have been revealed and it was hypothesized that clade TR I might represent *Agaricus* section *Brunneopicti*. This section was initially characterized by the presence of punctiform squamules, the remains of the veil, on the pileus and stipe. The present morphological study and phylogenetic ML, MP and Bayesian analyses based on ITS1+2 sequences show that clade TR I corresponds to *Agaricus* section *Brunneopicti* and includes 16 taxa grouped in four strongly supported subclades and two isolated branches. The six species with punctiform squamules which initially characterized the section constitute one of these subclades. We propose the new replacement name *Agaricus brunneopunctatus* for the illegitimate name *Agaricus brunneopictus*. All 16 species are discussed, full descriptions are provided for five, among them, *A. brunneosquamulosus*, *A. niveoconulatus*, *A. sordidocarpus* and *A. toluenolens* are described as new species. We also report on certain members of section *Brunneopicti* traits which generally characterize species belonging to other sections. These shared characters raise the issue of their origin and complicate the systematics and the identification of the tropical *Agaricus* species. An artificial dichotomous key is presented for species identification. Section *Brunneopicti* is the first reconstructed section of tropical *Agaricus*. Its known geographical distribution range is strictly palaeotropical. We predict that the species richness of other somewhat forgotten or new tropical sections will also increase in coming years.

Key words: Basidiomycota, phylogeny, systematics, tropical biodiversity

### Introduction

*Agaricus* L. is a genus of saprobic fungi within the order Agaricales (Basidiomycota) including more than 400 species worldwide (Zhao *et al.* 2011). This genus includes species of nutritional and medicinal interest, such as *A. bisporus* (J.E. Lange) Imbach or *A. subrufescens* Peck. Taxa from temperate regions are grouped into eight commonly recognized sections based on morphological and organoleptic traits, as well as macrochemical reactions (Cappelli 1984; Parra 2008, 2013). Species identification in *Agaricus* however, remains problematic due to a limited number of taxonomically relevant morphological features (Challen *et al.* 2003; Zhao *et al.* 2011). However, the circumscription of species and sections has been improved by exploiting the polymorphism of the nuclear ribosomal ITS (Internal transcribed spacer) DNA sequences (Challen *et al.* 2003; Kerrigan *et al.* 2005, 2008). Compared with temperate areas, knowledge of species diversity is less-developed in tropical regions. Zhao *et al.* (2011) found that two-thirds of

of Zhao *et al.* (2011) that geography and climate did had a major impact throughout the evolution of the genus. What are the factors which limit the migration of these species and which physiological process and genetic determinants are implicated in their cold tolerance remain unresolved questions on crucial aspects of the evolution and the adaptation of these saprobic fungi (Largeteau *et al.* 2011; Navarro *et al.* 2014). At a smaller scale similar questions arise to know if the species of section *Brunneopicti* are distributed in both Asian and African continents. We note that two of the four subclades contain both species initially described from Asia and Africa. On the other hand, we note that among the 16 species only two are reported from both continents: *A. inoxydabilis* and *A. brunneopunctatus* initially described from Asia and Africa respectively. However, in both cases this geographical range has not been confirmed by comparing sequences of specimens from both continents. This is the reason for which we consider that ITS sequence data of Asian collections are required to confirm the identification of our African specimen LAPAF 1 to *A. inoxydabilis*.

*Agaricus* species are considered with high nutritional and medicinal values, besides this several wild species are appreciated by human. In section *Brunneopicti*, *A. bingensis* and *A. subsaharianus* are consumed by local people. However, unless future experiments confirm their edibility, we do not recommend the consumption of the species with phenol-like or solvent odor. It remains also to confirm that the phenol-like odor is really due to the presence of this component as this has been done for the species of section *Xanthodermatei* (Gill and Strauch 1984; Petrova *et al.* 2007). Moreover the phenol is likely responsible for the poisoning (gastrointestinal symptoms) following consumption of these species (Kerrigan *et al.* 2005; Petrova *et al.* 2007).

In retrospect, it appears that since its establishment over 57 years ago no species has been introduced in section *Brunneopicti*. It is currently the first reconstructed section of tropical *Agaricus* and it already contains 16 species exclusively from palaeotropics. Although combinations of morphological traits can help to reject other sections and to identify species of section *Brunneopicti*, ITS sequence data remain essential to establish new species in this section. We believe that through such an approach some species previously placed in traditional sections could join the section *Brunneopicti* as that was the case for three species in the present study. From the study of Zhao *et al.* (2011) as from the present study it can be predicted that the species richness of other somewhat forgotten or new tropical sections will also increase in coming years.

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