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Molecular phylogeny and phylogeography of Holarctic species of *Pluteus* section *Pluteus* (Agaricales: Pluteaceae), with description of twelve new species

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Abstract

The taxonomy and phylogeography of *Pluteus* section *Pluteus* in the Holarctic region was investigated using morphological and molecular data. Over 300 specimens spanning the major areas of boreal and temperate forests of the Northern Hemisphere were studied and nrITS and *tef1* were obtained for phylogenetic analyses. In order to stabilize the taxonomy of the group all available type collections were studied and, if possible, sequenced. A total of 26 species occurring in Eurasia and North America were recovered in the phylogenetic analyses. Twelve species are described as new (*Pluteus rangifer*, *P. elaphinus*, *P. hibbettii*, *P. eos*, *P. orestes*, *P. methvenii*, *P. shikae*, *P. kovalenkoi*, *P. leucoborealis*, *P. sepiicolor*, *P. oreibatus*, *P. atrofibrillosus*), one is provisionally named (*P. parilis*) and one variety is raised to species rank (*P. americanus*). In many cases separation of the species based on morphology alone is challenging. In general, *tef1* distinguishes the species better than nrITS. Structured infraspecific genetic variation was detected in the nrITS phylogenies for five species (*P. atromarginatus*, *P. hibbettii*, *P. orestes*, *P. primus* and *P. shikae*) and in the *tef1* phylogenies for *P. cervinus*. Phylogeographic patterns are strikingly different among the species in this group and include widespread Holarctic species, exclusively Palearctic, putative disjuncts and endemics in each Holarctic subregion (Eastern/Western Palearctic and Nearctic). Identification keys are provided for each subregion.

Introduction

The taxonomy of the genus *Pluteus* Fr. has recently been revised using molecular phylogenies, which essentially upheld the morphologically recognized sections (*Pluteus*, *Celluloderma* Fayod and *Hispidoderma* Fayod) with minor rearrangements (Justo *et al.* 2011a, 2011b). Section *Pluteus* Fr. accommodates the species with metuloid hymenial cystidia and a pileipellis organized as a cutis, and includes the type species of the genus, *Pluteus cervinus* (Schaeffer) Kummer (1874: 138) or “deer mushroom”. *Pluteus cervinus* is commonly depicted in popular field guides (e.g. Bessette *et al.* 1997; Phillips 2010) and websites (e.g. <http://mushroomobserver.org/>; http://www.mushroomexpert.com/pluteus_cervinus.html) although it has been suspected for a long time to be a complex of several species (Singer 1956).

The questions about the actual number of species in section *Pluteus* that occur in the Northern Hemisphere, the morphological characters that might be used to separate them and the correct names that should be applied to these taxa have baffled mycologists for decades. Studies on section *Pluteus* in Europe (Kühner & Romagnesi 1953; Singer 1956; Orton 1986; Bonnard 1986, 1987, 2001; Vellinga 1990) have recognized around thirteen species, with numbers varying depending on taxonomic opinion, and with as many as seven described in the last three decades (Singer 1984; Bonnard 1986, 1987, 1991, 2001; Deparis 2003; Justo & Castro 2007a,b). In North America, section *Pluteus* has received considerable attention (Murill 1917; Singer 1956; Smith & Stuntz 1958; Banerjee & Sundberg 1993, 1995). A total of 18 species have been reported, again with discrepancies depending on the taxonomic concepts of the different authors. Furthermore, many species names based on European material (*P. atromarginatus*, *P. cervinus*, *P. pellitus*, *P. patricius*, *P. petasatus*, *P. pouzarianus*, *P. salicinus*) have been applied to North American collections (Banerjee & Sundberg 1995; Rodríguez 2013).

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