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The genus *Imleria* (Boletaceae) in East Asia

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Abstract

The genus *Imleria* can be easily distinguished from other genera of Boletaceae by the combination of the following characters: a chestnut brown pileus and stipe, a cream to pale yellow hymenophore, a viscid pileal surface when moist, a cyanescent context and hymenophore on handling or exposure, an ixotrichodermal pileipellis and smooth spores. The monophyly of *Imleria* and the detection of four independent species were highly supported by phylogenetic analyses using 5 gene markers. The four species, including the previously recognized *Im. badia*, *Im. obscurebrunnea*, plus the newly discovered *Im. parva* and *Im. subalpina*, are fully documented with taxonomic descriptions and illustrations, and a key to the taxa is provided. Geographically, *Im. badia* is widely distributed in Europe, North America and probably in Far East Asia, yet there is some intraspecific divergence between specimens from Europe and North America caused probably by geographic isolation. *Imleria subalpina* and *Im. obscurebrunnea* might diverge from each other relatively recently with the uplifts of the eastern Himalayas and Hengduan Mountains. An epitype collected from Sweden was designated for *Im. badia*.

Keywords: boletes, multiple gene analysis, molecular phylogeny, taxonomy, biogeography

Introduction

Boletus badius Fr. (1828: 126), commonly known as the Bay Bolete, *Xerocomus badius* (Fr. 1818: 247) Gilbert (1931: 92), is an edible mushroom originally described from Europe (Fries 1818). This species can easily be recognized by its chestnut brown pileus and stipe, cream to pale yellow hymenophore and viscid pileipellis when moist (Alessio 1985; Singer 1986; Bas *et al.* 1988; Breitenbach & Kränzlin 1991; Ladurner & Simonini 2003; Zang 2006; Hills 2008). Its systematic position in the Boletaceae, however, has been unsettled for a very long time. Due to its viscid pileus, it was placed in *Rostkovites* P. Karst. (1881: 16), *Viscipellis* (Fr. 1838: 419) Quél. (1886: 155), *Ixocomus* Quél. (1888: 411) and *Suillus* Gray (1821: 646) by Karsten (1881), Quélet (1886), Quélet (1888), and Kuntze (1898) respectively. However, all these four settlements were not broadly accepted, and the former three generic names are all in fact nomenclatural synonyms of the latter name *Suillus*. Since *B. badius* shares with other species of *Xerocomus* (1887: 477) the subtomentose pileus when dry, Gilbert (1931) transferred it into the genus *Xerocomus*, and this placement was then accepted by some mycologists (Singer 1945, 1986; Alessio 1985; Breitenbach & Kränzlin 1991; Horak 2005; Hills 2008). Others, such as Smith & Thiers (1971), Both (1993), and Kirk *et al.* (2008), however, maintained the name *B. badius*, as the generic rank of *Xerocomus* was considered doubtful in their opinion. Šutara (2008) also retained the species in the genus *Boletus* L. (1753: 1176), as the sticky pileal surface and the gelatinous ixotrichodermal pileipellis distinguished it from other xerocomoid taxa. Nevertheless, he pointed out that this solution seemed not to be fully satisfactory and the generic position of *B. badius* required further research.

Multi-gene phylogenetic analysis has been applied to the phylogenetic studies of boletes in the last fifteen years and several new genera and many new species have been uncovered in Boletales, supported with morphological and molecular evidence (Binder & Bresinsky 2002; Halling *et al.* 2007; Desjardin *et al.* 2008, 2009; Li *et al.* 2009, 2011; Zeng *et al.* 2012, 2013; Feng *et al.* 2012; Neves *et al.* 2012; Halling *et al.* 2012; Hosen *et al.* 2013; Zhao *et al*. 2014).

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