

= *Chalciporus piperatus* =

Chalciporus piperatus, commonly known as the peppery bolete, is a small pored mushroom of the family Boletaceae found in mixed woodland in Europe and North America. It has been recorded under introduced trees in Brazil, and has become naturalised in Tasmania and spread under native *Nothofagus cunninghamii* trees. A small bolete, the fruit body has a 1 @. @ 6 ? 9 cm (0 @. @ 6 ? 3 @. @ 5 in) orange @-@ fawn cap with cinnamon to brown pores underneath, and a 4 ? 9 @. @ 5 cm (1 @. @ 6 ? 3 @. @ 7 in) high by 0 @. @ 6 ? 1 @. @ 2 cm (0 @. @ 2 ? 0 @. @ 5 in) thick stipe. The rare variety *hypochryseus*, found only in Europe, has yellow pores and tubes.

Described by Pierre Bulliard in 1790 as *Boletus piperatus*, it is only distantly related to other members of the genus *Boletus* and was reclassified as *Chalciporus piperatus* by Frédéric Bataille in 1908. The genus *Chalciporus* was an early branching lineage in the Boletaceae and appears to be related to boletes with parasitic properties. Previously thought to be ectomycorrhizal (a symbiotic relationship that occurs between a fungus and the roots of various plant species), *C. piperatus* is now suspected of being parasitic on *Amanita muscaria*. The flesh of *C. piperatus* has a very peppery taste, and can be used as a condiment or flavouring.

= = Taxonomy and naming = =

French mycologist Pierre Bulliard described the species as *Boletus piperatus* in 1790. In its taxonomic history, it has been transferred to the genera *Leccinum* (Samuel Frederick Gray, 1821), *Viscipellis* (Lucien Quélet, 1886), *Ixocomus* (Quélet, 1888), *Suillus* (Otto Kuntze, 1898), and *Cerionomyces* (William Alphonso Murrill, 1909). It was reclassified and given its current binomial name in 1908 by Frédéric Bataille when he made it the type species of the newly circumscribed genus *Chalciporus*. The species name *piperatus* means " peppery " in Latin. It is commonly known as the " peppery bolete ".

Chalciporus piperatus is a member of the genus *Chalciporus*, with which the genus *Buchwaldoboletus* form a group of fungi that is an early offshoot in the Boletaceae. Many members of the group appear to be parasitic.

Two varieties have been described. *Chalciporus piperatus* var. *hypochryseus* was originally described as *Boletus hypochryseus* by Czech mycologist Josef ?utara in 1993, and was moved to *Chalciporus* a year later by Regis Courtecuisse. Wolfgang Klofac and Irmgard Krisai @-@ Greilhuber reclassified it as a variety of *C. piperatus* in 2006, although some sources continue to regard it as a distinct species. Variety *amarellus*, first published by Quélet as *Boletus amarellus* in 1883 and later transferred to *Chalciporus* by Bataille in 1908, was described as a variety of *C. piperatus* in 1974 by Albert Pilát and Aurel Dermek. Authorities disagree as to whether or not it has independent taxonomic significance.

= = Description = =

One of the smaller boletes, *Chalciporus piperatus* has an orange @-@ fawn 1 @. @ 6 ? 9 cm (0 @. @ 6 ? 3 @. @ 5 in) cap that is initially convex before flattening out in age. The cap surface can be furrowed; shiny when dry, it can be a little sticky when wet. The colour of the pore surface ranges from cinnamon to dark reddish brown in maturity. When bruised, the pore surface stains brown. Individual pores are angular, measuring about 0 @. @ 5 ? 2 mm wide, while the tubes are 3 ? 10 mm deep. Slender for a bolete, the stipe measures 4 ? 9 @. @ 5 cm (1 @. @ 6 ? 3 @. @ 7 in) long by 0 @. @ 6 ? 1 @. @ 2 cm (0 @. @ 2 ? 0 @. @ 5 in) thick, and is either roughly the same width throughout its length, or slightly thicker near the base. The colour of the stem is similar to the cap, or lighter, and there is yellow mycelium at the base. The flesh is yellow, sometimes with reddish tones, maturing to purplish brown. It has no odour. The spore print is brown to cinnamon. Variety *hypochryseus* is essentially identical to the main form except for its bright yellow tubes and pores. Variety *amarellus* has pinker pores and a taste that is bitter rather than peppery.

The spores are smooth, narrowly fusiform (fuse @-@ shaped), and measure 7 ? 12 by 3 ? 5 µm.

The basidia (spore @-@ bearing cells) measure 20 ? 28 by 6 ? 8 µm and are hyaline (translucent) , four @-@ spored , and narrowly club @-@ shaped , with many internal oil droplets . Cystidia are fusiform , sometimes with a rounded tip , and have dimensions of 30 ? 50 by 9 ? 12 µm . Some are more or less hyaline , while others are encrusted with a golden pigment . The cap cuticle is a trichodermium , an arrangement in which the outermost hyphae emerge roughly parallel , like hairs , perpendicular to the cap surface . These hyphae are 10 ? 17 µm wide and have elliptical to cylindrical cells at their ends that are not gelatinous . Clamp connections are absent from the hyphae .

= = = Similar species = = =

The fruit body of the North American species *Chalciporus piperatoides* are similar , but can be distinguished by its flesh and pores staining blue after cutting or bruising . It has a less peppery taste . Another mild @-@ tasting relative , *C. rubinellus* , has brighter colours than *C. piperatus* , including completely red tubes . One European species , *C. rubinus* , has a shape similar to *C. piperatus* , but has red pores and a stem covered in red dots .

= = Distribution and habitat = =

Fruit bodies of *Chalciporus piperatus* occur singly , scattered , or in groups on the ground . The fungus occurs naturally in or near coniferous or beech and oak woodlands , often on sandy soils . Fruit bodies appear in Europe in late summer and autumn from August to November . The fungus is widespread across North America , fruiting from July to October in the eastern states and from September to January on the Pacific Coast . It is found in Mexico and Central America . In Asia , it has been collected from Pakistan , West Bengal (India) , and Guangdong Province (China) . In South Africa , it is known from the southwestern Cape Province and the eastern Transvaal Province .

Chalciporus piperatus grows in conifer plantations associated with the fly agaric (*Amanita muscaria*) and the chanterelle (*Cantharellus cibarius*) . It has been recorded under introduced loblolly pine (*Pinus taeda*) plantations in Santa Catarina and Paraná states in southern Brazil , and under introduced trees in the Los Lagos Region of Chile . It has also spread into native forest in northeastern Tasmania and Victoria , having been found growing with the native myrtle beech (*Nothofagus cunninghamii*) . The rare variety *hypochryseus* occurs only in Europe , including Austria , the Czech Republic , Greece , Italy , and Spain . Also rare , variety *amarellus* is widespread in European coniferous forests , where it usually found near pines , spruce , and sometimes fir .

Fruit bodies can be parasitised by the mould *Sepedonium chalcipori* , a highly specialised mycoparasite that is only known to infect this bolete . Infections result in necrotic mushroom tissue and the production of copious yellow conidia .

Initially thought to be ectomycorrhizal (symbiotic with plants , like most Boletaceae) , *C. piperatus* has not been confirmed as such in multiple synthesis studies or in isotope fractionation studies . There is some speculation that *C. piperatus* is a mycoparasite on the mycorrhiza of *Amanita muscaria* . In New Zealand , *A. muscaria* is thought to have been introduced with *Pinus radiata* , and has made a host jump to the native *Nothofagus* trees ; *C. piperatus* has since been observed fruiting near *Nothofagus* trees with *A. muscaria* associations . *Buchwaldoboletus lignicola* is in the same clade as *C. piperatus* and is thought to be a parasite as well , strengthening the evidence that *C. piperatus* and its relatives may be mycoparasites .

= = Uses = =

This mushroom is edible but very peppery . The Italian chef Antonio Carluccio recommends only using it to add flavour to other mushrooms . It has been used as a condiment in many countries . The mushroom should be well @-@ cooked before consumption to minimize the risk of gastric symptoms ; the peppery taste is lost with cooking . In powdered form , it loses its peppery taste .

quickly . Some guidebooks classify *C. piperatus* as inedible . Fruit bodies can be used for mushroom dyeing ; depending on the mordant used , yellow , orange , or greenish @-@ brown dyes can be made .

= = Chemistry = =

Sclerocitrin , a pigment compound originally isolated from the common earthball (*Scleroderma citrinum*) , is the major contributor to the yellow colour of the mycelium and the stipe base of *C. piperatus* fruit bodies . Other compounds that have been isolated from this species include norbadione A , chalciporone , xerocomic acid , variegatic acid , variegatorubin , and another yellow pigment , chalcitrin . Chalciporone is responsible for the bitter taste of the fruit bodies . The pigments sclerocitrin , chalcitrin , and norbadione A are derived biosynthetically from xerocomic acid . Related compounds found in the fruit bodies include the chalciporone isomers isochalciporone and dehydroisochalciporone .

A field study of fungi growing in polluted sites in the Czech and Slovak Republics found that *C. piperatus* fruit bodies growing near lead smelters and on mine and slag dumps had the greatest ability to bioaccumulate the element antimony . In one collection , an " extremely high " level of the element was detected ? 1423 milligrams of antimony per kilogram of dried mushroom . In comparison , the antimony levels detected in other common terrestrial fungi from the same area , both saprobic and ectomycorrhizal , were more than an order of magnitude smaller .