= Hydnellum ferrugineum =

Hydnellum ferrugineum , commonly known as the mealy tooth or the reddish @-@ brown corky spine fungus , is a species of tooth fungus in the family Bankeraceae . A widely distributed species , it is found in north Africa , Asia , Europe , and North America . The fungus fruits on the ground singly or in clusters in conifer forest , usually in poor (low nutrient) or sandy soil . Fruit bodies are somewhat top @-@ shaped , measuring 3 ? 10 cm (1 ? 4 in) in diameter . Their velvety surfaces , initially white to pink , sometimes exude drops of red liquid . The lower surface of the fruit body features white to reddish @-@ brown spines up to 6 mm long . Mature fruit bodies become dark reddish brown in color , and are then difficult to distinguish from other similar Hydnellum species . H. ferrugineum forms a mat of mycelia in the humus and upper soil where it grows . The presence of the fungus changes the characteristics of the soil , making it more podzolized .

= = Taxonomy = =

The species was originally described scientifically by Elias Magnus Fries , who named it Hydnum ferrugineum in 1815 . Its taxonomic history includes transfers to the genera Calodon by Petter Karsten in 1881 , and Phaeodon by Joseph Schröter in 1888 . It was assigned its current binomial name by Karsten when he transferred it to its current genus , Hydnellum , in 1879 .

In 1964 , Canadian mycologist Kenneth A. Harrison described a hydnoid fungus found with Pinus resinosa in Michigan and Pinus banksiana in Nova Scotia . The fungus , which Harrison named Hydnellum pineticola , is considered to be synonymous with Hydnellum ferrugineum by the nomenclatural database Index Fungorum . Harrison noted " The attempts to recognize European species in North American collections has only increased the confusion in this country , and until someone has worked critically in the field on both continents , it is better to make a recognizable grouping of our own population as that to guess that they may be the same as those that grow in Europe . " Other taxa considered synonymous with H. ferrugineum are Pierre Bulliard 's 1791 Hydnum hybridum (including later synonyms Calodon hybridus (Bull .) Lindau , and Hydnellum hybridum (Bull .) Banker) ; Louis Secretan 's Hydnum carbunculus (1833) ; and Howard James Banker 's 1906 Hydnellum sanguinarium . Banker explained the difficulty in identifying old Hydnellum specimens : " A considerable number of collections have had to be set aside , as in the dried state , with no notes on the fresh characters , it was impossible to decide with any degree of satisfaction whether the plants represented H. sanguinarium , H. concrescens , H. scrobiculatum , or some undescribed form . "

Common names given to the species include the " reddish @-@ brown corky spine fungus " , and the British Mycological Society @-@ sanctioned name " mealy fungus " . The specific epithet ferrugineum is Latin for " rust @-@ colored " .

= = Description = =

The fruit bodies of Hydnellum ferrugineum are more or less top @-@ shaped with caps that are 3 ? 10 cm (1 @.@ 2 ? 3 @.@ 9 in) in diameter . They are at first convex , then pulvinate (cushion @-@ shaped) , later flattening or becoming slightly depressed in the center . The cap surface of young fruit bodies is uneven , with a velvety to felted texture , and a whitish to pink color . It sometimes exudes blood @-@ red drops of fluid in the depressions . The surface later becomes flesh @-@ colored to dark reddish brown , but with wavy margin remaining whitish . The lower surface of the fruit body bears the hymenium , the fertile spore @-@ bearing tissue . It comprises a dense arrangement of white to reddish brown spines up to 6 mm long , hanging vertically downwards . The stout stipe measures 1 ? 6 cm (0 @.@ 4 ? 2 @.@ 4 in) long by 1 ? 3 cm (0 @.@ 4 ? 1 @.@ 2 in) thick , and is the same color as the cap . Fruit bodies have a " distinctly mealy " odor (similar to the smell of freshly ground flour) , but are inedible .

The flesh is reddish or purplish @-@ brown with white flecks . Initially spongy and soft , it becomes tough and corky as the fruit body matures . In the stipe , the flesh can become blackish in age . Like

other Hydnellum species , fruit body tissue is made of generative hyphae that do not expand . This slows the growth of the fruit body , often enabling it to persist for several months . The fungus employs an indeterminate growth pattern , in which the fruit body formation begins from a vertical column of hyphae that eventually expand at the top to form the cap . Any solid objects encountered during growth , such as grass or twigs , can be enveloped by the expanding fruit body . Similarly , closely neighboring caps can fuse together during growth .

The broadly ellipsoid to roughly spherical spores are 5 @.@ 5 ? 7 @.@ 5 by 4 @.@ 5 ? 5 @.@ 5 ?m . Their surfaces are covered with small rounded bumps . The basidia (spore @-@ bearing cells) are narrowly club @-@ shaped , four @-@ spored , and measure 25 ? 30 by 6 ? 7 @.@ 5 ?m . The hyphae of the flesh are brownish with thin walls , and measure 4 ? 6 ?m ; hyphae in the spines are thin @-@ walled , septate , and sometimes branched , measuring 3 @.@ 5 ? 4 @.@ 5 ?m . The hyphae do not have clamp connections .

= = = Similar species = = =

Hydnellum peckii is similar in appearance , but has an acrid taste , and clamp connections in its hyphae . Hydnellum spongiosipes is readily confused with H. ferrugineum , and several authors have historically considered the two species to be the same ; molecular studies , however , indicate that the two fungi are closely related , but distinct . In contrast with H. ferrugineum , H. spongiosipes has a darker cap when young , darker flesh , and occurs in deciduous woods . Old fruit bodies of H. ferrugineum can be confused with those of Hydnellum concrescens .

= = Habitat and distribution = =

Hydnellum ferrugineum is found mainly in coniferous woodland , often near pines , but occasionally with spruce . Fruit bodies have a preference for sandy soil with low levels of organic matter and nutrients , and grow singly or in clusters . They are more likely to be found in older @-@ growth forests . The fungus occurs in North America , including Mexico . It is widespread but generally uncommon throughout Europe , although there may be local areas where it is common . In Britain , H. ferrugineum is provisionally classified as endangered , and is protected under the Wildlife and Countryside Act 1981 ; it was included as one of 14 species considered in the United Kingdom Biodiversity Action Plan for stipitate hydnoid fungi (i.e. , hydnoid fungi with a cap and stipe) in 2004 . The fungus is protected in Montenegro . It has been collected in India and North Africa .

The fungus forms a tough mat of mycelia in the humus and upper soil of pine forests . This mycelial mat grows larger with old trees , and can cover an area of several square meters . These areas generally lack dwarf shrubs and promote the vigorous growth of mosses ; reindeer lichens often occur in the center of large mats . The presence of the fungus changes the nature of the soil , resulting in a thinner humus layer , decreased groundwater penetration , decreased soil pH , and increases in the level of root respiration as well as the quantity of roots . The fungus also decreases the organic carbon and nitrogen concentrations . Soil with the mycelium becomes more podzolized than the surrounding soil . Similar to some other Hydnellum species , H. ferrugineum is sensitive to the increased nitrogen deposition resulting from clear @-@ cutting , a forestry practice used in some areas of Europe . The fungus forms an unusual type of mycorrhiza with Scots pine (Pinus sylvestris) in which the ectomycorrhiza appears normal at the leading edge of the mycelial mat , but leaves behind dead and atrophied roots at the trailing edge , showing saprophytic tendencies .

= = Bioactive compounds = =

Hydnellum ferrugineum fruit bodies contain the pigments hydnuferrigin (dark violet) and hydnuferruginin (yellow) , as well as small amounts of the polyphenol compound atromentin . Hydnuferrigin has a chemical structure that closely resembles that of thelephoric acid , a pigment found in other species of Hydnellum and Hydnum , and they may originate from a common precursor compound .

= = = Cited works = = =

Pegler DN , Roberts PJ , Spooner BM (1997) . British Chanterelles and Tooth Fungi . Kew , UK : Royal Botanic Gardens . ISBN 978 @-@ 1 @-@ 900347 @-@ 15 @-@ 0 .