= Polyozellus =

Polyozellus is a fungal genus in the family Thelephoraceae , a grouping of mushrooms known collectively as the leathery earthfans . A monotypic genus , it contains the single species Polyozellus multiplex , first described in 1899 , and commonly known as the blue chanterelle , the clustered blue chanterelle , or , in Alaska , the black chanterelle . The distinctive fruit body of this species comprises blue- to purple @-@ colored clusters of vase- or spoon @-@ shaped caps with veiny wrinkles on the undersurface that run down the length of the stem .

Polyozellus has had a varied taxonomic history and has been reclassified several times at both the family and genus level . The range of Polyozellus includes North America and eastern Asia , where P. multiplex may be found growing on the ground in coniferous forests , usually under spruce and fir trees . It is an edible species , and has been harvested for commercial purposes . Polyozellus multiplex contains the bioactive compound polyozellin , shown to have various physiological properties , including suppressive effects on stomach cancer .

= = History and taxonomy = =

The first published description of the species was written by botanist Lucien M. Underwood in 1899 , based on a specimen found the previous year in the woods of Mount Desert , Maine . Although he called the new species a Cantharellus , he noted that " the plant is a remarkable one and from its habit might well form a distinct genus since it has little in common with Cantharellus except its fold @-@ like gills . " In 1910 , William Murrill transferred it to the new genus Polyozellus ; Murrill thought the compound structure of the stem to be a sufficiently unique characteristic to warrant it being separated from Cantharellus species , which have simpler stem structures . In 1920 , specimens from a Japanese collection compiled by A. Yasuda were sent to mycologist Curtis Gates Lloyd , who believed the fungus to be a new species and named it Phyllocarbon yasudai .

No further collections of the fungus were reported until 1937 , when it was found in Quebec , Canada . The next year , Paul Shope considered the genus Polyozellus to be superfluous , pointed out that the compound fruit bodies and the wrinkled hymenium were instead consistent with the genus Craterellus . In 1939 , American mycologist Lee Oras Overholts , in a letter to the journal Mycologia , opined that both of these authors had overlooked a 1925 publication by Calvin Henry Kauffman , who made notes and photos of the species collected in the Rocky Mountains of Wyoming and Colorado , and in the Cascade Mountains of Washington and Oregon . Kauffman believed the species to be merely " a very extreme growth condition " of Cantharellus clavatus ( now known as Gomphus clavatus ) and suggested there was no reason for transferring the species to the genus Craterellus . Mycologists Alexander H. Smith and Elizabeth Morse , in their 1947 publication on Cantharellus species in the United States , placed the species in a new section Polyozellus , but did not separate it from the genus Cantharellus ; they defined the distinguishing characteristics of Polyozellus as the small , roughened , hyaline spores and the color change of the flesh in potassium hydroxide solution , adding that " the spores are unusual for the genus but in our estimation do not warrant excluding the species . "

In 1953 , Rokuya Imazeki took into consideration differences in spore characteristics : species in the genus Cantharellus were not known to have spores that were subglobose ( roughly spherical ) and tuberculate ( covered with wart @-@ like projections ) like Polyozellus ; however , these spore characteristics were common in species in the Thelephoraceae family ( Cantharellus belongs in a different family , the Cantharellaceae ) . Other characteristics linking the blue chanterelle with the Thelephoraceae included the dark color , the strong odor ( especially in dried specimens ) , and the presence of thelephoric acid , a mushroom pigment common in the family . Taken together , these factors led Imazeki to propose the new family Phylacteriaceae . The suggested family @-@ level taxonomical change was not accepted by other authors ; for example , in 1954 , Seiichi Kawamura renamed it Thelephora multiplex . As of 2009 , both Index Fungorum and MycoBank list Polyozellus as being within the Thelephoraceae family , a grouping of mushrooms commonly known as the leathery earthfans . The genus name is derived from the Greek poly meaning many , and oz ,

meaning branch . The specific epithet multiplex means " in many pieces " , referring to the compound nature of the fruit body . Common names for this species include the blue chanterelle and the clustered blue chanterelle . In Alaska , where specimens typically have very dark @-@ colored fruit bodies , it is called the black chanterelle , although this name is shared with some Craterellus species .

= = Description = =

Polyozellus multiplex is part of the group of fungi collectively known as cantharelloid mushrooms ( which includes the genera Cantharellus , Craterellus , Gomphus , and Polyozellus ) because of the similarity of their fruit body structures and the morphology of the spore @-@ producing region ( the hymenophore ) on the underside of the caps . The fan- or funnel @-@ shaped fruit bodies of the black chanterelle grow clustered together on the ground , often in large masses that may reach aggregate diameters of up to 1 meter ( 3 @.@ 3 ft ) , although they are usually up to 30 centimeters ( 11 @.@ 8 in ) .

The individual caps , 3 ? 5 cm ( 1 @.@ 2 ? 2 @.@ 0 in ) wide and almost as long , are violet @-@ black , with edges that are initially whitish , and with a glaucous surface ? a white powdery accumulation of spore deposit . The upper surface may be zonate ? lined with what appear to be multiple concentric zones of texture caused by areas of fine hairs ( a tomentum ) ; and the edges of the caps have a layer of very fine hairs and are lobed and wavy . The underside of the caps bears the fertile , spore @-@ making tissue called the hymenium , which typically has shallow , crowded wrinkles or veins that are roughly the same color or paler than the top surface . Some variation in color has been observed depending on the collection location . For example , specimens found in Alaska are more likely to be jet @-@ black in color with a dark gray underside .

Fruit bodies may be up to 15 cm ( 5 @.@ 9 in ) high ( including the stem ) and 10 cm ( 3 @.@ 9 in ) wide . Occasionally , much larger clusters of fused mushrooms are found , up to a meter in diameter . The stem is dark purplish @-@ black with a smooth ( glabrous ) and dry surface ; the stems are often fused at the base . It is typically 1 @.@ 5 ? 2 cm ( 0 @.@ 6 ? 0 @.@ 8 in ) wide and up to 5 cm ( 2 @.@ 0 in ) long . The flesh is dark violet , soft but breaking easily . The spore deposit is white .

= = = Microscopic characteristics = = =

The spores are roughly spherical to broadly ellipsoid in shape , covered with small wart @-@ like projections ( tubercules ) , and have dimensions of 6 ? 8 @.@ 5 by 5 @.@ 5 ? 8 µm . Viewed microscopically , they are hyaline , meaning they appear translucent or colorless . Chemical tests may also be used to help distinguish the spores : in the presence of potassium hydroxide ( KOH ) , the spores turn slightly green ; the spores are not amyloid , meaning they do not take iodine when treated with Melzer 's reagent ; the spores are acyanophilous , meaning they do not readily absorb methyl blue stain . The cystidia that comprise the hymenium are filamentous and 3 ? 4 µm wide by 28 ? 40 µm long . The outer tissue layer of the cap ? the cuticle , or pileipellis ? is made of interwoven hyphae , and stains olive @-@ green in KOH . Clamp connections are present , but not at all the cell partitions . The basidia , the spore @-@ bearing cells , are 32 ? 38 by 5 ? 6 µm and four @-@ spored .

= = = Similar species = = =

The horn @-@ of @-@ plenty mushroom ( Craterellus cornucopioides ) also has a blackish fruit body and a smooth hymenium , but is distinguished from P. multiplex by its thin flesh , a trumpet- or tubular @-@ shaped fruit body ( rather than fan- or spoon @-@ shaped ) , and grey to black colors . A closely related species , the fragrant chanterelle ( Cantharellus odoratus ) , also tends to grow in dense clusters , but it is orange rather than blue . Craterellus caeruleofuscus does not form compound clusters , and is not restricted to coniferous forests . The pig 's ear Gomphus , species

Gomphus clavatus , is similar in shape and form but fleshier , and light violet to pink .

= = Habitat and distribution = =

Polyozellus multiplex is an ectomycorrhizal species , meaning that the hyphae of the fungus grow in a mutualistic association with the roots of plants , but the fungal hyphae generally do not penetrate the cells of the plant 's roots . The species grows in coniferous woods under spruce and fir , and more frequently at higher elevations . It is most often encountered in summer and fall .

This species is northern and alpine in distribution , and rarely encountered . Collections have been made in the United States ( including Maine , Oregon , Colorado , New Mexico , and Alaska ) , Canada ( Quebec and British Columbia ) , China , Japan , and Korea . The disjunct distribution of this species in North America and East Asia has been noted to occur in a number of other fungal species as well . Polyozellus multiplex is also found in the Queen Charlotte Islands , where it is commercially harvested .

= = Uses = =

= = = Edibility = = =

Polyozellus multiplex is edible , and is collected for sale in Asian countries such as Korea , Japan , and China . In North America , it is sometimes collected recreationally , and commercially . The taste is described as mild , and the odor as mild or aromatic . Mycologist David Arora claims the flavor to be inferior to Craterellus . Fruit bodies may be preserved by drying .

= = = Bioactive compounds = = =

The compound polyozellin ? a chemical which can be isolated and purified from P. multiplex ? inhibits prolyl endopeptidase ( PEP ) , an enzyme that has a role in processing proteins ( specifically , amyloid precursor protein ) in Alzheimer 's disease . Chemicals that inhibit PEP have attracted research interest due to their potential therapeutic effects . Further analyses of extracts from P. multiplex revealed similar dibenzofuranyl derivatives of polyozellin , each with different chemical properties , including kynapcin @-@ 12 , kynapcin @-@ 13 and -28 , and -24 . A total synthesis of kynapcin @-@ 24 was achieved in 2009 .

= = = Antitumor properties = = =

Research conducted in 2003 suggests that extracts from Polyozellus multiplex may have suppressive effects on stomach cancer . The study showed that feeding a low concentration ( 0 @.@ 5 % or 1 % ) of the mushroom extract enhanced the activities of the enzymes glutathione S @-@ transferase and superoxide dismutase , and increased the abundance of the molecule glutathione . The extract also augmented the expression of the protein p53 . All of these substances protect the human organism against cancer . Additional studies reported in 2004 and 2006 attribute anti @-@ tumor properties to polyozellin .

= = Cited literature = =

Pilz D , Norvell L , Danell E , Molina R ( 2003 ) . Ecology and management of commercially harvested chanterelle mushrooms . General Technical Report PNW @-@ GTR @-@ 576 ( PDF ) . Portland , OR : Department of Agriculture , Forest Service , Pacific Northwest Research Station . Retrieved 2009 @-@ 09 @-@ 23 .