= Lycoperdon perlatum =

Lycoperdon perlatum , popularly known as the common puffball , warted puffball , gem @-@ studded puffball , or the devil 's snuff @-@ box , is a species of puffball fungus in the family Agaricaceae . A widespread species with a cosmopolitan distribution , it is a medium @-@ sized puffball with a round fruit body tapering to a wide stalk , and dimensions of 1 @.@ 5 to 6 cm (0 @.@ 6 to 2 @.@ 4 in) wide by 3 to 7 cm (1 @.@ 2 to 2 @.@ 8 in) tall . It is off @-@ white with a top covered in short spiny bumps or " jewels " , which are easily rubbed off to leave a netlike pattern on the surface . When mature it becomes brown , and a hole in the top opens to release spores in a burst when the body is compressed by touch or falling raindrops .

The puffball grows in fields , gardens , and along roadsides , as well as in grassy clearings in woods . It is edible when young and the internal flesh is completely white , although care must be taken to avoid confusion with immature fruit bodies of poisonous Amanita species . L. perlatum can usually be distinguished from other similar puffballs by differences in surface texture . Several chemical compounds have been isolated and identified from the fruit bodies of L. perlatum , including sterol derivatives , volatile compounds that give the puffball its flavor and odor , and the unusual amino acid lycoperdic acid . Laboratory tests indicate that extracts of the puffball have antimicrobial and antifungal activities .

= = Taxonomy = =

The species was first described in the scientific literature in 1796 by mycologist Christiaan Hendrik Persoon. synonyms include Lycoperdon gemmatum (as described by August Batsch in 1783) ; the variety Lycoperdon gemmatum var. perlatum (published by Elias Magnus Fries in 1829) ; Lycoperdon bonordenii (George Edward Massee , 1887) ; and Lycoperdon perlatum var. bonordenii (A.C. Perdeck , 1950) .

L. perlatum is the type species of the genus Lycoperdon . Molecular analyses suggest a close phylogenetic relationship with L. marginatum .

The specific epithet perlatum is Latin for " widespread " . It is commonly known as the common puffball , the gem @-@ studded puffball (or gemmed puffball) , the warted puffball , or the devil 's snuff @-@ box ; Samuel Frederick Gray called it the pearly puff @-@ ball in his 1821 work A Natural Arrangement of British Plants . Because some indigenous peoples believed that the spores caused blindness , the puffball has some local names such as " blindman 's bellows " and " no @-@ eyes " .

= = Description = =

The fruit body ranges in shape from pear @-@ like with a flattened top , to nearly spherical , and reaches dimensions of 1 @.@ 5 to 6 cm (0 @.@ 6 to 2 @.@ 4 in) wide by 3 to 7 cm (1 @.@ 2 to 2 @.@ 8 in) tall . It has a stem @-@ like base . The outer surface of the fruit body (the exoperidium) is covered in short cone @-@ shaped spines that are interspersed with granular warts . The spines , which are whitish , gray , or brown , can be easily rubbed off , and leave reticulate pock marks or scars after they are removed . The base of the puffball is thick , and has internal chambers . It is initially white , but turns yellow , olive , or brownish in age . The reticulate pattern resulting from the rubbed @-@ off spines is less evident on the base .

In maturity , the exoperidium at the top of the puffball sloughs away , revealing a pre @-@ formed hole (ostiole) in the endoperidium , through which the spores can escape . In young puffballs , the internal contents , the gleba , is white and firm , but turns brown and powdery as the spores mature . The gleba contains minute chambers that are lined with hymenium (the fertile , spore @-@ bearing tissue) ; the chambers collapse when the spores mature . Mature puffballs release their powdery spores through the ostiole when they are compressed by touch or falling raindrops . A study of the spore release mechanism in L. pyriforme using high @-@ speed schlieren photography determined that raindrops of 1 mm diameter or greater , including rain drips from nearby trees , were sufficient to

cause spore discharge . The puffed spores are ejected from the ostiole at a velocity of about 100 cm / second to form a centimeter @-@ tall cloud one @-@ hundredth of a second after impact . A single puff like this can release over a million spores .

The spores are spherical , thick @-@ walled , covered with minute spines , and measure 3 @.@ 5 ? 4 @.@ 5 ?m in diameter . The capillitia (threadlike filaments in the gleba in which spores are embedded) are yellow @-@ brown to brownish in color , lack septae , and measure 3 ? 7 @.@ 5 ?m in diameter . The basidia (spore @-@ bearing cells) are club @-@ shaped , four @-@ spored , and measure 7 ? 9 by 4 ? 5 ?m . The basidia bear four slender sterigmata of unequal length ranging from 5 ? 10 ?m long . The surface spines are made of chains of pseudoparenchymatous hyphae (resembling the parenchyma of higher plants) , in which the individual hyphal cells are spherical to elliptical in shape , thick @-@ walled (up to 1 ?m) , and measure 13 ? 40 by 9 ? 35 ?m . These hyphae do not have clamp connections .

= = = Edibility = = =

Lycoperdon perlatum is considered to be a good edible mushroom when young , when the gleba is still homogeneous and white . They have been referred to as " poor man 's sweetbread " due to their texture and flavor . The fruit bodies can be eaten after slicing and frying in batter or egg and breadcrumbs , or used in soups as a substitute for dumplings . As early as 1861 , Elias Fries recommended them dried and served with salt , pepper , and oil . The puffballs become inedible as they mature : the gleba becomes yellow @-@ tinged then finally develops into a mass of powdery olive @-@ green spores . L. perlatum is one of several edible species sold in markets in the Mexican states of Puebla and Tlaxcala . The fruit bodies are appealing to other animals as well : the northern flying squirrel (Glaucomys sabrinus) includes the puffball in their diet of non @-@ truffle fungi , while the " puffball beetle " Caenocara subglobosum uses the fruit body for shelter and breeding . Nutritional analysis indicates that the puffballs are a good source of protein , carbohydrates , fats , and several micronutrients . The predominant fatty acids in the puffball are linoleic acid (37 % of the total fatty acids) , oleic acid (24 %) , palmitic acid (14 @.@ 5 %) , and stearic acid (6 @.@ 4 %) .

The immature ' buttons ' or ' eggs ' of deadly Amanita species can be confused with puffballs . This can be avoided by slicing fruit bodies vertically and inspecting them for the internal developing structures of a mushroom . Additionally , Amanitas will generally not have " jewels " or a bumpy external surface .

The spores are ornamented with many sharp microscopic spines and can cause severe irritation of the lung (lycoperdonosis) when inhaled . This condition has been reported to afflict dogs that play or run where puffballs are present .

= = Similar species = =

There are several other puffball species with which L. perlatum might be confused . L. nettyanum , found in the Pacific Northwest region of the United States , is covered in granular patches , but these granules adhere more strongly to the surface than those of L. perlatum . L. pyriforme lacks prominent spines on the surface , and grows on rotting wood ? although if growing on buried wood , it may appear to be terrestrial . The widely distributed and common L. umbrinum has spines that do not leave scars when rubbed off , a gleba that varies in color from dark brown to purple @-@ brown at maturity , and a purple @-@ tinged base . The small and rare species L. muscorum grows in deep moss . L. peckii can be distinguished from L. pyriforme by the lavender @-@ tinged spines it has when young . L. rimulatum has purplish spores , and an almost completely smooth exoperidium . L. excipuliforme is larger and grayer , and , in mature individuals , the upper portion of its fruit body breaks down completely to release its spores . In the field , L. marginatum is distinguished from L. perlatum by the way in which the spines are shed from the exoperidium in irregular sheets .

= = Ecology and distribution = =

A saprobic species , Lycoperdon perlatum grows solitarily , scattered , or in groups or clusters on the ground . It can also grow in fairy rings . Typical habitats include woods , grassy areas , and along roads . It has been reported from Pinus patula plantations in Tamil Nadu , India . The puffball sometimes confuses golfers because of its resemblance to a golf ball when viewed from a distance .

A widespread species with an almost cosmopolitan distribution , it has been reported from Africa (Kenya , Rwanda , Tanzania) , Asia (China , Himalayas , Japan , southern India) , Australia , Europe , New Zealand , and South America (Brazil) . It has been collected from subarctic areas of Greenland , and subalpine regions in Iceland . In North America , where it is considered the most common puffball species , it ranges from Alaska to Mexico , although it is less common in Central America . The species is popular on postage stamps , and has been depicted on stamps from Guinea , Paraguay , Romania , Sierra Leone , and Sweden .

The puffball bioaccumulates heavy metals present in the soil , and can be used as a bioindicator of soil pollution by heavy metals and selenium . In one 1977 study , samples collected from grassy areas near the side of an interstate highway in Connecticut were shown to have high concentrations of cadmium and lead . L. perlatum biomass has been shown experimentally to remove mercury ions from aqueous solutions , and is being investigated for potential use as a low @-@ cost , renewable , biosorptive material in the treatment of water and wastewater containing mercury .

= = Chemistry = =

Several steroid derivatives have been isolated and identified from fruit bodies of L. perlatum , including (S) -23 @-@ hydroxylanostrol , ergosterol ? @-@ endoperoxide , ergosterol 9 @,@ 11 @-@ dehydroendoperoxide and (23E) -lanosta @-@ 8 @,@ 23 @-@ dien @-@ 3? , 25 @-@ diol . The compounds 3 @-@ octanone , 1 @-@ octen @-@ 3 @-@ ol , and (Z) -3 @-@ octen @-@ 1 @-@ ol are the predominant components of the volatile chemicals that give the puffball its odor and flavor . Extracts of the puffball contain relatively high levels of antimicrobial activity against the human pathogenic bacteria Bacillus subtilis , Staphylococcus aureus , Escherichia coli , and Pseudomonas aeruginosa , with an efficiency comparable to that of the antibiotic ampicillin . These results corroborate an earlier study that additionally reported antibacterial activity against Salmonella enterica serovar Typhimurium , Streptococcus pyogenes , and Mycobacterium smegmatis . Extracts of the puffball have also been reported to have antifungal activity against Candida albicans , C. tropicalis , Aspergillus fumigatus , Alternaria solani , Botrytis cinerea , and Verticillium dahliae . A 2009 study found L. perlatum puffballs to contain the phenolic compound cinnamic acid at a concentration of about 14 milligrams per kilogram of mushroom . The fruit bodies contain the pigment melanin .

The amino acid lycoperdic acid (chemical name 3- (5 (S) -carboxy @-@ 2 @-@ oxotetrahydrofuran @-@ 5 (S) -yl) -2 (S) -alanine) was isolated from the puffball , and reported in a 1978 publication . Based on the structural similarity of the new amino acid with (S) -glutamic acid , (S) - (+) -lycoperdic acid is expected to have antagonistic or agonistic activity for the glutamate receptor in the mammalian central nervous system . Methods to synthesize the compounds were reported in 1992 , 1995 , and 2002 .