= Dendrocollybia =

Dendrocollybia is a fungal genus in the family Tricholomataceae of the order Agaricales . It is a monotypic genus , containing the single species Dendrocollybia racemosa , commonly known as the branched Collybia or the branched shanklet . The somewhat rare species is found in the Northern Hemisphere , including the Pacific Northwest region of western North America , and Europe , where it is included in several Regional Red Lists . It usually grows on the decaying fruit bodies of other agarics ? such as Lactarius and Russula ? although the host mushrooms may be decayed to the point of being difficult to recognize .

Dendrocollybia racemosa fruit bodies have small pale grayish @-@ white or grayish @-@ brown caps up to 1 cm (0 @.@ 4 in) wide , and thin stems up to 6 cm (2 @.@ 4 in) long . The species is characterized by its unusual stem , which is covered with short lateral branches . The branches often produce spherical slimeheads of translucent conidiophores on their swollen tips . The conidiophores produce conidia (asexual spores) by mitosis . Because the fungus can rely on either sexual or asexual modes of reproduction , fruit bodies sometimes have reduced or even missing caps . The unusual stems originate from black pea @-@ sized structures called sclerotia . The anamorphic form of the fungus , known as Tilachlidiopsis racemosa , is missing the sexual stage of its life cycle . It can reproduce at relatively low temperatures , an adaptation believed to improve its ability to grow quickly and fruit on decomposing mushrooms .

= = Taxonomy and phylogeny = =

The genus Dendrocollybia was first described in 2001 , to accommodate the species previously known as Collybia racemosa . Before then , the so @-@ named taxon was considered to be one of four species of Collybia , a genus which had itself been redefined and reduced in 1997 , when most of its species were transferred to Gymnopus and Rhodocollybia . C. racemosa was originally described and named Agaricus racemosus by Christian Hendrik Persoon in 1797 , and sanctioned under that name by Elias Magnus Fries in 1821 . In his Systema Mycologicum , Fries classified it in his " tribe " Collybia along with all other similar small , white @-@ spored species with a convex cap and a fragile stem . In 1873 Lucien Quélet raised Fries ' tribe Collybia to generic rank . Samuel Frederick Gray called the species Mycena racemosa in his 1821 Natural Arrangement of British Plants ; both this name and Joanne Lennox 's 1979 Microcollybia racemosa are considered synonyms .

Rolf Singer 's fourth edition (1986) of his comprehensive Agaricales in Modern Taxonomy included Collybia racemosa in section Collybia , in addition to the three species that currently comprise the genus Collybia : C. tuberosa , C. cirrhata and C. cookei . A phylogenetic analysis of the internal transcribed spacer sequences of ribosomal DNA by Karen Hughes and colleagues showed that C. tuberosa , C. cirrhata and C. cookei form a monophyletic group within a larger Lyophyllum ? Tricholoma ? Collybia clade that includes several species of Lyophyllum , Tricholoma , Lepista , Hypsizygus and the species C. racemosa . Hughes and colleagues could not identify a clade that included all four species of Collybia . Restriction fragment length polymorphism analysis of the ribosomal DNA from the four species corroborated the results obtained from phylogenetic analysis . Based on these results , as well as differences in characteristics such as the presence of unique stem projections , fruit body pigmentation , and macrochemical reactions , they circumscribed the new genus Dendrocollybia to contain C. racemosa .

The fungus is commonly known as the branched Collybia , or the branched shanklet ; Samuel Gray referred to it as the " racemelike high @-@ stool " . The genus name Dendrocollybia is a combination of the Ancient Greek words dendro- , meaning " tree " , and collybia , meaning " small coin " . The specific epithet racemosa is from the Latin word racemus ? " a cluster of grapes " .

= = Description = =

The cap of Dendrocollybia racemosa is typically between 3 to 10 mm (0 @.@ 1 to 0 @.@ 4 in) in

diameter , and depending on its stage of development , may be conic to convex , or in maturity , somewhat flattened with a slight rounded central elevation (an umbo) . The cap surface is dry and opaque , with a silky texture ; its color in the center is fuscous (a dusky brownish @-@ gray color) , but the color fades uniformly towards the margin . The margin is usually curved toward the gills initially ; as the fruit body matures the edge may roll out somewhat , but it also has a tendency to fray or split with age . There may be shallow grooves on the cap that correspond to the position of the gills underneath , which may give the cap edge a crenate (scalloped) appearance . The flesh is very thin (less than 1 mm thick) and fragile , lacking in color , and has no distinctive odor or taste . The gills are relatively broad , narrowly attached to the stem (adnexed) , spaced closely together , and colored gray to grayish @-@ tan , somewhat darker than the cap . There are additional gills , called lamellulae , that do not extend all the way to the stem ; they are interspersed between the gills and arranged in up to three series (tiers) of equal length . Occasionally , the fungus produces stems with aborted caps , or with the caps missing entirely .

The stem is 4 to 6 cm (1 @.@ 6 to 2 @.@ 4 in) long by 1 mm thick , roughly equal in width throughout , and tapers to a long " root " which terminates in a dull black , roughly spherical sclerotium . The stem may be buried deeply in its substrate . The stem surface is roughly the same color as the cap , with a fine whitish powder on the upper surface . In the lower portion , the stem is brownish , and has fine grooves that run lengthwise up and down the surface . The lower half is covered with irregularly arranged short branch @-@ like protuberances at right angles to the stem that measure 2 ? 3 by 0 @.@ 5 mm . These projections are cylindrical and tapering , with ends that are covered with a slime head of conidia (fungal spores produced asexually) . D. racemosa is the only mushroom species known that forms conidia on side branches of the stem . The sclerotium from which the stem arises is watery grayish and homogeneous in cross section (not divided into internal chambers) , with a thin dull black outer coat , and measures 3 to 6 mm (0 @.@ 12 to 0 @.@ 24 in) in diameter . American mycologist Alexander H. Smith cautioned that novice collectors will typically miss the sclerotium the first time they find the species . The edibility of D. racemosa is unknown , but as David Arora says , the fruit bodies are " much too puny and rare to be of value . "

= = = Microscopic characteristics = = =

The spores are narrowly ellipsoid to ovoid , thin @-@ walled , hyaline (translucent) , with dimensions of 4 ? 5 @.@ 5 by 2 ? 3 µm . When stained with Melzer 's reagent , the spores turn a light blue color . The basidia (the spore @-@ bearing cells) are four @-@ spored , measure 16 ? 20 by 3 @.@ 5 ? 4 µm , and taper gradually towards the base . Cystidia are not differentiated in this species . The cap surface is made of a cuticle of radial , somewhat agglutinated , rather coarse hyphae that differ chiefly in size from the underlying tissue ? initially 1 ? 3 µm in diameter , becoming 5 ? 7 µm wide in the underlying tissue . The hyphae are clamped , and encrusted with shallow irregularly shaped masses that are most conspicuous in the surface cells . The gill tissue is made of hyphae that project downward from the cap and arranged in a subparallel fashion , meaning that the hyphae are mostly parallel to one another and are slightly intertwined . The hyphae are clamped , with a narrow , branched compact subhymenium (a narrow zone of small , short hyphae immediately beneath the hymenium) composed of hyphae 2 ? 3 µm in diameter . The conidia are 8 @.@ 5 ? 12 by 4 ? 5 µm , peanut @-@ shaped , non @-@ amyloid (not changing color when stained with Melzer 's reagent) , clamped , and produced by fragmentation of the coarse mycelium . Clamp connections are present in the hyphae . Asexual spores are 10 @.@ 0 ? 15 @.@ 5 by 3 ? 4 µm , ellipsoid to oblong , non @-@ amyloid , and contain granular contents . The grayish color of the fruit bodies is caused by encrusted pigments (crystalline aggregates of pigment molecules , possibly melanin) that occur throughout the tissue of the stem and cap , including the gills ; these pigments are absent in Collybia species .

= = = Similar species = = =

In contrast to the three species of Collybia , D. racemosa shows negligible reactivity to common

chemical tests used in mushroom identification , including aniline , alpha @-@ napthol , guaiacol , sulfoformol , phenol , and phenol @-@ aniline .

The cortex (outer tissue layer) of the sclerotium can be used as a diagnostic character to distinguish between D. racemosa and small white specimens of Collybia . The hyphae of the cortex of D. racemosa are " markedly angular " , in comparison with C. cookei (rounded hyphae) and C. tuberosa (elongated hyphae) . The cortical layer in D. racemosa has an arrangement that is known as textura epidermoidea ? with the hyphae arranged like a jigsaw puzzle . Heavy deposits of dark reddish @-@ brown pigment are evident throughout the cortical tissue in or on the walls and the tips of hyphae . The remaining Collybia species , C. cirrhata , does not form sclerotia .

= = = Anamorph form = = =

The anamorphic or imperfect fungi are those that seem to lack a sexual stage in their life cycle , and typically reproduce by the process of mitosis in conidia . In some cases , the sexual stage ? or teleomorph stage ? is later identified , and a teleomorph @-@ anamorph relationship is established between the species . The International Code of Botanical Nomenclature permits the recognition of two (or more) names for one and the same organism , one based on the teleomorph , the other (s) restricted to the anamorph . Tilachlidiopsis racemosa (formerly known as Sclerostilbum septentrionale , described by Alfred Povah in 1932) was shown to be the anamorphic form of Dendrocollybia racemosa . The synnemata (reproductive structures made of compact groups of erect conidiophores) produced by T. racemosa always grow on the stem of Dendrocollybia racemosa . The anamorph has an unusually low optimum growth temperature , between 12 and 18 ° C (54 and 64 ° F) , within a larger growth range of 3 and 22 ° C (37 and 72 ° F) . It is thought this is an adaptation that allows the mycelium to grow quickly and enhance its chances of fruiting on agaric mushrooms , which are generally short @-@ lived .

= = Habitat , distribution , and ecology = =

Dendrocollybia racemosa is a saprobic species , meaning it derives nutrients by breaking down dead or dying tissue . Its fruit bodies grow on the well @-@ decayed remains of agarics , often suspected to be Lactarius or Russula , although the hosts ' identities are often unclear due to an advanced state of decay . A 2006 study used molecular analysis to confirm Russula crassotunicata as a host for D. racemosa . This Russula has a long and persistent decay period , and , in the Pacific Northwest region of the United States where the study was conducted , provides a " nearly year @-@ round substrate for mycosaprobic species " . Dendrocollybia is one of four agaric genera obligately associated with growth on the fruit bodies of other fungi , the others being Squamanita , Asterophora , and Collybia . Dendrocollybia is also found less commonly in deep coniferous duff , in groups or small clusters . The fungus can form sclerotia in the mummified host fruit bodies , and may also develop directly from their sclerotia in soil . The fungus is widely distributed in temperate regions of the Northern Hemisphere , but rarely collected " probably due to its small size , camouflage color , and tendency to be immersed in its substrate . " In North America , where the distribution is restricted to the Pacific Northwest , fruit bodies are found in the late summer to autumn , often after a heavy fruiting period for other mushrooms is over . In Europe , it is known from the United Kingdom , Scandinavia , and Belgium . Dendrocollybia racemosa is in the Danish , Norwegian , and British Red Lists .

The saprobic behaviors of Collybia and Dendrocollybia are slightly different . In the autumn , fruit bodies of C. cirrhata , C. cookei and C. tuberosa , can be found on blackened , leathery , mummified fruit bodies of their hosts . Sometimes , these species appear to be growing in the soil (or from their sclerotium in soil or moss) , but usually not in huge clusters . In these cases it is assumed that the hosts are remnants of fruit bodies from a previous season . In all observed cases of D. racemosa , however , the hosts have not been readily observed , suggesting that rapid digestion of the host (rather than mummification) may have taken place . Hughes and colleagues suggest that this may indicate the presence of a different enzymatic system , and a differing ability to compete with other

fungi or bacteria .