

MORPHOLOGICAL AND MORPHOMETRIC FEATURES OF THE COMMON RUSTGILL MUSHROOM (*GYMNOPIILUS PENETRANS* (Fr; Fr) MURRAY) IN GHANA

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ABSTRACT

A novel mushroom in the genus *Gymnopilus* was observed in the rainy season (June – November 2022) in the Adenta Municipality of the Greater Accra Region, on a pile of dry wood earmarked for firewood. The fruiting body produced prolific basidiospores akin to the order Agaricales of the gilled mushrooms. The fruiting body was small to medium in size and was solitary in small groups, appearing cream to brown in colour and later turning rusty with age. The stipe was solid tapering towards the attachment and was 4.5 - 7.0 cm long and cylindrical in diameter (0.6 – 1.2 cm). The pileus was 5.0 – 9.0 cm in diameter, convex to applanate, silky growth with a central depression. Its orange, brown colour without scales compared favourable with reported 4.0 – 8.0 diameter for *G. penetrans*. The gills were adnate, crowded to radiate, yellow to golden brown in colour. The basidiospores were golden brown to rusty brown colour, ellipsoidal in shape (6.0 - 9.0 μm x 3.0 – 5.0 μm) akin to what obtains in the taxonomic records for *G. penetrans* (7.0- 9.0 μm x 4.0 – 5.5 μm). The reported biologically active components found in this mushroom are discussed and the use of the compounds for pharmaceutical and medical therapy are highlighted.

Keywords: *Gymnopilus penetrans*, morphology, morphometric dimensions of pileus, stipe, basidiospores; bioactive compounds

Introduction

Gymnopilus is a genus of the gilled mushrooms in the Phylum: Basidiomycota; Class: Agaricomycetes; Order: Agaricales and Family: Strophariaceae. This genus contains about 200 rust-orange to rusty-spores mushrooms (Kuo, 2007; Kirk et al. 2001). They are the most prolific spore producers in the Agaricales rivaled only by the Oyster mushrooms (*Pleurotus spp.*) (Kuo, 2007; Guzmán-Dávalos and Oureto, 2001; Guzmán-Dávalos, 1994). The etymology of the name is Greek; Gymno = naked, pilus = cap, hence naked or bald cap. The epithet *penetrans* means penetrating (www.first-nature.com>fungi).

This mushroom has several synonyms namely, *Flammula hybrida*, *Gymnopilus hybridus*, *Agaricus penetrans*, *Flammula penetrans* (Fr.) Quel and *Dryophila penetrans* (Fr.) Quel (Strausse et al. 2022; O'Reilly, 2022).

The fruiting body (basidioma) is medium to small in size, has no ring on the stipe and is found solitary but can be gregarious as well as in small groups (www.first-nature.com>fungi). They appear brown or creamy with whitish fibrils, or off-white fibres running down the stipe. The stipe is solid at the base tapering towards the attachment to substrate (Anon, 2022). The stipe length is in the range of 6.5-7.0 cm long; cylindrical (0.5-1.2 cm

wide). The pileus (cap) is 4 - 8 cm in diameter, convex to appanate, silky smooth with a central depression yellow to orange brown in colour with smooth wavy edge (Anon, 2022) not breaking into scales (Strausse et al. 2022; O'Reilly, 2022). The gills are adnate, crowded to radiate (Lodge et al. 2004); yellow to golden brown in colour with rusty, brown-coloured spores, darkening as they age. The basidiospores are ellipsoidal (7.0- 9.0 μm x 4.0-4.5 μm) and double-walled with small warts (Strausse et al. 2022; O'Reilly, 2022). The basidiospore print is rusty to orange, brown in colour and radiate.

This mushroom grows on rotting stumps, twigs, fallen branches, conifers, cones, sawdust or wood chippings. It is fairly common in Britain, Ireland, France, Scandinavian countries from June to November. It is also found in Mediterranean regions of North Africa, and North America, Mexico and Costa Rica (O'Reilly, 2022). It has been reported to grow in South and Central Africa, Democratic Republic of Congo (Ryvarden et al. 1994; Masibono et al. 1991; Anon, 2022). *Gymnopilus penetrans* and related species have never been recorded in the pertinent literature in the collection of macrofungi in Ghana (Piening, 1962; Clerk et al., 1994; Oduro, 2000; Motey, 2006).

This genus *Gymnopilus* is known to be seriously poisonous as well as containing some useful antioxidants and bioactive compounds (www.first-nature.com>fungi; Kuo, 2007; Strausse et al. 2022). For example, *G. spectabilis* and *G. penetrans* contain hallucinogenic psilocybin (Lee et al. 2008) as well as gymnoprenols, polyisoprenepolyols (Sawabe et al. 1999), gymnoplin (gymnopirenol F), cerevisterol (Alam et al. 2020; Appiah et al. 2018; 2020), antioxidants (4,6, decodinye-1-3,8-triol) (Beauchamp and Fridovich, 1971), ergosta-4,6,8 (Re et al. 1991), 2,2-tetraen-3-

one (Berger and Guzz, 2005), trisnoryangonin, hispidin (Brady and Benedict, 1972), and 4,6-decadiyne-1,3,8 triol, ergesta-4,6,8,22-tetraen-3-one (Lee et al. 2008).

The objective of this paper is to provide some preliminary morphological and morphometric characteristics diagnostic of the species in Ghana as well as its bioactive compound in the pertinent fungal taxonomic literature.

Experimental

Location of study area

The specimen was observed growing on a pile of miscellaneous collected firewood of dead plants in the Adenta Municipality of the Greater Accra Region (N 40.33'280 E 00 55'5' Latitude 4.557611, Longitude 0.99322071).

Fruiting body (Basidioma)

The fresh basidioma was small to medium sized, solitary appearing creamy initially and turning golden brown or rusty with age. The pileus (cap) was fully opened in some of the fruiting bodies.

Dimensions of pileus, stipe, gills

The cap and stipe dimensions were estimated by using a measuring tape. Gill morphology and colour of spores were described using the procedure of Lodge et al. (2004).

Spore print

The colour and morphology of fungal spores is one of the most reliable and useful character used in identifying many groups of macrofungi in the Agaricales. The standard procedure for spore print prescribed by Lodge et al. (2004) was used. The cap was detached from the stipe (stem) and placed with its spore-bearing surface (gills) downwards on a piece of white paper. The specimen was covered by a clean

transparent glass to exclude draught and maintain moist atmosphere. The set up was left undisturbed overnight after which the cap was lifted to reveal the spore deposit. Samples of the discharged basidiospores were placed on a glass slide, stained using plain lactophenol or safranin and then observed under a microscope.

Spore dimensions and photography

Dimensions of at least 30 basidiospores were estimated by using stage micrometer and eyepiece graticule. Photographs were taken with a photomicroscope Leica Computer Model ICC 50 W with a software measuring device (Image J Version 153 NIH/LOC2, Wisconsin, USA).

Identification and classification of specimen

This was done using standard identification manuals; Ainsworth and Bisby's Dictionary of fungi (Kirk et al. 2001), The Large Fungi of South-Central Africa (Ryvarden et al. 1994), Mushrooms of Tanzania (Härkönen et al. 1995), Encyclopedia of Mushrooms (Dickson and Lucas, 1979), Mushrooms (Otto, 1951), Growing Gourmet and Medicinal Mushroom (Stamets, 1993), (Musibono et al. 1991; Kuo, 2007; Strausse et al. 2022; O'Reilly, 2022; Anon, 2022) and internet: www.first-nature.com; www.google.com; Wikipedia.com.

Results and discussion

The fruiting body of the rustgill mushroom was found growing on a pile of dry wood of miscellaneous species earmarked for firewood (Fig. 1). The period of appearance coincided with the major and minor rainy seasons June to

November in Ghana akin to what was reported in other places where this rustgill mushroom has been recorded (Anon, 2022; Strausse et al. 2022; O'Reilly, 2022; Ryvarden et al. 1994; Musibono et al. 1991).



Fig.1: Fruiting bodies of *Gymnopilus penetrans* growing in proximity of pile of dry wood of earmarked for firewood

The fruiting body was small to medium size (Fig. 2) and was solitary in small groups. This agrees with the recorded report of the habit and size of this mushroom (Khan et al. 2017; Kaur, Kaur, Kaur & Rather, 2015; www.first-nature.com>fungi). The basidiomata appeared from creamy to brown and turned rusty with age (Fig. 3). The stipe was solid at the base tapering toward the attachment and length was in the range of 4.5 - 7.0 cm long and cylindrical with diameter of 0.6-1.2 cm (Fig. 3). These data agree with the reported average dimensions in the pertinent literature (Anon, 2022) of *Gymnopilus penetrans*.

The pileus was 5.0-9.0 cm in diameter (Table 1A & B) convex to applanate, silky smooth with a central depression (Fig. 4), yellow to orange, brown in colour and not breaking into scales. This compares favourably with 4.0-8.0 cm diameter of *G. penetrans* as stated by (Anon, 2022; Strausse et al. 2022 and O'Reilly, 2022) (Table 1A & B).

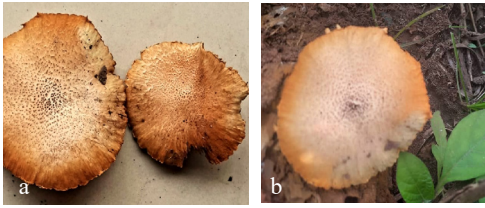


Fig. 2a & b: Different sizes of basidiocarp of *G. penetrans* (a), *G. penetrans* growing on substrate of wood



Fig. 3: Gill region of the basidiocarp of *Gymnopilus penetrans* (note the rusty brown colouration with age)

TABLE 1A

Comparative morphology, morphometric measurements, and physical characteristics of G. penetrans in Ghana with the reported data in the pertinent literature

Parameters	Literature Record	Current paper	Illustration
Fruiting basidioma			
Pileus (cm)	4 - 8	5-9	Figs 2a &b, Fig 4
Gills	Crowded, adnate to radiate; yellow to yellow brown	Crowded, adnate to radiate; yellow to yellow brown	Fig 3
Stipe (cm)	6.5-7.0 cm long Diameter 0.5 – 1.0 cm No rings	4.0-7.0 cm long Diameter 0.6 – 1.2 cm No rings	Fig 5
Spore shape	Ellipsoidal	Ellipsoidal	Fig 7
Spore dimensions (µm)	7.0- 9.0 x 4.0 – 5.5 µm	6.0- 9.0 x 3.0 – 5.0 µm	
Spore print colour	Rusty orange, brown	Rusty orange, brown	Fig 7

(Misibone *et al.* (1991); Ryvardeen *et al.* (1991); Anon, 2022); (O' Reilly, 2022); Strausse *et al.* (2022) & Lodge *et al.* (2004))

TABLE 1B

Comparative phenology, distribution, habit and some physical attributes of fruiting body of G. penetrans in Ghana with reported data in the pertinent literature

Parameters	Literature Record	Current paper	Illustration (If any)
Phenology of occurrence	June - November	June - November	-
Ecological distribution	Widespread on conifers, dead wood in temperate and tropics	Found on a pile of wood earmarked for firewood	Fig 1
General appearance	Creamy to yellowish brown, fibrous, stem solid, bulbose at base tapering toward substrate. No ring	Creamy to yellowish rusty brown. Stipe solid, bulbose at base. No ring	Figs 2 - 5
Smell/Odour	Faint fruity, stronger when fresh	Bitter taste, mildly fruity	-

(Anon, 2022); Lodge *et al.* (2004); (Kuo, 2007); (Guzmán-Dávalos & Oureto, 2001); (O' Reilly, 2022); Strausse *et al.* (2022) & Ryvardeen *et al.* (1991))



Fig. 4: *G. penetrans* pileus showing central depression and yellow to brown colour

The gills were adnate, crowded to radiate, yellow to golden brown in colour corresponding closely to the description by Lodge et al. (2004) and Ryvardeen et al. (1994) (Fig. 5 and Fig. 6). The harvested basidiospores from the spore print were golden brown to rusty brown in colour, darkening as they age (Fig. 7) with ellipsoidal shape (6.0-9.0 μm x 3.0-5.0 μm) (Fig. 7 and Table 1). This fairly agrees with the ellipsoidal shape (7.0-9.0 μm x 4.0-5.5 μm) reported for *G. penetrans* by Strausse et al. (2022), O'Reilly (2022) and (Anon, 2022) (Table 1). The spore print was also rusty orange, brown in colour (Table 1; Anon, 2022).



Fig. 5: Gill region adnate to radiate, yellow to rusty brown colouration



Fig.6: The East and Southern African *G. penetrans* (after Ryvardeen et al. 1994)

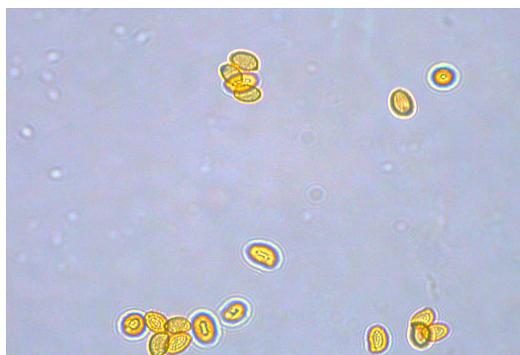


Fig.7: Basidiospores of *G. penetrans* showing golden brown colour and ellipsoid in shape

This paper has provided morphometric and morphological evidence that this mushroom *G. penetrans* occurs in Ghana and is recorded for the first time in the Greater Accra Region of Ghana.

According to the pertinent literature, *G. penetrans* contains the hallucinogenic compound psilocybin similar in action to lysergic acid diethylamide (LSD). It also contains a plethora of useful biologically active secondary metabolites of high therapeutic applications for medicines (Lee et al. 2008; Sawabe et al. 1999; Alam et al. 2020;

Appiah et al. 2018; 2020; Beauchamp and Fridovich, 1971; Re et al. 1991; Berger and Guss, 2005; Brady and Benedict, 1972). There could be economically beneficial compounds in *G. penetrans* that can make it useful for the pharmaceutical industry if exploited and studied extensively. This is more so because of the recent interest in mushrooms because of a wide variety of biologically active compounds isolated from them already in use in the pharmaceutical industry for health therapy.

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