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**Article**

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# Mushroom Characterization: Part I – Illustrated Morphological Characteristics

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**Abstract**

Conventional taxonomy of mushrooms is often not very easy for amateur taxonomists and research scholars to initiate the research on taxonomy and diversity of mushrooms due to the complex morphological characteristics that is often very difficult to comprehend. We illustrate the external morphological characteristics of mushrooms through colorful photographs to facilitate the taxonomic characterization of mushrooms and to promote the research on mushrooms. In addition, a data sheet for morphological characteristics of agaric mushrooms is provided.

**Key words** – agarics – basidiomycetes – fungi – morphology – mushrooms – polypores – taxonomy

## Introduction

It is an endeavor to simplify the morphological characteristics of mushrooms and to make known to the amateur mycologists beyond a shadow of doubt for easy identification of mushrooms. Although, several materials and field guides in the form of drawings are available for illustrating the morphotaxonomy of mushrooms (Largent & Stuntz 1977, Singer 1986, Lodge et al. 2004), still amateur mushroom taxonomists feel it tiresome to take up initial research on mushrooms due to an array of mushroom characteristics to be recorded. Further, outsourcing as well as DNA extraction followed by ITS sequences of mushrooms samples for molecular identification is very expensive. In addition, the Institutes which provide identification services mostly prefer to sequence the pure cultures of mushrooms rather than exsiccata since the latter often gets contaminated by other microbes due to improper storage conditions. Isolation of pure cultures of mushrooms is also cumbersome and there are stringent requirements for expertise. Further, obtaining pure cultures is not possible for all the mushrooms. However, identification of mushrooms through conventional taxonomy cannot be omitted. Mushroom characterization is complicated due to its vast morphotaxonomic characters which cannot be simply understood. Therefore, we aimed to simplify the morphological characteristics of mushrooms through color photographs taken in natural habitats for their easy recognition. This manuscript deals exhaustively with the morphological characteristics of agarics studied mainly from the Western Ghats, and other regions. Isolation and

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long term preservation, microscopical characteristics, and identification of agarics will be discussed in future publication.

**Materials & Methods**

The collections of mushrooms have been made from different plain regions, western coastal regions as well as Western Ghats of Maharashtra, Karnataka, Goa, Tamil Nadu and Kerala during 2001–2017. More than 1500 mushroom samples have been collected and being maintained in a personal collection "Macrofungal Collection of India (MCI)". In addition, several mushroom samples and their photographs were received for identification. Based on the mushroom samples collected and studied, a data sheet on the morphological characteristics of agarics has been prepared. The terms for morphological characteristics have been adopted from Largent & Stuntz (1977), Singer (1986) and Lodge et al. (2004).

**Collection**

Collections should be made between early morning to early or late afternoon to have enough time for processing (morphological characteristics, spore print, isolation and dehydration) of the mushrooms after collection. In the field, notes on the general type of habit, habitat, place and date of collection, geographical coordinates, vegetation, and name of the host plant for ectomycorrhizal fungi should be recorded in the field note book. Young to mature fruit bodies should be collected for each species to measure the range of dimensions and color characteristics. Photographs should be taken to show the mushrooms in their natural habitat. If photography is not possible in the field, it should be taken either in the laboratory or nearby work station. It is essential to show the mushroom pileal surface as well as gill views to record the characteristics like color, shape and texture of the pileus, and type of attachment of the gills with the stipe (Fig. 1). The photographs should illustrate almost all the external features of the mushrooms.

**Fig. 1** – Surface and gill views of the mushroom

The samples should be collected in paper bags and brought to the laboratory or work station for further processing of morphological characterization. Minimal number of species should be collected to conserve the biodiversity of mushrooms as well as to avoid the wastages of mushrooms. The perfect identification method should be in the following steps: 1) Collection, 2) Morphological Characterization, 3) Collection of Spore Print, 4) Isolation & Preservation of

Pure Cultures, 5) Dehydration and Herbarium Preparation, 6) Microscopical Characterization, 7) Morphotaxonomic Identification and 8) Molecular Characterization. For describing a new species of mushroom, all the steps are mandatory for authentic identification and finding its relationship with closely related species.

**Morphological characterization of mushrooms**

The morphological characteristics of mushrooms should be obtained from fresh specimens. The following characteristics should be recorded as mentioned in the "Character Recording Chart for Agarics" provided at the end of this paper.

**Size**

The measurements of the pileus (generally diameter, and height if the shape is conic, campanulate and parabolic), stipe (length, width at the widest point, width at the bulbous base, if any), width of lamellae, thickness of pileal context and height of volva, if any, should be taken in millimeter to avoid any decimal value when describing morphological characters.

**Color**

The color characters should be noted using any standard color charts (Kornerup & Wanscher 1978, Ridgway 1912) in natural light conditions for accurate notation of the color. If the color charts are not available, the HSV Color Plates for Mycology (http://website.nbm-mnb.ca/mycologywebpages/EssaysOnFungi/Collecting_mushrooms_for_scientific_study/Illustrations/HSV_plates_for_mycology.pdf) may be used. The color of the pileal surface, fibrils or squamules if any, gills, pileal context and stipe should be recorded. It is also important to note the color variations of young to mature pileus (Fig. 2) and gills (Fig. 3), color changes of the surface of the pileus, pileal context, gills or tubes (Fig. 4), surface of the stipe on bruising and hygrophanous nature (Figs 7B, 16, 21) of the pileus, etc.

**Pileus**

**Shape of the pileus**

CONVEX: A shape that has the appearance of an umbrella or an inverted bowl. The convex shape is one of the most common pileal shapes of agarics and boletoid mushrooms (Fig. 5A).

CONIC: If the height of the pileus is comparatively greater than its diameter and its apex is more or less pointed then the shape is called conic (Fig. 5B).

UPLIFTED: When the margin of the pileus turns upward due to age and loss of water, a shape is called uplifted (Fig. 5C).

BROADLY CONVEX: If the apex of the convex pileus is broadly flattened, it is said to be broadly convex (Fig. 5D).

PLANE: A flat pileal shape is called plane or applanate in which the margin of the pileus is perpendicular to the stipe (Fig. 5E).

PARABOLIC: If the pileal height is greater than its width like the shape of conic, but the cap is still regularly rounded it is called parabolic (Fig. 6A, B).

CAMPANULATE: The bell shaped pileus is called campanulate (Fig. 6F).

**Umbo**

UMBONATE: A protrusion or a bump at the apex of the pileus is called an umbo. The pileus is called umbonate if an umbo occurs at its apex.

BROADLY UMBONATE: If the protrusion is broadly rounded, it is termed broadly umbonate (Fig. 6C). A small umbo is called subumbonate (Fig. 20A, B).

ACUTELY UMBONATE: If the protrusion is sharp, the pileus is called acutely umbonate (Fig. 6D).

CUSPIDATE: The umbo is sharply demarcated, rounded and elongated, the condition is said to be cuspidate (Fig. 6E).

MAMMILLATE/PAPILLATE: The breast shaped pileus is termed mammillate or papillate in which the umbo is sharply demarcated but not elongated (Fig. 7A).
UMBLICATE: If an umbo occurs in the depression of the pileus, it is said to be umblicate (Fig. 7B).


**Fig. 2** – Color of pileal surface: A Young basidiomes. B, C Mature basidiomes.


**Fig. 3** – Color of gills: A. Young basidiomes. B. Mature basidiomes with appendiculate pileus.

**Depression**
DEPRESSED: If the pileus has a depression at the disc, the condition is said to be depressed.
NARROWLY-SHALLOWLY DEPRESSED. If the depression is shallow with smaller diameter, the condition is said to be narrowly-shallowly depressed (Fig. 8A).
NARROWLY-DEEPLY DEPRESSED: If the depression of the pileus is deep with smaller diameter, it is termed narrowly-deeply depressed (Fig. 8B).
BROADLY-SHALLOWLY DEPRESSED: If the depression of the pileus is shallow, and the diameter of the depression is broad, it is referred to as broadly-shallowly depressed (Fig. 9A).
BROADLY-DEEPLY DEPRESSED (INFUNDIBULIFORM): If the depression is so broad as well as deep, the condition is said to be deeply-broadly depressed or infundibuliform. The shape of the infundibuliform pileus resembles a funnel (Fig. 9B).
PERFORATED: Sometimes the depression continuous with the lumen of the stipe and forms an opening at the disc (Figs 10, 16). The perforated pileus is mostly associated with a hollow stipe.

**Shape when looking down on the pileus (top view)**
ORBICULAR: If the shape of the pileus is more or less perfectly round, it is said to be orbicular (Fig. 5E).
DIMIDATE: A semi-circular shape is called dimidate (Fig. 11A).

FLABELLIFORM: A fan-shaped pileus is termed flabelliform (Fig. 11B).
CONCHATE: If the pileus is oyster-shaped, the term conchate is used (Fig. 12A).
SPATHULATE: If the pileus is spoon shaped, it is termed spathulate (Fig. 12B).
PETALOID: A petal-shaped pileus is referred to as petaloid.

**Fig. 4** – Colour changes on bruising of the tubes.

**Shape of the margin**
INROLLED (INVOLUTE): If the margin of the pileus is rolled inward and it points towards itself, it is called inrolled or involute (Fig. 13A).
INCURVED: If the margin of the pileus is pointing towards the lamellae, then it is said to be incurved (Fig. 13B).
DECURVED: If the margin is pointing towards the stipe and also the condition is in between incurved and plane, it is called decurved (Fig. 5B).
UPLIFTED (UPTURNED): If the margin of the pileus is pointed upward, it is termed uplifted or upturned (Fig. 5C).
PLANE: If the margin of the pileus is perpendicular to the stipe, it is termed plane (Fig. 5E).

**Shape of the margin (surface view)**
ENTIRE: If the pileal margin is a perfect round without any interruptions, it is called entire (Figs 16, 19A).
CRISPED (CRENULATE): If the pileal margin is finely wavy, it is said to be crisped or crenulate (Fig. 5E).
APPENDICULATE: If the veil is attached as patches at the expanded pileal margin, it is termed appendiculate (Figs 3B, 14A).
UNDULATING: If the margin is broadly wavy, it is said to be undulating (Fig. 14B).
RIMOSE: If the margin is split and radially runs towards the disc, it is termed rimose (Fig. 13B).
ERODED: If the margin of the pileus is torn irregularly, the term eroded is used (Fig. 5B, C).
CRENATE (SCALLOPED): If the interruptions of the margin are regular, like the edge of a scallop, it is said to be crenate or scalloped (Fig. 18).
CILIATE: If the margin has hair like appendages, it is called ciliate (Fig. 8A).

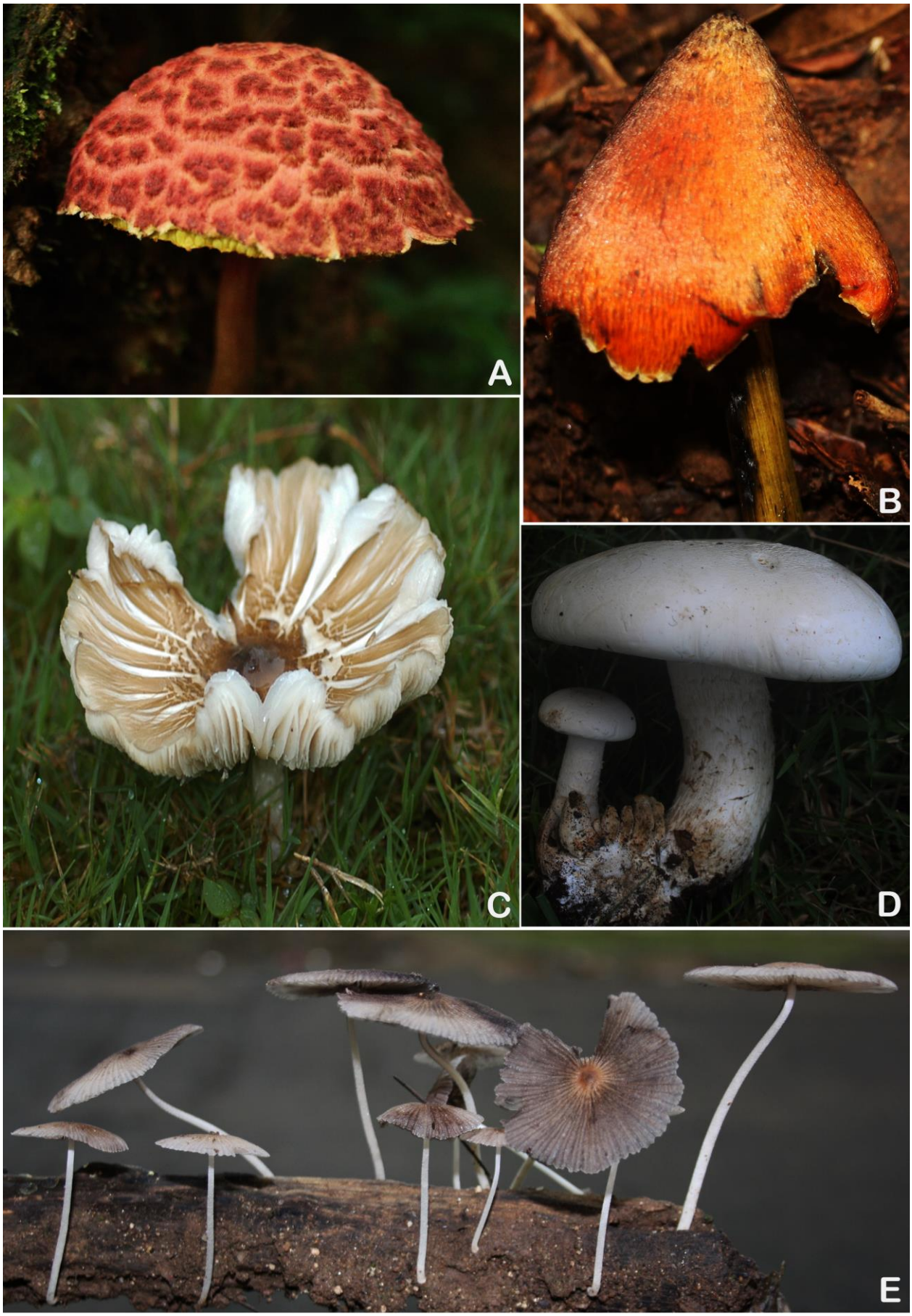


**Fig. 5** – Shape of the pileus: A Convex. B Conic with decurved and eroded pileal margin. C Uplifted with eroded margin. D Broadly convex. E Plane, orbicular and crisped margin.

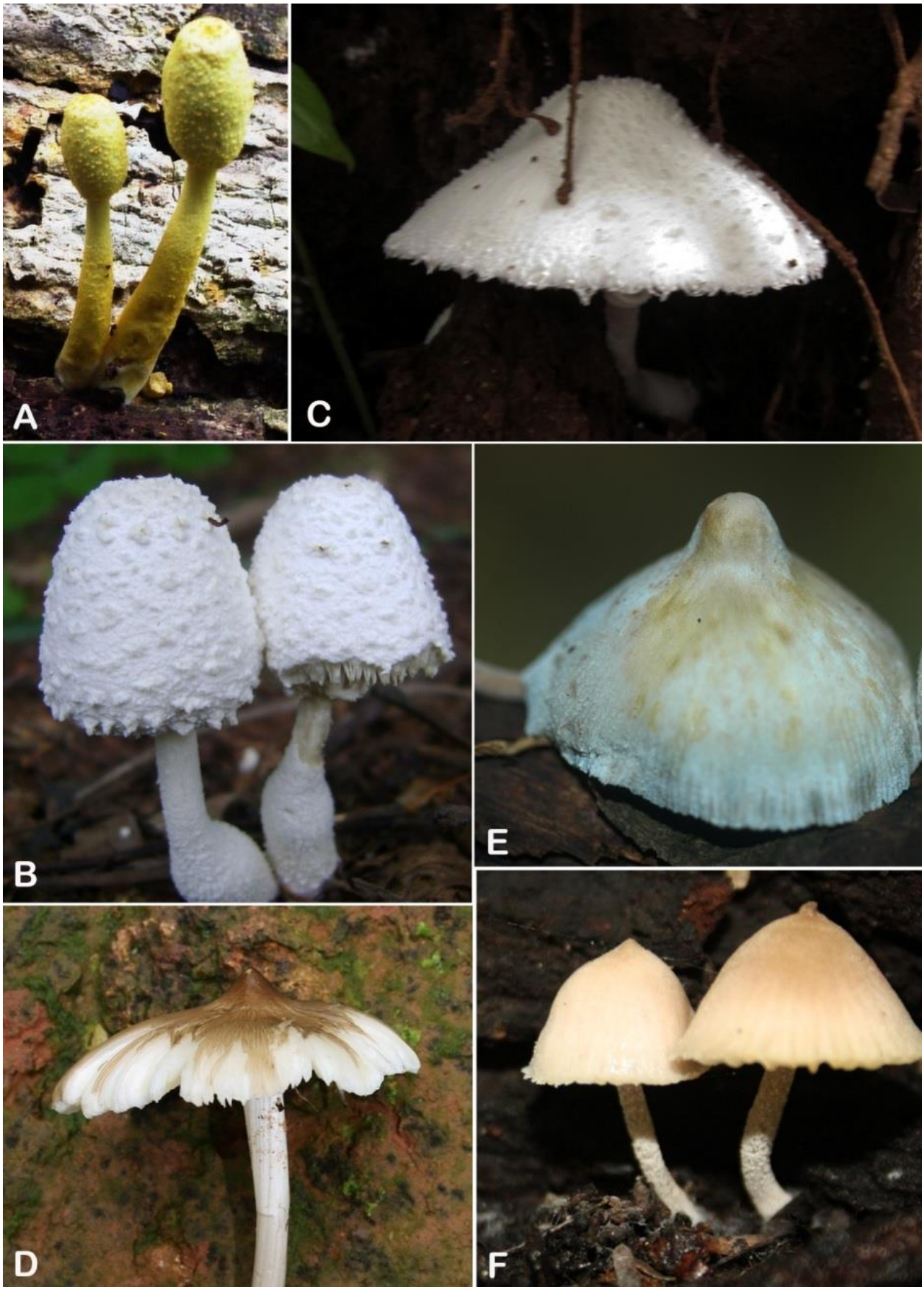


**Fig. 6** – Shape of the pileus: A Narrowly parabolic. B Broadly parabolic. C Broadly umbonate. D Acutely umbonate. E Cuspidate. F Campanulate.


**Fig. 7** – Shape of the pileus: A Mammillate umbo. B Umblicate with hygrophanous pileus.


**Fig. 8** – Depression of the pileus: A Narrowly-shallowly depressed with ciliate margin. B Narrowly-deeply depressed.


**Fig. 9** – Depression of the pileus: A Broadly-shallowly depressed. B Broadly-deeply depressed (Infundibuliform).

**Fig. 10** – Depression of the pileus: Perforated.

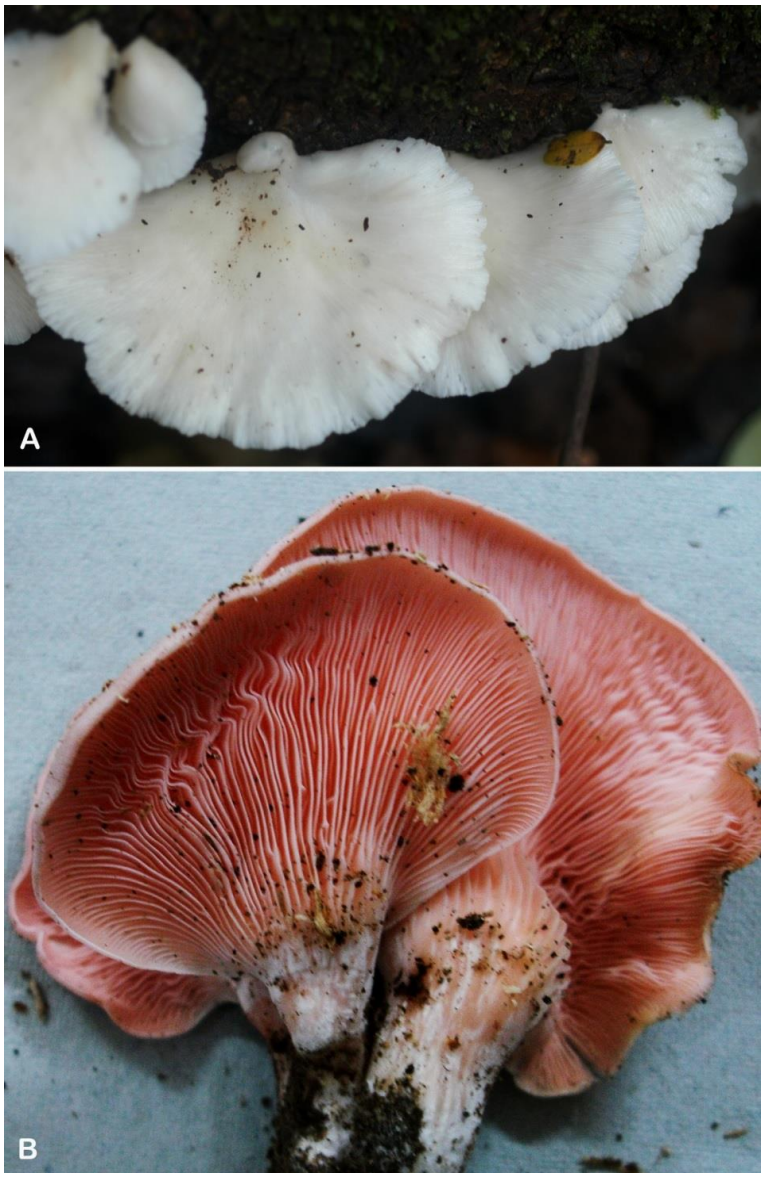


**Fig. 11** – Shape of the pileus on top view: A Dimidate with striate margin. B Flabelliform.

**Surface of the margin**

TRANSLUCENT-STRIATE (PELLUCID): If the pileal surface is transparent and the gills can be seen through the wet pileus as lines, the condition is said to be translucent striate or pellucid (Fig. 16).

STRIATE: If definite lines are present as part of the cap itself, the margin is called striate (Fig. 11A).

PLICATE-STRIATE: If folds are present between the striae, the condition is referred to as plicate striate (Fig. 17A).

TUBERCULATE-STRIATE: If small bumps occur on the striae, the term tuberculate-striate is applied (Fig. 17B).

SULCATE: If the lines form definite grooves, the margin is said to be sulcate (Fig. 18).


**Fig. 12** – Shape of the pileus on top view: A Conchate. B Spathulate.


**Fig. 13** – Margin of the pileus: A Inrolled, B Rimose to lacinate with incurved margin.

**Shininess of pileal surface**

SHINY (LUCIDUS): If the surface of the pileus appears as polished, it is said to be shiny or lucidus (Fig. 19A).

DULL: If the pileus lacks shininess, it is referred to as dull (Fig. 19B).

SILKY (SERICEOUS): If the pileal surface appears to be made of silk like hairs, it is said to be silky or sericeous (Fig. 15).

**Wetness of pileal surface**

DRY: If the pileal surface is free from moisture and lacks any glue material, the cap is said to be dry (Fig. 19B).

MOIST: If the surface looks like wet but does not fit any of the following categories mentioned below, it is called moist (Figs 16, 20A).

GLUTINOUS: If the pileal surface is covered by a glutinous substance (liquid glue) then the surface is called glutinous (Fig. 20B).

GELATINOUS: If the pileal surface appears to be jelly like, it is said to be gelatinous. Generally, jelly mushrooms have gelatinous surface.

VISCID: If a pileal surface is sticky to the touch or becomes sticky when a drop of water is placed, it is said to be viscid pileus.

SUBVISCID: It refers to a very slightly sticky surface.

**Hygrophanous nature of the pileus**

The color of the pileal surface may change from original color if the surface dries, then it is said to be hygrophanous. Depending on the species the time for processing of color variation may change (Figs 7B, 16, 21).

**Texture of pileal surface**

SMOOTH: If the surface of the pileus has no cracks, wrinkles or pits, it is called smooth (Fig. 19A, B).

SCROBICULATE: If the pits or depressions on the surface are shallow, the condition is called scrobiculate.

ALVEOLATE: The pits or depression can be deep, the pores of which are called alveolate.

LACUNOSE: If the pits are very deep, surrounded by ridges, the surface is called lacunose.

LACINATE: If the splits and cracks are deep thus cutting the pileal surface into large segments, the condition is referred to as lacinate (Fig. 13B).

AREOLATE: If the surface of the pileus splits in an irregular manner that results in the formation of block-like areas like dried mud surface, the condition is said to be areolate (Fig. 22).

GLABROUS: The pileal surface is bald, devoid of wrinkles, pits and fibrils, and appears like a wax coated surface which is more or less of an optical illusion, and is dependent on light reflection (Fig. 19A).

ATOMATE: If the pileal surface appears to be covered by minute, shining particles it is called atomate.

MICACEOUS: If the surface looks to be covered by glistening mica-like particles, it is said to be micaceous.

Automate and micaceous structures are visible only with the help of hand lens.

SUPERFICIAL: If the fibrils are present on the surface of young pilei, but disappear when the pilei become mature, they are said to be superficial. The superficial structures are usually the remains of the partial veil or universal veil or both.

INNATE: If the fibrils present on both young and old fruit bodies and lasting long, they are called innate (Figs 26, 28A). The innate structures are derived from an intergrowth of the hyphae in the pileal cuticle. Both superficial and innate structures are not uncommon in mushrooms.

PRUINOSE (PULVERULENT): If the pileal surface is covered with a fine powder and appears as the surface is sprinkled with very fine flour, it is said to be pruinose or pulverulent (Fig. 23).

FURFURACEOUS: If the surface is covered by bran-like structures composed of dry external scales and the pileus appears scurfy, it is called furfuraceous (Fig. 24A).

GRANULOSE (GRANULAR): If the surface is covered by larger, salt like grains, it is said to be granulose or granular (Fig. 24B).

FIBRILLOSE: If the pileal surface is covered by visible filaments or fibrils it is said to be fibrillose. The fibrils are composed of hyphae adhered with the pileal cuticle.
APPRESSED-FIBRILLOSE: If the fibrils are appressed on the pileal surface, it is termed appressed-fibrillose (Fig. 15).
TOMENTOSE: If the fibrils are densely mated and wooly, like a woolen blanket on the pileal surface, it is said to be tomentose.
VIRGATE: If the appressed fibrils appear as mere streaks, the surface is referred to as virgate.


**Fig. 14** – Shape of the margin: A Appendiculate pileus with longitudinal-striate stipe. B Undulating.

**Fig. 15** – Shininess of the pileus: Silky with appressed-fibrillose.

**Fig. 16** – Striations of the wet, perforated pileus: Translucent striate with entire margin.


**Fig. 17** – Striations of the pileus: A Plicate striate. B Tuberculate-striate.

**Fig. 18** – Striations of the pileus: Sulcate striate with crenate margin.

DOWNY-FIBRILLOSE: When the fibrils form a downy layer, the pileal surface is said to be downy-fibrillose.
FLOCCOSE: If the fibrils have the appearance of flattened cottony layer, the term floccose is used.
DOWNY-WOOLLY: Downy-woolly is a condition intermediate between downy-fibrillose and tomentose i.e. densely matted and wooly fibrils (Fig. 25A).
MATTED-FIBRILLOSE: If the fibrils are matted and inter-woven, appearing like felt is said to be matted-fibrillose (Fig. 25B).
VELUTINOSE: If the pileal surface is covered by compact, short, fine and soft hairs (velvety), it is called velutinose.


**Fig. 19** – Shininess of the pileus: A Shiny, smooth, glabrous. B Smooth, dull, dry.


**Fig. 20** – Wetness of the pileus: A Moist, subumbonate. B Glutinous, subumbonate.

**Fig. 21** – Hygrophanous pileus with glabrous stipe.

VILLOSE: If the hairs on the pileal surface are rather long and weak, it is termed villose (Figs 26, 27)
PUBESCENT: If the hairs are short, it is said to be pubescent.
HISPID: If the hairs retain a bit of flexibility resulting in a surface tending to be villose, the term hispid is used (Fig. 28A)
STRIGOSE: Strigose is a condition where the pileal surface is having long and coarse, bristle-like hairs.
SQUAMOSE: If cohesion of fibrils occurs at the tips of the hyphae as well as laterally, the tips stick together to form scale like structure on the surface, and the scaly surface is called squamose.
SQUAMULOSE: If the pileal surface is covered by small scales it is called squamulose. The small scales are called squamules.

FIBRILLOSE SQUAMULOSE: An intermediate condition between fibrillose and squamulose in which the fibrils are joined at their tips but still retain the individual hyphae below the tips (Fig. 28B).

**Fig. 22** – Areolate pileus, eroded gills with fleshy fibrous stipe.

APPRESSED-SQUAMULOSE: If the scales are flattened or appressed to the pileus surface, it is said to be appressed-squamulose (Fig. 29A).
RECURVED-SQUAMULOSE: If the tips of the scales are erect and turned backwards on the pileal surface, the term recurved squamulose is used (Fig. 29B).
IMBRICATE-SCALY: The appressed squamules may sometimes overlap with one another, giving a surface referred to as imbricate-scaly (Fig. 30).
SQUARROSE: If the scales are upright on the surface of the pileus particularly, at the disc of the pileus, the term squarrose is applied (Fig. 31).
PUNCTUATE-SQUAMULOSE: If the surface of the pileus is dotted with minute scales or points, it is called punctuate-squamulose.

SCABROUS: If the texture of the surface is rough to the touch due to the presence of large plate like scales or points, it is said to be scabrous (Fig. 32).

**Fig. 23** – Texture of the pileus: Pruinose.

**Gills**

**Attachment of the gills with the stipe**
REMOTE: The gills are not attached and free from the stipe in large extent (Fig. 33).
FREE: The gills are narrowly free from the stipe (Fig. 34A).
ADNEXED: The gills are narrowly attached with the extreme apex of the stipe (Fig. 34B).
SINUATE: The gills are notched near the attachment with the stipe (Fig. 35).
ADNATE: The gills are broadly attached with the stipe along the entire width of the gills (Fig. 36).
SUBDECURRENT: This is an intermediate condition between adnate and decurrent where the gills just run down to the stipe for relatively a short distance (Fig. 37A).
DECURRENT: The gills are broadly attached and running down the stipe (Fig. 37B).

**Spacing of the gills**
CROWDED: The gills are numerous and closely arranged (Figs 33, 34A, B, 35).
CLOSE: The gills are close to each other (Fig. 41A).
SUBDISTANT: This is an intermediate condition between close and distant where the gills are moderately spaced (Fig. 41B).
DISTANT: The space between the gills is wide (Figs 36, 42).


**Fig. 24** – Texture of the pileus: A Furfuraceous. B Granulose.

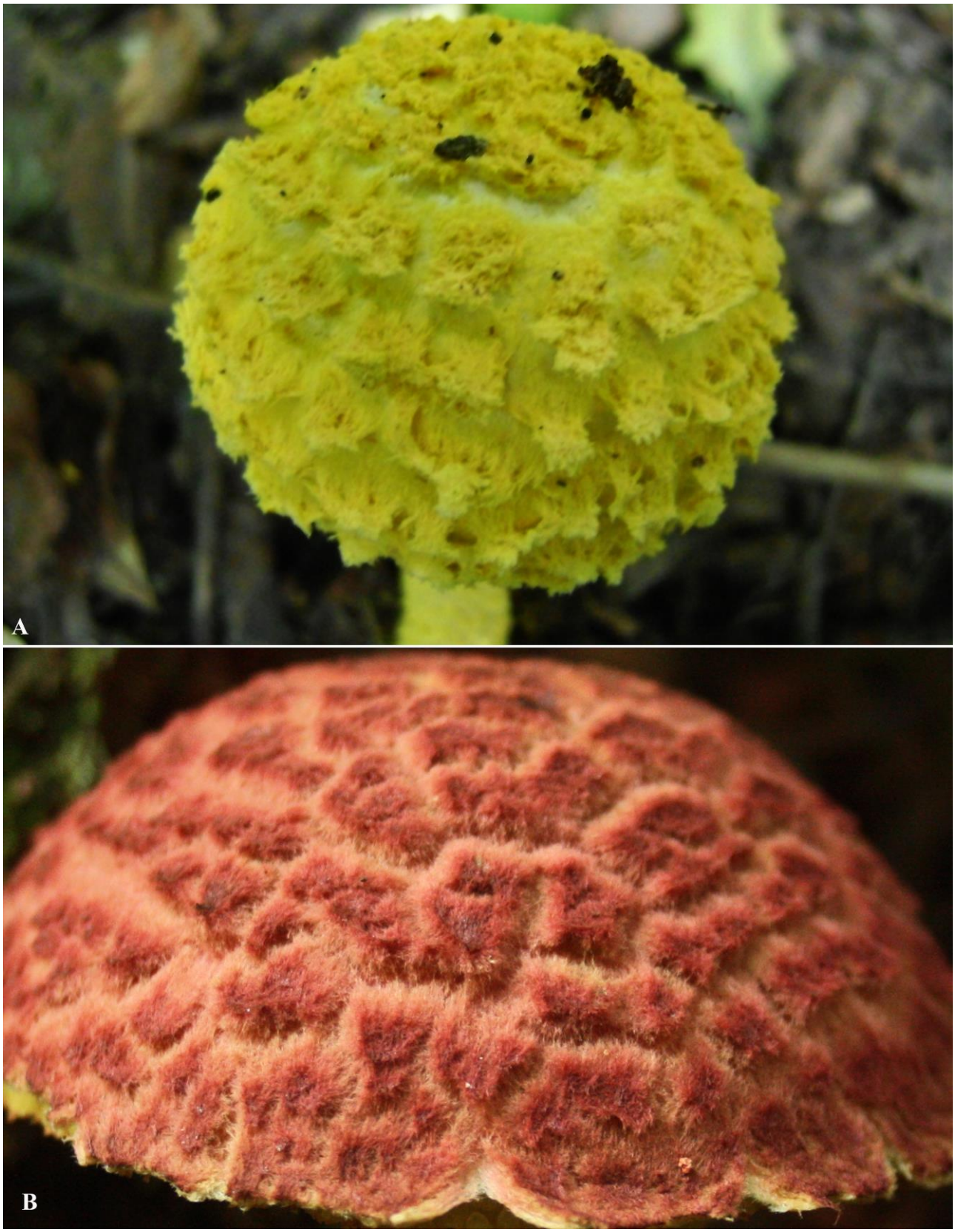


**Fig. 25** – Texture of pileus: A Downy wooly. B Matted fibrillose.

**Fig. 26** – Texture of the pileus: Villose.

**Fig. 27** – Close view of villose hairs.


**Fig. 28** – Texture of the pileus: A Innate, hispid pileus. B Fibrillose squamulose.


**Fig. 29** – Texture of pileus: A Appressed-squamulose. B Appressed- to recurved-squamulose.

**Fig. 30** – Texture of pileus: Imbricate-scaly pileus.

**Fig. 31** – Texture of pileus: Squarrose.

**Margin of the gills**

SMOOTH: If the margin of gills is entire and without any disruption, it is said to be smooth (Fig. 37A).

SERRATE: If the margin of the gills is tooth like with sharp edges, it is referred to as serrate (Fig. 38).

ERODED: If the margin of the gills is torn irregularly, it is said to be eroded (Fig. 22).

UNDULATING: If the margins of the gills are broadly wavy, the term undulating is used (Fig. 40).

**Fig. 32** – Texture of the pileus: Scabrous.

**Fig. 33** – Attachment of gills: Remote with crowded gills.


**Fig. 34** – Attachment of gills: A Free, crowded gills, centrally attached stipe with the pileus. B Adnexed, crowded gills.

**Fig. 35** – Attachment of gills: Sinuate, crowded gills.

**Fig. 36** – Attachment of the gills: Adnate with distant gills alternating with lamellulae.


**Fig. 37** – Attachment of gills: A Subdecurrent, smooth gills. B Decurrent.

**Fig. 38** – Serrate gills alternating with lamellulae and attenuated stipe towards base.

**Fig. 39** – Gill features: Anastomosing of gills.

**Gill features**

LAMELLULAE: Smaller form of gills which do not reach the stipe and occur in between gills (Figs 36, 38).

ANASTOMOSING: The lamellae and lamellulae are interconnected by lamellulae which makes the entire gill area appear as veined. The gills are termed anastomosing gills and the branching pattern is said to be intervenose or costate (Fig. 39)

COSTATE-RETICULATE: If the gills are interconnected by numerous veins and the hymenium appears like a net, it is said to be costate-reticulate (Fig. 42).

**Fig. 40** – Margin of the gills: Undulating; Annulus: Double.

FURCATE: If the gills divide into distinct branches between the pileal margin and stipe apex and the branching is irregular and sporadic, the gills are called furcated (Fig. 43).

BIFURCATE: If the gills divide into just two branches, whether the branches are regular or not, it is said to be bifurcate.

DICHOTOMOUS: If the gills are branched repeatedly and the branched gills are of equal length, the gills are said to be dichotomous or dichotomously branched (Fig. 44).

**Stipe**

**Attachment of the stipe with the pileus**

CENTRAL: The stipe is exactly attached at the center of the pileus (Fig. 34A).
LATERAL: The stipe is attached at the margin of the pileus (Fig. 45A).
ECCENTRIC: The intermediate condition between central and lateral where the stipe is attached at the pileus anywhere in between the center and margin (Fig. 45B).

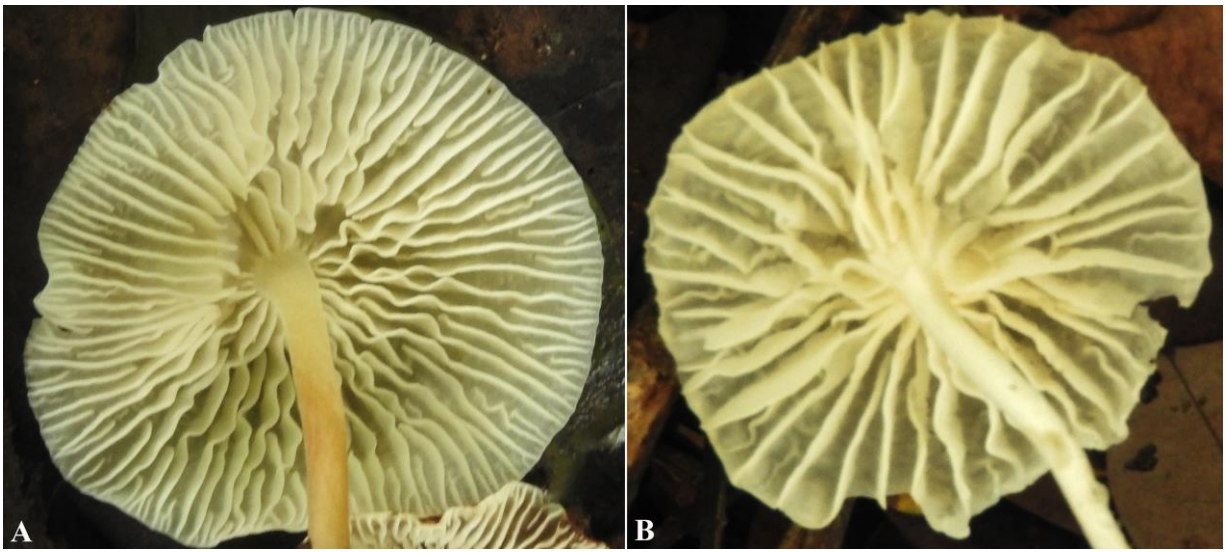


**Fig. 41** – Spacing of gills: A Close. B Subdistant.

**Fig. 42** – Gill features: Distant with costate-reticulate gills.

**Fig. 43** – Gill features: Furcate.

**Fig. 44** – Gill features: Dichotomous.


**Fig. 45** – Attachment of the pileus with the stipe: A Lateral. B Eccentric, scabrous stipe.

**Attachment to the substrate and basal tomentum**

BASAL TOMENTUM: The attachment of the stipe to the substrate is by mycelium arising from the substrate and superficially running up on the surface at the base of the stipe is called the basal tomentum (Fig. 46).

RHIZOIDS (RHIZOIDAL): If the hyphae are large and distinct from one another, the hyphae are called rhizoids, and the basal tomentum is defined as rhizoidal (Fig. 46A).

RHIZOMORPHS: If the hyphae are cord-like and elastic in consistency, it is said to be rhizomorphs (Fig. 46B)

STRIGOSE: If the hyphae are large and look like bristles at the base of the stipe, it is referred to as strigose (Fig. 47A).

PSEUDORRHIZA (RADICATED): Stipe of some mushrooms continues as a root-like process called pseudorrhiza. The stipe of such mushroom is said to be radicated (Figs 47B, 48).

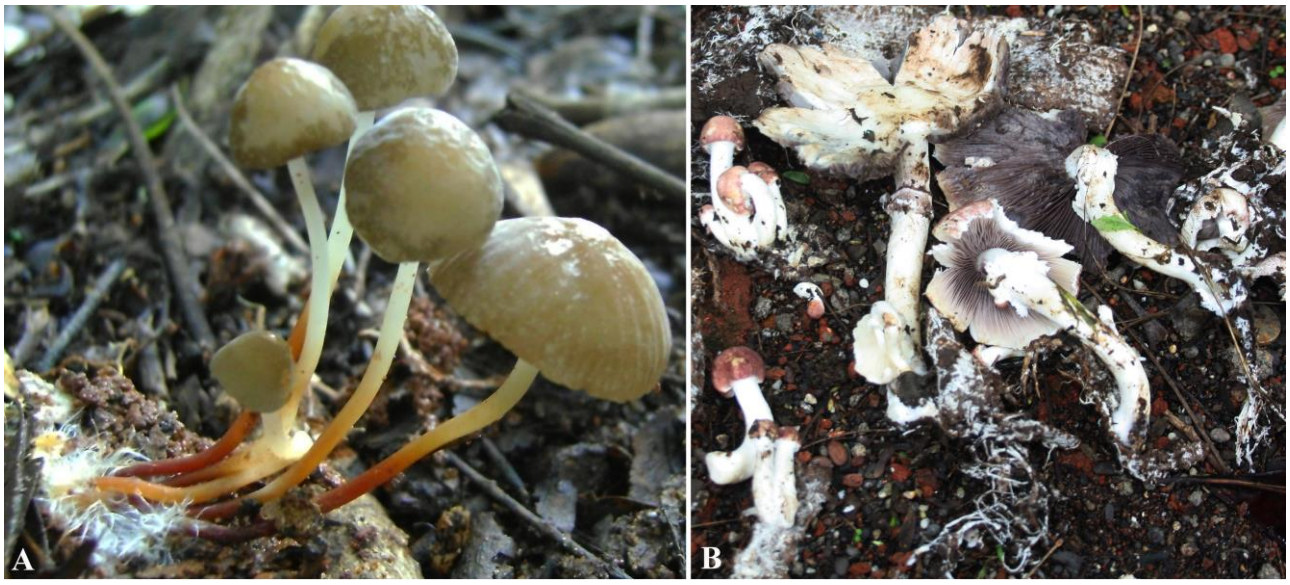


**Fig. 46** – Stipe attachment with the substrate: A Rhizoids. B Rhizomorphs.


**Fig. 47** – Stipe attachment with the substrate: A Strigose. B Radicated.

INSERTED: When the stipe is completely devoid of any hyphae, rhizoids or rhizomorphs, where it originates from the substrate the stipe is said to be inserted (Figs 53A, 54A).

**Shape of the stipe**

TERETE: The regularly rounded stipe is said to be terete (Fig. 49A).
COMPRESSED: The flattened stipe is called compressed (Fig. 49B)
EQUAL: If the diameter of the stipe is uniform from base to apex, it is termed equal (Fig. 49A).
ATTENUATED: If the diameter of the stipe is reduced gradually on either side of the stipe, it is said to be attenuated. If the diameter is reduced at the apex or base then it is called attenuated towards apex (Fig. 49C) or attenuated towards base (Fig. 38), respectively.

**Fig. 48** – Stipe attachment with the substrate: Radicated.

CLAVATE: If the stipe base is enlarged and appears as a club, it is said to be clavate (Fig. 49D).
OBCLAVATE: If the stipe apex is enlarged and appears as an inverted clavate, it is called obclavate.
BULBOUS: If the base of the stipe is enlarged abruptly, the term bulbous is used (Fig. 50).

**Surface of the stipe**

SMOOTH: If the surface devoid of any squamules or scales, it is called smooth (Fig. 49C).
GLABROUS: If the stipe surface is smooth, bald and appears like a waxed surface it is said to be glabrous (Figs 21, 51).
SCALY: The stipe is covered either partly or wholly by the squamules or scales (Figs 49D, 50).
SCABROUS: In case, the stipe apex is roughened due to erect, pointed scales, the term scabrous is used (Figs 45B, 54B).
RETICULATE: If the apex region of the stipe has fine lines or less frequently fibrils in the form of a distinct net, the condition is a pattern of raised lines referred to as reticulate.
LONGITUDINAL-STRIATE: If the ridges occur in the form of fine lines, and the lines appear parallel to one another in longitudinal manner, the surface is called longitudinal-striate (Fig. 14A).
HISPID: If the stipe is covered by thick, small to large hairs, it is said to be hispid (Fig. 52).

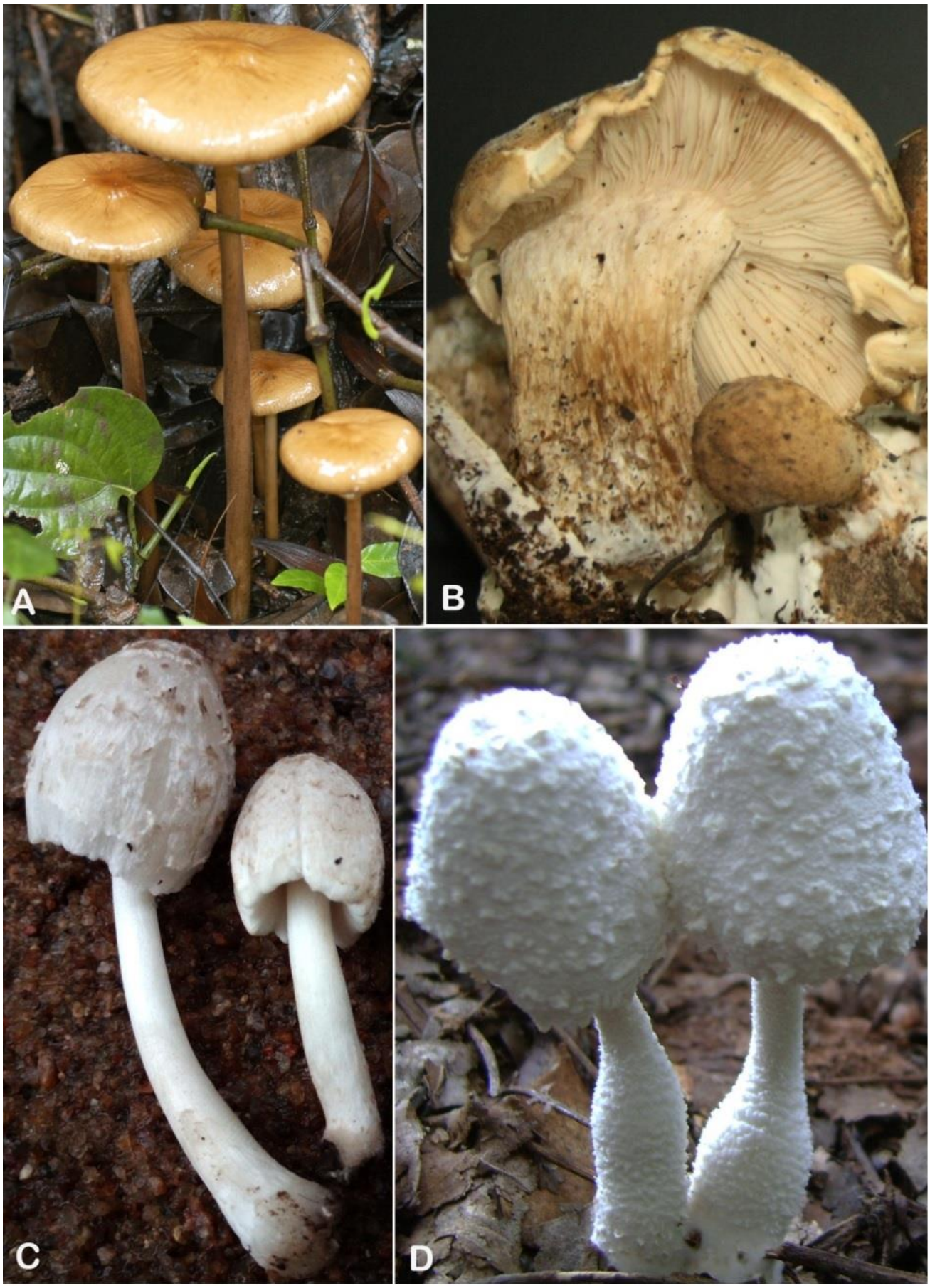


**Fig. 49** – Shape of the stipe: A Terete, equal stipe. B Compressed. C Smooth stipe, attenuated towards apex. D Clavate, scaly stipe.

**Fig. 50** – Shape of the stipe: Bulbous, scaly stipe.

**Consistency of the stipe**

WIRY: If the stipe is extremely thin like a wire, it is referred to as wiry (Fig. 53A).

FLESHY FIBROUS: If the stipe is very thick, often ≥5 mm diam., when it breaks down, leaves irregular edge, it is said to be fleshy fibrous (Figs 22, 53B).

CARTILAGINOUS: If the stipe is thin, often ≤ 5 mm diam., when it breaks down, breaks like a twig, the term cartilaginous is used (Fig. 54A).

WOODY: If the stipe is very hard like a wood and rough to break, it is said to be woody (Fig. 54B).

**Flesh of the stipe**

SOLID: The flesh of the stipe in which the hyphae are closely packed, and the stipe is called solid (Fig. 55). Generally, the fleshy fibrous, cartilaginous and woody stipes are solid.

Hollow: If the stipe lacks the flesh in the center, it is said to be hollow.

STUFFED: If the flesh of the stipe is an intermediate condition between solid and hollow, it is called stuffed.

**Fig. 51** – Surface of the stipe: Glabrous.

**Partial veil (Annulus)**
SUPERIOR: If the veil is located in the top half of the stipe, it is said to be superior (Fig. 56A).
CENTRAL: If the annulus is located approximately in the middle of the stipe, the term central is applied (Fig. 56B).
INFERIOR: If the veil is located in the lower half of the stipe, it is called inferior.
ATTACHED: If the annulus is attached firmly to the stipe and do not fall out in mature specimen, it is said to be attached (Fig. 56C).
FUGACIOUS: If the annulus is loosely or tightly attached in young specimens and fall out at maturity, it is called fugacious (Fig. 56A).
DOUBLE ANNULUS: It may have cottony roll of tissue on the underside, in which case it is called a double annulus (Figs 40, 56C).
SINGLE ANNULUS: If the undersurface is smooth, the annulus is termed single (Fig. 56A).

**Fig. 52** – Surface of the stipe: Hispid.

**Universal veil/Volva**
The cup like membranous structure present at the base of the stipe is called volva.

**Free volvas**
SACCATE: In this case, the volva is free from the stipe except at the extreme base (Fig. 57).

**Adherent volvas**

FLARING: The volva is attached at the stipe along its length except at the volval margin where it flares out (Fig. 58A).

CIRCUMSESSILE: The adherent volva is similar to flaring, however; instead of flaring out at the volval margin, it forms a tight rim around the stipe. It is called circumsessile (Fig. 58B).

ZONED: This type of volva is similar to circumsessile. However, in this case, the upper part of the volva forms a ring or zone like structures just above the main part of the volva.

**Growth habit**

SOLITARY: The fruit body grows alone and apparently no other fruit bodies of same species grow near its vicinity. Single fruit body present on the substratum (Fig. 59C).

GREGARIOUS: Fruit bodies grow close together as group in large numbers, but occur as individuals and do not share a common base (Fig. 59A).

SCATTERED: The solitary or group of fruit bodies scattered apart one to two feet (Fig. 59B).

CAESPITOSE: Several fruit bodies grow in clusters and share a common base (Fig. 60A).

CONNATE: The stipes of two or more fruit bodies are joined together at the base (Fig. 60B).

**Type of fruiting body attachment**

STIPITATE: Fruiting bodies are attached to their substrate by the stipe. This is termed stipitate.

PSEUDOSTIPE: A flap of tissue that is not distinctly a stalk that serves for attachment. The structure is called a pseudostipe, and the condition is described as substipitate (Fig. 62).

SESSILE: If the attachment is directly to the pileus with no stipe or pseudostipe, the mushroom is referred to as sessile (Fig. 61).

IMBRICATE: If the sessile fruiting bodies overlap one another, this condition is called imbricate (Fig. 63A).

UNGULATE: If the entire sessile fruiting body looks like a horse's hoof, it is called ungulate (Fig. 63B).

EFFUSO-REFLEXED: If part of the fruiting body is closely appressed to the substrate except for the margin which flares out to form the pileus, it is called effuso-reflexed (Fig. 63C).

RESUPINATE: If the entire fruiting body including the margin is closely appressed to the substrate, it is called resupinate (Fig. 63D).


**Fig. 53** – Consistency of the stipe: A Wiry, inserted stipe. B Fleshy fibrous.


**Fig. 54** – Consistency of the stipe: A Cartilaginous, inserted stipe. B Woody, scabrous.

**Fig. 55** – Consistency of the stipe: Solid.

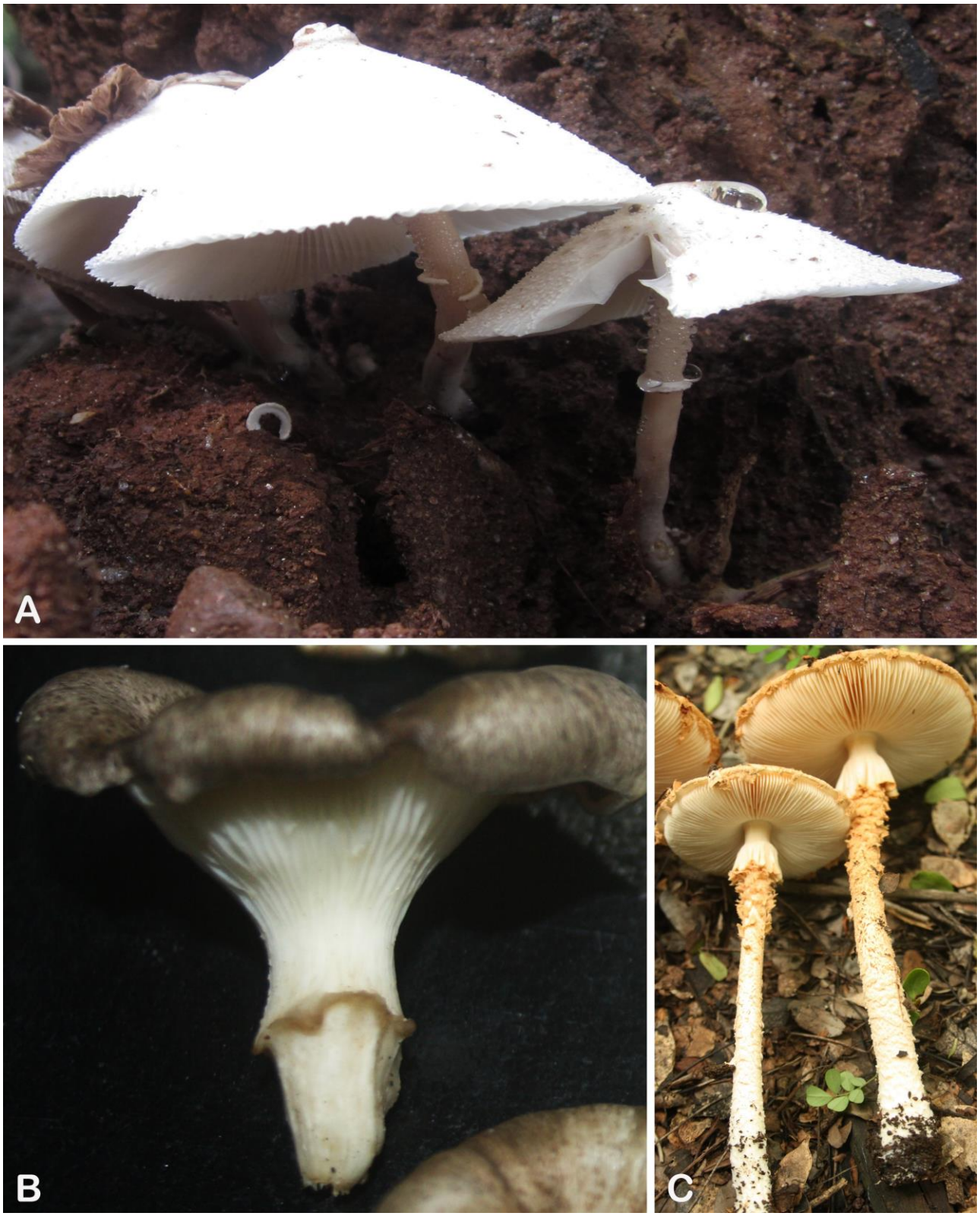


**Fig. 56** – Partial veil: A Single, superior, fugacious. B Central. C Attached, double annulus.

**Fig 57** – Free volva: Saccate.


**Fig. 58** – Adherent volvas: A Flaring. B Circumsessile.


**Fig. 59** – Growth habit: A Gregarious. B Scattered. C Solitary.


**Fig. 60** – Growth habit: A Caespitose. B Connate.

**Fig. 61** – Type of fruit body: Sessile.

**Fig. 62** – Type of fruit body: Substipitate.


**Fig. 63** – Type of fruit body: A Imbricate. B Ungulate. C Effuso-reflexed. D Resupinate.

## CHARACTER RECORDING CHART FOR AGARICS

**Ref. No.** **Date of Collection**

**Place of Collection** **Substrate**

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## PILEUS

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**Size:** Young Old

**Color:** Young: Disc Margin Old: Disc Margin
Elsewhere

Hygrophanous Non-hygrophanous Color changes on bruising
Color of the scales/fibrils

**Shape:** Conic Campanulate Convex Plane Uplifted
Broadly-parabolic Narrowly-parabolic Dimidiate

**Umbo:** Absent Broadly umbonate Acutely Umbonate Cuspidate
Mammillate Umblicate Subumbonate

**Depression:** Narrowly-shallowly depressed Narrowly-deeply depressed Perforated
Broadly-shallowly depressed Broadly-deeply depressed (Infundibuliform)

**Margin:** Inrolled Incurved Decurved Plane Uplifted Eroded
Rimose Appendiculate

Translucent striate Striate Sulcate Tuberculate-striate

**Surface:** Shiny Dull Dry Moist Viscid

**Texture:** Smooth Pruinose Furfuraceous Granulose Fibrillose
Squamulose Appressed-squamulose Recurved squamulose
Scabrous Imbricate-scaly

**Context:** Color & Color changes on bruising/injury

Thickness Consistency

**Odor:** **Taste:**

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## LAMELLAE

---

**Color:** Young Old Color changes on bruising

**Attachment:** Remote Free Adnexed Adnate Decurrent
Subdecurrent

**Spacing:** Crowded Close Sub-distant Distant

| | | | | | |
|---|---|---|---|---|---|
| **Margin:** | Entire | Serrate | Undulating | | |
| **Branching:** | Entire | Furcate | Dichotomous | Intervenose | |
| **Lamellulae:** | Absent | If present, no. of lengths | | | |
| **Latex:** | Absent | If present, colour | | | |

## STIPE

| | | | | | | |
|---|---|---|---|---|---|---|
| **Size:** | Young | Old | | | | |
| **Color:** | Young | Old | Squamules | | | |
| **Attachment to the pileus:** | Central | Lateral | Eccentric | | | |
| **Attachment to the substrate:** | Rhizoidal Radicated | Strigose | Rhizomorphs | Inserted | | |
| **Shape:** | Terete | Compressed | Clavate | Sub-clavate | Bulbous | Abruptly bulbous |
| **Surface:** | Smooth | Glabrous | Fibrillose | Scabrous | Reticulate | |
| **Consistency:** | Cartilaginous | Fibrous | Woody | Wiry | Solid | Hollow Stuffed |

## ANNULUS

| | | | | | | |
|---|---|---|---|---|---|---|
| Superior | Inferior | Central | Attached | Moveable | Double | Single Fugacious |

## VOLVA

| | | | |
|---|---|---|---|
| Saccate | Adherent | Flaring | Color |

## GROWTH HABIT

| | | | | |
|---|---|---|---|---|
| Solitary | Scattered | Gregarious | Caespitose | Connate |

## FRUITING BODY ATTACHMENT

| | | | |
|---|---|---|---|
| Stipitate | Sessile | Effuso-reflexed | Resupinate |

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