

Biodiversity and morphological characterization of mushrooms at the tropical moist deciduous forest region of Bangladesh

ABSTRACT

Mushroom flora is an important component of the ecosystem and their biodiversity study has been largely neglected and not documented for the tropical moist deciduous forest regions of Bangladesh. This investigation was conducted in seven different areas of tropical moist deciduous forest region of Bangladesh namely Dhaka, Gazipur, Bogra, Rajshahi, Pabna, Jaipurhat and Dinajpur. Mushroom flora associated with these forest regions were collected, photographed and preserved. A total of fifty samples were collected and identified to fourteen genera and twenty four species. The predominant genera were *Ganoderma* sp., *Lepiota* sp., *Marasmius* sp. and *Collybia* sp. The entire mushroom flora and its morphological characteristics have been described and illustrated. This is the first investigation on mushroom flora associated with tropical moist deciduous forest region of Bangladesh.

Key words: Tropical moist deciduous forest, Biodiversity, Mushroom, Bangladesh

1. Introduction

The term "Mushroom" is used mainly for the fruiting body produce by the macro-fungi and these are Ascomycota and Basidiomycota, some are edible and many are poisonous and non-edible. More than 10,000 species of mushrooms are present in and around the world and about 2000 of them are considered as edible [1]. Along with the cultivated mushrooms, wild mushrooms also have profound biological as well as economical features and have a great impact along with the beneficiaries' of human-kind. Mushroom have high nutritional value along with high proteins, vitamins, minerals, fibers, trace elements content and even low or more or less no calories and cholesterol contents. Now-a-days, they are considered as an ideal food item. Besides these, mushrooms are the sources of various bioactive substances like, antibacterial, antifungal, antiviral, anti-parasitic, antioxidant, anti-inflammatory, anti-proliferative, anticancer, anti-tumor, cytotoxic, DNA damaging, anti-HIV, hypo-cholesterolemic, anti-diabetic, anti-coagulant, hepato-protective, insecticidal properties and an efficient tool for recycling of organic wastes [2]. Along with the beneficial impacts to mankind, large number of mushroom species is the wood-rotter's, which are causing serious damage to the forest trees [2]. That is why it is causing considerable economic loss to timber industry every year. Besides, some are toxic, even deadly when eaten [3]. Bangladesh is a sub-tropical country. Depending on location, nature and type of management, there are four broad categories of forest in Bangladesh namely mangrove forest, tropical evergreen and semi evergreen forest, tropical moist deciduous forest and village forest.

A number of species of mushrooms are grown mainly during the rainy season, on almost all types of soils, on decaying organic matter, wooden stumps, etc. naturally. The climate and the forest vegetation of the tropical moist deciduous forest region of Bangladesh, supports the growth and reproduction of various mushroom flora. According to Bangladesh forest department, the central and

northern districts covering an area of 120000 hector about 0.81% of total landmass of the country and 7.8% of the countries forest land are bestowed with tropical moist deciduous forests. Tropical moist deciduous forest region is under about 80% of Bangladesh's rain falls area during the monsoon season extending from June to September and the mean annual rain fall for these region of Bangladesh is ranged between 3,280 and 4,780 mm (129.1 and 188.2 inch) per year. The mean daily temperature ranged between 38°C and 41°C (100.4°F and 105.8°F) with relative humidity ranged from lower in March between 55% and 81% to higher in July between 94% and 100%. Winds are mostly from the north and northwest area in the monsoon, blowing gently at 1 to 3 kilometers per hour (0.6 to 1.9 mph). Thus, the northern region of Bangladesh was expected to furnish with diverse macro fungal population.

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The search for diverse macro fungal population in the country is important as the demand and consumer preference of mushrooms for utilization among the people and farmers in the country is increasing day by day. Discovery of new biomolecules from mushrooms controlling human and crop diseases and pests is a challenging field of study. The purpose of the present survey was to collect morphological characterization and preserve macro fungal species present in the tropical moist deciduous forest region of Bangladesh.

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51 **2. Materials and Methods**

2.1. Survey on wild mushrooms: The survey and collection of different wild mushrooms were done after the rainy season starting from July 2013 to October 2013 and July 2014 to October 2014. The survey was conducted in Dhaka, Gazipur, Bogra, Rajshahi, Pabna, Jaipurhat, and Dinajpur biosphere reserved area, which is situated in tropical moist deciduous forest region of Bangladesh. According to the National Mapping Organization of Bangladesh, Dhaka is located at 23°42'37" N (Latitude), 90°24'26" E (Longitude) and it has an average elevation of 4 meters (13.12 ft.). Gazipur is located at 24.00°N (Latitude), 90.43°E (Longitude) and it has an average elevation of 10 meters (32.8 ft.). Bogra is located at 24°51'00" N (Latitude), 89°22'00" E (Longitude) and it has an average elevation of 24 meters (78 ft.). Rajshahi is located at 24°22'00" N (Latitude), 88°36'00" E (Longitude) and it has an average elevation of 31 meters (101 ft.). Pabna is located at 24°00'00" N (Latitude), 89°15'00" E (Longitude) and it has an average elevation of 8 meters (26 ft.). Jaipurhat is located at 25.1° N (Latitude), 89.02° E (Longitude) and it has an average elevation of 29 meters (94.25 ft.). Dinajpur is located at 25°37'37" N (Latitude), 88°38'19" E (Longitude) and it has an average elevation of 34 meters (111 ft.). The collection sites were forests, university campus, residential area, botanical garden, parks and nearby villages of those above mentioned areas of tropical moist deciduous forest region (Figure 1).

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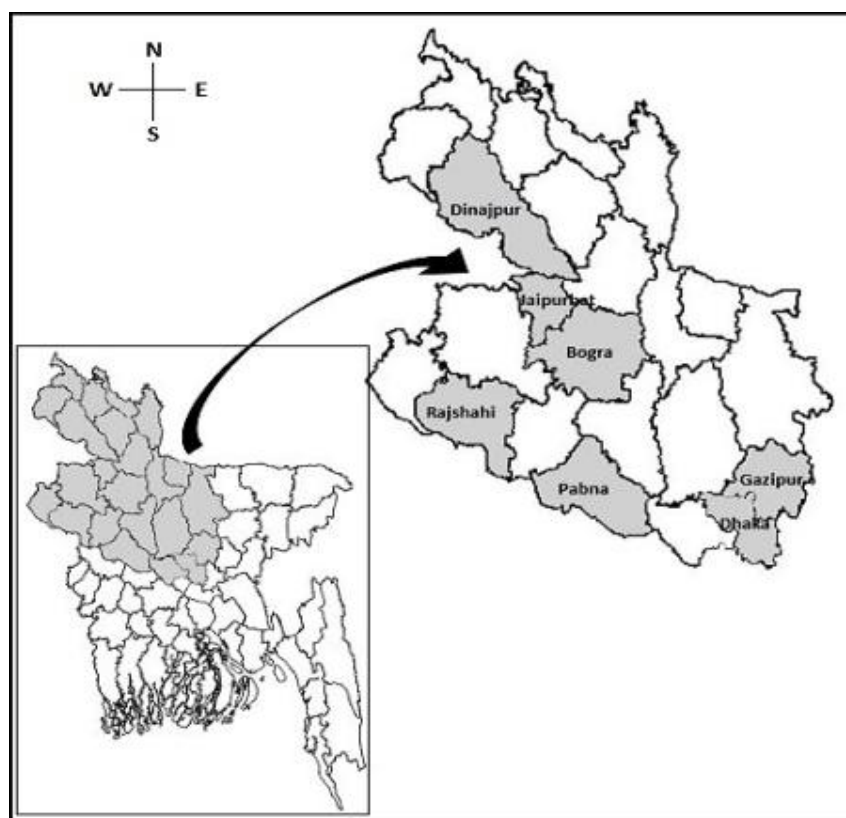


Figure 1: Survey area of tropical moist deciduous forest region of Bangladesh

2.2. Collection of mushroom samples: The collection was made following the method of Hailing [4]. Systematic and periodical survey of different locations and other habitats were done in the tropical moist deciduous forest region of the country. Necessary materials and equipment such as isolation kit, slants, isolation chamber, data recording sheet, digital camera for photography, digging equipment, heat convector card board were arranged and collection of samples were usually made during day time and field characteristics of mushrooms were recorded in the data sheet which was prepared following Molina *et al.*, [5]. Then the specimens were dried in hot air oven at 40-50°C and stored in air tight containers with silica gel for further microscopic studies. Spotted mushrooms were minutely inspected in their natural habitats and brought to laboratory for detailed study. Photographs were taken by means of a Sony Cyber-shot Digital Camera with power of 14.2 megapixels.

2.3. Identification of wild mushrooms: The collected mushroom samples were identified on their morphological, macroscopic, physiological and ecological features according to the previously published documents by Arora, Singer, Singer [6, 7, 8]. The morphological parameters used for identification of mushrooms specimens were cap color, cap surface, cap margin, cap diameter, stipe length, gill attachment, gill spacing and spore diameter [9]. The spore diameter and the photograph of spore were calculated using the Motic microscope (Motic Images Plus 2.0) with the magnification of 40x. One mature and one immature (growing) mushroom were sampled for each collection to record

accurate information. Through comparing recorded characteristics the mushrooms were identified following Dickinson and John, Jorden, Pegler and Spooner [10, 11, 12].

3. Results

Through the investigation, 14 genera and 24 mushroom species were identified [Figure 2 to 6]. The identified genera were *Ganoderma* sp., *Hebeloma* sp., *Craterellus* sp., *Lepiota* sp., *Ramariopsis* sp., *Ampulloclitocybe* sp., *Lycoperdon* sp., *Volvariella* sp., *Russula* sp., *Termitomyces* sp., *Amanita* sp., *Marasmius* sp., *Collybiasp.* and *Mycena* sp. These genera were described below:

Genus: *Ganoderma* sp.

Ganoderma lucidum

Family: Ganodermataceae

Common name: Lingzhi or Reishi mushroom

Color: Red (Young and mature stage)

Length (Mature): 13.5cm

Width (Mature): 9.6cm

Spore bearing surface under cap: Pores on hymenium

Spore diameter (Average): Length: 9.57µm; Width: 6.77µm

Spore shape: Single walled, smooth and ellipsoidal

Cap of the carpophore: Size: 9.6cm; Shape: Offset

Pileus: Color: Pinkish; Surface character and Zonation: Smooth, Silky, some kind of leathery having cracking property and dry in nature; Margin: Incurved in shape

Texture of the fruiting body: Brittle, tough, leathery and woody

Flesh odor: Pleasant

Lamellae: Pores present; Pores attachment: Free in nature; Pores color: Yellowish to white in color; Pores shape: Broad; Pores spacing: Crowded

Stipe: Present; Size: 11.8cm; Shape: Unequal; Position: Lateral; Surface characteristics: Dry and polished in nature; Color: Pink to chocolaty in color; Firmness: Solid or sometime in fleshy

Ecological features: Locality found: Gazipur, Dhaka, Tropical Moist Deciduous Forest region, Bangladesh; Habitat: On soil, in an association near the Ipil-Ipil (*Leucaena leucocephala*) and Golden shower (*Acacia auriculiformis*) trees; Habit: Scattered; Type of association: Root associated; Forest type: Leveled; Constancy of occurrence in specific habitat: Abundant; Type of soil: Sandy soil in nature; Weather at the time of collection: Literally dry weather around the habitat

Ganoderma boninense

Family: Ganodermataceae

Common name: Young resinous polypore mushroom

Color: Center is orange in color with white boarder

Length: 07cm

Width: 0.9cm

- 130 **Spore diameter (Average):** Length: 4.9µm; Width: 4.12µm
- 131 **Spore shape:** Single walled, smooth and more or less circular
- 132 **Cap of the carpophore:** Size: 7.0 cm x 5.3cm; Shape: Flat
- 133 **Pileus:** Color: Center is orange in color with white boarder; Margin: Regular in shape
- 134 **Texture of the fruiting body:** Soft and spongy
- 135 **Flesh odor:** Unpleasant
- 136 **Ecological features:** Locality found: Rajshahi University, Rajshahi, Tropical Moist Deciduous Forest
- 137 region, Bangladesh; Habitat: On root of the Bamboo (*Bambuseae*) tree; Habit: Caespitose cluster and
- 138 closely merged with the root; Type of association: Root associated; Forest type: Leveled; Constancy
- 139 of occurrence in specific habitat: Not in abundant; Type of soil: Loamy soil in nature; Weather at the
- 140 time of collection: Less moist weather around the habitat
- 141
- 142 ***Ganoderma tsugae***
- 143 **Family:**Ganodermataceae
- 144 **Common name:** Reishi mushroom
- 145 **Color:** Mature: Red in center with white boarder; Young: Yellow at the top with red in the bottom
- 146 **Length (Mature):** 8.5cm
- 147 **Width (Mature):** 9.3cm
- 148 **Spore bearing surface under cap:** Pores on hymenium
- 149 **Spore diameter (Average):** Length: 5.8µm; Width: 4.7µm
- 150 **Spore shape:** Single walled, smooth and oval
- 151 **Cap of the carpophore:** Size: 9.6cm x 5.3cm; Shape: Flat in the top around
- 152 **Pileus:** Color: Creamy; Surface character and Zonation: Leathery; Margin: Irregular in shape
- 153 **Texture of the fruiting body:** Brittle, leathery and woody
- 154 **Flesh odor:** Pleasant (chocolaty)
- 155 **Stipe:** Present; Size: 3cm; Shape: Unequal; Position: Central; Surface characteristics: Dry and
- 156 Polished in nature; Color: Pink to chocolaty in color; Firmness: Solid or sometime in erect
- 157 **Ecological features:** Locality found: Sujanagar, Pabna; Nature: Saprotrophic or parasitic; Habitat: On
- 158 soil, in the bark of Golden shower (*Acacia auriculiformis*) tree; Habit: Scattered; Type of association:
- 159 Closely root associated; Forest type: Leveled; Constancy of occurrence in specific habitat: Abundant;
- 160 Type of soil: loamy soil in nature; Weather at the time of collection: Literally dry weather around the
- 161 habitat
- 162
- 163 ***Ganoderma zonatum***
- 164 **Family:** Ganodermataceae
- 165 **Common name:** Lingzhi or Reishi mushroom
- 166 **Color:** Young: White
- 167 **Length (Young):** 3.4cm to 1.7cm
- 168 **Width (Young):** 3.3cm to 2.1cm
- 169 **Spore bearing surface under cap:** Pores present

170 **Spore diameter (Average):** Length: 6.63µm; Width: 4.47µm
 171 **Spore shape:** Single walled, smooth and ellipsoidal
 172 **Pileus:** Color: Milky white to Creamy; Surface character and Zonation: Dry in nature
 173 **Texture of the fruiting body:** Woody
 174 **Flesh odor:** Pleasant
 175 **Lamellae:** Absent; Pores color: Milky white in color; Pores shape: Broad; Pores spacing: Crowded;
 176 Firmness: Solid or somewhat in fleshy
 177 **Ecological features:** Locality found: Kalai, Jaipurhat; Nature: Parasitic; Habitat: On bark of the tree,
 178 in an association with the Mahogany (*Swieteniamahogani*) trees; Habit: Closely associated on the
 179 bark of the tree; Type of association: Scattered and somewhat caespitose cluster; Forest type:
 180 Leveled; Constancy of occurrence in specific habitat: Not in abundant; Type of soil: Clay loam soil in
 181 nature; Weather at the time of collection: Moderate moist weather around the habitat
 182

183 ***Ganoderma applanatum***

184 **Family:** Ganodermataceae
 185 **Common name:** Lingzhi or Reishi mushroom
 186 **Color:** Mature: Red with white color pores
 187 **Length (Mature):** 6.4cm
 188 **Width (Mature):** 3.5cm
 189 **Spore bearing surface under cap:** Pores on hymenium
 190 **Spore diameter (Average):** Length: 7.46µm; Width: 6.0µm
 191 **Spore shape:** Single walled, smooth and oblong or spherical
 192 **Pileus:** Surface character and Zonation: Dry in nature; Margin: Incurved in shape
 193 **Texture of the fruiting body:** Woody
 194 **Flesh odor:** Disagreeable
 195 **Pores color:** White
 196 **Ecological features:** Locality found: Kalai, Jaipurhat; Nature: Parasitic; Habitat: On bark wood of the
 197 tree, in an association with the Golden shower (*Acacia auriculiformis*) tree; Habit: Scattered; Type of
 198 association: Closely associated; Forest type: Leveled; Constancy of occurrence in specific habitat:
 199 Un-abundant; Type of soil: Loamy soil in nature; Weather at the time of collection: Moist weather
 200 around the habitat
 201

202 ***Ganoderma resinaceum***

203 **Family:** Ganodermataceae
 204 **Common name:** Bracket fungi or Reishi mushroom
 205 **Color:** Blackish with grayish color boarder (Mature)
 206 **Length:** Mature: 06cm; Young: 05cm
 207 **Width:** Mature: 4.1cm; Young: 3.2cm
 208 **Spore bearing surface under cap:** Pores on hymenium
 209 **Spore diameter (Average):** Length: 14.9µm; Width: 10.0µm

- 210 **Spore shape:** Single walled, smooth and ellipsoidal
- 211 **Pileus:** Color: Whitish to Creamy; Surface character and Zonation: Smooth, leathery and moist in
212 nature; Margin: Regular in shape
- 213 **Texture of the fruiting body:** Spongy, leathery and woody
- 214 **Flesh odor:** Unpleasant
- 215 **Lamellae:** Absent; Pores color: White in color; Pores spacing: Crowded
- 216 **Ecological features:** Locality found: Kalai, Jaipurhat; Habitat: On bark wood of the tree, in an close
217 association with the Golden shower (*Acacia auriculiformis*) trees; Habit: Scattered; Type of
218 association: Closely associated; Forest type: Leveled; Constancy of occurrence in specific habitat:
219 Un-abundant; Type of soil: Loamy soil in nature; Weather at the time of collection: Moderately moist
220 weather around the habitat
221
- 222 **Genus:** *Hebelomasp.*
- 223 *Hebelomacrustuliniforme*
- 224 **Family:** Hymenogastraceae
- 225 **Common name:** Poison pie or fairy cakes
- 226 **Color:** White (Young); Creamy (Mature)
- 227 **Length:** Mature: 6.2cm; Young: 3.7cm
- 228 **Width:** Mature: 3.3cm; Young: 1.2cm
- 229 **Spore bearing surface under cap:** Gills
- 230 **Spore diameter (Average):** Length: 5.85µm; Width: 3.7µm
- 231 **Spore shape:** Single walled, smooth and ellipsoidal
- 232 **Cap of the carpophore:** Size: Mature: 3.3cm; Young: 1.2cm; Shape: Umbonateand flatten
- 233 **Pileus:** Color: Creamy; Surface character and Zonation: Smooth and dry in nature; Margin: Regular
- 234 **Texture of the fruiting body:** Soft and spongy
- 235 **Flesh odor:** Pleasant
- 236 **Lamellae:** Present; Gill attachment: Adnate; Gill color: Yellowish white; Gill shape and width:
237 Moderately broad; Gill spacing: Close; Lamellulae: Present; Forking pattern: Branched
- 238 **Stipe:** Present; Size: Mature: 3.9cm; Shape: Bare; Position: Central; Surface characteristics: Dry and
239 polished; Color: Creamy; Firmness: Solid but fleshy
- 240 **Ecological features:** Locality found: Botanical garden, Mirpur, Dhaka; Habitat: On soil and root of the
241 tree; in an association with the stem of Bamboo (*Bambuseae*) tree; Habit: Scattered; Type of
242 association: Close; Forest type: Leveled; Constancy of occurrence in specific habitat: Un-abundant;
243 Type of soil: Sandy; Weather at the time of collection: Less moist weather
244
- 245 **Genus:** *Craterellus sp.*
- 246 *Craterellus cornucopioides*
- 247 **Family:** Cantharellaceae
- 248 **Common name:** Black trumpet mushroom
- 249 **Color:** Violet (Young); Black with whitish color boarder (Mature)

250 **Length (Mature):** 7.4cm
 251 **Width (Mature):** 3.8cm
 252 **Spore diameter (Average):** Length: 4.46µm; Width: 3.96µm
 253 **Spore shape:** Single walled, smooth and cylindrical
 254 **Cap of the carpophore:** Size: 3.4cm × 2.6cm; Shape: Infundibular
 255 **Pileus:** Color: Pinkish and somewhat mixed; Surface character and Zonation: Smooth, leathery,
 256 sticky and moist; Margin: Incurved
 257 **Texture of the fruiting body:** Brittle but moist in nature
 258 **Flesh odor:** Pleasant
 259 **Ecological features:** Locality found: Botanical garden, Mirpur, Dhaka; Habitat: On soil and root of the
 260 tree; in an association with the stem of Bamboo (*Bambuseae*) tree; Habit: Scattered; Type of
 261 association: Close; Forest type: Leveled; Constancy of occurrence in specific habitat: Un-abundant;
 262 Type of soil: Sandy; Weather at the time of collection: Moist weather
 263
 264 **Genus:** *Lepiota* sp.
 265 *Lepiota americana*
 266 **Family:** Agaricaceae
 267 **Common name:** Rogers mushroom
 268 **Color:** Brown (Young); Brown or dark brown having pinkish spots or scales (Mature); Color changed
 269 from dark brown to black in the border region after one hour of collection
 270 **Length:** Mature: 3.0cm to 4.5cm; Young: 4.0cm
 271 **Width:** Mature: 3.8cm to 5.1cm; Young: 1.8cm
 272 **Spore bearing surface under cap:** Gills
 273 **Spore diameter (Average):** Length: 6.28µm; Width: 4.32µm
 274 **Spore shape:** Single walled, smooth and ellipsoid
 275 **Cap of the carpophore:** Size (Mature): 3.8cm to 5.1cm; Shape: Convex
 276 **Pileus:** Color: Pinkish, brownish or mixed; Surface character and Zonation: Smooth and dry in nature;
 277 Margin: Regular
 278 **Texture of the fruiting body:** Soft and spongy
 279 **Flesh odor:** Pleasant
 280 **Lamellae:** Present; Gill attachment: Emarginated; Gill color: Light brown; Gill shape: Broad; Gill
 281 spacing: Close; Lamellulae: Present; Forking pattern: Unbranched
 282 **Stipe:** Present; Size: 2.4cm × 5.8cm; Shape: Equal; Position: Central; Surface characteristics: Dry,
 283 glabrous and polished; Color: Grey to light brown; Firmness: Tubular
 284 **Annulus (position):** Present and single
 285 **Scale:** Present and brown in color
 286 **Umbo:** Present and convex well shaped
 287 **Ecological features:** Locality found: Botanical garden, Mirpur, Dhaka; Habitat: On soil; in an
 288 association with the mango (*Magifera indica*) tree; pH in soil: 5.6; Moisture: 7.0%; Temperature: 34°C;

289 Habit: Scattered; Type of association: Distant; Forest type: Leveled; Constancy of occurrence in
290 specific habitat: Un-abundant; Type of soil: Loam; Weather at the time of collection: Dry weather

291

292 ***Lepiota helveola***

293 **Family:** Agaricaceae

294 **Color:** White and creamy (Young); White and creamy with dark brown spots on cap and stipe
295 (Mature)

296 **Length (Mature):** 13cm to 15cm; Young: 8.0 cm

297 **Width (Mature):** 6.0cm to 6.3cm; Young: 4.4cm

298 **Spore bearing surface under cap:** Gills

299 **Spore diameter (Average):** Length: 8.8µm; Width: 5.88µm

300 **Spore shape:** Single walled, smooth and ellipsoid

301 **Cap of the carpophore:** Size: 6.0cm to 6.3cm; Shape: Convex or flat

302 **Pileus:** Color: White, creamy and brownish with brown spot; Surface character and Zonation:
303 Smooth, scaly and dry in nature; Margin: Regular

304 **Texture of the fruiting body:** Soft and spongy

305 **Flesh odor:** Fragrant

306 **Lamellae:** Present; Gill attachment: Free; Gill color: White; Gill shape: Broad; Gill spacing: Close;
307 Lamellulae: Present; Forking pattern: Unbranched

308 **Stipe:** Present; Size: 10.5cm; Shape: Clavate; Position: Central; Surface characteristics: Dry and
309 glabrous; Color: Grey to light brown with dark brown spots; Firmness: Tubular;

310 **Annulus (position):** Present and single

311 **Scale:** Present and brown in color

312 **Umbo:** Present and oyster shaped

313 **Ecological features:** Locality found: Jahangirnagar University, Savar, Dhaka; Habitat: On humus;
314 Habit: Solitary; Forest type: Mixed; Constancy of occurrence in specific habitat: Abundant; Weather at
315 the time of collection: Moist weather

316

317 ***Lepiota aspera***

318 **Family:** Agaricaceae

319 **Common name:** Freckled dapperling

320 **Color:** Brown (Young and maturity)

321 **Length:** 4.0cm

322 **Width:** 1.5cm

323 **Spore bearing surface under cap:** Gills

324 **Spore diameter (Average):** Length: 3.77µm; Width: 3.6µm

325 **Spore shape:** Single walled, smooth and cylindrical

326 **Cap of the carpophore:** Size: 1.5cm; Shape: Campanulate

327 **Pileus:** Color: Brownish; Surface character and Zonation: Scaly and dry in nature; Margin: Regular

328 **Texture of the fruiting body:** Soft and spongy

329 **Flesh odor:** Pleasant

330 **Lamellae:** Present; Gill attachment: Free; Gill color: Pale light brown; Gill shape: Moderately broad;
 331 Gill spacing: Crowded; Lamellulae: Present; Forking pattern: Branched
 332 **Stipe:** Present; Size: 3.9cm; Shape: Equal; Position: Central; Surface characteristics: Dry but spiny
 333 scale present and pruinose; Color: Grey to light brown; Firmness: Solid
 334 **Ecological features:** Locality found: Sher-e-Bangla Nagar, Dhaka; Habitat: On humus; Habit:
 335 Scattered; Forest type: Leveled; Constancy of occurrence in specificHabitat: Un-abundant; Type of
 336 soil: Clay loam; Weather at the time of collection: Moist weather

337

338 ***Macrolepiota procera***

339 **Family:** Lepiotaceae

340 **Color:** Creamy (Young); Creamy with dark brown scale (Mature)

341 **Length:** 13cm

342 **Width:** 7.0 cm

343 **Spore bearing surface under cap:** Gills

344 **Spore diameter (Average):** Length: 8.82µm; Width: 5.82µm

345 **Spore shape:** Single walled, smooth and elongated, ellipsoid

346 **Cap of the carpophore:** Size: Length: 7.0cm; Width: 0.8cm; Shape: Umbonate

347 **Pileus:** Color: Creamy with spots; Surface character and Zonation: Smooth, scaly and dry in nature;
 348 Margin: Regular

349 **Texture of the fruiting body:** Soft and spongy

350 **Flesh odor:** Pleasant

351 **Lamellae:** Present; Gill attachment: Free; Gill color: Pale white; Gill shape: Broad; Gill spacing: Close;
 352 Lamellulae: Present; Forking pattern: Unbranched

353 **Stipe:** Present; Size: 11.5cm; Shape: Bulbous; Position: Central; Surface characteristics: Dry and
 354 polished; Color: White to light brown with spots; Firmness: Tubular and fleshy

355 **Annulus (position):** Present and single

356 **Scale:** Present and brown in color

357 **Umbo:** Present and oyster shaped

358 **Ecological features:** Locality found: Jahangirnagar University, Savar, Dhaka; Habitat: On humus;
 359 Habit: Solitary; Forest type: Mixed; Constancy of occurrence in specific habitat: Un-abundant;
 360 Weather at the time of collection: Moist weather

361

362 **Genus:** *Ramariopsis* sp.

363 ***Ramariopsis kunzei***

364 **Family:** Clavariaceae

365 **Common name:** White coral

366 **Color:** White (Young and mature)

367 **Length (Mature):** 5.2cm

368 **Width (Mature):** 2.5 cm

369 **Spore diameter (Average):** Length: 4.0µm; Width: 3.6µm

370 **Spore shape:** Single walled, smooth and spherical
 371 **Texture of the fruiting body:** Soft, spongy and brittle
 372 **Flesh odor:** Unpleasant
 373 **Forking pattern:** Branched
 374 **Surface characteristics:** Dry
 375 **Color:** White
 376 **Firmness:** Fistulose and narrow
 377 **Ecological features:** Locality found: Botanical garden, Mirpur, Dhaka; Habitat: On soil; in an
 378 association with the Ipil-Ipil (*Leucaena leucocephala*) and Golden shower (*Acacia auriculiformis*);
 379 Habit: Solitary and some others are caespitose cluster; Type of association: Distant and some are
 380 closely crowded; Forest type: Leveled; Constancy of occurrence in specific habitat: Un-abundant;
 381 Type of soil: Sandy; Weather at the time of collection: Moist weather
 382
 383 **Genus:** *Ampulloclitocybe* sp.
 384 *Ampulloclitocybe clavipes*
 385 **Family:** Hygrophoraceae
 386 **Common name:** Club footed ditocybe
 387 **Color:** White (Young and mature)
 388 **Length:** Mature: 2.4cm; Young: 1.8cm
 389 **Width:** Mature: 1.4cm; Young: 0.6cm
 390 **Spore bearing surface under cap:** Gills
 391 **Spore diameter (Average):** Length: 4.56µm; Width: 4.56µm
 392 **Spore shape:** Single walled, smooth and spherical
 393 **Cap of the carpophore:** Size: Mature: 1.4cm; Young: 0.6cm; Shape: Ovate
 394 **Pileus:** Color: White; Surface character and Zonation: Smooth and dry in nature; Margin: Regular
 395 **Texture of the fruiting body:** Soft and spongy
 396 **Flesh odor:** Pleasant
 397 **Lamellae:** Present; Gill attachment: Free; Gill color: White; Gill shape: Moderately broad; Gill spacing:
 398 Close; Lamellulae: Present; Forking pattern: Unbranched
 399 **Stipe:** Present; Size: 2.4cm; Shape: Bare; Position: Central; Surface characteristics: Dry and
 400 glabrous; Color: White and some became grey to light brown after one hour; Firmness: Solid and
 401 tubular
 402 **Ecological features:** Locality found: Botanical garden, Mirpur, Dhaka; Habitat: On soil; in an
 403 association with the Golden shower (*Acacia auriculiformis*); Habit: Scattered; Type of association:
 404 Distant; Forest type: Mixed; Constancy of occurrence in specific habitat: Un-abundant; Type of soil:
 405 Clay loam; Weather at the time of collection: Moderately moist weather
 406
 407 **Genus:** *Lycoperdon* sp.
 408 *Lycoperdon pyriforme*
 409 **Family:** Lycoperdaceae

410 **Common name:** Pear-shaped puffball or stump puffball
 411 **Color:** White (Young and mature)
 412 **Length:** 1.15 cm
 413 **Width:** 1.3cm
 414 **Spore diameter (Average):** Length: 5.27µm; Width: 4.07µm
 415 **Spore shape:** Single walled, smooth and ellipsoid
 416 **Cap of the carpophore:** Size: 1.3cm; Shape: Flat
 417 **Pileus:** Color: White; Surface character and Zonation: Smooth
 418 **Texture of the fruiting body:** Soft and spongy
 419 **Flesh odor:** Pleasant
 420 **Firmness:** Solid but fleshy
 421 **Ecological features:** Locality found: Gazipur, Dhaka; Habitat: On bark wood of the tree; in an
 422 association with the stem of Bamboo (*Bambuseae*) tree; Habit: Scattered; Type of association: Close;
 423 Forest type: Leveled; Constancy of occurrence in specific habitat: Un-abundant; Type of soil: Loam;
 424 Weather at the time of collection: Moist weather
 425
 426 **Genus:** *Volvariella* sp.
 427 *Volvariella gloiocephala*
 428 **Family:** Pluteaceae
 429 **Common name:** Big sheath mushroom, rose-gilled grisette, or stubble rosegill
 430 **Color:** White (Young and mature)
 431 **Length:** 10.5cm
 432 **Width:** 6.8cm
 433 **Spore bearing surface under cap:** Gills
 434 **Spore diameter (Average):** Length: 10.5µm; Width: 10.1µm
 435 **Spore shape:** Single walled, smooth and ellipsoidal
 436 **Cap of the carpophore:** Size: 6.8cm; Shape: Ovate or flat
 437 **Pileus:** Color: Creamy, brownish and some are mixed; Surface character and Zonation: Smooth and
 438 dry in nature; Margin: Incurved
 439 **Texture of the fruiting body:** Soft and spongy
 440 **Flesh odor:** Disagreeable after half an hour of collection
 441 **Lamellae:** Present; Gill attachment: Free; Gill color: Pale white; Gill shape: Broad; Gill spacing: Close;
 442 Lamellulae: Present; Forking pattern: Branched
 443 **Stipe:** Present; Size: 9.2cm; Shape: Clavate; Position: Central; Surface characteristics: Dry and
 444 glabrous; Color: White to creamy; Firmness: Tubular and narrow
 445 **Volva:** Present
 446 **Ecological features:** Locality found: Sujanagar, Pabna; Habitat: On soil; in an association with the
 447 Mahogany (*Swietenia mahogani*) tree; Habit: Scattered; Type of association: Close; Forest type:
 448 Leveled; Constancy of occurrence in specific habitat: Un-abundant; Type of soil: Loam; Weather at
 449 the time of collection: Moist weather

450 **Note:** Started rotting after half an hour of collection
 451
 452 **Genus:** *Russula* sp.
 453 *Russula nobilis*
 454 **Family:** Russulaceae
 455 **Common name:** Beechwoodsickener
 456 **Color:** Red and white mixture (Young and mature)
 457 **Length:** 4.8cm
 458 **Width:** 5.3cm
 459 **Spore bearing surface under cap:** Gills
 460 **Spore diameter (Average):** Length: 8.78µm; Width: 7.6µm
 461 **Spore shape:** Single walled, smooth and spherical
 462 **Cap of the carpophore:** Size: 6.0cm × 5.3cm; Shape: Convex
 463 **Pileus:** Color: Reddish; Surface character and Zonation: Dry and rough in nature; Margin: Regular
 464 **Texture of the fruiting body:** Soft and spongy
 465 **Flesh odor:** Aromatic
 466 **Lamellae:** Present; Gill attachment: Free and some are emarginated; Gill color: White; Gill shape:
 467 Broad; Gill spacing: Close; Lamellulae: Present; Forking pattern: Unbranched
 468 **Stipe:** Present; Size: 3.8cm; Shape: Bare; Position: Central; Surface characteristics: Dry and
 469 polished; Color: Creamy; Firmness: Tubular and fleshy
 470 **Ecological features:** Locality found: Sujanagar, Pabna; Habitat: On soil; in an association with the
 471 Golden shower (*Acacia auriculiformis*) tree; Habit: Scattered; Type of association: Close; Forest type:
 472 Leveled; Constancy of occurrence in specific Habitat: Un-abundant; Type of soil: Loam; Weather at
 473 the time of collection: Moderately moist weather
 474
 475 **Genus:** *Termitomyces* sp.
 476 *Termitomyces heimii*
 477 **Family:** Lyophyllaceae
 478 **Color:** White (Young and mature)
 479 **Length:** 21.1cm
 480 **Width:** 12cm
 481 **Spore bearing surface under cap:** Gills
 482 **Spore diameter (Average):** Length: 14.0µm; Width: 10.8µm
 483 **Spore shape:** Single walled, smooth and cylindrical as well as ellipsoid
 484 **Cap of the carpophore:** Size: 12cm; Shape: Convex
 485 **Pileus:** Color: Creamy; Surface character and Zonation: Smooth and dry in nature; Margin: Regular
 486 **Texture of the fruiting body:** Soft and spongy
 487 **Flesh odor:** Fragrant
 488 **Lamellae:** Present; Gill attachment: Adnexed; Gill color: White; Gill shape: Broad; Gill spacing:
 489 Crowded; Lamellulae: Present; Forking pattern: Unbranched

490 **Stipe:** Present; Size: 20.0cm; Shape: Bulbous; Position: Central; Surface characteristics: Dry and
 491 polished; Color: Creamy; Firmness: Solid; Scale: Present and white in color

492 **Ecological features:** Locality found: Dinajpursadar, Habitat: On humus; near the mango (*Magifera*
 493 *indica*) tree; Habit: Scattered; Type of association: Distant; Forest type: Leveled; Constancy of
 494 occurrence in specific habitat: Un-abundant; Type of soil: Clay loam; Weather at the time of collection:
 495 More moist weather

496

497 **Genus:** *Amanita* sp.
 498 *Amanita muscaria*
 499 **Family:** Amanitaceae

500 **Common name:** Fly agaric
 501 **Color:** Red (Young and mature)
 502 **Length:** 4.2cm
 503 **Width:** 2.5cm
 504 **Spore bearing surface under cap:** Gills
 505 **Spore diameter (Average):** Length: 4.8µm; Width: 3.28µm
 506 **Spore shape:** Single walled, smooth and ellipsoid
 507 **Cap of the carpophore:** Size: 2.5cm; Shape: Convex
 508 **Pileus:** Color: Pinkish; Surface character and Zonation: Smooth and dry in nature; Margin: Regular
 509 **Texture of the fruiting body:** Spongy
 510 **Flesh odor:** Pleasant
 511 **Lamellae:** Present; Gill attachment: Free; Gill color: White; Gill shape: Moderately broad; Gill spacing:
 512 Crowded; Lamellulae: Present; Forking pattern: Branched

513 **Stipe:** Present; Size: 4.3cm; Shape: Equal; Position: Central; Surface characteristics: Dry and
 514 polished; Color: Pinkish; Firmness: Solid; Annulus (position): Present and single; Scale: Present and
 515 reddish to pinkish in color

516 **Ecological features:** Locality found: Sher-e-Bangla Nagar, Dhaka; Habitat: On humus; Habit:
 517 Scattered; Forest type: Leveled; Constancy of occurrence in specific habitat: Un-abundant; Type of
 518 soil: Loam; Weather at the time of collection: Moderately moist weather

519

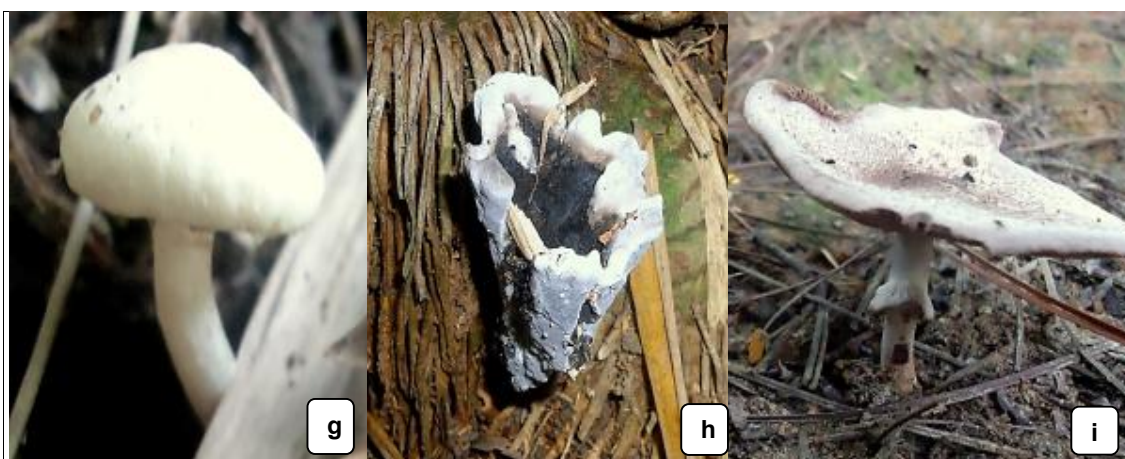
520 **Genus:** *Marasmius* sp.
 521 *Marasmius confertus*
 522 **Family:** Marasmiaceae
 523 **Color:** Pink and purple (Young and mature)
 524 **Length:** 5.5cm
 525 **Width:** 2.1cm
 526 **Spore bearing surface under cap:** Gills
 527 **Spore diameter (Average):** Length: 4.28µm; Width: 3.9µm
 528 **Spore shape:** Single walled, smooth and oval
 529 **Cap of the carpophore:** Size: 1.8cm to 2.1cm; Shape: Flat

- 530 **Pileus:** Color: Pinkish; Surface character and Zonation: Glabrous and dry in nature; Margin: Incurved
 531 **Texture of the fruiting body:** Soft
 532 **Flesh odor:** Pleasant
 533 **Lamellae:** Present; Gill attachment: Adnexed; Gill color: White; Gill shape: Moderately broad; Gill
 534 spacing: Crowded; Lamellulae: Present; Forking pattern: Unbranched
 535 **Stipe:** Present; Size: 5.0cm; Shape: Radicating; Position: Central; Surface characteristics: Dry and
 536 glabrous; Color: White to pinkish; Firmness: Narrow
 537 **Ecological features:** Locality found: Sher-e-Bangla Nagar, Dhaka; Habitat: On humus; Habit:
 538 Solitary; Forest type: Leveled; Constancy of occurrence in specific habitat: Abundant; Type of soil:
 539 Loam; Weather at the time of collection: Moist weather
 540
 541 ***Marasmius elegans***
 542 **Family:** Marasmiaceae
 543 **Common name:** Velvet parachute
 544 **Color:** Pink and purple (Young and mature)
 545 **Length:** 4.5cm
 546 **Width:** 1.3cm
 547 **Spore bearing surface under cap:** Gills
 548 **Cap of the carpophore:** Size: 1.3cm; Shape: Convex
 549 **Pileus:** Color: Brownish; Surface character and Zonation: Smooth; Margin: Regular
 550 **Texture of the fruiting body:** Soft and spongy
 551 **Flesh odor:** Pleasant
 552 **Lamellae:** Present; Gill attachment: Adnate; Gill color: Pale reddish; Gill shape: Narrow; Gill spacing:
 553 Close; Lamellulae: Present; Forking pattern: Branched
 554 **Stipe:** Present; Size: 4.5cm to 4.8cm; Shape: Bare; Position: Central; Surface characteristics: Dry
 555 and glabrous; Color: White to light brown; Firmness: Solid
 556 **Ecological features:** Locality found: Ramna park, Dhaka; Habitat: On humus; Habit: Scattered;
 557 Forest type: Leveled; Constancy of occurrence in habitat: Abundant; Type of soil: Loam; Weather at
 558 the time of collection: Moist weather
 559
 560 ***Marasmius oreades***
 561 **Family:** Marasmiaceae
 562 **Common name:** California fungi or Scotch bonnet
 563 **Color:** Brown (Young and mature)
 564 **Length:** 2.2cm to 2.5cm
 565 **Width:** 1.3cm to 1.4cm
 566 **Spore bearing surface under cap:** Gills
 567 **Spore diameter (Average):** Length: 11.05µm; Width: 7.75µm
 568 **Spore shape:** Single walled, smooth and ellipsoid
 569 **Cap of the carpophore:** Size: 1.2cm to 1.5cm; Shape: Convex

570 **Pileus:** Color: Brownish; Surface character and Zonation: Glabrous and dry in nature; Margin:
 571 Regular
 572 **Texture of the fruiting body:** Soft
 573 **Flesh odor:** Pleasant
 574 **Lamellae:** Present; Gill attachment: Adnate; Gill color: Pale brown; Gill shape: Narrow; Gill spacing:
 575 Close; Lamellulae: Present; Forking pattern: Branched
 576 **Stipe:** Present; Size: 2.2cm to 2.5cm; Shape: Bare; Position: Central; Surface characteristics: Dry and
 577 glabrous; Color: Grey to light brown; Firmness: Solid
 578 **Umbo:** Present and oyster shaped
 579 **Ecological features:** Locality found: Ramna park, Dhaka; Habitat: On bark wood of the tree; Habit:
 580 Solitary; Type of association: Close; Forest type: Leveled; Constancy of occurrence in specific habitat:
 581 Un-abundant; Type of soil: Loam; Weather at the time of collection: Moist weather
 582
 583 **Genus:** *Collybia* sp.
 584 *Collybia cookei*
 585 **Family:** Tricholomataceae
 586 **Color:** White (Young and mature)
 587 **Length:** 5.0cm
 588 **Width:** 2.5cm
 589 **Spore bearing surface under cap:** Gills
 590 **Spore diameter (Average):** Length: 7.8µm; Width: 6.46µm
 591 **Spore shape:** Single walled, smooth and elongated
 592 **Cap of the carpophore:** Size: 1.5cm to 2.5cm; Shape: Convex
 593 **Pileus:** Color: White; Surface character and Zonation: Smooth; Margin: Regular
 594 **Texture of the fruiting body:** Spongy
 595 **Flesh odor:** Fragrant
 596 **Lamellae:** Present; Gill attachment: Adnate; Gill color: White; Gill shape: Moderately broad; Gill
 597 spacing: Crowded; Lamellulae: Present; Forking pattern: Unbranched
 598 **Stipe:** Present; Size: 4.5cm to 5.0cm; Shape: Bare; Position: Central; Surface characteristics: Dry and
 599 glabrous; Color: White; Firmness: Solid
 600 **Ecological features:** Locality found: Sher-e-Bangla Nagar, Dhaka; Habitat: On the bark wood of the
 601 tree; in an association with the Mahogany (*Swieteniamahogani*) and Eucalyptus (*Eucalyptus*
 602 *citriodora*) tree; Habit: Solitary; Type of association: Close; Forest type: Leveled; Constancy of
 603 occurrence in specific habitat: Abundant; Type of soil: Loam; Weather at the time of collection: Moist
 604 weather
 605
 606 **Genus:** *Mycena* sp.
 607 *Mycena alba*
 608 **Family:** Mycenaceae
 609 **Common name:** Tropical white mushroom

610 **Color:** White (Young and mature)
 611 **Length:** 1.0cm
 612 **Width:** 2.1cm
 613 **Spore bearing surface under cap:** Gills
 614 **Spore diameter (Average):** Length: 5.32 μ m; Width: 4.43 μ m
 615 **Spore shape:** Single walled, smooth and elongated
 616 **Cap of the carpophore:** Size: 2.0cm to 2.1cm, Shape: Conical
 617 **Pileus:** Color: Creamy, Surface character and Zonation: Smooth, Margin: Regular
 618 **Texture of the fruiting body:** Soft and spongy
 619 **Flesh odor:** Fragrant
 620 **Lamellae:** Present; Gill attachment: Adnate; Gill color: White; Gill shape: Moderately broad; Gill
 621 spacing: Close; Lamellulae: Present; Forking pattern: Branched
 622 **Stipe:** Present; Size: 1.0cm; Shape: Bare; Position: Lateral; Surface characteristics: Dry and polished;
 623 Color: White and creamy; Firmness: Solid
 624 **Ecological features:** Locality found: Botanical garden, Mirpur, Dhaka; Habitat: On bark wood of the
 625 tree; in an association with the Mahogany (*Swietenia mahogani*) and Eucalyptus (*Eucalyptus*
 626 *citriodora*) tree; Habit: Solitary; Type of association: Close; Forest type: Leveled; Constancy of
 627 occurrence in specific habitat: Un-abundant; Type of soil: Loam; Weather at the time of collection:
 628 Moderately moist weather
 629





630

631 Figure 2: Fruiting body of collected mushrooms; a. *Ganoderma lucidum*; b. *Ganoderma boninense*
 632 (Growing stage); c. *Ganoderma tsugae*; d. *Ganoderma zonatum* (Young stage); e. *Ganoderma*
 633 *applanatum*; f. *Ganoderma resinaceum*; g. *Hebeloma crustuliniforme*; h. *Craterellus cornucopioides*; i.
 634 *Lepiota americana*





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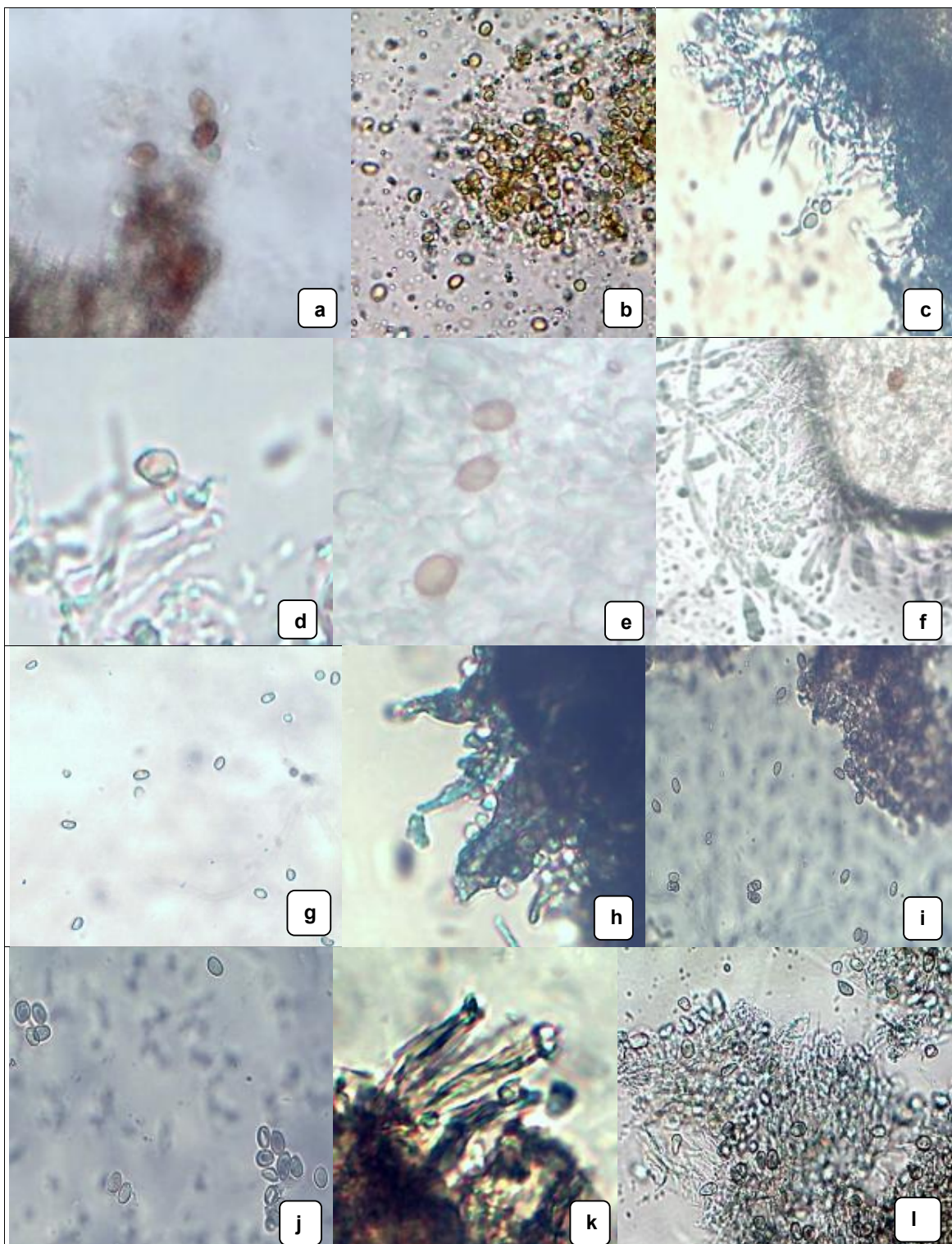
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Figure 3: Fruiting body of collected mushrooms; a. *Lepiota helveola*; b. *Lepiota aspera*; c. *Macrolepiota procera*; d. *Ramariopsis kunzei*; e. *Ampulloclitocybe clavipes*; f. *Lycoperdon pyriforme*; g. *Volvariella gloiocephala*; h. *Russula nobilis*; i. *Termitomyces heimii*

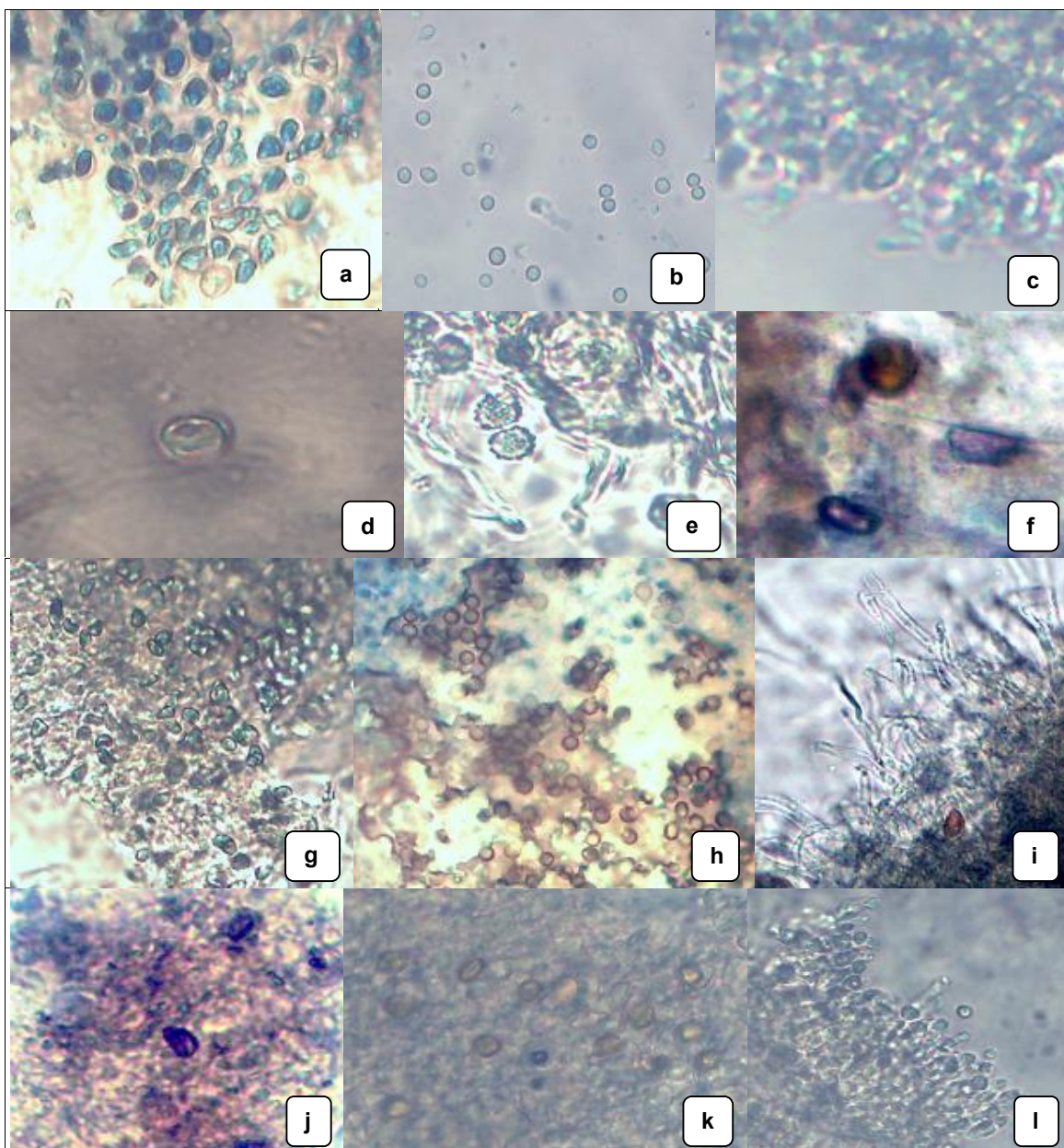


640 Figure 4: Fruiting body of collected mushrooms; a. *Amanita muscaria*; b. *Marasmius confertus*; c.
641 *Marasmius elegans*; d. *Marasmius oreades*; e. *Collybia cookii*; f. *Mycena alba*
642



643 Figure 5: Spores of the collected mushrooms; a. *Ganoderma lucidum*; b. *Ganoderma boninense*; c.
644 *Ganoderma tsugae*; d. *Ganoderma zonatum*; e. *Ganoderma applanatum*; f. *Ganoderma resinaceum*;

645 g. *Hebeloma crustuliniforme*; h. *Craterellus cornucopioides*; i. *Lepiota americana*; j. *Lepiota helveola*,
646 k. *Lepiota aspera*; l. *Macrolepiota procera*



647
648 Figure 6: Spores of the collected mushrooms; a. *Ramariopsis kunzei*; b. *Ampulloclitocybe clavipes*; c.
649 *Lycoperdon pyriforme*; d. *Volvariella gloiocephala*; e. *Russula nobilis*; f. *Termitomyces heimii*; g.
650 *Amanita muscaria*; h. *Marasmius confertus*; i. *Marasmius elegans*; j. *Marasmius oreades*; k. *Collybia*
651 *cookie*; l. *Mycena alba*

652 4. Discussion

653 Mushrooms alone are represented by about 41,000 species [13]. Due to their beneficial properties as
654 well as the economic importance, it increases the interest to the modern research. The occurrence of
655 such familiar substrate as wood, litter and soil, implies a role for them in these micro habitats [14].

Usually in the rainy season (July to October), fleshy mushrooms are found. Some are also found in the summer as well as in the winter season and it basically grown in everywhere, where they get adequate moisture or their favorable environment. They actually emerge from substrates such as peat, along or soil, humus, dung, saw dust, charcoal heaps etc. [15].

An investigation was carried out to collect identify and preserve mushrooms from the tropical moist deciduous forest region in Bangladesh. Through this investigation, 14 genera and 24 species were identified including 6 species of *Ganoderma*, 4 species of *Lepiota*, 3 species of *Marasmius* and 1 species of each of the genera of *Collybia*, *Hebeloma*, *Craterellus*, *Ramariopsis*, *Ampulloclitocybe*, *Lycoperdon*, *Volvariella*, *Russula*, *Termitomyces*, *Amanita* and *Mycena*.

Ganoderma sp. was found at Rajshahi, Pabna, Jaipurhat and Dhaka district of the tropical moist deciduous forest region in Bangladesh. It was first found in 1905 by American mycologist named William Murrill [16]. This species was also reported in China [17] and India [18, 19, 20, 21]. Furthermore, *Ganoderma lucidum* and *Ganoderma appalantum* both were reported in India and Nigeria [19, 22,23] whereas, *Ganoderma boninense* and *Ganoderma tsugae* were reported by Hushiarian *et al.* [24] and Vyas *et al.* [25] accordingly. On the other hand, *Ganoderma resinaceum* was also reported by Mohanty *et al.* in India [26]. *Hebeloma* sp. was found at Dhaka district of the tropical moist deciduous forest region in Bangladesh, whereas, it was also common all over the world especially in Western Australia. It was also reported in the western United States [27]. The similar type of *Hebeloma crustuliniforme* was also reported by both Geml *et al.* and Romano *et al.* [28, 29]. Meanwhile, *Craterellus* sp. was found at Dhaka district whereas, the genus was described by some other researchers [30]. Later on the genus was more specified by the DNA studies [31]. During the investigation all *Lepiota* species were found at Dhaka district of Bangladesh, whereas, around 400 species were already identified all over the world and most of them are poisonous. The species was first reported in South Africa [32] and also reported in India [19, 20]. Furthermore, the similar genus of *Lepiota americana* was reported in India [33]. *Lepiota hevelvo* was reported by Sysouphanthong *et al.* [34]. On the other hand, *Lepiota aspera* was also reported from India and Philippines [34, 35] and *Macrolepiota procera* was reported in India and Burma [34, 36] as well. Throughout the investigation, *Ramariopsis* sp. was found in Dhaka district of the tropical moist deciduous forest region in Bangladesh. This genus has a widespread distribution and contains 44 species [37]. Two species of this genus were reported in Western Ghats, Kerala, India [38] whereas, *Ramariopsis kunzei* was also reported in Northeast Ohio [39].

Ampulloclitocybe sp., *Lycoperdon* sp. and *Volvariella* sp., were collected from Dhaka district of the tropical moist deciduous forest region in Bangladesh. The genus *Ampulloclitocybe* has three species and widely distributed [37] whereas, *Ampulloclitocybe clavipes* was also reported by Matheny *et al.* [40]. Recently, *Volvariella* sp. and *Lycoperdon* sp. were also reported from India [41, 20]. Furthermore, *Russula* sp., *Termitomyces* sp. and *Amanita* sp. were found to be distributed at Pabna, Dinajpur and Dhaka district respectively. The genera *Amanita* and *Russula* were reported in India [19,

20, 38], whereas, *Termitomyces* sp. was circumscribed by Roger Heim [42]. *Termitomyces* sp. was also found in India [20] and the morphological characterization and yield potential of *Termitomyces* sp. mushroom was studied at Gorakhpur forest division in India [43]. On the other hand, the similar genus of *Russula nobilis* and *Termitomyces hemii* species were reported by Pala *et al.* [44] and Dwivedi *et al.* [19] respectively. Furthermore, *Amanita muscaria* was also reported by Hawkeswood [45], Michelot and Melendez-howell [46] and Pala *et al.* [44].

In the Dhaka district of the tropical moist deciduous forest region in Bangladesh, all the three species of *Marasmius* sp. were found. It was also reported in Madagascar and Mascarenes by Antonín and Buyck [47]. The similar genus of *Marasmius confertus* and *Marasmius elegans* were also reported by Farook *et al.* [48] and Horton [49] accordingly. Furthermore, *Collybia* sp. and *Mycena* sp. was also found at Dhaka district of the tropical moist deciduous forest region in Bangladesh throughout the investigation. However, the genera *Collybia* and *Mycena* have nearly 3 species and 33 species, respectively [50]. The genus *Collybia* sp. has a widespread but rarely distributed in north temperate areas [51]. On the other hand, *Mycena* sp. was also reported in India [20].

5. Conclusion

The survey of different locations was done in rainy season. Most mushrooms are found in forest area, in field area, on branches of trees, and some time in waste land area; although they may be found throughout the year. This is the first investigation of mushroom biodiversity at tropical moist deciduous forest region of Bangladesh. Future investigation is also needed in different seasons as well as in different forest regions to identify the new exotic species of mushroom flora, which will represent a complete overview about the available mushroom flora in Bangladesh.

REFERENCES

1. Borah TR, Rahman H, Avasthe RK, Mohanty AK, Toppo S. In Mushroom Production an overview. Technical Bulletin No. RC/SKM/05 ICAR Research Complex for NEH Region, Sikkim Centre, Tadong, Gangtok, Sikkim. pp.34; 2010.
2. Das K. Diversity and conservation of wild mushrooms in Sikkim with special reference to Barsey Rhododendron Sanctuary, NeBIO.2010;1(2):1-13.
3. Das K. Mushrooms of Sikkim I: Barsey Rhododendron Sanctuary. Sikkim State Biodiversity Board, Gangtok and Botanical Survey of India, Kolkata. pp.1-160; 2009.
4. Hailing RE. Recommendations for collecting mushrooms for scientific. In Alexialdes M. M. and J. W. (eds). Selected Guide Lined for Ethnobotanical Research. A field Manual, The New York Botanical garden Press, Bronx. pp.135-141; 1996.
5. Molina R, O'Dell T, Luoma D, Nair MC, Devi SB. Collection and Identification of Agaricales, In Beneficial fungi and their cultivation (M.C. Nair and S. Balakrishanan eds.), Scientific Publishers SA, New Pali Road, P.O. Box, 91, Jodhpur-342001, India; 1995.
6. Arora D. Mushrooms Demystified: A Comprehensive Guide to the Fleshy Fungi. Barkeley Speed Press; 1986.

- 736 7. Singer R. The Agaricales in Morden Taxonomy. J Cramer, Weinheim, 4th ed. pp. 912; 1986.
- 737 8. Singer R. The Agaricales in Morden Taxonomy. Seven Koeltz Scientific Books, Koenigstein,
- 738 Germany. pp.624; 1986.
- 739 9. Chandulal K, Gopal C, John P. Studies on biodiversity of fleshy fungi in Navsari (South Gujarat),
- 740 India. International Journal of Biodiversity and Conservation. 2013;5(8):508-514.
- 741 10. Dickinson C, John L. The Colour Dictionary of Mushroom. Orbis Publishing, London; 1982.
- 742 11. Jorden P. The Mushroom Guide and Identifier. Anness publishing limited Hermes house,
- 743 London; 2000.
- 744 12. Pegler D, Spooner B. The Mushroom Identifier. Quintet publishing limited; 1997.
- 745 13. Deshmukh SK. Mushroom Cultivation Nutritional value, Medicinal effect and Environmental
- 746 impact, Second Edition, CRC Press. pp.2-4; 2004.
- 747 14. Lakhanpal TN. Mushrooms of India Boletaceae-Vol-I Studies in Cryptogamic Botany (ed.
- 748 Mukherjee KG), APH Publishing Corporation, Delhi; 1996.
- 749 15. Sharman SS, Samota RK. Trapping into India's Mushroom biodiversity; Identification,
- 750 Conservation and Domestication of wild Mushroom flora. Compendium of lectures-Emerging
- 751 Areas in Mushroom diversity, production and post-harvest development. Organized by
- 752 Mushroom Research laboratory, Dept. of Plant Pathology. Indira Gandhi Agriculture University,
- 753 Raipur. pp.69-84; 2006.
- 754 16. Murrill WA. Tomophagus for Dendrophagus. Torreyana. 1905;5:197.
- 755 17. Wang XC, Xi RJ, Li Y, Wang DM, Yao YJ. The Species Identity of the Widely Cultivated
- 756 *Ganoderma*, '*G. lucidum*' (Ling-zhi), in China. PLoS ONE. 2012;7(7):e40857.
- 757 18. Ram RC, Pandey VN, Singh HB. Morphological characterization of edible fleshy fungi from
- 758 different forest regions. Indian J. Sci. Res. 2010;1(2):33-35.
- 759 19. Dwivedi S, Tiwari MK, Chauhan UK, Pandey AK. Biodiversity of mushrooms of Amarkantak
- 760 Biosphere Reserve forest of Central India. International Journal of Pharmacy & Life Sciences.
- 761 2012;3(1):1363-1367.
- 762 20. Thiribhuvanamala G, Prakasam V, Chandrasekar G, Sakthivel K, Veeralakshmi S, Velazhahan
- 763 R, Kalaiselvi G. Biodiversity, Conservation and Utilization of Mushroom Flora from the Western
- 764 Ghats Region of India. Proceedings of the 7th International Conference on Mushroom Biology
- 765 and Mushroom Products (ICMBMP7), Tamil Nadu, India. pp.155-164; 2011.
- 766 21. Cooper RM, Flood J, Rees RW. *Ganoderma boninense* in Oil Palm Plantations: Current
- 767 Thinking on Epidemiology, Resistance and Pathology. The Planter. 2011;87(1024):515-526.
- 768 22. Pushpa H, Purushothama KB. Biodiversity of Mushrooms in and Around Bangalore
- 769 (Karnataka), India. American-Eurasian J. Agric. & Environ. Sci. 2012;12(6):750-759.
- 770 23. Bankole PO, Adekunle AA. Studies on biodiversity of some mushrooms collected in Lagos
- 771 State, Nigeria using biotechnological methods. Journal of Yeast and Fungal Research.
- 772 2012;3(4):37-48.
- 773 24. Hushiarian R, Yusof NA, Dutse SW. Detection and control of *Ganoderma boninense*: strategies
- 774 and perspectives. SpringerPlus; 2013.

- 775 25. Vyas D, Chaubey A, Dehariya P. Biodiversity of mushrooms in Patharia forest of Sagar (M.P.)-
776 III. International Journal of Biodiversity and conservation. 2014;6(8):600-607.
- 777 26. Mohanty PS, Harsh NSK, Pandey A. First report of *Ganoderma resinaceum* and *G.*
778 *weberianum* from north India based on ITS sequence analysis and
779 micromorphology. Mycosphere. 2011;2(4):469-474.
- 780 27. Smith AH, Evenson VS, Smith DHM. The veiled species of *Hebeloma* in the western United
781 States, University of Michigan Press; 1904.
- 782 28. Geml J, Timling I, Robinson CH, Lennon N, Nusbaum HC, Brochmann C, Noordeloos ME,
783 Taylor DL. An arctic community of symbiotic fungi assembled by long-distance dispersers:
784 phylogenetic diversity of ectomycorrhizal basidiomycetes in Svalbard based on soil and
785 sporocarp DNA. Journal of Biogeography (J. Biogeogr.). Blackwell Publishing Ltd; 2011.
- 786 29. Romano GM, Calcagno JA, Lechner BE. Biodiversity of *Agaricomycetes basidiomes* associated
787 to *Salix* and *Populus* (Salicaceae) plantations. DARWINIANA. nueva serie. 2013;1(1):67-75.
- 788 30. Fries EM, Nordisk F. (In Swedish) 8 (2 ed.). pp. 1393-1397, (Retrieved 3 September 2010); 1908.
- 789 31. Dahlman M, Danell E, Spatafora JW. Molecular systematics of *Craterellus*: cladistic analysis of
790 nuclear LSU rDNA sequence data. Mycological Research. 2000;104(4):388-394.
- 791 32. Chater AO, Brummitt RK. Subspecies in the works of Christiaan Hendrik Persoon. Taxon.
792 1966;15(4):143-148.
- 793 33. Tagade WY, Kawale MV. Diversity of Wild Macrofungi in forests of Bhandara District, (MS),
794 India. Int. J. of Life Sciences. Special Issue A2, pp. 125-127; 2014.
- 795 34. Sysouphanthong P, Hyde KD, Chukeatirote E, Vellinga EC. A review of genus *Lepiota* and its
796 distribution in Asia. Current Research in Environmental & Applied Mycology. 2011;1(2):161-176.
- 797 35. Tadiosa ER. Preliminary Study on the Macrofungi of Bazal-Baobo Watershed, Aurora Province,
798 Central Luzon, Philippines. Asian Journal of Biodiversity. 2011;2:149-171.
- 799 36. Thaug MM. A preliminary survey of macromycetes in Burma. Australasian Mycologist.
800 2007;26(1):16-36.
- 801 37. Kirk PM, Cannon PF, Minter DW, Stalpers JA. Dictionary of the Fungi (10th ed.). Wallingford,
802 UK: CABI, pp. 394-401; 2008.
- 803 38. Mohanan C. Macrofungi of Kerala, Kerala, India: Kerala Forest Research Institute.
804 pp. 597; 2011.
- 805 39. Bunyard AB. A Survey of Fungal Diversity in Northeast Ohio. The Ohio Journal of Science.
806 2003;103(2):29-32.
- 807 40. Matheny PB, Curtis JM, Hofstetter V, Aime MC, Moncalvo J, Ge ZW, Yang ZL, Slot JC,
808 Ammirati JF, Baroni TJ, Bougher NL, Hughes KW, Lodge DJ, Kerrigan RW, Seidl MT, Aanen
809 DK, DeNitis M, Daniele GM, Desjardin DE, Norvell LL, Kropp BR, Parker A, Vellinga EC,
810 Vilgalys R, Hibbett DS. Major clades of Agaricales: a multilocus phylogenetic overview.
811 Mycologia. 2006;98(6):982-995.
- 812 41. Senthilarasu G, Sharma R, Singh SK. A new species of *Volvariella* from India. Mycotaxon.
813 2012;119:467-476.

- 814 42. Heim R. Nouvelles études descriptives sur les agarics termitophiles d'Afrique tropicale. Archives
815 du Muséum National d'Histoire Naturelle. 1942;18(6):107-166.
- 816 43. Srivastava B, Dwivedi AK, Pandey VN. Morphological characterization and yield potential of
817 *Termitomyces* spp. mushroom in Gorakhpur forest Division. Bulletin of Environment,
818 Pharmacology & Life Sciences. 2011;1(1):54-56.
- 819 44. Pala SA, Wani AH, Mir RA. Diversity of macrofungal genus *Russula* and *Amanita* in Hirpora
820 Wildlife Sanctuary, Southern Kashmir Himalayas. BIODIVERSITAS. 2012;13(2):65-71.
- 821 45. Hawkeswood TJ. A record of *Amanita muscaria* (L.) Lam. (Basidiomycetes: Amanitaceae) from
822 Wentworth Falls, New South Wales, Australia with a review of some literature on the ecology of
823 the species within Australia. Calodema. 2006;7:29-31.
- 824 46. Michelot D, Melendez-howell LM. *Amanita Muscaris*: chemistry, biology, toxicology and
825 ethnomycology. Mycol. Res. 2003;107(2):131-146.
- 826 47. Antonín V, Buyck B. *Marasmius* (Basidiomycota, Marasmiaceae) in Madagascar and the
827 Mascarenes. Fungal Diversity. 2006;23:17-50.
- 828 48. Farook VA, Khan SS, Manimohan P. A checklist of agarics (gilled mushrooms) of Kerala State,
829 India. Mycosphere. 2011;4(1):97-131.
- 830 49. Horton B. Mushrooms of Maatsuyker Island. The Tasmanian Naturalist. 2006;128:11-22.
- 831 50. Desjardin DE, Perry BA, Lodge DJ, Stevani CV, Nagasawa E. *Luminescent Mycena*: new and
832 noteworthy species. Mycologia. 2010;102(2):459-477.
- 833 51. Knudsen H, Vesterhout J. Funga Nordica. Copenhagen, Denmark: Nordsvamp. pp.403; 2008.