Journal of Advances in Biology & Biotechnology
11(4): 1-18, 2017; Article no.JABB.30970
ISSN: 2394-1081

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Morphological Characterization of Macro Fungi Associated with Forest Tree of National Botanical Garden, Dhaka

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Authors' contributions

This work was carried out in collaboration between all authors. Author HR wrote the protocol, carried out research and wrote the first draft of the manuscript. Author KD carried out microscopic work and spore morphology. Author FMA designed and supervised the research, identified the fungal genera and also edited the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JABB/2017/30970
Editor(s):
(1) Mohammad Arif, Department of Plant Pathology, Kansas State University, Manhattan, Kansas, USA.
Reviewers:
(1) Chitta Ranjan Deb, Nagaland University, Lumami, India.
(2) Rajesh Kumar, Rain Forest Research Institute, Assam, India.
Complete Peer review History: http://www.sciencedomain.org/review-history/17933

Original Research Article

Received 12th December 2016
Accepted 6th February 2017
Published 23rd February 2017

ABSTRACT

This investigation was conducted in National Botanical Garden, Dhaka located at 24°00′ N (Latitude), 90°00′ E (Longitude) to document the morphology, diversity and distribution of macro fungi during the rainy seasons of July to October, 2015. A total of 23 macro fungi samples were collected and identified to 20 species under 10 genera and 10 families. The predominant genera were *Ganoderma* sp*., Lepiota* sp., *Daedeleopsis* sp., *Russula* sp., *Psythyrella* sp., *Lycoperdon* sp., *Crepidotus* sp., *Psilocybe* sp, *Flammulina* sp. and *Cantharellus* sp. The survey revealed that six species are edible, thirteen species are inedible but among them nine species have medicinal value and only one species of unknown uses. The maximum density of occurrence was exhibited by *Psilocybe cubensis* (45%) followed by *Lepiota* sp. (40%), *Ganoderma pfeifferi* (35%) and *Ganoderma lucidum* (25%). The specimens were deposited to Sher-e-Bangla Agricultural University Herbarium of Macrofungi (SHMF). The present investigation emphasized the existence of a distinct biodiversity in macrofungi population at National Botanical Garden, Dhaka.

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Keywords: National Botanical Garden; diversity; macrofungi; distribution and macro fungi.

1. INTRODUCTION

Macro fungi are macromycetes forming macroscopic fruiting bodies such as agarics, boletus, jelly fungi, coral fungi, stinkhorns, bracket fungi, puffballs and bird's nest fungi. There are 14,000 mushroom species has been reported, which is about 10% of the total estimated mushroom species on the earth. Mushrooms are seasonal fungi, which occupy diverse niches in nature in the forest ecosystem. Mushrooms are mainly in the rainy season. About 80% of Bangladesh's rain falls during the monsoon season. There are 800 species of mushrooms with the potential of medicinal properties [1]. The Romance and Greeks treated mushrooms as a special kind of food [2] and there is historical evidence of mushroom consumption in ancient India [3]. Most of the *Ganoderma* sp. has medicinal properties. In China, for over 2,000 years, the mushroom known as Reishi (*Ganoderma lucidum*) has been called "God's Herb". Also recognized by its Chinese name, Ling Zhi, Reishi's reputation for being effective in treating a wide range of ailments moved.

A survey was conducted giving emphasis on the importance and diversity of macro fungi at the south western region of Bangladesh [4]. About 67% of Bangladesh's nonurban land is arable. Permanent crops cover only 2%, meadows and pastures cover 4%, and forests and woodland cover about 16%. The National Botanical Garden of Bangladesh is making up the largest plant conservation center in Bangladesh, with an area of around 84 hectares (210 acres). It is located at Mirpur in Dhaka, beside the Dhaka Zoo. It was established in 1961. National Botanical garden is a charming and comfortable garden. It is managed by Bangladesh Forest Department under Ministry of Environment and Forest Government of the people republic of Bangladesh. There are approximately 50,000 plants and trees of 1200 species are found in botanical garden. Among them Bohera (*Terminalia bellirica),* Mango (*Mangifera indica*), Jackfruit *(Artocarpus heterophyllus*), Bel tree (*Aegle marmelos),* Raj koroi (*Albizia lebbeck*), Neem (*Azadhiracta indica*) and Golden shower *(Acacia auriculiformis)* etc are major. The main objective of the present survey study was to collect, morphologically characterize and preserve macro fungal species associated with forest tree of National Botanical Garden, Dhaka, Bangladesh.

2. MATERIALS AND METHODS

In the present study morphological characterization of mushrooms at National Botanical Garden, Dhaka was investigated.

2.1 Survey Area

The survey was conducted in National Botanical Garden, Dhaka which is situated in tropical moist deciduous forest region of Bangladesh. According to the National Mapping Organization of Bangladesh, Dhaka is located at 23º42′37″ N (Latitude), 90°24′26″ E (Longitude) where National Botanical garden is located at 24°00′ N (Latitude), 90°00′ E (Longitude).

2.2 Collection Time

Periodical survey was made to the selected area for the collection of macro fungi during rainy season from July to October 2015.

2.3 Mushroom Collection

The fungal survey depends on timing and location of observation. Necessary materials and equipments such as isolation kit, slants, petridishes containing medium, isolation chamber, typed data sheet, digital camera for photography, digging equipment, heat convector card board, chemical reagents for biochemical analysis were arranged and collection of samples were usually made during day time and field characteristics of mushrooms were recorded in the data sheet. Soft mushrooms were collected carefully by using forceps/free hand while the mushrooms growing on wood were collected along with small part of wood. The photograph was taken in their natural habitat. Each sample was wrapped in the paper envelop along with field notes, date of collection, habitat, locality and specimen number on tag.

2.4 Mushroom Identification

The collected specimens were brought to the laboratory. The measurements of various parts of mushrooms were recorded and morphological features were observed. The taxonomy has been done on the basis of macro and microscopic characteristic according to the literatures

[5,6,7,8]. The morphological parameters used for the identification of mushroom specimens such as- cap color, cap surface, cap margin, cap diameter, stipe length, gill attachment, gill spacing and spore dimension. Microscopic features were carried out using standard microscopic methods [9]. The information of the various characters stated was used to identify each specimen by comparison with illustrations in colour field guides and also by the use of descriptions and keys [10,11,12,13].

The specimens were dried in hot air at 40°-50°C and stored in air tight containers with some silica gel for further microscopic studies. The spores of collected mushrooms were mounted on slide by using glycerine and cotton blue for their size measurement. The spore diameter and the photograph of spores were calculated using the Motic Microscope (Motic images plus 2.0) with the magnification of 40x. Collected mushroom species have been categorized as edible, inedible and medicinal uses based on available world literature.

2.5 Diversity Analysis

A predesigned collection and data analysis procedures were used to collect the information in level of knowledge on biodiversity of mushroom. The density of different species has been determined by the following formula [5]:

(%) Density = (Total number of individual of a particular species/ Total number of species) X 100

3. RESULTS

Through the investigation, 20 species, 10 genera and 10 families were identified [Table 1 and Fig. 1, Fig. 2, Fig. 3, Fig. 4 and Fig. 5]. The identified genera were *Ganoderma, Daedaleopsis, Russula*, *Psathyrella, Lycoperdon, Flammulina, Psilocybe, Cantharellus,* C*repidotus* and *Lepiota.* The details about the identified macro fungi through this investigation on that particular time in the National Botanical Garden, Dhaka Bangladesh were described below:

3.1 *Ganoderma* sp.

3.1.1 *Ganoderma lucidum*

Common name: Lingzhi or Reishi mushroom
Family: Ganodermataceae

Macroscopic character:

Pileus shape: Kidney to funnel shaped; Color: Brick red
Length: 15.3-22.1 cm; Width: 10.5 -17.6 cm
Surface character and zonation: Redish yellowish and dry in nature
Margin: Incurved in shape; Texture of the fruiting body: Woody to corky
Spore bearing surface under cap: Pores on hymenium
Pores color: Yellowish to white in color, Pore spacing: Crowded
Stipe: Present; Size: 3.5 cm-4.5 cm. Shape: Equel; Color: Brick red

Spore morphology:

Spore size: Length: 5.9 µm; Width: 4.5 µm
Spore shape: Thick walled, smooth and ellipsoid; Color: Brownish

Ecological features:

Habitat: On root of the tree, in an association with Koroi (*Albizia procera*) and Golden shower *(Acacia auriculiformis).* Habit: Scattered and constancy of occurrence in specific habitat was abundant. Forest type mixed. Type of soil was loamy; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 25%.
Edibility: Inedible but use for medicinal purpose.

3.1.2 *Ganoderma tropicum*

Family: Ganodermataceae

Macroscopic character:

Pileus shape: Flat; Color: Dark red with white border
Length: 7.5 cm to 8.7 cm; Width: 6.1 cm to 6.5 cm
Surface character and zonation: Brittle, rugose, reddish brown and dry in nature
Margin: Incurved in shape, thick and coffee color
Texture of the fruiting body: Corky to woody
Spore bearing surface under cap: Pores on hymenium
Pores color: Whitish; Pore spacing: Crowded
Stipe: Absent or short

Spore morphology:

Spore size: Length: 9.0 µm, Width: 7.6 µm
Spore shape: Thick walled, smooth and ellipsoid;
Color: Brown

Ecological features:

Habitat: On dead plant wood, Aurjun (*Terminalia arjuna*). Habit: Scattered and constancy of occurrence in specific habitat was abundant. Type of soil was loam; factor affecting their distribution was moderately moist weather.
Biodiversity**:** The density of its presence was 10 %.
Edibility: Inedible but it has medicinal properties.

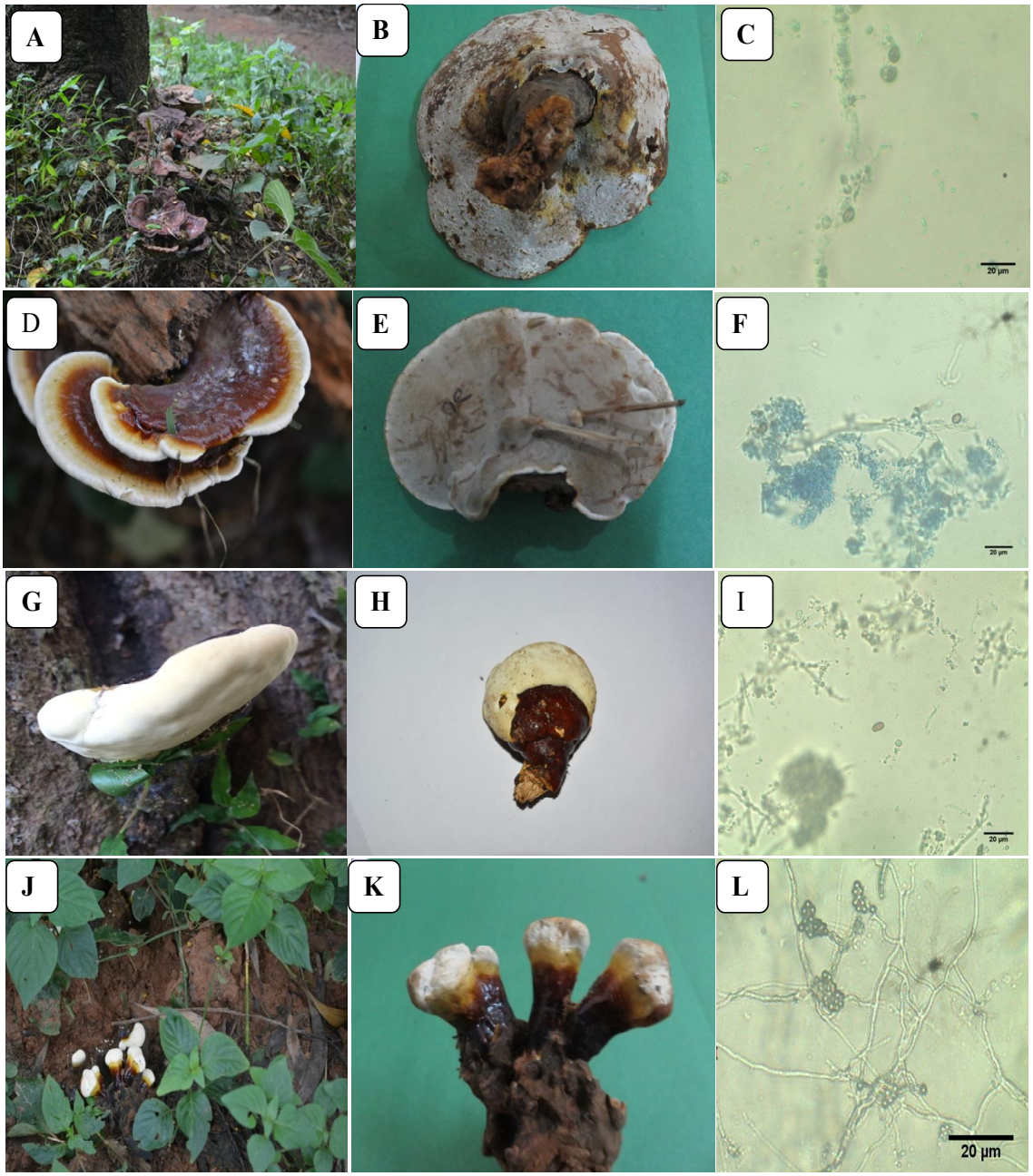

Fig. 1. Fruiting body of *Ganoderma lucidum* (A), Pores (B) Spore (C); *Ganoderma tropicum* (D), Pores (E), Spore (F), *Ganoderma boninense* (G), Gils (H, Spore (I), *Ganoderma* sp. (J), Pores (K), Spore (L)

Table 1. List of macro fungi recorded in Dhaka Botanical Garden with utilization

Fungi	Family	Utilization	(%) Density
Ganoderma lucidum	Ganodermataceae	Inedible, medicinal	25
Ganoderma tropicum	Ganodermataceae	Inedible, medicinal	10
Ganoderma boninense	Ganodermataceae	Inedible, medicinal	5
Ganoderma sp.	Ganodermataceae	Inedible, medicinal	10
Ganoderma tsugae	Ganodermataceae	Inedible, medicinal	11
Ganoderma lipsiense	Ganodermataceae	Inedible, medicinal	5
Ganoderma applanatum	Ganodermataceae	Inedible, medicinal	10
Ganoderma lobatum	Ganodermataceae	Inedible, medicinal	20
Ganoderma pfeifferi	Ganodermataceae	Inedible, medicinal	35
Daedaleopsis confragosa	Polyporaceae	Inedible	5
Russula nobilis	Russulaceae	Inedible	5
Psathyrella candolleana	Psathyrellaceae	Edible	5
Lycoperdon pyriforme	Lycoperdaceae	Edible	5
Flammulina velutipes	Pleurotaceae	Edible	5
Psilocybe cubensis	Strophariaceae	Edible	45
Cantharellus cinereus	Cantharellaceae	Edible	5
Crepidotus variabilis	Crepidotaceae	Inedible	15
Lepiota cristata	Agaricaceae	Inedible	10
Lepiota procera	Agaricaceae	Edible	10
Lepiota sp.	Agaricaceae	Unknown	40

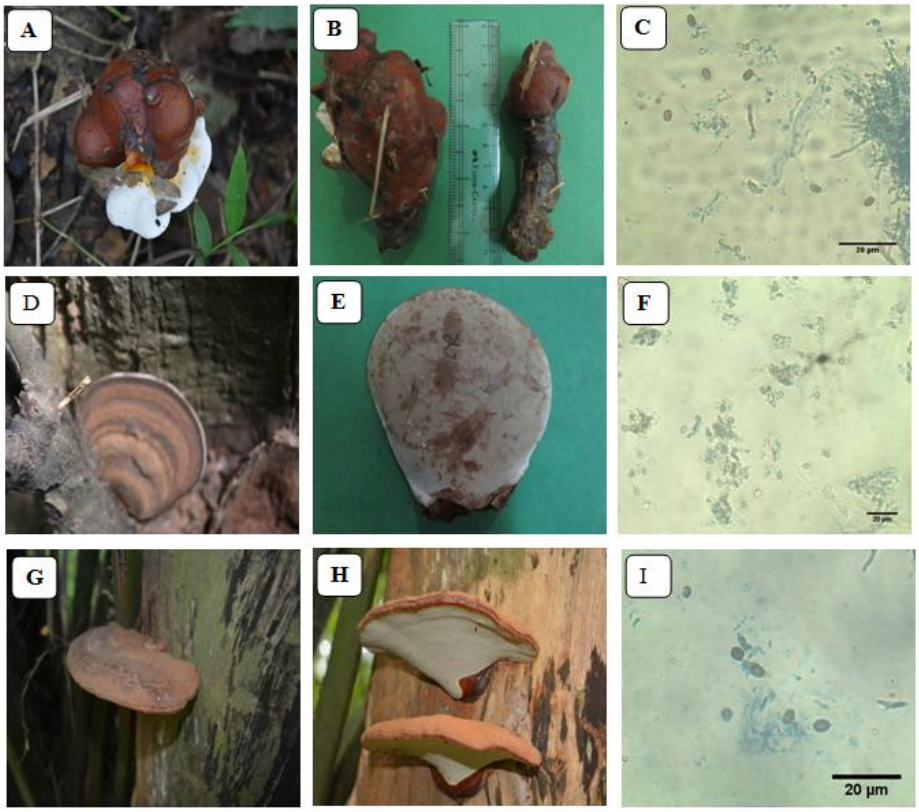

Fig. 2. Fruiting body of *Ganoderma tsugae* (A), Pores (B), Spore(C); *Ganoderma lipsiense* (D), Pores(E), Spore(F); *Ganoderma applanatum* (G), Gills(H), Spore(I); *Ganoderma lobatum*(J), Pores(K), Spore(L)

3.1.3. *Ganoderma boninense*

Common name: Lingzhi or Reishi mushroom
Family: Ganodermataceae

Macroscopic character:

Pileus shape: Concave; Color: White color cap
Length: 4.1 cm; Width: 2.9 cm
Surface character and zonation: Dry in nature
Margin: Incurved in shape
Texture of the fruiting body: Brittle and woody
Spore bearing surface under cap: Pores on hymenium
Stipe: Present; Size: 3.2 cm. Shape: Equal; Position: Central; Color: Chocolaty, Firmness: Solid

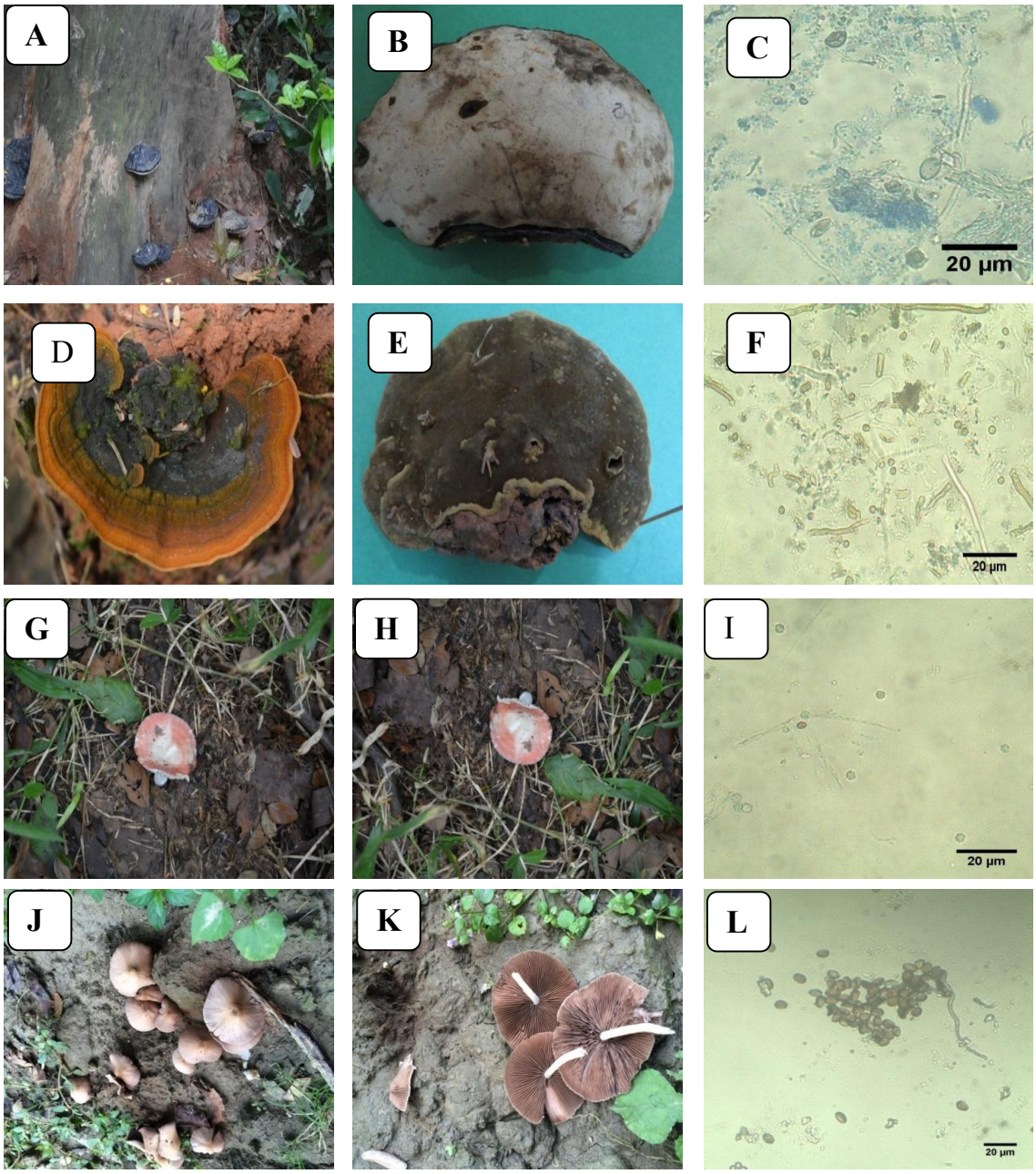

Fig. 3. Fruiting body of *Ganoderma pfeifferi* (A), Pores (B), Spore(C); *Daedaleopsis confragosa* (D), Pores(E), Spore(F); *Russula nobilis* (G), Gills(H), Spore(I); *Psathyrella candolleana*(J), Pores(K), Spore(L)

Fig. 4. Fruiting body of *Lycoperdon pyriforme* (A), Pores (B), Spore(C); *Flammulina velutipes* (D), Pores(E), Spore(F); *Psilocybe cubensis* (G), Gills(H), Spore(I); *Cantharellus cinereus* (J), Pores(K), Spore(L)

Spore morphology:

Spore size: Length: 8.9 µm; Width: 5.0 µm
Spore shape: Thin walled, smooth and elongated; Color: Brown

Ecological features:

Habitat: On Bark wood of the Mango (Mangifera indica) tree. Habit: Scatter and constancy of occurrence in specific habitat was unabundant.

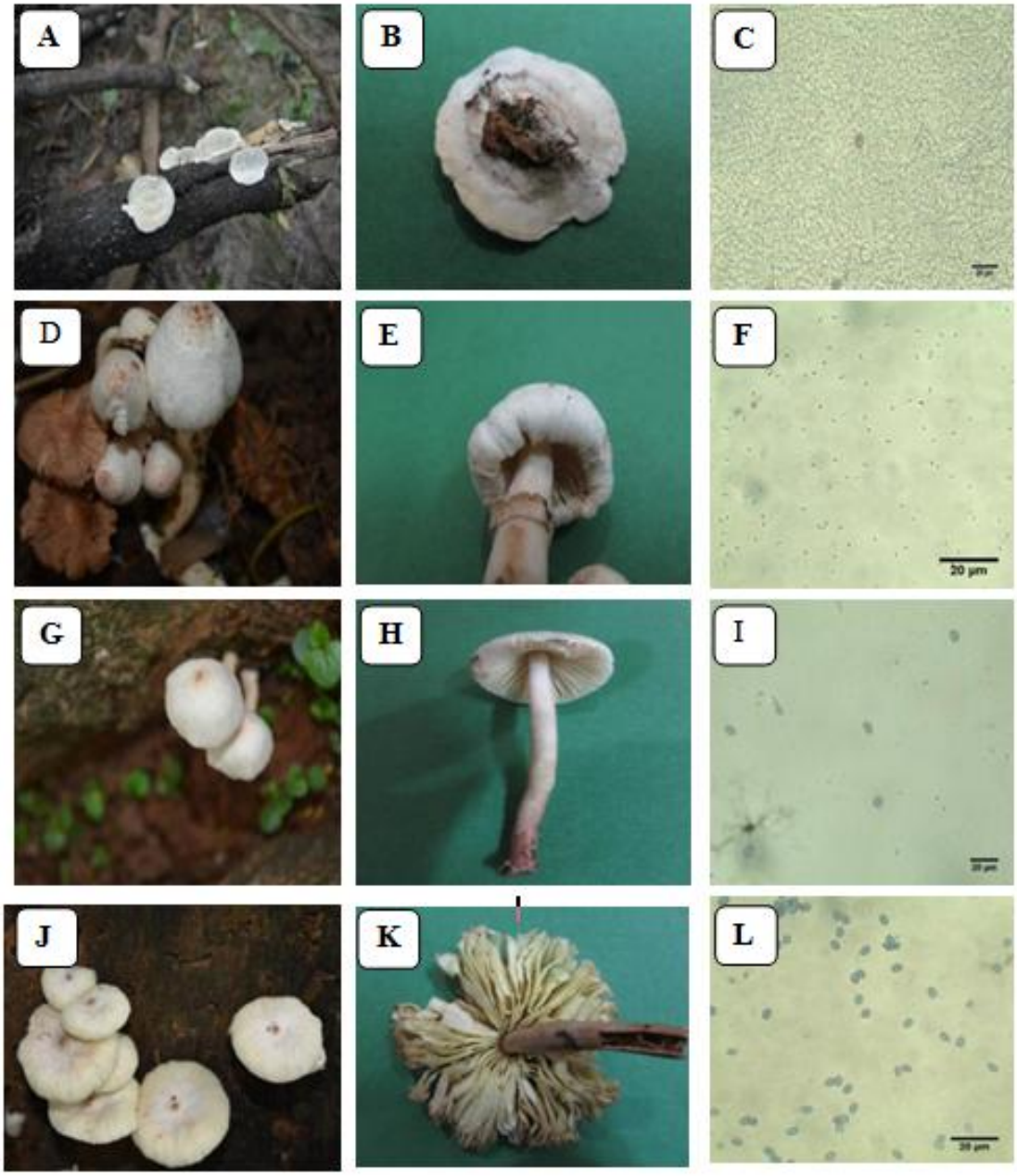

Fig. 5. Fruiting body of C*repidotus variabilis* (A), Pores (B), Spore(C); *Lepiota cristata* (D), Pores(E), Spore(F); *Lepiota procera* (G), Gills(H), Spore(I); *Lepiota* sp.(J), Pores(K), Spore(L)

Type of soil was loamy; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 5%.
Edibility: Inedible but it has medicinal properties.

3.1.4 *Ganoderma* sp.

Family: Ganodermataceae

Macroscopic character:

Pileus shape: Figure like; Color: Upper portion white and lower portion brick red
Length: 3.8 cm to 4.1 cm; Width: 2.1 cm to 2.4 cm
Surface character and zonation: Dry in nature
Margin: Incurved in shape

Texture of the fruiting body: Brittle and woody
Spore bearing surface under cap: Pores on hymenium; Pores color: White

Spore morphology:

Spore size: Length: 7.4 µm; Width: 3.1 µm
Spore shape: Thin walled, smooth and round; Color: Hyaline

Ecological features:

Habitat: On root of the dead plant, Bohera (*Terminalia bellirica);* Habit: Solitary and constancy of occurrence in specific habitat was abundant. Type of soil was loamy. Factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 10%.
Edibility: Although inedible but it has medicinal properties.

3.1.5 *Ganoderma tsugae*

Common name: Hemlock varnish self, Lingzhi or Reishi mushroom
Family: Ganodermataceae

Macroscopic character:

Color: Young: Brick red, Mature: Brick red in center with white cap; Pileus shape: Conical; Length: 3.8 cm; Width: 2.1 cm
Stipe: Present; Size: 8.1 cm. Shape: Position: Lateral; Color: Chocolaty, Firmness: Solid
Surface character and zonation: Dry in nature
Margin: Irregular in shape
Texture of the fruiting body: Brittle and woody
Spore bearing surface under cap: Pores on hymenium

Spore morphology:
Spore size: Length: 5.3 µm; Width: 3.7 µm
Spore shape: Thin walled, smooth and elongated; Color: Brown

Ecological features:

Habitat: On root of the tree Bohera (*Terminalia bellirica*). Habit: Scatter and constancy of occurrence of a particular mushroom in specific habitat was unabundant. Type of soil was loamy; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 10%.
Edibility: Inedible but it has medicinal properties.

3.1.6 *Ganoderma lipsiense*

Common name: Lingzhi and Reishi mushroom
Family: Ganodermataceae

Macroscopic character:

Pileus shape: Convex; Color: Dark brown to coccoa coloured
Length: 8 cm; Width: 6.5 cm
Surface character and zonation: Dry in nature, slightly zonate, solitary, crust and rigid.
Margin: Incurved in shape. Margin thick, coffee colour
Texture of the fruiting body: Corky and tough
Spore bearing surface under cap: Pores on hymenium
Pores color: Milky coffee; Pore spacing: Crowded

Spore morphology:

Spore size: Length: 5.9 µm; Width: 3.5 µm
Spore shape: Thin walled, smooth and ellipsoid; Color: Pale brown

Ecological features:

Habitat: On bark of the tree in an association with Neem (*Azadhiracta indica*) plant. Habit: Scatatered and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 5%.
Edibility: Medicinal purpose.

3.1.7 *Ganoderma applanatum*

Common name: Basil decay, Lingzhi or Reishi mushroom
Family: Ganodermataceae

Macroscopic character:

Pileus shape: Convex; Color: Shiny reddish to brownish-orange
Length: 12.5 cm; Width: 9.8 cm
Surface character and zonation: Dry in nature, surface become dull when coated by deposit spores
Margin: Incurved in shape; Texture of the fruiting body: Corky
Spore bearing surface under cap: Pores on hymenium

Pores color: Whitish, becoming brown in age or when bruised
Pore spacing: Moderately crowded

Microscopic character:

Spore size: Length: 6.2µm; Width: 4.8 µm
Spore shape: Thick walled, rough and ellipsoid; Color: Brownish

Ecological features:

Habitat: On bark wood of the tree, in an association with the Golden shower *(Acacia auriculiformis).* Habit: Solitary and constancy of occurrence in specific habitat was abundant. Type of soil was loam; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 10%.
Edibility: Although inedible but it has medicinal properties.

3.1.8. *Ganoderma lobatum*

Family: Ganodermataceae

Macroscopic character:

Pileus shape: Convex to irregular in shape, Color: Mature reddish brown
Length: 8.3 cm to 13.6 cm, Width: 5.8 cm to 9.8 cm
Surface character and zonation: Dry in nature laccate, highly sulcate, brown of chestnut
Margin: Incurved in shape, hard, acute
Texture of the fruiting body: Woody and corky
Spore bearing surface under cap: Pores on hymenium
Pores color: Pore surface creamy white at first later ochraceous to pale brown coffee colour;
Pore spacing: Moderately crowded
Stipe: Absent

Spore morphology:

Spore size: Length: 10.4 µm; Width: 7.3 µm
Spore shape: Moderately thick walled, smooth and ellipsoid, Color: Brown

Ecological features:

Habitat: On the root of the Neem (*Azadhiracta indica*) plant. Habit: Scattered and constancy of occurrence in specific habitat was unabundant. Type of soil was loamy; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 20%.
Edibility: Use for medicinal purpose.

3.1.9 *Ganoderma pfeifferi*

Common name: Lingzhi or Reishi mushroom.
Family: Ganodermataceae.

Macroscopic character:

Pileus shape: Convex, Color: Black
Length: 14.2 cm to 15.1 cm, Width: 12.8 cm to 13.2 cm
Surface character and zonation: Dry in nature and blackish
Margin: Incurved in shape
Texture of the fruiting body: Woody and corky
Spore bearing surface under cap: Pores on hymenium
Pores color: Milky white in color

Spore morphology:

Spore size: Length: 4 µm; Width: 4 µm
Spore shape: Thick walled, smooth and ovoid; Color: Brownish

Ecological features:

Habitat: On the wood of the Golden shower (*Acacia auriculiformis*); Habit: Scattered and constancy of occurrence in specific habitat was abundant. Type of soil was loam; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 35%.
Edibility: Medicinal purpose.

3.2 *Daedaleopsis* sp.

3.2.1 *Daedaleopsis confragosa*

Common name: Blushing bracket
Family: Polyporaceae

Macroscopic character:

Pileus shape: Concave; Color: Yellow with deep brown
Length: 11 cm; Width: 8.6 cm
Surface character and zonation: Leathery and dry in nature
Margin: Incurved in shape and grayish color
Texture of the fruiting body: Brittle, tough and woody.

Spore bearing surface under cap: Pores on hymenium
Pores color: Blackish

Spore morphology:

Spore size: Length: 3.7 µm; Width: 3.3 µm
Spore shape: Thin walled, smooth and round; Color: Yellow color

Ecological features:

Habitat: On wood of Golden shower (*Acacia auriculi formis).* Habit: Scattered and constancy of occurrence of a particular mushroom in specific habitat was unabundant. Type of soil was sandy; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 5%.
Edibility**:** Inedible.

3.3 *Russula* sp.

3.3.1 *Russula nobilis*

Common name: Big beech wood sickener
Family: Russulaceae

Macroscopic character:

Pileus shape: Funnel shape; Color: Pink to red
Length: 4.5 cm; Width: 3.5 cm
Surface character and zonation: Dry and rough in nature; Margin: Incurved in shape
Texture of the fruiting body: Soft and spongy
Spore bearing surface under cap: Gills; Gill color: White
Stipe: Present; Length: 3.1 cm. Shape: Rediating; Position: Central; Surface characteristics: Dry and polished; color: White to creamy, Firmness: Tubular and fleshy.

Spore morphology:

Spore size: Length: 4.0 µm; Width: 3.4 µm
Spore shape: Thick walled, rough and round; Color: Hyaline.

Ecological features:

Habitat: On humus, in an association with Kalmegh (*Andrographis paniculata*); Habit: Scattered and constancy of occurrence was unabundant. Type of soil was loam; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 5%.
Edibility: Inedible.

3.4 *Psathyrella* sp.

3.4.1 *Psathyrella candolleana*

Common name: Pale Brittle stem, Common Psathyrella, Suburban Psathyrella.
Family: Psathyrellaceae

Macroscopic character:

Pileus shape: Convex; Color: Brownish; Length: 3 cm; Width: 2.1 cm
Surface character and zonation: Dry and smooth in nature; Margin: Irregular in shape
Texture of the fruiting body: Soft and spongy
Spore bearing surface under cap: Gill
Gill attachment: Adnex; Gill spacing: Crowed
Gill color: Brown; Gill shape and width: Moderately broad
Stipe: Present; Size: 4.1 cm. Shape: Equal; Position: Central; Surface characteristics: Dry and glabrous; Color: White, Firmness: Narrrow

Spore morphology:

Spore size: Length: 5.2 µm; Width: 3.2 µm
Spore shape: Thin walled, smooth, elongated; Color: Brown

Ecological features:

Habitat: On humus, in association with White rangun (*Ixora superba*); Habit: Scattered and constancy was unabundant. Type of soil was loam; factor affecting their distribution was moderately moist weather
Biodiversity: The density of its presence was 5%.
Edibility: Edible but not recommended due to uncertainties in identification.

3.5 *Lycoperdon* sp.

3.5.1 *Lycoperdon pyriforme*

Common name: Stump puffball or pear shape puffball
Family: Lycoperdaceae

Macroscopic character:

Pileus shape: Pear-Shaped; Color: Mature: Whitish first later becoming pale brown; Length: 7.1 cm; Width: 6 cm.

Surface character and zonation: Its surface is scurfy at first comprising tiny warts and granules which are soon lost, leaving a smooth inner wall. The inner wall is thin papery with opening by a small irregular pore at the top; Margin: Plane; Texture of the fruiting body: Soft and spongy; Spore bearing surface under cap: Pores
Stipe: Present; Size: 4.1 cm. Shape: Equal and swollen, Position: Central; Color: White to creamy. Firmness: Solid and fleshy

Spore morphology:

Spore size: Length: 8.8 µm; Width: 5.4 µm
Spore shape: Thick walled, ovate and smooth; Color: Brown

Ecological features:

Habitat: On Humus, in an association with Neem tree (*Azadhirachta indica*). Habit: Scattered and constancy of occurrence in specific habitat was unabundant. Forest type mixed. Type of soil was loam; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 5%.
Edibility: Edible.

3.6 *Flammulina* sp.

3.6.1 *Flammulina velutipes*

Common name: Enoki, enokitake, golden needle or velvet foot
Family: Pleurotaceae

Macroscopic character:

Pileus shape: Convex; Color: White
Length: .4 cm-.43 cm; Width: .3 cm-.36 cm
Surface character and zonation: Dry and smooth in nature
Margin: Regular in shape
Texture of the fruiting body: Soft and spongy
Spore bearing surface under cap: Gills; Gill attachment: Free
Gill color: White; Gill shape and width: Narrow; Gill spacing: crowed
Surface character and zonation: Dry and smooth in nature
Stipe: Present; Size: 2.1 cm. Shape: Equal, Position: Central; Surface characteristics: Dry and glabrous; Color: White to light brown, Firmness: Narrow, Annulus present.

Spore morphology:

Spore size: Length: 4.3 µm; Width: 3.3 µm
Spore shape: Thick walled, smoth and elongated; Color: Hyaline

Ecological features:

Habitat: On humas, in an association with the Golden shower (*Acacia auriculiformis*). Habit: Caespitose and constancy of occurrence in specific habitat was abundant. Type of soil was loam; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 5%.
Edibility: Edible.

3.7 *Psilocybe* sp.

3.7.1 *Psilocybe cubensis*

Common name: **S**rooms, magic mushrooms, golden tops or cubes
Family: Strophariaceae

Macroscopic character:

Pileus shape: Flat to convex; Color: Brownish
Length: 5.5 cm; Width: 4.1 cm
Surface character and zonation: Smooth in nature Margin: Regular in shape Texture of the fruiting body: Soft and spongy
Spore bearing surface under cap: Gills; Gill attachment: Emerginate, Gill color: Brown, Gill shape and width: Moderately broad
Stipe size: 5.1 cm; Shape: Clavate; Position: Central; Surface characteristics: Dry and polished; Color: Light brown; Firmness: Tubular

Spore morphology:

Spore size: Length: 9.7 µm; Width: 6.9 µm
Spore shape: Thick walled, smooth and ellipsoid; Color: Brown

Ecological features:

Habitat: On the dead plant wood of Rain tree (*Albizia lebbeck*); Habit: Solitary and constancy of occurrence in specific habitat was unabundant. Type of soil was loam; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 45%.
Edibility: Unknown.

3.8 *Cantharellus* sp.

3.8.1 *Cantharellus cinereus*

Common name: Chanterelle or girolle
Family: Cantharellaceae

Macroscopic character:

Pileus shape: Funnel; Color: Ash; Length: 2.7 cm; Width: 2.1 cm
Surface character and zonation: Dry and rough in nature, Margin: Regular in shape
Texture of the fruiting body: Spongy
Spore bearing surface under cap: Gills; Gill attachment: Emerginate in nature; Gill color: Brownish, Gill shape and width: Moderately broad; Gill spacing: Moderately crowed
Stipe: Present; Size: 3.5 cm. Shape: Equal, Position: Ecentric, Surface characteristics: Dry and polished; Color: Light brown, Firmness: Narrow and tubular

Spore morphology:

Spore Diameter: Length: 5.6 µm; Width: 3.7 µm
Spore shape: Thin walled, smooth and elongated, Color: Brown

Ecological features:

Habitat: On wood of the dead plant Jackfruit (*Artocarpus heterophyllus)*; Habit: Scatter and constancy of occurrence was unabundant. Type of soil was loam; factor affecting their distribution was moderately moist weather.
Biodiversity**:** The density of its presence was 5%.
Edibility: Edible.

3.9 C*repidotus* sp.

3.9.1 C*repidotus variabilis*

Common name: Variable Oysterling
Family: Crepidotaceae

Macroscopic character:

Pileus shape: Flat; Color: Mature: White to creamy
Length: 2.8 cm; Width: 2.1 cm
Surface character and zonation: Dry and scaly; Margin: Incurve in shape
Texture of the fruiting body: Soft and flesh Fiberous
Spore bearing surface under cap: Pores on hymenium
Pores color: White
Stipe: Absence

Spore morphology:

Spore size: Length: 9.9 µm; Width: 7.9 µm
Spore shape: Thin walled, smooth and ovoid; Color: Brown

Ecological features:

Habitat: On the branch of dead plant, in an *association* with the Raj koroi (*Albizia richardiana*), Habit: Solitary and constancy of occurrence in specific habitat was abundant. Type of soil was loam; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 15 %.
Edibility: Inedible.

3.10 *Lepiota* sp.

3.10.1 *Lepiota cristata*

Common name: Stinking dapperling or the stinking parasol
Family: Agaricaceae

Macroscopic character:

Pileus shape: Conical; Color: Mature: White with brown spot
Length: 2.5 cm; Width: 2.1 cm
Surface character and zonation: rough and dry; Margin: Regular in nature in shape
Texture of the fruiting body: Spongy
Spore bearing surface under cap: Gills
Gill attachment: Free in nature
Gill color: White; Gill shape and width: Moderately broad
Gill spacing: Crowded
Stipe: Present; Size: 5.2 cm. Shape: Equal or clavate, Position: Center; Surface characteristics: Dry and polished; Color: White, Firmness: Narrow and tubular. Scale: Brown; Annulus: Present

Spore morphology:

Spore size: Length: 3.8 µm; Width: 2.0 µm
Spore shape: Very small, thin walled, smooth and elongated; Color: Hyaline

Ecological features:

Habitat: On the wood of dead plant White chandan (*Santalum album*). Habit: Solitary and constancy of occurrence in specific habitat was abundant. Type of soil was loam; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 10%.
Edibility: Inedible.

3.10.2 *Lepiota procera*

Common name: Parasol mushroom
Family: Agaricaceae

Macroscopic character:

Pileus shape: Ovoid; Color: White with brown spot
Length: 2.5 cm; Width: 2.1 cm
Surface character and zonation: Smooth and dry Margin: Regular in shape; Texture of the fruiting body: Soft and spongy
Spore bearing surface under cap: Gills; Gill attachment: Adnexed in nature; Gill color: White; Gill shape and width: Moderately broad; Gill spacing: Crowded
Stipe: Present; Size: 5.1 cm. Shape: Clavate, Position: Center; Surface characteristics: Dry and polished; Color: Gray to light brownd, Firmness: Narrow and tubular. Scale: Brown

Spore morphology:

Spore size: Length: 10.1 µm; Width: 5.3 µm
Spore shape: Thin walled, smooth and ellipsoid; Color: Blue

Ecological features:

Habitat: On root of Jackfruit tree (*Artocarpus heterophyllus*), Habit: Scatter and constancy of occurrence in specific habitat was unabundant. Type of soil was loamy; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 10%.
Edibility: Edible but slightly toxic.

3.10.3 *Lepiota* sp.

Common name: Unknown
Family: Agaricaceae

Macroscopic character:

Pileus shape: Flat; Color: Mature: White to creamy
Length: 7.5 cm; Width: 5.6 cm
Surface character and zonation: Dry and smooth in nature; Margin: Regular in shape
Texture of the fruiting body: Soft and spongy
Spore bearing surface under cap: Gills
Gill attachment: Emerginate; Gill color: Cream, Gill shape and width: Moderately broad
Gill spacing: Crowed
Stipe: Present; Size: 5.1 cm. Shape: Equal, Position: Central; Surface characteristics: Moist and glabrous; Color: Brownish, Firmness: Tubular and solid.

Spore morphology:

Spore size: Length: 5.6 µm; Width: 4.1 µm
Spore shape: Thin walled, smooth and elongated; Color: Blue.

Ecological features:

Habitat: On wood of dead plant, in an association with the Jackfruit tree (*Artocarpus heterophyllus*); Habit: Solitary and constancy of occurrence was abundant. Type of soil was loam; factor affecting their distribution was moderately moist weather.
Biodiversity: The density of its presence was 40%
Edibility: Inedible

4. DISCUSSION

Survey was conducted during the period from July to October 2015 for morphological characterization of mushrooms, from national botanical garden, Dhaka. A total of 23 mushroom samples were collected and identified to 20 species which belong to 10 genera and 10 families.

Nine species of *Ganoderma* were recorded. Among nine species, *Ganoderma lucidum* were recorded in association with Koroi (*Albizia procera*) and Aurjun **(***Terminalia Arjuna*) with the density of 25%. Ryvarden studied the morphology of 53 specimens of *Ganoderma lucidum* from Norway and found large variation among the species [14]. The species was also reported from tropical moist deciduous forest of Bangladesh [15]. *Ganoderma boninense* was identified in association with Mango (*Mangifera indica*) tree with a density of 5%. The pathogenicity of *Ganoderma boninense* was examined [16]. *Ganoderma tsuage* was recorded in association with Bohera (*Terminalia bellirica*). The density its presence was 11% and also *Ganoderma* sp. was collected with the density of

10%. The morphology of *Ganoderma tsuage* was also reported in India [17]. *Ganoderma lipsiense* was identified in association with Neem (*Azadhiracta indica*). The density of its presence was 5%. *Ganoderma applanatum* were recorded in association with Golden shower (*Acacia auriculiformis*) and Neem (*Azadhiracta indica*) with the density of 10%. Moncalvo and Ryvarden published a world list of *Ganoderma* species [18]. The study considered the species described in last 200 years listing 386 names for Ganodermataceae as whole. Taxonomy and diversity of *Ganoderma lipsiense* and *Ganoderma applanatum* was also reported in India [19]. *Ganoderma pfeifferi* was recorded in association with the Golden shower (*Acacia auriculi formis*). The density of its presence was 35%. On the other hand, *Ganoderma* sp. was also reported in India [19,20,21].

One species of *Daedelphus* was recorded viz. *Daedaleopsis confragosa* in association with Golden shower (*Acacia auriculi formis*). The density of its presence was 5%. *Daedelphus* sp. was also reported in Pakistan [22]. This species was also indentified from tropical moist deciduous forest of Bangladesh [23].

One species of *Russula* was recorded as *Russula nobilis* in association with Kalmegh (*Andrographis paniculata*) with the density of 5%. The genus *Russula* sp. was also reported from India [24]. Seven species of *Russula* was recorded in Southern Kashmir Himalayas [25]. *Russula brevipes* Peck., is widely distributed throughout North America, and mainly associated with species of *Abies, Picea, Tsuga* and *Pseudosuga* [26,27]. *Russula brevipes* also forms ectomycorrhizal association with *Abies lacicarpa* [28]. Two ectomycorrhizal species of genus *Russula* have been characterized and identified from Kashmir Himalaya using morphanatomical and molecular methods targeting its r DNA [29].

One species of *Psathyrella* was recorded viz. *Psathyrella candolleana* in association with White rangun (*Ixora superba*). The density of its presence was 5%. Descriptions, figures of microscopic characters, data on ecology and distribution of four species of *Psathyrella* sp. was reported in Czech Republic and Slovakia [30]. A new species of *Psathyrella* (Psathyrellaceae, Agaricales) collected on dung from Punjab, India [31].

One species of *Lycoperdon* was identified viz. *Lycoperdon pyriforme* in association with Neem tree (*Azadhirachta indica).* The density of its presence was 5%. The Biodiversity of *Lycoperdon pyriforme* was reported in India [17]. A β-Glycosidase from *Lycoperdon pyriforme*, a wild edible mushroom, was characterized biochemically in Turkey [32]. *Lycoperdon pyriforme* was also collected from India [33,34].

One species of *Flammulina* was recorded viz. *Flammulina velutipes* in association with Golden shower (*Acacia auriculiformis*) and with the density of 5%. Hassan and also with their fellows reported that Enoke velvet stems; mushroom (*Flammulina velutipes*) is well known as a very popular, delicious, edible and medicinal mushroom in Asian countries specially China and Japan [35]. This study tended to optimize the submerged culture conditions for the production of mycelial biomass of *F. velutipes* (two strains). Morphological, phylogenetic and biogeographic studies were carried out on Chinese collections of *Flammulina* species. It was revealed that at least four species [*F. rossica, Flammulina* sp. *(HKAS 51191), F. velutipes* and *F. yunnanensis*] occur in China [36].

One species of *Psilocybe* was identified viz. *Psilocybe cubensis* in association with Rain tree (*Albizia lebbeck*) and density of 45%. *Psilocybe* sp. was introduced as a new bluing species from Ohio and Bethany, West Virginia [37]. *Psilocybe* sp. was also found in Germany [38].

One species of *Cantharellus* was recorded viz. *Craterellus cinereus* in association with Jackfruit (*Artocarpus heterophyllus*) and the density of 5%. *Cantharellus* was identified and neotypification of *Craterellus cinereus* by Contu and their fellows. Even they stated the description of *Cantharellus atrofuscus* [39]. A new species of *Craterellus* was reported in Pakaraima Mountains of Guyana, macromorphological, micromorphological and habitat data were provided for the new species [40].

One species of *Crepidotus* was recorded viz. C*repidotus variabilis* in association with Raj koroi (*Albizia richardiana*) and the density of 15%. *Crepidotus ehrendorferi* in Slovakia and taxonomic notes on related species [41]. The new species *Crepidotus pseudoantillarum* and *Crepidotus herrerae* were collected from Costa Rica and Mexico respectively [42].

Three species of *Lepiota* was found such as- *Lepiota cristata, Lepiota oreadiformis* and

another *Lepiota* species.These species was recorded in association with White chandan (*Santalum album*) and Jackfruit (*Artocarpus heterophyllus).* The density of *Lepiota cristata, Lepiota procera* and *Lepiota* sp. were 10,10 and 40%,accordingly. Whereas, around 400 *Lepiota s*pecies were already identified all over the world and most of them are poisonous. The species was first reported in India [20,15]. *Lepiota americana* was reported from southern region of Bangladesh in association with Betal nut (*Areca catechu*) [43].

5. CONCLUSION

For the study of bio-diversity, habitat and morphology of macro fungi a survey was conducted in National Botanical Garden, Dhaka. After morphological study in both field and laboratory and spore ornamentation under microscope 20 different species were found from 23 collected samples. *Psilocybe cubensis* is the most abundant species having the highest density of occurrence (45%) followed by *Ganoderma pfeifferi* (35%), *Ganoderma lucidum* (25%), *Ganoderma applanatum* (20%), *Crepidotus variabilis* (15%) and *Lepiota cristata* (10%).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
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