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RESEARCH ARTICLE

BIODIVERSITY, DISTRIBUTION AND MORPHOLOGICAL CHARACTERIZATION OF MACROFUNGI IN SYLHET AND MOULVIBAZAR UNDER TROPICAL EVERGREEN AND SEMI- EVERGREEN FOREST REGIONS OF BANGLADESH.

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Abstract

Tropical evergreen and semi-evergreen forest regions under Sylhet and Moulvibazar districts which is located at 24.8917°N and 91.8833°E, in the north eastern region of Bangladesh. A total of 53 macro fungal samples were collected and identified to 15 genera and 25 species. The predominant species were *Ganoderma tsugae*, *Ganoderma applanatum*, *Ganoderma bonninese*, *Agaricus bernardii*, *Coprinus disseminates*, *Daeleopsis confragosa*, *Schizophyllum commune*, *Pleurotus ostreatus*, *Pleurotus populinus*, *Mycena epiptergia*, *Steccherinum ochraceum* and *Steccherinum ciliolatum*. The maximum frequency (37.5%) was recorded for *Ganoderma tsugae* and *Pleurotus ostreatus*. The maximum density was 26.8% recorded for *Coprinus sp.* The predominant families were *Ganodermataceae*, *Agaricaceae*, *Polyporaceae*, *Schizophyllaceae*, *Pleurotaceae*, *Mycenaceae* and *Steccherinaceae*. The specimens were deposited to the Sher-E-Bangla Agricultural University Herbarium of Macro Fungi (SHMF). This is the first details investigation macrofungi recorded from Sylhet and Moulvibazar regions of Bangladesh.

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Introduction:-

Macrofungi is a fleshy spore bearing fruiting body of a fungus. Macrofungi have been the objects of much curiosity and speculation since time immemorial. They are one of the most important components of the forest ecosystem. (Metzler and Metzler, 1992) reported that most macrofungi producing fungi are members of the phylum Basidiomycota, also known as basidiomycetes that have a stem (stipe) and cap (pileus), and gills (lamellae, singular-lamella) or pores on the underside of the cap. Their edibility, poisonous nature, psychotropic properties, mycorrhizal and parasitic associations with the forest trees make them economically important and interesting to study. The northeast region of India abounds in forest wealth, including many species of trees and other woody plants. The biodiversity of woody flora is correlated with an equally diverse mycoflora. The high humidity during monsoon period provides ideal atmospheric conditions for the growth of many saprophytes, including the macrofungi. They have diverse shapes, sizes and colors and also have varied appearance, ranging from patches on wood to brackets, coral-like tufts simple clubs rosettes cauliflower like structure or centrally or laterally stalked fruit bodies. Macrofungi can be categorized as edible or non-edible. Right from the beginning man has learnt to differentiate the edible and non-edible mushroom through numerous observation, trials and errors. Through these experiences man has learned to use macrofungi as a part of their diet. Seasonal mushroom hunting and collection are

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the part of seasonal activity of the people. (Barros *et al.*, 2008) reported the wild macrofungi are richer sources of protein and have a lower amount of fat than commercial macrofungi. The proteins of wild edible mushroom contains considerable amounts of non-essential amino acids like alanine, arginine, glycine, glutamic acid, aspartic acid, proline and serine (Manzi and Pizzoferrato, 2000). The add-value arising from macrofungi are bioactive materials which lead to an increase in its consumption and therefore, stimulating the commercialization of edible species. Macrofungi also have been used extensively in traditional medicine for curing variety of diseases including viral infection, bacterial infection, cancer, tumor, inflammation, cardiovascular diseases (Benedict and Brady, 1972; Iwalokun *et al.*, 2007). Many researchers have been working on wild mushroom and reported more than 2000 species of edible mushroom all over the world (Adhikari, 2000; Purkayastha and Chandra, 1985) have reported 283 edible species from India, out of which some are cultivated. Production of mushroom all over the world exceeds three million tones. Most of the exporting countries are Netherlands, Poland, Ireland, Belgium, India and China. Among these countries China is the largest exporter of preserved macrofungi. In India most commonly cultivated mushroom species are Button (*Agaricus bisporus*), Oyster (*Pleurotus* spp.) and Paddy straw mushroom (*Volvariella volvacea*) as documented by (Harsh and Joshi, 2008). In India, mushroom is a unique non-traditional cash crop and as popular as food among the tribal people of north east India. Many rural communities of Nagaland are using macrofungi in the traditional dishes because of their delicious flavor. The favorable climatic condition of north-eastern states of India leads to rich mushroom diversity and form a valuable non-timber forest resource for local folk.

Macrofungi are sold in traditional markets or commercially exploited as food or medicines. Some of the edible species like *Termitomyces eurhizus*, *Lentinus conatus*, *Schizophyllum commune*, *Tricholoma giganteum* and *Pleurotus* are sold in the markets of Kohima district of Nagaland by the local people (Tanti *et al.*, 2011). In spite of rich diversity of macrofungi in Nagaland state very few studies have been reported on diversity and market survey from North-Eastern Hills of India (Verma *et al.*, 1995; Singh *et al.*, 2007 and Sarma *et al.*, 2010). Detailed study on biodiversity, distribution and morphological characterization of macrofungi in tropical moist deciduous forest, mangrove forest and social forest have been carried out (Rumainul *et al.*, 2015; Rumainul and Aminuzzaman, 2016; Das and Aminuzzaman, 2017; Das *et al.*, 2017; Aminuzzaman and Das, 2017). But no such kind of work had been carried out in tropical evergreen and semi-evergreen forest of Bangladesh. The present study was conducted to generate a database on morphology and ecology of important wild macrofungi species of Sylhet and Moulvibazar under tropical evergreen and semi-evergreen forest of Bangladesh with the following objectives.

1. To study the biodiversity, distribution and morphology of macrofungi in Sylhet and Moulvibazar tropical evergreen and semi-evergreen forest of Bangladesh.
2. To identify the macrofungi up to the genus and species level from Sylhet and Moulvibazar tropical evergreen and semi-evergreen forest of Bangladesh.

Materials And Methods:-

Experimental site

Experiment was conducted at the Laboratory, Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), Dhaka. The samples were collected from different location of Sylhet and Moulvibazar districts of Bangladesh.

Source of data and sampling procedure

A systematic sampling procedure was used baseline survey. Eight locations under tropical evergreen and semi-evergreen forest of Sylhet and Moulvibazar districts were selected for conducting survey analysis on mushroom biodiversity, distribution, habitat and morphology. A pre-designed collection procedure and data analysis procedure were used to collect information on level of knowledge on biodiversity, habitat and morphology of macrofungi.

Collection of macrofungi samples

Detailed survey was carried out in 8 locations such as- Sylhet (Jaintiapur, Gowainghat, Jaflong, Tilagor Eco Park) and Moulavibazar (Sreemangal, Madhabkundu, Lawachara, Barlekha) of Bangladesh from July to October, 2016, to record the morphological variability in the macrofungi population. The collection was made by method given by (Hailing, 1996). Spotted macrofungi were inspected in their natural habitats and brought to laboratory for detailed study. Photographs were taken by means of a Sony Camera with power of 16 megapixels. The collected macro fungi were studied for their macroscopic detail partnering the habit, habitat, morphology and other phenotypic parameter noted in fresh form. Standard methods of collection, preservation, macroscopic and microscopic preservations were

recorded. Collected specimens were preserved as dried specimens in the Plant Pathology Laboratory of Sher-e-Bangla Agricultural University.

Collection site

Collection site was two districts of Sylhet and Moulvibazar (Jaintiapur, Gowainghat, Jaflong, Tilagor Eco Park, Sreemangal, Madhabkundu, Lawachara, Barlekha) located is located at 24.8917°N and 91.8833°E, in the north eastern region of Bangladesh (Figure 1 and Table 1). Minimum and maximum temperature was 12.9°C and 31.6°C. The average annual relative humidity was 68-85%. The dominant tree species of this area were Kala koroi (*Albizia lebbeck*), Koroi (*Albizia procera*), Shil koroi (*Albizia lucidior*), Mehagani (*Swietenia mahagoni*), Sissoo (*Dalbergia sissoo*), Chatim (*Alstonia scholaris*), Boilam (*Anisoptera scaphula*), Kadam (*Anthocephalus chinensis*), Chapalish (*Artocarpus chama*), Telsur (*Hopea odorata*), Neem (*Azadirachta indica*), Shimul (*Bombax ceiba*). During rainy season, there is abundant growth of several kinds of macrofungi.

Table 1:-Survey areas of Sylhet division of Bangladesh

District(s)	Surveyed Location(s)			
Sylhet	Jaintiapur	Gowainghat	Jaflong	Tilagor Eco Park
Moulavibazar	Sreemangal	Madhabkundu	Lawachara	Barlekha
Districts = 2	Locations = 8			

Processing of macrofungi

Freshly harvested macrofungi was washed by water for removing debris. It has been realized that merely fleshy collected mushroom is of no use unless these are properly preserved. During the analysis period some precautions were followed before processing of macrofungi were followed on the basis of study purpose and structure of the mushroom (Kim, 2004).

Drying

Collected specimens were dried by using electrical air flow drier. The power supply capacity of this drier was 1000 voltage, which easily remove moisture from collected mushroom within three to seven hours with regular interval basis power supply (15 minutes switch off and 30 minutes switching) depending on the structure and texture of the species (Kim, 2004).

Storage

Dried macrofungi were stored in Zip lock poly bag during research period. Silica gel was used at the rate of 10% of dry basis during the storage period. Collecting specimens dried with the help of electric dryer dried specimens are preserved with 10% silica gel (Kim, 2004).

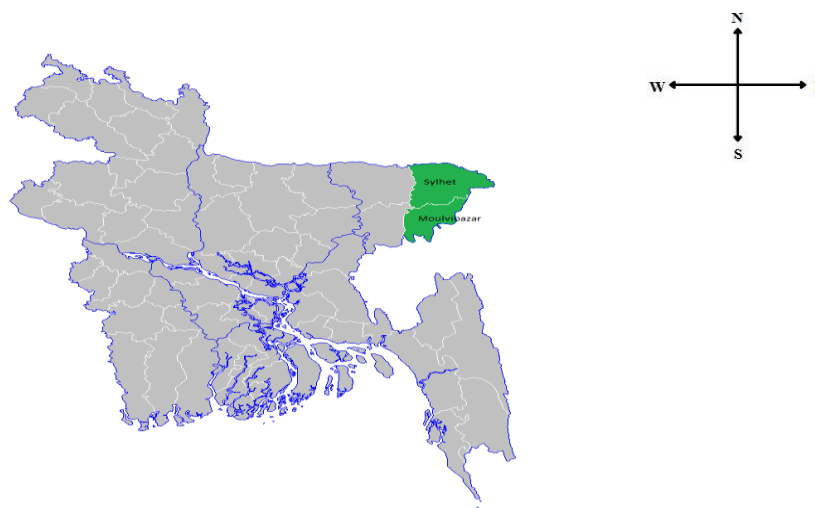


Figure 1:-Survey and sampling areas of macrofungi in Sylhet and Moulvibazar district of Bangladesh

Morphological observation

Data on the following parameters were recorded for identification of macrofungi such as locality, habitat, type of soil, forest type, size of the fructification, carpophores shape, umbo, scale, the gills, color, gills edges, stipes, length, width, color, shape, type of veil, annuls (position), volva, (Srivastava and Bano, 2010). Cap color, cap surface, cap margin, cap diameter, stipe length, gill attachment, gill spacing and spore print. Individual spore characteristics like shape, size and color were recorded. For this purpose, compound microscope (Motic BA210) was used and measuring shape, size and color with help of Motic Images Plus 2.0 software. Final identification and classification were done by comparing recorded characteristics of macrofungi with the color dictionary of mushroom given by (Dickinson and Lucas, 1982), the mushroom guide and followed by the reference of (Jordan, 2004) and (Pegler and Spooner, 1997).

Morphological characterization procedures

The basidiocarps were rehydrated by soaking in water for few minutes before analyzing their morphology. Qualitative characters such as color, shape, and presence of hymenia were evaluated by eye observation while texture was determined by feeling the back and top surfaces using fingers. Most of the morphological data were recorded during collection period that is when the mushroom was in fresh form. For microscopic characters, permanent glass slides were made from rehydrated basidiocarps with the aid of a sharp surgical blade. Basidiocarps were immersed in cotton blue stain and glycerin and placed on glass slides and covered with cover slips. Motic compound microscope (40x) were used to observe the slides. Spore size was measured by Motic Images plus 2.0 software.

Habitat, distribution and diversity analysis

The specimens were found attached to various substrata. The surrounding environment temperature, soil pH, moisture condition, vegetation recorded for biodiversity of macrofungi. Soil pH, soil moisture were measured by pH meter and air temperature by thermometer during collection period. Collected samples were wrapped in polybag and brought to the **laboratory** for their further study. The frequency and density of different species has been determined by the following formulas (Zoberi, 1973).

$$\text{Frequency of fungal species(\%)} = \frac{\text{Number of site in which the species is present}}{\text{Total number of sites}} \times 100$$

$$\text{Density (\%)} = \frac{\text{Total number of individual of a particular species}}{\text{Total number of species}} \times 100$$

Results:-

Morphology and ecology of *Agaricus* sp.

Scientific Name:

Agaricus bernardii

Common name: Salt-loving mushroom

Family: Agaricaceae.

Morphological features

1. Pileus shape: Convex; Color: Dark brown and creamy
2. Length: 2.6cm, Width: 2.1cm
3. Surface character and zonation: Moderately in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: Brown
7. Gills spacing: Distant
8. Stipe: Present
9. Spore size (Average): Length: 8.6µm; Width: 8.4µm
10. Spore shape: Moderately thick walled, smooth and oval, Color: Black and Brown

Ecological features

Habit: Solitary and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to sandy loam; factor affecting their distribution was less moist weather. The frequency of its presence was 12.5% and the density was 8%.

1. Host : Soil surface.
2. Scientific Name: Agaricus sp.
3. Family: Agaricaceae.

Morphological features

1. Pileus shape: Convex and Flat; Color: Dark brown and white
2. Length: 3.1cm, Width: 1.8cm
3. Surface character and zonation: Moderately in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: Brown
7. Gills spacing: Distant
8. Stipe: Present
9. Spore size (Average): Length: 17.2 μ m; Width: 9.3 μ m
10. Spore shape: Thick walled, smooth and ellipsoid, Color: Dark brown and Yellow

Ecological features

Habit: Solitary and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to sandy loam; factor affecting their distribution was less moist weather. The frequency of its presence was 25% and the density was 16%.

Host: Soil surface.

Morphology and ecology of Coprinus sp.

Scientific Name: Coprinus disseminatus

Common name: Inkcaps

Family: Agaricaceae.

Morphological features

1. Pileus shape: Conical; Color: White
2. Length: 1.8cm, Width: 0.6cm
3. Surface character and zonation: Moist in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: white
7. Gills spacing: Distant
8. Stipe: Present
9. Spore size (Average): Length: 12.3 μ m; Width: 7.2 μ m
10. Spore shape: Moderately thick walled, smooth and ellipsoid, Color: Dark yellow and Brown

Ecological features

Habit: Clustered and constancy of occurrence in specific habitat was abundant. Type of soil was sandy to clay loam; factor affecting their distribution was moderately moist weather. The frequency of its presence was 25% and the density was 108%.

Host : Neem (Azadirachta indica) tree.

Scientific Name: Coprinus sp.

Family: Agaricaceae.

Morphological features

1. Pileus shape: Umbonate; Color: Dark brown and yellow
2. Length: 2.1cm, Width: 0.8cm
3. Surface character and zonation: Moderately moist in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: White
7. Gills spacing: Distant
8. Stipe: Present
9. Spore size (Average): Length: 11.2 μ m; Width: 8.6 μ m
10. Spore shape: Moderately thick walled, rough and ellipsoid, Color: Black

Ecological features

Habit: Clustered and constancy of occurrence in specific habitat was abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was less moist weather. The frequency of its presence was 12.5% and the density was 268%.

Host: Soil surface.

Morphology and ecology of Ganoderma sp.

1. Scientific Name: Ganoderma tsugae
1. Common name: Hemlock varnish shelf.
2. Family: Ganodermataceae
3. Morphological features
4. Pileus shape: Finger like; Color: Dark brown and white
5. Length: 2.6cm, Width: 0.7cm
6. Surface character and zonation: Dry in nature
7. Texture of the fruiting body: Woody, tough and brittle
8. Spore bearing surface under cap: Micro pores
9. Pores: White
10. Pores spacing: Crowded
11. Stipe: Present
12. Spore size (Average): Length: 13.2 μ m; Width: 8.9 μ m
13. Spore shape: Moderately thick walled, rough and ellipsoid, Color: Dark Brown

Ecological features

Habit: Scattered and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to sandy loam; factor affecting their distribution was dry weather. The frequency of its presence was 37.5% and the density was 12%.

Host: Soil surface.

1. Scientific Name: Ganoderma applanatum
2. Common name: The artist's bracket, artist's Conk or bear bread
3. Family: Ganodermataceae

Morphological features

1. Pileus shape: Flat; Color: Dark brown with the white at end of the edge.
2. Length: 2.4cm, Width: 3.1cm
3. Surface character and zonation: Dry in nature
4. Texture of the fruiting body: Woody, tough and brittle
5. Spore bearing surface under cap: Micro pores
6. Pores color: White
7. Pores spacing: Crowded
8. Stipe: Pseudo stipe present
9. Spore size (Average): Length: 11.8 μ m; Width: 8.70 μ m

10. Spore shape: Moderately thick walled, rough and ellipsoid, Color: Dark brown and yellow

Ecological features

1. Habit: Scattered and constancy of occurrence in specific habitat was abundant. Type of soil was sandy to sandy loam around the tree; factor affecting their distribution was dry weather. The frequency of its presence was 12.5% and the density was 24%.
2. Host : Soil surface

1. Scientific Name: *Ganoderma boninense*
2. Common name: Lingzhi or Reishi mushroom.
3. Family: Ganodermataceae

Morphological features

1. Pileus shape: Flat; Color: Dark brick red
2. Length: 2.6cm, Width: 3.5cm
3. Surface character and zonation: Dry in nature
4. Texture of the fruiting body: Woody, tough and brittle
5. Spore bearing surface under cap: Micro pores
6. Pores color: White
7. Gills spacing: Crowded
8. Stipe: Pseudo stipe present
9. Spore size (Average): Length: 9.2 μ m; Width: 6.8 μ m
10. Spore shape: Moderately thick walled, rough and ellipsoid, Color: Dark Brown

Ecological features

Habit: Solitary and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to sandy loam around the tree; factor affecting their distribution was dry weather. The frequency of its presence was 12.5% and the density was 4%.

1. Host : Shimul (*Bombax ceiba*) tree.
2. Scientific Name: ***Ganoderma sp.***
3. Family: Ganodermataceae

Morphological features

1. Pileus shape: Flat; Color: Dark yellow with the white color at the end of edge
2. Length: 1.6cm, Width: 2.1cm
3. Surface character and zonation: Dry in nature
4. Texture of the fruiting body: Woody, tough and brittle
5. Spore bearing surface under cap: Micro Pores
6. Pores color: White
7. Pores spacing: Crowded
8. Spore size (Average): Length: 8.6 μ m; Width: 7.2 μ m
9. Spore shape: Thick walled, smooth and eoval, Color: Dark Brown

Ecological features

Habitat: On the tree. Habit: Solitary and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to clay loam; factor affecting their distribution was dry weather. The frequency of its presence was 12.5% and the density was 4%.

Host : Sisso (*Dalbergia sissoo*) tree.

Morphology and ecology of *Daedaleopsis sp.*

1. Scientific Name: ***Daedaleopsis confragosa***
2. Common name: Thin walled maze polypore or the blushing
3. Family: Polyporaceae

Morphological features

1. Pileus shape: Flat; Color: Dark brown and whitish at the end of edge
2. Length: 4.2cm, Width: 5.4cm
3. Surface character and zonation: Dry in nature
4. Texture of the fruiting body: Tough and brittle
5. Spore bearing surface under cap: Macro pores
6. Pores color: White
7. Pores spacing: Distant
8. Stipe: Pseudo stipe present
9. Spore size (Average): Length: 8.6 μ m; Width: 5.8 μ m
10. Spore shape: Moderately thick walled, smooth and oval, Color: Dark and light Brown

Ecological features

Habit: Scattered and constancy of occurrence in specific habitat was unabundant. Type of soil was loam to clay loam; factor affecting their distribution was less dry weather. The frequency of its presence was 25% and the density was 28%.

Host : Soil surface.

Scientific Name: *Daedaleopsis* sp.

Family: Polyporaceae

Morphological features

1. Pileus shape: Flat and wavy; Color: White
2. Length: 4.4cm, Width: 5.2cm
3. Surface character and zonation: Dry in nature
4. Texture of the fruiting body: Tough and brittle
5. Spore bearing surface under cap: Macro Pores
6. Pores color: White
7. Pores spacing: Distant
8. Stipe: Pseudo stipe present
9. Spore size (Average): Length: 6.2 μ m; Width: 5.8 μ m
10. Spore shape: Moderately thick walled, smooth and oval, Color: Dark and light Brown

Ecological features

Habitat: On the tree. Habit: Scattered and constancy of occurrence in specific habitat was abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was less dry weather. The frequency of its presence was 12.5% and the density was 12%.

Host : Koro (Albizia lebbek) tree.

Morphology and ecology of *Trametes* sp.

1. Scientific Name: ***Trametes* sp.**
2. Family: Polyporaceae

Morphological features

1. Pileus shape: Flat; Color: Dark brown and whitish at the end of edge
2. Length: 2.2cm, Width: 4.1cm
3. Surface character and zonation: Dry in nature
4. Texture of the fruiting body: Tough and brittle
5. Spore bearing surface under cap: Micro Pores
6. Pores color: White
7. Pores spacing: Crowded
8. Stipe: Pseudo stipe present
9. Spore size (Average): Length: 8.2 μ m; Width: 6.4 μ m
10. Spore shape: Single walled, smooth and oval, Color: Light Brown

Ecological features

Habit: Clustered and constancy of occurrence in specific habitat was abundant. Type of soil was sandy to sandy loam around the tree; factor affecting their distribution was dry weather. The frequency of its presence was 12.5% and the density was 36%.

Host : Sissoo (*Dalbergia sissoo*) tree.

Morphology and ecology of *Volvariella* sp.

Scientific Name: *Volvariella* sp.

Family: Pluteaceae

Morphological features

1. Pileus shape: Flat and Depressed, Ovate; Color: Brown and creamy
2. Length: 4.2cm, Width: 1.8cm
3. Surface character and zonation: Moderately moist in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: Brown
7. Gills spacing: Distant
8. Stipe: Present
9. Spore size (Average): Length: 14.1 μ m; Width: 8.4 μ m
10. Spore shape: Moderately thick walled, smooth and ellipsoid, Color: Dark yellow

Ecological features

Habit: Solitary and constancy of occurrence in specific habitat was un-abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was moderately moist weather. The frequency of its presence was 25% and the density was 12%.

Host :Soil surface.

Morphology and ecology of *Tylopilus* sp.

1. Scientific Name:*Tylopilus rubrobrunneus*
2. Common name:Bitter bolete or the bitter tylopilus
3. Family: Boletaceae

Morphological features

1. Pileus shape: Convex; Color: Dark brown and black spot top of the cap
2. Length: 3.1cm, Width: 4.8cm
3. Surface character and zonation: Less dry in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Micro pores
6. Pores color: Light yellow
7. Pores spacing: Crowded
8. Stipe: Present
9. Spore size (Average): Length: 12.1 μ m; Width: 8.7 μ m
10. Spore shape: Thick walled, smooth and oval, Color: Dark brown and black

Ecological features

Habitat: On the tree/surface. Habit: Solitary and constancy of occurrence in specific habitat was un-abundant. Type of soil was sandy to clay loam; factor affecting their distribution was less moist weather. The frequency of its presence was 25% and the density was 4%.

Host :Shimul (*Bombax ceiba*) tree.

Morphology and ecology of *Schizophyllum* sp.

Scientific Name: *Schizophyllum* commune

Common name: Split-gill
Family: Schizophyllaceae

Morphological features

1. Pileus shape: Flat with crenate; Color: Dark brown
2. Length: 0.8cm, Width: 0.4cm
3. Surface character and zonation: Dry in nature
4. Texture of the fruiting body: Tough and brittle
5. Spore bearing surface under cap: Gills
6. Gills color: Brown
7. Gills spacing: Distant
8. Stipe: Pseudo stipe present
9. Spore size (Average): Length: 11.6 μ m; Width: 9.6 μ m
10. Spore shape: Moderately thick walled, smooth and oval, Color: Brown and light yellow

Ecological features

Habitat: On the tree. Habit: Scattered and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to sandy loam around the tree; factor affecting their distribution was dry weather. The frequency of its presence was 25% and the density was 104%.

Host :Koroi (Albizia lebeck) tree.

1. Scientific Name: Schizophyllum sp.
2. Family: Schizophyllaceae

Morphological features

1. Pileus shape: Flat and crenate; Color: white
2. Length: 0.9cm, Width: 0.6cm
3. Surface character and zonation: Dry in nature
4. Texture of the fruiting body: Tough and brittle
5. Spore bearing surface under cap: Gills
6. Gills color: Brown
7. Gills spacing: Distant
8. Stipe: Pseudo stipe present
9. Spore size (Average): Length: 7.6 μ m; Width: 7.4 μ m
10. Spore shape: Single walled, smooth and oval, Color: Brown

Ecological features

Habitat: On the tree. Habit: Scattered and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to clay loam around the tree; factor affecting their distribution was dry weather. The frequency of its presence was 12.5% and the density was 28%.

Host: Kadam (Neolamarckia cadamba) tree.

Morphology and ecology of *Pleurotus sp.*

Scientific Name: *Pleurotus ostreatus*

Common name: Oyster mushroom

Family: Pleurotaceae

Morphological features

1. Pileus shape: Flat and wavy at the end of edge; Color: White
2. Length: 3.1cm, Width: 1.7cm
3. Surface character and zonation: Moderately moist in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: White

7. Gills spacing: Distant
8. Stipe: Pseudo stipe present
9. Spore size (Average): Length: 6.7 μ m; Width: 5.6 μ m
10. Spore shape: Single walled, smooth and round, Color: Light Brown

Ecological features

Habit: Clustered and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to sandy loam; factor affecting their distribution was less moist. The frequency of its presence was 37.5% and the density was 36%.

Host: Soil surface.

1. Scientific Name: *Pleurotus populinus*
2. Common name: Aspen oyster mushroom
3. Family: Pleurotaceae

Morphological features

1. Pileus shape: Flat and wavy at the end of edge; Color: Milky white
2. Length: 3.2cm, Width: 2.6cm
3. Surface character and zonation: Moderately moist in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: White
7. Gills spacing: Distant
8. Stipe: Pseudo stipe present
9. Spore size (Average): Length: 9.3 μ m; Width: 7.8 μ m
10. Spore shape: Single walled, smooth and oval, Color: Dark and light Brown

Ecological features

Habit: Solitary and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to sandy loam; factor affecting their distribution was dry weather. The frequency of its presence was 12.5% and the density was 12%.

Host : Soil surface.

Morphology and ecology of *Mycena* sp.

Scientific Name: *Mycena epipterygia*

Family: Mycenaceae

Morphological features

1. Pileus shape: Convex and Ovate; Color: Dark brown and creamy
2. Length: 2.1cm, Width: 0.4cm
3. Surface character and zonation: Moderately moist in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: Brown
7. Gills spacing: Crowded
8. Stipe: Present
9. Spore size (Average): Length: 9.6 μ m; Width: 6.8 μ m
10. Spore shape: Moderately thick walled, rough and ellipsoid, Color: Dark yellow

Ecological features

Habitat: On the tree. Habit: Scattered and constancy of occurrence inspecific habitat was unabundant. Type of soil was sandy to clay loam; factor affecting their distribution was less moist weather. The frequency of its presence was 25% and the density was 28%.

Host: Chatim (*Alstonia scholaris*) tree

Scientific Name: *Mycena* sp.

Family: Mycenaceae

Morphological features

1. Pileus shape: Convex and Ovate; Color: Brown and creamy
2. Length: 4.8cm, Width: 0.8cm
3. Surface character and zonation: Dry in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: Brown
7. Gills spacing: Distant
8. Stipe: Present
9. Spore size (Average): Length: 10.2 μ m; Width: 8.3 μ m
10. Spore shape: Moderately thick walled, rough and ellipsoid, Color: Black

Ecological features

Habit: Scattered and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to clay loam under the humus; factor affecting their distribution was dry weather. The frequency of its presence was 25% and the density was 12%.

Host : Humus

Morphology and ecology of *Steccherinum* sp.

1. Scientific Name: *Steccherinum ochraceum*
2. Common name: Ochre spreading tooth
3. Family: Steccherinaceae

Morphological features

1. Pileus shape: Flat and wavy at the end of edge; Color: White with the creamy at centre
2. Length: 3.1cm, Width: 3.4cm
3. Surface character and zonation: Dry in nature
4. Texture of the fruiting body: Tough and brittle
5. Spore bearing surface under cap: Teeth
6. Teeth color: White and brown
7. Teeth spacing: Crowded
8. Spore size (Average): Length: 14.1 μ m; Width: 10.2 μ m
9. Spore shape: Moderately thick walled, smooth and oval, Color: Dark yellow

Ecological features

Habitat: On the tree. Habit: Solitary and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to clay loam; factor affecting their distribution was dry weather. The frequency of its presence was 25% and the density was 4%.

Host : Sissoo (*Dalbergia sisso*) tree

Scientific Name: *Steccherinum ciliolatum*

Family: Steccherinaceae

Morphological features

1. Pileus shape: Flat and crenate wavy; Color: White and slight blue
2. Length: 2.8cm, Width: 4.2cm
3. Surface character and zonation: Dry in nature
4. Texture of the fruiting body: Tough and brittle
5. Spore bearing surface under cap: Teeth

6. Teeth color: Slight blue
7. Teeth spacing: Crowded
8. Spore size (Average): Length: 16.8 μ m; Width: 14.2 μ m
9. Spore shape: Moderately thick walled, rough and oval, Color: Dark and light Brown

Ecological features

Habitat: On the tree. Habit: Solitary and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to clay loam; factor affecting their distribution was dry weather. The frequency of its presence was 12.5% and the density was 4%.

Host : Sissoo (*Dalbergia sisso*) tree

Morphology and ecology of *Cortinarius* sp.

1. Scientific Name: *Cortinarius colymbadinus*
2. Family: Cortinariaceae

Morphological features

1. Pileus shape: Convex and Depressed; Color: Dark brick red
2. Length: 1.8cm, Width: 2.1cm
3. Surface character and zonation: Less dry in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: Brick red
7. Gills spacing: Crowded
8. Stipe: Present
9. Spore size (Average): Length: 8.4 μ m; Width: 6.2 μ m
10. Spore shape: Moderately thick walled, smooth and oval, Color: Brown

Ecological features

Habit: Scattered and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to sandy loam; factor affecting their distribution was dry weather. The frequency of its presence was 12.5% and the density was 12%.

Host : Soil surface.

Morphology and ecology of *Amanita* sp.

Scientific Name: *Amanita regalis*

Common name: The royal fly agaric or the king of Sweden *Amanita*

Family: Amanitaceae

Morphological features

1. Pileus shape: Ovate; Color: Dark brown with light brown scale
2. Length: 2.2cm, Width: 1.1cm
3. Surface character and zonation: Moderately moist in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: Brown
7. Gills spacing: Crowded
8. Stipe: Present
9. Spore size (Average): Length: 7.8 μ m; Width: 5.3 μ m
10. Spore shape: Single walled, smooth and ellipsoid, Color: Dark and light Brown

Ecological features

Habit: Solitary and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy; factor affecting their distribution was moderately moist weather. The frequency of its presence was 12.5% and the density was 4%.

Host : Soil surface.

Morphology and ecology of *Cantharellus* sp.

1. Scientific Name: *Cantharellus subalbidus*
2. Common name: White chanterelle
3. Family: Cantharellaceae

Morphological features

1. Pileus shape: Flat and Depresse; Color: Brown and creamy
2. Length: 2.1cm, Width: 2.3cm
3. Surface character and zonation: Moderately moist in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: Slight yellow
7. Gills spacing: Distant
8. Stipe: Present
9. Spore size (Average): Length: 9.2 μ m; Width: 6.8 μ m
10. Spore shape: Moderately thick walled, smooth and ellipsoid, Color: Dark yellow

Ecological features

Habit: Solitary and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to sandy loam; factor affecting their distribution was dry weather. The frequency of its presence was 25% and the density was 4%.

Host :Soil surface

Morphology and ecology of *Russula* sp.

1. Scientific Name: *Russula monspeliensis*
2. Family: Russulaceae

Morphological features

1. Pileus shape: Flat and depressed; Color: White
2. Length: 2.1cm, Width: 1.3 cm
3. Surface character and zonation: Moderately moist in nature
4. Texture of the fruiting body: Soft and spongy
5. Spore bearing surface under cap: Gills
6. Gills color: White
7. Gills spacing: Crowded
8. Stipe: Present
9. Spore size (Average): Length: 6.4 μ m; Width: 5.6 μ m
10. Spore shape: Single walled, smooth and round, Color: Light Brown

Ecological features

1. Habit: Solitary and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to clay loam; factor affecting their distribution was less moist weather. The frequency of its presence was 12.5% and the density was 4%.
2. Host :Soil surface.



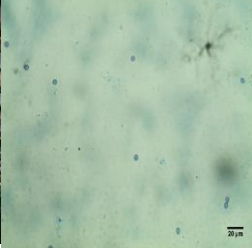


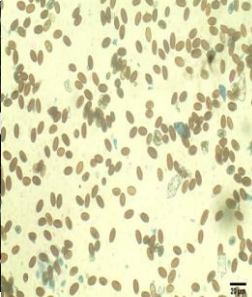


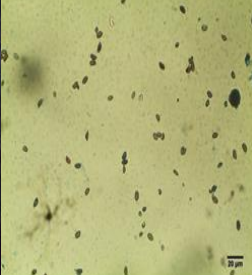


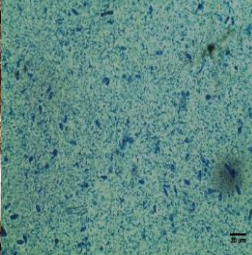
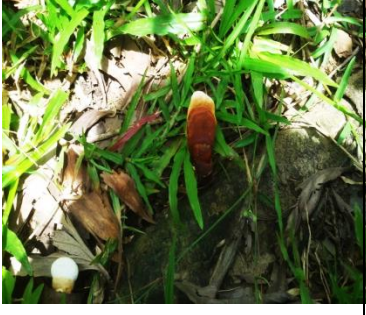

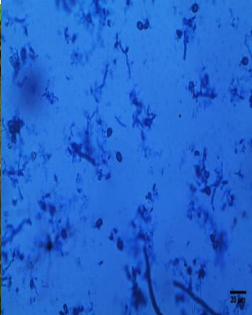
Plate no.	Name of the MACROFUNGI (s)	Mature fruiting bodies of MACROFUNGI (s) from different angles		Spore (s) in 40x microscopic magnification
		a	b	C
1.	<i>Agaricusberna rdii</i>			
2.	<i>Agaricus sp.</i>			
3.	<i>Coprinusdissemi natus</i>			
4.	<i>Coprinus sp.</i>			
5.	<i>Ganoderma tsuga</i>			



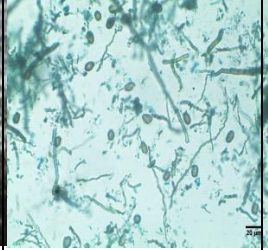


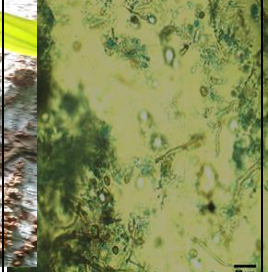


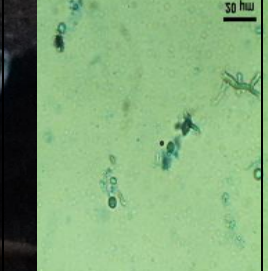


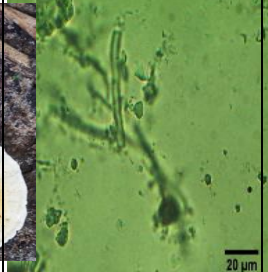


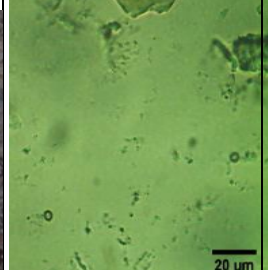
Plate no.	Name of the MACROFUNGI(s)	Mature fruiting bodies of MACROFUNGI (s) from different angles		Spore (s) in 40x microscopic magnification
		a	b	c
6.	<i>Ganodermaap planatum</i>			
7.	<i>Ganodermabon inense</i>			
8.	<i>Ganoderma sp.</i>			
9.	<i>Daedaleopsis confragosa</i>			
10.	<i>Daedaleopsis sp.</i>			



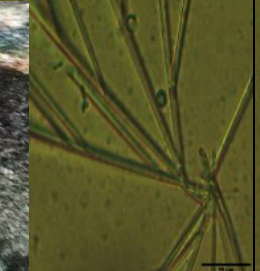





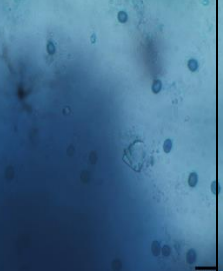


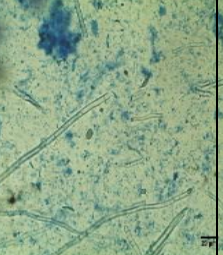


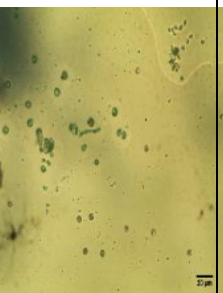
Plate no.	Name of the MACROFUNGI(s)	Mature fruiting bodies of MACROFUNGI (s) from different angles		Spore (s) in 40x microscopic magnification
		a	b	c
11.	<i>Trametes</i> sp.			
12.	<i>Volvariella</i> sp.			
13.	<i>Tylopilus rubrobrunneus</i>			
14.	<i>Schizophyllum commune</i>			
15.	<i>Schizophyllum</i> sp.			






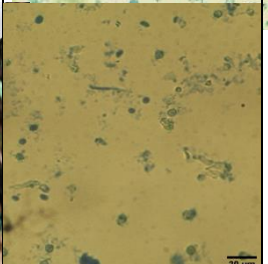
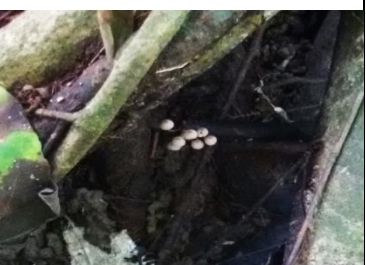

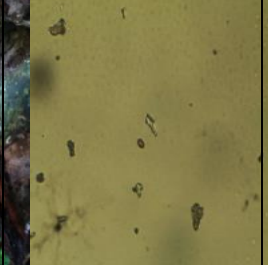


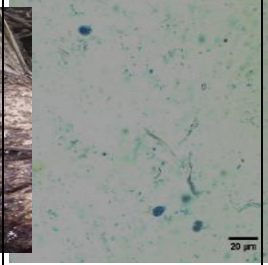


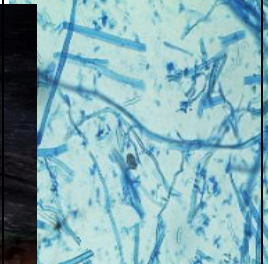


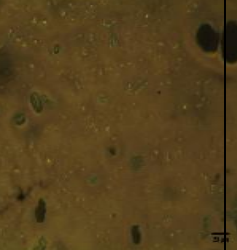


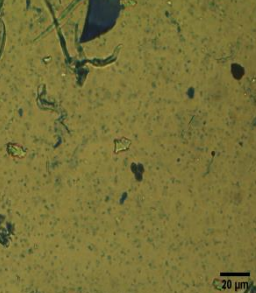


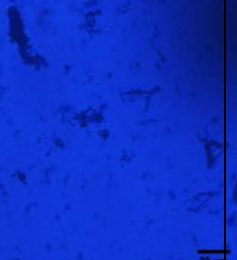





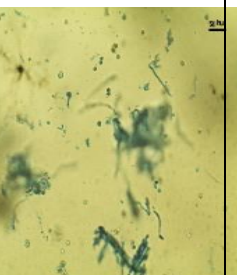
Plate no.	Name of the MACROFUNGI(s)	Mature fruiting bodies of MACROFUNGI (s) from different angles		Spore (s) in 40x microscopic magnification
		a	b	c
16.	<i>Pleurotusostreatus</i>			
17.	<i>Pleurotuspopulinus</i>			
18.	<i>Mycenaepityrgia</i>			
19.	<i>Mycena</i> sp.			
20.	<i>Steccherinumochraceum</i>			

Plate no.	Name of the MACROFUNGI(s)	Mature fruiting bodies of MACROFUNGI (s) from different angles		Spore (s) in 40x microscopic magnification
		a	b	
21.	<i>Steccherinum lilolatum</i>			
22.	<i>Cortinariscoly mbadinus</i>			
23.	<i>Amanita regalis</i>			
24.	<i>Cantharellus subalbidus</i>			
25.	<i>Steccherinumochraceum</i>			

Discussion:-

During survey, 25 macrofungi species were identified under 15 genera and 13 families. Two species of macrofungi were recorded under Agaricaceae family in Sreemangal and Madhabkundusuch as- *Agaricus bernardii* and *Agaricus* sp. from the soil organic matter near tree where the spore color were dark brown and creamy with spore size of $8.6 \times 8.4 \mu\text{m}$ and $17.2 \times 9.3 \mu\text{m}$, respectively. The findings of the present study was supported by (Das *et al.*, 2017).

Two species of *Coprinus* were identified under Agaricaceae family viz. *Coprinus disseminates* and one unidentified *Coprinus* with the frequency of 25, 12.5% and density of 16, 26.8%, respectively. The spore color were dark brown and creamy with spore size was $8.6 \times 8.4 \mu\text{m}$ and $17.2 \times 9.3 \mu\text{m}$, respectively which was collected from Neem (*Azadirachta indica*) tree and also from the soil surface. The findings of the present study was supported by (Das *et al.*, 2017). The collected *Coprinus disseminates* with white colored spore and size of spore was $12.3 \times 7.2 \mu\text{m}$ from the mangrove forest. Another unidentified *Coprinus* sp. with the frequency of 12.5% and density of 26.8% and the spore color were dark brown and creamy with spore size was $8.6 \times 8.4 \mu\text{m}$ and $17.2 \times 9.3 \mu\text{m}$ that was unique characteristics which was not supported previous study.

Four species of *Ganoderma* were found during collection such as- *Ganoderma* spp., *Ganoderma tsugae*, *Ganoderma applanatum* and *Ganoderma boninense* from Sylhet division. The frequencies of collected of *Ganoderma* were 37.5, 12.5, 12.5% and the densities were 12, 24, 4%, respectively. The color of *Ganoderma tsugae* was dark brown and white, *Ganoderma applanatum* was dark brown and *Ganoderma boninense* was brick red. The spore size of *Ganoderma* spp. were $13.2 \times 8.9 \mu\text{m}$, $11.8 \times 8.7 \mu\text{m}$ and $9.2 \times 6.8 \mu\text{m}$, accordingly. These *Ganoderma* spp. were collected from soil, Mehogani (*Swietenia macrophylla*) and Shimul (*Bombax ceiba*) tree, respectively. The findings of the present study was supported by (Das and Aminuzzaman, 2017) and (Rubina *et al.*, 2017).

Two species of *Daedaleopsis* found on the Telsur (*Hopea odorata*) and Koroi (*Albizzia procera*) tree such as- *Daedaleopsis confragosa* and *Daedaleopsis* sp. from Tilagor Eco Park, Lawachara and Jaflong, respectively. The color and spores size were dark brown and white and the spores size were $8.6 \times 5.8 \mu\text{m}$ and $6.2 \times 5.8 \mu\text{m}$, respectively. The frequencies of *Daedaleopsis* spp. were 25, 12.5% and the densities were 28 and 12%, respectively from soil and the Koroi (*Albizia lebbek*) tree.

One species of *Trametes* sp. was identified from Sissoo (*Dalbergia sissoo*) tree with the frequency 12.5% and density of 36% respectively. The color of spores was dark brown and the spores size were $8.2 \times 6.4 \mu\text{m}$. The findings of the present study was supported by (Das and Aminuzzaman, 2017).

One species of *Volvariella* sp. found in Tilagor Eco Park and Barlekha which spores was dark yellow and Spore size were $14.1 \times 8.4 \mu\text{m}$. The findings of the present study was supported by (Rumainul *et al.*, 2015).

Tylopilus rubrobrunneus was collected on the root zone of Neem (*Azadirachta indica*) from Sreemangal and Jaflong with the frequency and density of 25 and 4%, respectively. The spores color was dark brown and black with the size of $12.1 \times 8.7 \mu\text{m}$. The results of that study was supports with our findings of (Murray, 2013) where the color of spore was dark brown.

Two species of *Schizophyllum* found such as- *Schizophyllum commune* and unidentified *Schizophyllum* sp. were collected from Sreemangal, Madhabkundu and Jaintiapur. The spores color was brown with the size of $11.6 \times 9.6 \mu\text{m}$ and $7.6 \times 7.4 \mu\text{m}$, respectively. These species were collected from Kala koroi (*Albizia lebbek*) and Kadam (*Anthocephalus chinensis*) tree, respectively. The findings of the present study was supported by (Murray, 2013) and (Chandulal *et al.*, 2013). The *Schizophyllum commune* and unidentified *Schizophyllum* sp. species were also recorded on the Sissoo (*Dalbergia sissoo*) tree by (Das *et al.*, 2016) from Mangrove forest and deciduous forest (Rumainul *et al.*, 2015) of Bangladesh.

Two species of *Pleurotus* were recorded from Jaintiapur, Tilagor Eco Park and Barlekha such as- *Pleurotus ostreatus* and *Pleurotus populinus* with the frequency of 37.5, 12.5% and density of 36, 12%, respectively. The spores color was dark and light brown with the size of $6.7 \times 5.6 \mu\text{m}$ and $9.3 \times 7.8 \mu\text{m}$, respectively. The result of the present study was supported by Das *et al.*, 2017).

Two species of *Mycena* were collected from Gowainghat, Jaflong and Tilagor Eco Park viz. *Mycena epipterygia* and one unidentified *Mycena* sp. were collected with same frequency (25%). *Mycena epipterygia* was identified form

Chatim (*Alstonia scholaris*) tree. The spores color was dark yellow and black with the size of $9.6 \times 6.8 \mu\text{m}$ and $10.2 \times 8.3 \mu\text{m}$, respectively. The findings of the present study was supported by (Das *et al.*, 2017).

Two xylotrophic macro fungi namely- *Steccherinum ochraceum* and *Steccherinum ciliolatum* were identified on the bark of Mehagani (*Swietenia mahagoni*) and Sissoo (*Dalbergia sissoo*) tree, respectively. The spore color was dark yellow and brown with the size of $14.1 \times 10.2 \mu\text{m}$ and $16.8 \times 14.2 \mu\text{m}$, respectively. This species was also reported from the mangrove forest of Bangladesh in association with Mehagani (*Swietenia mahagoni*) tree (Das and Aminuzzaman, 2017).

Amanita regalis was found in Sreemangal with the frequency and density of 12.50 and 4%, respectively. The spores color was dark and light brown with the size of $7.8 \times 5.3 \mu\text{m}$. The result of the present study was supported by (Rashid *et al.*, 2016).

Cantharellus subalbidus was collected from Sreemangal and Madhabkundu with the frequency and density of 25 and 4%, respectively. The spores color was dark yellow with the size of $9.2 \times 6.8 \mu\text{m}$. The findings of the present study was supported by Murray, 2013.

In the present study *Russula monspeliensis* was identified from Madhabkundu. The spores color was light brown with the size of $6.4 \times 5.6 \mu\text{m}$. The frequency of its presence was 12.5% and the density was 4%. The findings of the present study were supported by Rubina *et al.*, 2017. In another study *Xylaria polymorpha* showed highest frequency of occurrence (44.44%) and highest density (55.56%) at Chittagong Hill Tracts under tropical evergreen and semi-evergreen forest Marjana *et al.*, (2018) whether in the present study highest frequency (37.5%) and highest density (26.8%) was found for *Ganoderma tsugae* and *Coprinus* sp. respectively even *Xylaria polymorpha* was not detected in the study. This might be due to the environmental factors, soil factors or host factors for their differential occurrence in different sites of the same forest area.

Conclusion:-

There are 25 species with 15 genera under 13 families. Highest 4 species were found under Ganodermataceae and Agaricaceae family. Three (3) species under Polyporaceae family. There are 2 species under- Schizophyllaceae, Pleurotaceae, Mycenaceae, Steccherinaceae family. Highest frequency was 37.5% for *Ganoderma tsugae*, and *Pleurotus ostreatus*. Highest density was 26.8% for *Coprinus* sp. The predominant families were Ganodermataceae, Agaricaceae, Polyporaceae, Schizophyllaceae, Pleurotaceae, Mycenaceae and Steccherinaceae. Through this survey it can be concluded that tropical evergreen and semi-evergreen forest regions of Bangladesh shows distinct biodiversity and distribution of macrofungal population. However, the list of macrofungi in this study provides the baseline information needed for the assessment of changes in biological diversity in Sylhet division. It is an important first step towards producing a checklist of macrofungi in Sylhet division of Bangladesh. Through this study we are reporting the existing biodiversity of macrofungi in this region for the first time.

Further study may be needed to ensure the occurrence, diversity, distribution, edibility or toxicity of newly evolved macrofungi in Tropical Evergreen and Semi-Evergreen Forest regions of Bangladesh and their seasonal variation of distribution in respect to different forests of Bangladesh.

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Competing Interests

Authors have declared that no competing interests exist regarding the publication of this paper.

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