BIODIVERSITY, DISTRIBUTION AND MORPHOLOGICAL CHARACTERIZATION OF MACROFUNGI IN CHITTAGONG HILL TRACTS AND ADJACENT AREAS

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BY

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CERTIFICATE

This is to certify that the thesis entitled, **" BIODIVERSITY, DISTRIBUTION AND MORPHOLOGICAL CHARACTERIZATION OF MACROFUNGI IN CHITTAGONG HILL TRACTS AND ADJACENT AREAS''** submitted to the Department of Plant Pathology, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in the partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M.S.) IN PLANT PATHOLOGY,** embodies the result of a piece of bonafide research work carried out by **MARZANA AFROSE** bearing **Registration No. 15-06885** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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ABSTRACT

A survey was conducted on biodiversity and distribution of macrofungi collected from Chittagong Hill Tracts and adjacent areas of Bangladesh. This Hill Tracts (CHT) the only extensive hilly area in Bangladesh lies in south-eastern part of the country (210 25' N to 230 45' N latitude and 910 54' E to 920 50' E longitude). A total 66 samples of macrofungi were collected and identified to 27 genera under 18 families were recorded during the survey. The predominat species were found under the families of Agaricaceae, Pleutaceae, Ganodermataceae, Marasmiaceae, Polyporaceae, Xylariaceae, Psathyrellaceae and Hymenochaetaceae. Among the collected species, the highest frequency was 44.44% and density of 55.56% for *Xylaria polymorpha* and *Pleurotus sapidus* followed by the frequency of 33.33% for *Agaricus aungustus, Coprinus disseminatus* and *Xylaria hypoxylon* and then 22.22% and 11.11% for the rest of the species. The lowest frequency was 11.11% and density 2.78% for different species. Macrofungal species in dominant trees were associated with Teak/Segun (*Tectona grandis*), Gamari (*Gmelina arborea*), Koroi (*Albizzia procera*), Rubber (*Hevea brasiliensis*), Mahogony (*Macrophyla mahogoni*), Sisso (*Dalbergia sisso*), Bamboo (*Bambusa vulgaris*), Chapalish tree (*Artocarpus chaplasha*) and Rain tree (*Albizia lebbeck*). This is the first report of macro fungi biodiversity and their distribution in the Chittagong Hill Tracts and adjacent areas of Bangladesh.

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CHAPTER I

INTRODUCTION

Macrofungi are fruiting bodies of macroscopic, filamentous and epigeal fungi made up of hypae which form interwoven web of tissue known as mycelium in the substrate upon which the fungus feeds; most often their mycelia are buried in the soil around the root of the trees, beneath leaf litters, in the tissue of tree trunk or in their nourishing substrate (Ramsbottom, 1989). Mushroom is a general term used mainly for the fruiting body of the macro fungi (*Ascomycota* and *Basidiomycota*) and represents only a short reproductive stage in their life cycle (Das, 2010). The number of recognized mushroom species has been reported to be 14,000, which is about 10% of the total estimated mushroom species on the earth (Cheung, 2008).

Macrofungi are macromycetes forming macroscopic fruiting bodies such as agarics, boletes, jelly fungi, coral fungi, stinkhorns, bracket fungi, puffballs and bird's nest fungi. They are fleshy, sub fleshy or sometimes leathery and woody and bear their fertile surface either on lamellae lining the tubes or opening out by means of pores. Lamellae members are called agarics and the tube bearing period members, as boletes and polypores. Their fruiting bodies ephemeral structures, whereas their mycelia living on dead organic matters in the soil may last for years. It 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. The Romance and Greeks treated mushrooms as a special kind of food (Miles and Chang, 2004) and there is historical evidence of mushroom consumption in ancient India (Chopra, 1933).

Macrofungi have been found in fossilized wood that are estimated to be 300 million years old and almost certainly, prehistoric man has used mushroom collected from the forest as food. There are many edible macrofungi i.e. *Volvarias*, polypore and tubers fungi that used ethno botanical food by the tribal of forest regions of India and Nepal (Alexopolous *et al.*,1996). Besides, they are valued for food and medicinal properties by people. However, the food value and acceptance of these edible fungi by the scientific and civilized world have not been recognized. These edible fungi are more important for a tropical and subtropical country which have a climate, most congenial for the natural growth of such fungi (Purkayastha and Chandra, 1985). Many mushrooms have been used as food and medicines. So they contribute towards diet, income and human health. Some mushrooms have been important source of revenue for rural communities in India and other developing countries (Wani *et al.*, 2010). These are invariably high protein rich and have been considered as potential source of proteins, amino acids, vitamins and minerals. Indigenous peoples are utilizing mushroom for the treatment of different types of diseases and also as an aphrodisiac and tonic (Devkota, 2006).

Ample species wild edible and medicinal mushroom occur in all biodiversity rich region during the rainy season. They can be found on wood of living or dead trees on the leaf litters on the soil through the branching mycelia infiltration. Some mushrooms are found growing in association with trees of a particular family or genus (Arora, 2008; Karwa and Rai, 2010). Mushroom species are the indicators of the forest life support system.

The presence or absence of fungal species is a useful indicator to assess the damage or the maturity of an ecosystem. Data on their diversity in different vegetation types is important for planning and managing ecosystem biodiversity. Biodiversity refers to the variety and variability among living

organism and ecological complexes in which they occur. It plays a significant role in nature by enriching soil, maintaining water and climatic cycle, humidity precipitation, conservation and recycling of waste material into nutrient. Their habitat and climate are major factors that indicate their biodiversity (Nilson and Presson, 1978).

Macrofungi are one of the promising concepts for crops diversification in Bangladesh as well as the whole world. Keeping this view in mind the present research work was conducted by a systematic survey in Chittagong hill tracts and adjacent areas of Bangladesh with the following objective :

1. To identify the macrofungi up to the genus and species level from Chittagong hill tracts and adjacent areas of Bangladesh.

2. To study the biodiversity, distribution and morphology of identified macrofungi.

CHAPTER I I

REVIEW OF LITERATURE

The forest of Bangladesh can be grouped in to four broad categories depending on their location, nature and type of management. They are mangrove forest, tropical moist deciduous forests, tropical evergreen and semi evergreen forests and village forests. Among them the mushroom biodiversity of Chittagong hill tracts are described. The main purpose of this chapter is to review the previous studies, which are related to the present study. Therefore, an attempt has been made here to compile the research work carried out on the subject elsewhere.

Sharareh *et al.* (2016) reported that the wild mushrooms provide a significant source of nutritional and medicinal bioactive compounds. They have been collected and consumed by people from many countries for thousands of years. However, there is a shortage of information in the literature regarding Iranian wild mushrooms. Thus, this mini-review tries to outline recent efforts made in order to collect, identify, and maintain wild mushrooms of Iran. This review may also encourage more research on collection, assessment, and biochemical analysis of Iranian wild mushrooms in order to establish a germplasm bank of wild mushrooms.

Beuy and Viroj (2016) stated Linzhi (*Ganoderma lucidum)* as a well-known medicinal mushroom. This mushroom originated from China becomes the widely used supplementation worldwide. The usefulness to kidney is mentioned in the literature. Linzhi (*Ganoderma lucidum*) is a well-known medicinal mushroom. This mushroom originated from China becomes the widely used supplementation worldwide. The active ingredient in the mushroom is mentioned for anti-oxidative, glucose controlling and anti-cancerous proliferative activities. In nephrology, the

advantage of Linzhi on kidney is also mentioned. However, the evidence in human beings is limited. In this short manuscript, the authors discuss on evidence of Linzhi's clinical usefulness in renal diseases.

Deepak *et al.* (2016) reported Mushrooms as well known for their nutritional as well as therapeutic values worldwide. They have been reported to be the most valuable ones for humans. Investigations on the therapeutic and nutritional properties of mushrooms are underway throughout the world. Researchers are providing crucial data on the array of bioactive compounds found within these fascinating fungi. People are now accepting mushrooms more as food and food supplements. Various academic and research institutes are all involved actively in research on bioactive metabolites of mushrooms.

Rahaman *et al.* (2016) surveyed five south western region of Bangladesh, namely Kushtia, Chuadanga, Jessore, Satkhira and Khulna. A total of 16 mushroom species belong to 10 genera, under 8 families were recorded during the survey. *Lepiota cristata* was found abundantly in the survey areas among the other collected species and it exhibited the maximum frequency of occurrence (25%), whereas the maximum density (13.51%) was recorded for *Hypholoma fasciculeare* and *Coprinellus micaceus*, followed by *Lepiota cristata*, *Coprinus comatus* and *Mycena californiensis* (10.81%). The density of *Gymnopilus purpuratus*, *Coprinus sterquilinus*, *Marasmius oreades*, *Hypholoma capnoides* and *Coprinellus plagioporus* were recorded as 8.10%.

Vanessa *et al.* (2016) studied that the wild mushroom *Leucopaxillus candidus* (Bres.) Singer was studied for the first time to obtain information about its chemical composition, nutritional value and bioactivity. Free sugars, fatty acids, tocopherols, organic and phenolic acids were analysed

by chromatographic techniques coupled to different detectors. *L. candidus* methanolic extract was tested regarding antioxidant potential (reducing power, radical scavenging activity and lipid peroxidation inhibition). *L. candidus* was shown to be an interesting species in terms of nutritional value, with high content in proteins and carbohydrates, but low fat levels, with the prevalence of polyunsaturated fatty acids. Mannitol was the most abundant free sugar and tocopherol was the main tocopherol isoform. Other compounds detected were oxalic and fumaric acids, phydroxybenzoic and cinnamic acids. The methanolic extract revealed antioxidant activity and did not show hepatoxicity in porcine liver primary cells. The present study provides new information about *L. candidus.*

Rumainul and Aminuzzaman (2016) studied biodiversity of macro fungi of Dhaka, Gazipur, Bogra, Rajshahi, Pabna, Jaipurhat and Dinajpur district of central and northern region of Bangladesh, where 50 samples were collected, morphologically characterized, photographed and preserved. They were identified 8 genera and 9 species. The predominant genera were *Trametes*, *Daedaleopsis*, *Collybia* and *Armillaria*. This preliminary investigation suggested that, the central and northern region of Bangladesh under tropical moist deciduous forest region is enriched with diversity of wild mushrooms.

Rashid *et al.* (2016) conducted to study on biodiversity as well as the distribution of wild mushrooms, which naturally grow, in different localities, at different seasons, in the southern region of Bangladesh. A total 24 species of mushrooms belonging to 17 genera and 14 families were identified. Those mushrooms were collected between July and October, 2013 and 2014, accordingly from 16 sub-districts of Barisal, Patuakhali, Borguna, Pirojpur, Jhalokhathi districts, which situated in the

southern region of Bangladesh. The identified genera were viz., *Amanita* sp., *Agaricus* sp., *Ganoderma* sp., *Armillaria* sp., *Coprinus* sp., *Cortinarius* sp., *Hebeloma* sp., *Mycena* sp., *Lepiota* sp., *Lycoperdon* sp., *Macrolepiotia* sp., *Daldinia* sp., *Tuber sp., Volvariella* sp., *Steccherinum* sp., *Hypholoma* sp. *and Coprinellus* sp. Moreover, the maximum frequency of occurrence in this survey was exhibited by *Ganoderma applanatum, Amanita vaginata and Agaricus silvicola* (18.75%), whereas, the maximum density was recorded for *Coprinus silvaticus* (48.83%).

Rumainul *et al.* (2015) investigated mushrooms flora 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 50 samples were collected and identified to 14 genera and 24 species. The predominant genera were *Ganoderma* sp., *Lepiota* sp., *Marasmius* sp. and *Collybia* sp.

Krishna *et al*. (2015) collected the fruiting bodies of macrofungi from some forests, fences, waste fields, timber depots of Telangana state during rainy season. This was an attempt to give a broad picture of diversity of macrofungi belonging to the class Basidiomycetes in some forest areas of Telangana region. A total number of 50 fruiting bodies were collected and cultured and among them only 10 were identified based on their macroscopic features and molecular identification since they showed good lignolytic activity.

Kinge and Mih (2015) studied the diversity and distribution of species of *Ganoderma* in south western Cameroon. Four species namely *Ganoderma weberianum, Ganoderma cupreum, Ganoderma steyaertanum, Ganoderma zonatum* are new records for Cameroon. The remaining 11 species belong

to *Ganoderma ryvardense*, *Ganoderma lobenense* and *Ganoderma* species 1-9 with different affinities might be new to science. Six plant species were identified as hosts to different species of *Ganoderma.* They are *Elaeis guineensis*, *Cassia* sp., *Acacia* sp., *Pinus sylvestris*, *Avocado* sp. and unidentified hardwood with *E. guineensis*, hosting the highest number of species.

Among 18 mushroom species related to tribal use, the most useable species were *Astraeus hygrometricus*, *Amanitavaginata var. alba, Amanita banningiana*, *Russula nigricans*, *Termitomyces eurrhizus* and *Termitomyces microcarpus.* Manna et al. (2014) Monsoon and post-monsoon periods which fall during the second half of August were found to be the optimum time for the production of 11 wild edible mushrooms. Out of the total calculated production, 47.2% of the same was noted during this time. These regions with tribal populations, especially the Santals in the forest fringes, have traditional knowledge related to mushrooms.

Vyas *et al*. (2014) identified 18 mushroom species belonging to 12 families viz. *Vascellum pretense, Lycoperdon pyriform, Coniphora puteana, Clitocybe geotrapa, Ganoderma tsugae, Microglossum virde, Panaeolus sphinctrinus, Pleurotus cornucopiae*, *Fomes fomentarius, Tyromyces lacteus, Lenzites betulina, Hypholoma elongatum, Pholita highlandensis, Serpula lacrymans, Tremella mesenterica, Lepisa nuda, Collybia butyracea* and *Omphalina ericetorum*. Among them some were recorded as edible *Lepisa nuda* and *Clitopilus prunnulus*used to prepare indigenous medicines following traditional techniques.

Chelela *et al.* (2014) conducted a survey to assess mycological knowledge and socio-economic benefits along the wild edible mushrooms value chain among *Benna* and *Hehe* ethnic groups in the Southern Highlands of

Tanzania. They collected wild edible mushrooms in the *Miombo* woodland surrounding six villages during rainy season in January 2014. From the survey, mushroom collection and selling was gender oriented dominated by women at 70 and 93.5% respectively. Moreover, it was found that 30% of men were involved in collecting and only 6.5% in selling. About 45 species of wild edible mushrooms were collected mainly from *Lactarius, Russula, Cantharellus* and *Amanita* species.

Andrew *et al.* (2013) reported the diversity and distribution of macrofungi in the Mount Cameroon Region. These were assessed at low and high altitudinal ranges in the four flanks of the mountain during the rainy and early dry seasons of 2010 and 2011. A total of 177 macrofungal species belonging to 83 genera and 38 families were recorded. Species richness was higher in the rainy seasons (134 species) than in the early dry seasons (89 species) and tended to decrease with altitude, with 116 and 112 species for low and high altitudes, respectively. 88 species were recorded only in the rainy seasons, 43 species in the early dry seasons only and 46 species were common to both seasons. 65 species were found only in the low altitude, 61 species only in the high altitude, and 51 species were common to both altitudes. *Auricularia auricular* was the most abundant species during the rainy seasons, while *Coltricia cinnamomea* was rare during the rainy seasons, and the most abundant during the dry seasons. 6 of the 12 morpho-groups identified occurred across the sites, with the gilled fungi being the most frequent. *Cyathus striatus* was found only in Buea Town during the rainy seasons.

Pandey *et al.* (2013) conducted a study in Jeypore Reserve Forest located in Assam, India to investigate the diversity of macro fungi associated with different tree species. 30 macro fungal species representing 26 genera belonging to 17 families were collected from six different sites in the study

area. Out of these maximum 6 genera assignable to family *Polyporaceae,* 5 genera to *Russulaceae*, 3 genera to *Agaricaceae*, 2 genera to *Ganodermataceae* and *Cantharellaceae* each and rest of the families were represented by single genus only. The study revealed that maximum frequency of occurrence was exhibited by *Trametes versicolor* and *Schizophyllum commune* (83.33%), followed by *Microporus xanthopus Pycnoporus sanguineus* (66.67%) and *Coprinus disseminates* (50%). The rest of the species exhibited the frequency distribution ranging between 16.67-33.33%. The maximum density was recorded for *Schizophyllum commune* (126.67%) followed by *Trametes versicolor* (120%) and *Xylaria polymorpha* (93.33%). The density of rest of the species were ranged between 3.33- 6.67%.

Farooq *et al.* (2013) carried out an experiment on Soon Valley Sakasar located in District Khushab of the province Punjab, Pakistan coordinates 72°00'and 72°30' E longitudes 32°25' and 32°45' N latitudes with diversified ecosystem. The ethno- mycological study of soon valley has been strongly neglected in the past. A total of 25 mushroom species belonging to 9 families and 14 genera were identified from the study area. Among the collected mushroom species *Agaricus* was found as most dominant genus (36%) followed by *Innocybe* (12%). All the mushroom species exhibited remarkable variation in terms of habitat, season and locations. Ethnological survey revealed that 12 species are edible, 9 inedible and 4 act as poisonous ones.

Chandulal *et al.* (2013) identified 17 species belonging to two different classes namely, Gastromycetes – *Daldinia concentrica* [(Xylariaceae) (cramp ball)], *Lycoperedon pyriforme* [(Lycoperdaceae, edible) (wood or stump puff ball)], *Scleroderma citrinum* (sclerodermataceae, edible); Hymenomycetes – *Cantharrellus umbonatus, Coriolusversicolor*

(polyporaceae, inedible), *Schizophyllum commune* (Schizophyllaceae, inedible) (the split gill), *Ganoderma lucidum* (Ganodermataceae), *Ganoderma applanatun* (ganodermataceae), *Laetiporus sulphureus* (Polyporaceae, edible), *Lepiota organensis, Collybia butyracea,Lentineullus cochleatus* (Aurisclpinaceae, edible), *Galerina unicolor* (Hymenogatraceae), *Citocybe flaccid* (Trichomataceae, edible), *Oudemansiella redicata* (Physalacriaceae, edible), *Hygrophorus eburnes* (Hygrophoraceae, edible) and *Agaricus campestris* (Agaricaceae, edible). The investigation proves the existence of a distinct biodiversity in mushroom population.

Das *et al*. (2013) reported three species namely *Russula sharmae*, *R. dubdiana* and *R. sikkimensis* as new taxa in west district of Sikkion (India), located in the Eastern Himalaya. Macro- and micromorphological illustrated descriptions of these species are given along with their taxonomic positions and relations to allied species.

Farid *et al.* (2013) identified 44 species of mushrooms belonging to 29 genera collected from different localities in Erbil Governorate of Kurdistan region. The identified species were *Agaricus* sp., *Clitocybe* sp., *Collybia* sp., *Coprinus* sp., *Cortinarius* sp., *Craterellus* sp., *Crepidotus* sp., *Exidia* sp., *Fomes* sp., *Galerina* sp., *Hebeloma* sp., *Helvella* sp., *Auricularia auricula-judae, Hygrocybe pratensis, Inocybe* sp., *Lactarius* sp., *Laccaria* sp., *Mycena* sp., *Peziza* sp., *Pluteus* sp., *Psathyrella* sp., *Panellus Paxillus atrotomentosus, Russula fellea, Scutellinia scutellata, Trichloma* sp., *Tyromyces* sp., *Lepiota* sp. and *Cystoderma* sp. the last two genera were the new record in Erbil, Kurdistan region-Iraq.

Hosen *et al.* (2015) described a new monotypic genus in the Boletaceae, *Borofutus,* typified by *B. dhakanus* using morphological and molecular

evidence. This considered as putatively ectomycorrhizal fungus associated with *Shorea reobusta*. *Borofutus* is sister to Spongi forma in molecular phylogenetic analysis using DNA nucleotide sequences of single or multiple loci. They presented a description, line drawings, phylogenetic placement and comparison with allied taxa.

Kumar *et al.* (2013) reported the macro-fungal diversity and nutrient content of some edible mushrooms of Nagaland, India. They collected young and matured carpophores of 15 wild edible mushroom species from 12 locations in different districts of Nagaland. Out of the four species belongs to family Agaricaceae, two belongs to Tricholomataceae and rest belongs to Boletaceae, Cantherallaceae, Russulaceae, Sarcoscyphaceae, Auriculariaceae, Polyporaceae, Schizophyllaceae, Pleurotaceae and Lyophyllaceae.

Shannon Berch (2013) found the Truffles (true and false), fruiting bodies of ectomycorrhizal fungi and some of them produce appealing aromas. Until recently, commercial truffles have all been Mediterranean in distribution but some of these species are now cultivated around the world and other native species are being collected and marketed. While cultivation of black truffles can be complicated by horticultural challenges, production of other species appears to be less problematic. The potential for the discovery and commercialization of novel native truffles is good, but only if trained dogs are used for exploration and harvesting can this potential be sustainably and ethically realized.

Pushpa and Purushothama (2012) conducted a survey on the biodiversity of mushrooms belonging to the class Basidiomycetes in Bangalore. The survey were conducted from June 2007 to November 2010 in eight different places which included scrub jungles and urban places in a around

Bangalore. A total number of 90 species in 48 genera belonging to 19 families in 05 orders were recorded, 28 species were found to be recorded for the first time in India. Among the collected species *Coprinus disseminates* followed by *Coprinus fibrillosis* and *Schizophyllum communae* was found to be abundant in their occurrence. The Simpson and Sannon diversity biodiversity index was found to be 0.8 and 1.24 respectively.

Pithak and Pukahute (2012) conducted a survey on the diversity of mushrooms in dry dipterocarp forest at Phuphan National Park to study the variety of mushrooms grown in the Dry Dip- terocarp forest during the year 2008-2009 by releve method and to study the relationship between *Shoreasia mensis* Miq. and ectomycorrhizal of the Amanitaceae and the Belotaceae families. The findings of the study reveals the presence of a total 34 types of mushrooms in Dry Dipterocarp forest at the Phuphan where there were 26 types found in both years.

Dwivedi *et al.* (2012) studied on the taxonomy and diversity of macro fungi in semi evergreen and moist deciduous forest of Amarkantak where more than 50 samples were collected which is situated in Madhya Pradesh in India. Extensive surveys were conducted from July 2010 to September 2010, where collection, characterization, preservation and photo of macro fungal carried the genera like is *Agaricus, Amanita, Nyctalis, Russula, Boletus, Macrolapiota, Ganoderma and Termitomyces.* Out of 50 samples only 16 samples were identified up to species level. This preliminary study shows that the forest is very rich in mushroom diversity.

Bankole and Adekunle (2012) conducted an experiment on biodiversity of mushrooms in Lagos State, Nigeria as they collected in Lagos State for 12 months. The mushrooms collected included*Agaricus campestris, Coprinus*

comatus, Daldinia concetrica, Ganoderma adspersum, Ganoderma applanatum, Ganoderma lucidum, Mycena haematopus, Mycena sp., *Pleurotus ostreatus, Pleurotus tuber-regium, Polyporus* sp., *Polyporus squamosus, Polyporus sulphureus, Trametes versicolor, Xylaria polymorpha* and *Xylaria* sp.

Smith and Thiers (2011) reported fruit bodies of the genus *Tylopilus* that encountered as large stout bolete mushrooms, which arise from the ground or occasionally from the wood having stout stipes. A key field character which distinguishes them from members of genus *Boletus* is the presence of their pink-tinged pores. It is a polyphyletic morphology that does not unite the *Tylopilus* species using traditional morphological characters.

Onyango and Ower (2011) investigated morphological characters and spawn production procedures of three Kenyan native strains of wood ear mushroom [*Auricularia auricula* (L. ex Hook.) Underw]. Nine basidiocarps were selected from collections made in three forest reserves within Kakamega Forest in Western Kenya and morphologically characterized.

Karwa and Rai (2010) reported on the tapping into the edible fungi biodiversity of Melghat forest in Central India for occurrence of wild edible fungi and their prevalent favorable ecological factors in consecutive years in the months of June to February (2006-2008). A total of 153 species of mushrooms were recorded, collected, photographed and preserved. The enormous biomass in the forest favors variety of edible and medicinal mushrooms. Dominating species belong to genera *Agaricus, Pleurotus, Termitomyces, Cantharellus, Ganoderma, Auricularia, Schizophyllum, Morchella* etc.

Hanlon and Harrington (2010) conducted study on diversity and distribution of Agaricomycete species in the Republic of Ireland (ROI) and compared records with similar records from Northern Ireland, England, Scotland and Wales. The number of Agaricomycete species recorded from Ireland was much lower than in the other countries examined. The ROI has 100, 700, 1300 and 2200 fewer species than Northern Ireland, Wales, Scotland and England respectively. According to major taxonomic clades Agaricomycete species from the ROI is common throughout all of the clades.

CHAPTER I I I

MATERIALS AND METHODS

3.1 Experimental site

The samples were collected from different Chittagong hill tracts and adjacent areas of Bangladesh. Experiment was conducted at the Laboratory, Department of Plant Pathology (DPP), Sher-e-Bangla Agricultural University (SAU), Dhaka.

3.1.1 Sampling procedure

A systematic sampling procedure was used baseline survey. Nine locations under the division of Chittagong in Bangladesh were selected for conducting a survey on mushroom biodiversity, distribution, habitat and morphology. A pre-designed collection procedure were used to collect information on level of knowledge on biodiversity, habitat and morphology of mushroom in selected regions of Bangladesh.

3.2 Collection of mushroom samples

Detailed survey was carried out in 9 locations viz. Chittagong University Campus, Rangunia, Kaptai, Manikchhari, Lama, Ruma, Rowangchhari, Matiranga and Kawkhali of Rangamati, Bandarban and Khagrachari districts. Samples were collected during July to October, 2016, to record the morphological variability in the mushrooms population. The collection was made by method given by Hailing (1996). Spotted mushrooms were inspected in their natural habitats and brought to laboratory for detailed study. The collected fleshy fungi were studied for their macroscopic detail on the habit, habitat, morphology and other phenotypic parameter noted in fresh form.

Standard methods of collection, preservation, macroscopic and microscopic preservations were recorded. Collected mushroom was

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

3.2.1 Collection site

Collection site was three districts (Rangamati, Bandarban and Khagrachari) of Chittagong hill tracts of Bangladesh (Figure -1and Table-1) located between (210 25' N to 230 45' N latitude and 910 54' E to 920 50' E longitude) which consists of three wildlife sanctuaries. Collection site was Chittagong hill tracts and adjacent areas of nearby villages of Rangamati, Bandarban and Khagrachari Districts. Minimum and maximum temperature was 27°C and 32.1°C. The average annual relative humidity was 70-84%. The dominant tree species of this area were Teak/Segun (*Tectona grandis*), Gamari (*Gmelina arborea*), Koroi (*Albizzia procera*), Rubber (*Hevea brasiliensis*), Mahogony (*Macrophyla mahogoni*), Sisso (*Dalbergia sisso*), Bamboo (*Bambusa vulgaris*), Chapalish tree (*Artocarpus chaplasha*), Rain tree (*Albizia lebbeck*).

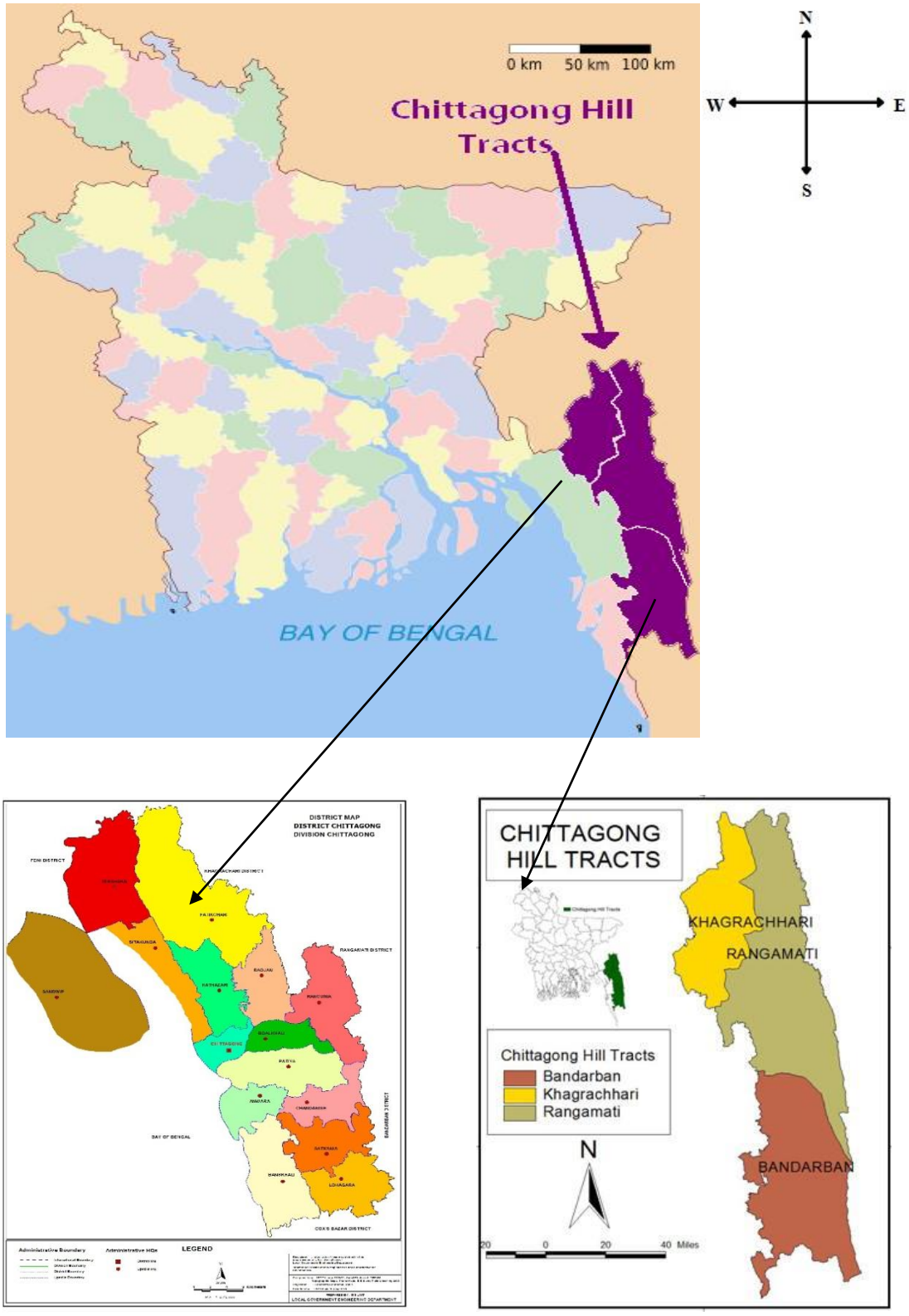

Figure 1. Survey areas of Chittagong Hill Tracts and Adjacent Areas

Table 1. Survey areas on the basis of the location of Chittagong Hill Tracts and adjacent areas

Sl. No.	**District(s)**	**Surveyed Location(s)**		
		Name of surveyed Upazilla(s)		
1.	Rangamati	Kaptai	Kawkhali	
2.	Bandarban	Lama	Ruma	Rowangchhari
3.	Khagrachari	Matiranga	Manikchhari	
4.	Chittagong Sadar	Chittagong University Campus		Rangunia
Total		Upazilla (s) = 9		

3.3 Processing of macrofungi

Freshly harvested macrofungi was washed with water for removing dust. Fleshy macrofungi is highly perishable as it is susceptible to deterioration by the enzyme and microorganism. 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. Mainly two types of preservation process-one is short term preservation and another is long term preservation were followed on the basis of study purpose and structure of the macrofungi (Kim, 2004).

3.3.1 Drying

Collected samples 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).

3.3.2 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).

3.4 Morphological observation

Data on the following parameters were recorded for identification of mushrooms specimens 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 vail, 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, motic microscope was used and measuring shape, size and color with help of Motic Images Plus 2.0software. Final identification and classification were done by comparing recorded characteristics of mushrooms with the color dictionary of mushroom given by Dickinson and Lucus (1982), the mushroom guide and followed by the reference of Jorden (2004) and Pegler and Spooner (1997).

3.4.1 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 water 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.

3.5 Habitat, distribution and diversity analysis

The different forests under survey of mixed type of forests impregnated with decaying wood and rotting plant parts, termites nests, cow dungs, leaf litters etc. The specimens were found attached to various substrata. The surrounding environment temperature, soil pH, moisture condition and vegetation were recorded for biodiversity of mushroom. Soil pH and soil moisture were measured by pH meter and air temperature by thermometer during collection period, respectively. Soil moisture is usually expressed in units termed pH. 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) :

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

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

CHAPTER IV

RESULTS AND DISCUSSION

4.1. Morphology, habitat and biodiversity of *Agaricus* sp.

4.1.1. *Agaricus aungustus*

Common name : The prince

Family : Agaricaceae
Location : Ruma, Lama, Rowangchhari from Bandarban

Macroscopic character

Pileus shape : Convex and Flat , Color : Dark brown and black

Length : 4.8 to 5.5 cm, Width : 2.6 to 3.0 cm

Surface character and zonation : Glabrous with Less dry in nature

Margin : Regular in shape

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Black

Gills spacing : Crowded

Stipe : Present

Spore morphology

Spore size (Average): Length :10.1 μm ; Width: 5.8 μm

Spore shape : Moderately thick walled, smooth and ellipsoid, Color: Dark and light Brown

Ecological features

Habitat : On the soil surface. Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was less moist weather.

Biodiversity : *Agaricus aungustus*was found in Bandorban of Chittagong hill tracts. A total eight number of mushrooms were found during collection.The frequency of its presence was 33.33% and the density was 22.22%.

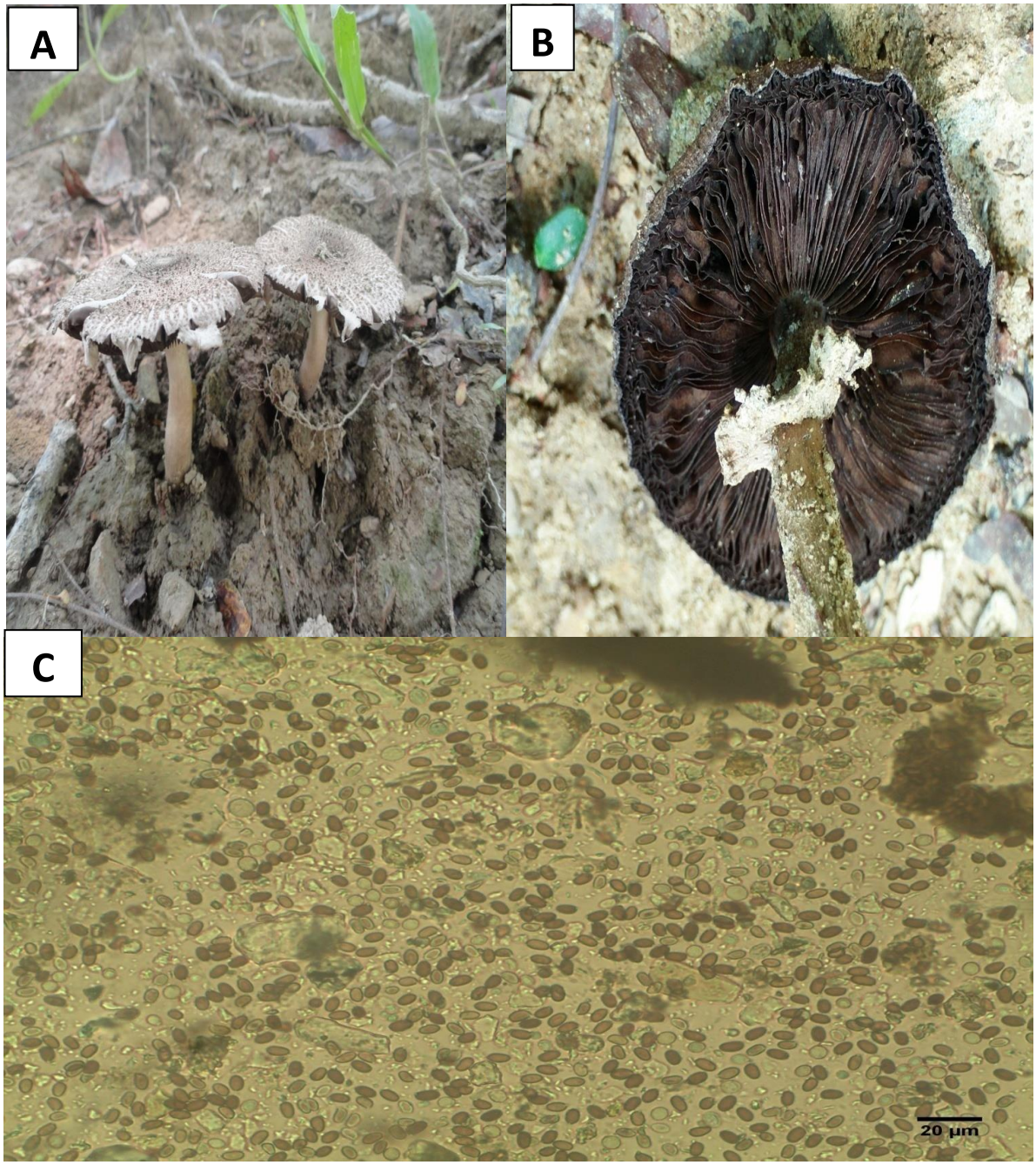

PLATE 1. ***Agaricus aungustus*****;** Mature fruiting body (A), Gills (B), Spores (C).

4.1.2. *Agaricus moelleri*

Common name : Inky mushroom or dark scaled mushroom

Family : Agaricaceae

Location : Chittagong University Campus and Rangunia, Chittagong

Macroscopic character

Pileus shape : Convex and flat , Color : White and Grey

Length : 4.8 to 5.8 cm, Width : 2.3 to 3.1 cm

Surface character and zonation : Smooth and round with moderately moist in nature

Margin : Regular in shape

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Creamy

Gills spacing : Less crowded, distant and adnate attachment

Stipe : Present

Spore morphology

Spore size (Average): Length : 8.2 μm ; Width: 5.4 μm

Spore shape : Thick walled, smooth and ellipsoid, Color: Light brown

Ecological features

Habitat : On the humus. Habit : Solitary and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to loamy; factor affecting their distribution was moderately moist weather.

Biodiversity : *Agaricus moelleri*was found in Chittagong University Campus. A total six number of mushrooms were found during collection.The frequency of its presence was 22.22% and the density was 16.67%.

PLATE 2. ***Agaricus moelleri*****;** Mature fruiting body (A), Gills (B), Spores (C).

4.2. Morphology, habitat and biodiversity of *Coprinus* sp.

4.2.1. *Coprinus* sp.

Family : Agaricaceae

Location : Kawkhali, Rangamati

Macroscopic character

Pileus shape : Convex and also Ovate, Color : Dark brown with cream color scale

Length : 3.8 to 14.2 cm, Width : 1.3 to 1.5 cm

Surface character and zonation : Scaly and moderately moist in nature

Margin : Regular in shape

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Black

Gills spacing : Crowded

Stipe : Present

Spore morphology

Spore size (Average): Length : 13.1 μm ; Width: 6.8 μm

Spore shape : Thick walled, smooth and ellipsoid, Color : Dark brown and deep yellow

Ecological features

Habitat : On the soil surface. Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was moderately moist weather.

Biodiversity : *Coprinus* sp. was found in Rangamati of Chittagong hill tracts. A total two number of mushrooms were found during collection.The frequency of its presence was 11.11% and the density was 5.56%.

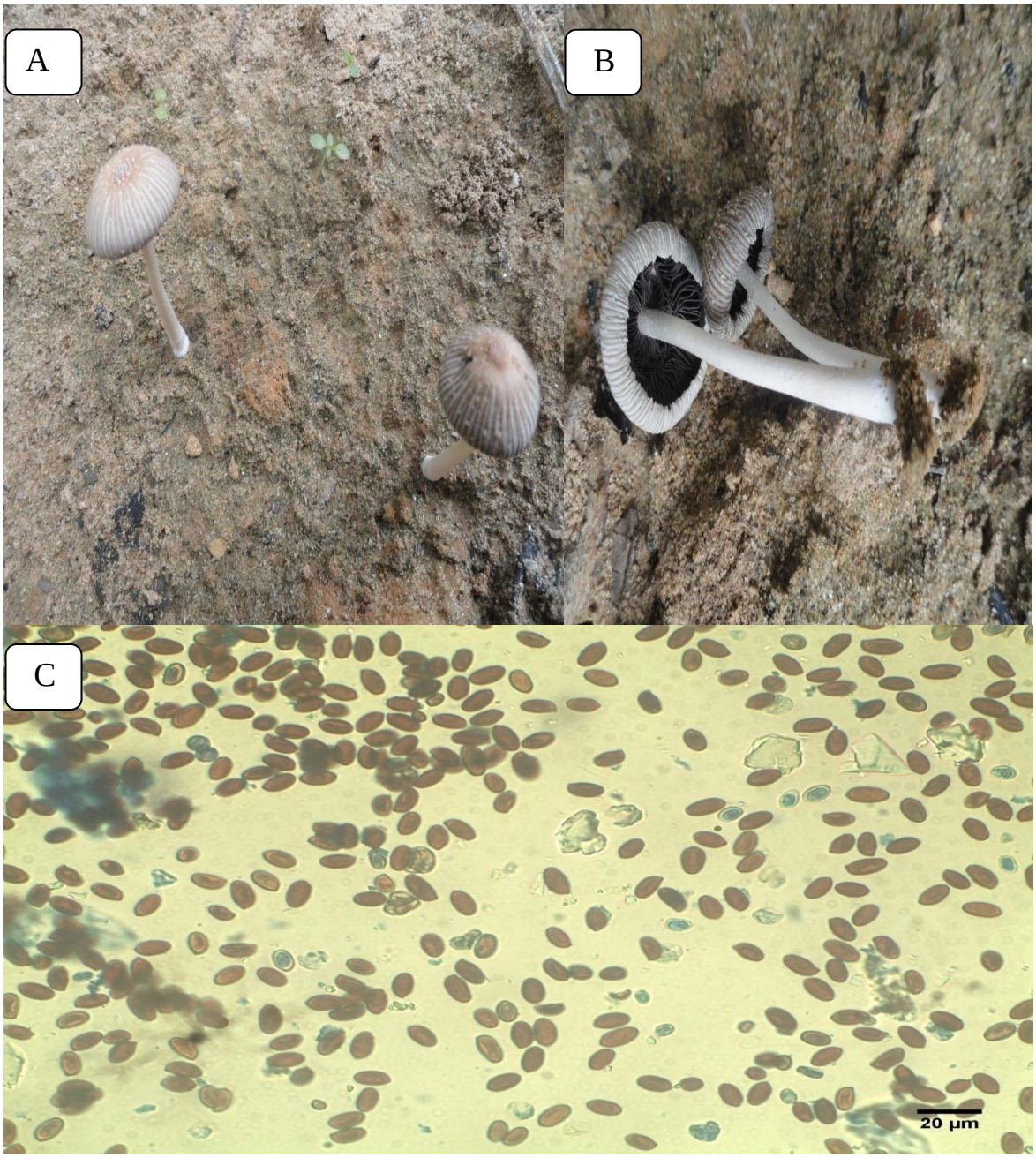

PLATE 3. *Coprinus* sp.; Mature fruiting body (A), Gills (B), Spores (C)

4.2.2. *Coprinus disseminatus*

Common name : Inkcaps

Family : Agaricaceae

Location : Rangunia, Kaptai and Manikchhari

Macroscopic character

Pileus shape : Convex, Color : Creamy with white

Length : 1.1 to 1.6 cm, Width : 0.2 to 0.4 cm

Surface character and zonation : Moderately moist in nature

Margin : Smooth and round with regular in shape

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Light brown

Gills spacing : Less crowded

Stipe : Present

Spore morphology

Spore size (Average): Length : 8.32 μm ; Width: 4.7 μm

Spore shape : Moderately thick walled, smooth and ellipsoid, Oval, Color: Brown and deep yellow

Ecological feature:

Habitat : On the soil surface. Habit : Clustered and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy with large size sand and rock; factor affecting their distribution was moderately moist weather.

Biodiversity : *Coprinus disseminatus*was found in Rangamati of Chittagong hill tracts. A total ninteen number of mushrooms were found during collection.The frequency of its presence was 33.33% and the density was 52.78%.

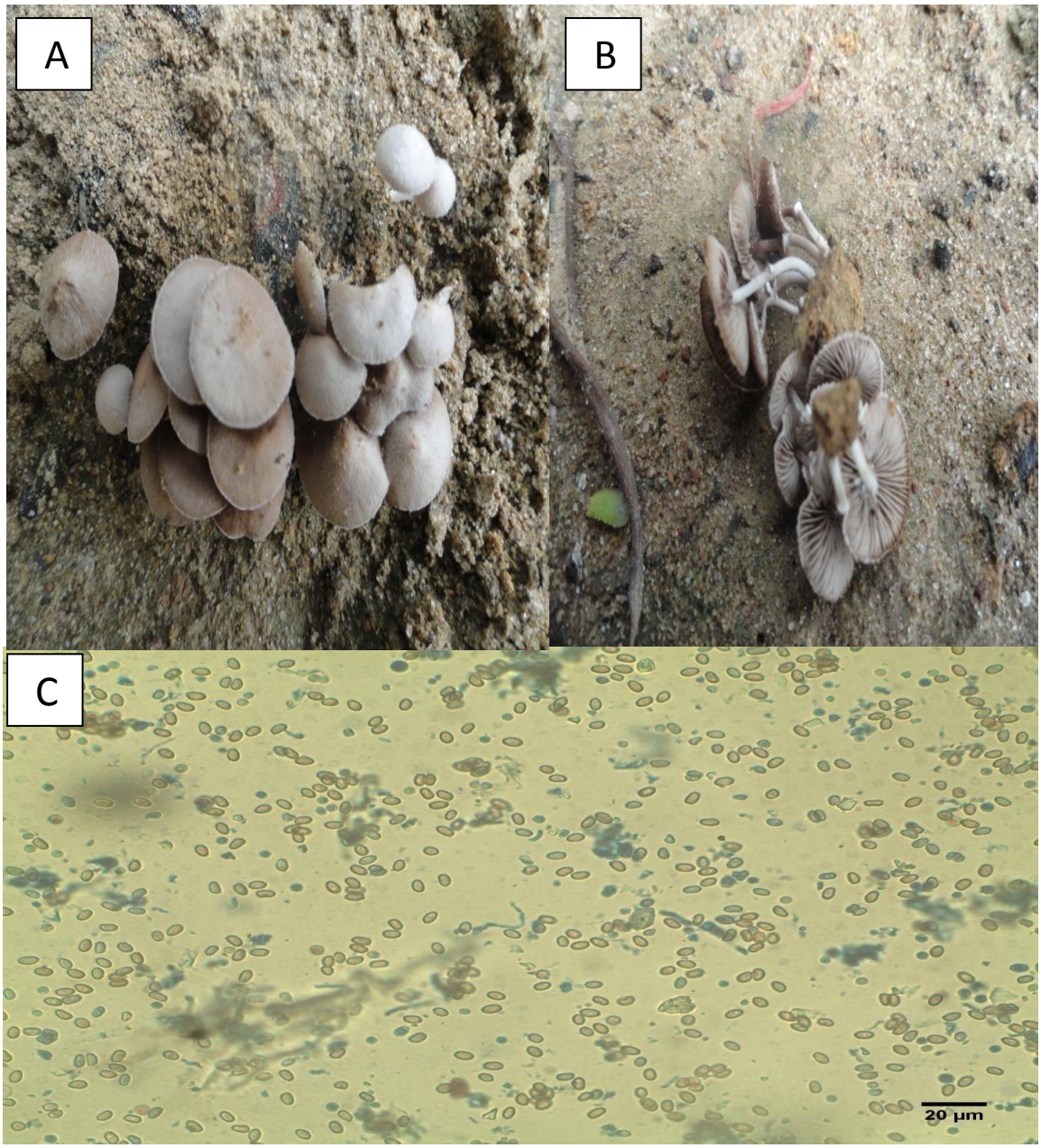

PLATE 4. ***Coprinus disseminates*****;** Mature fruiting body (A), Gills (B), Spores (C).

4.3. Morphology, habitat and biodiversity of *Calvatia* sp.

4.3.1. *Calvatia* sp.

Common name : Puffball

Family : Agaricaceae

Location : Ruma and Lama from Bandarban

Macroscopic character

Pileus shape : Ball shaped, Color : Brown

Length : 6.0 cm, Width : 4.0 cm

Surface character and zonation : Cracking with moderately moist weather

Margin : Regular in shape

Texture of the fruiting body : Tough and spongy

Spore bearing surface under cap : Pores on hymenium

Pores color : Absent

Stipe: Pseudostipe present

Spore morphology

Spore size (Average): Length : 9.6 μm ; Width: 5.2 μm

Spore shape : Thick walled, rough and round, Color : Dark brown and deep yellow

Ecological features

Habitat : On the soil surface. Habit : Solitary and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to sandy loam with mixture of humus; factor affecting their distribution was moderately moist weather.

Biodiversity : *Calvatia* sp. was found in Bandorban of Chittagong hill tracts. A total four number of mushrooms were found during collection.The frequency of its presence was 22.22% and the density was 11.11%.

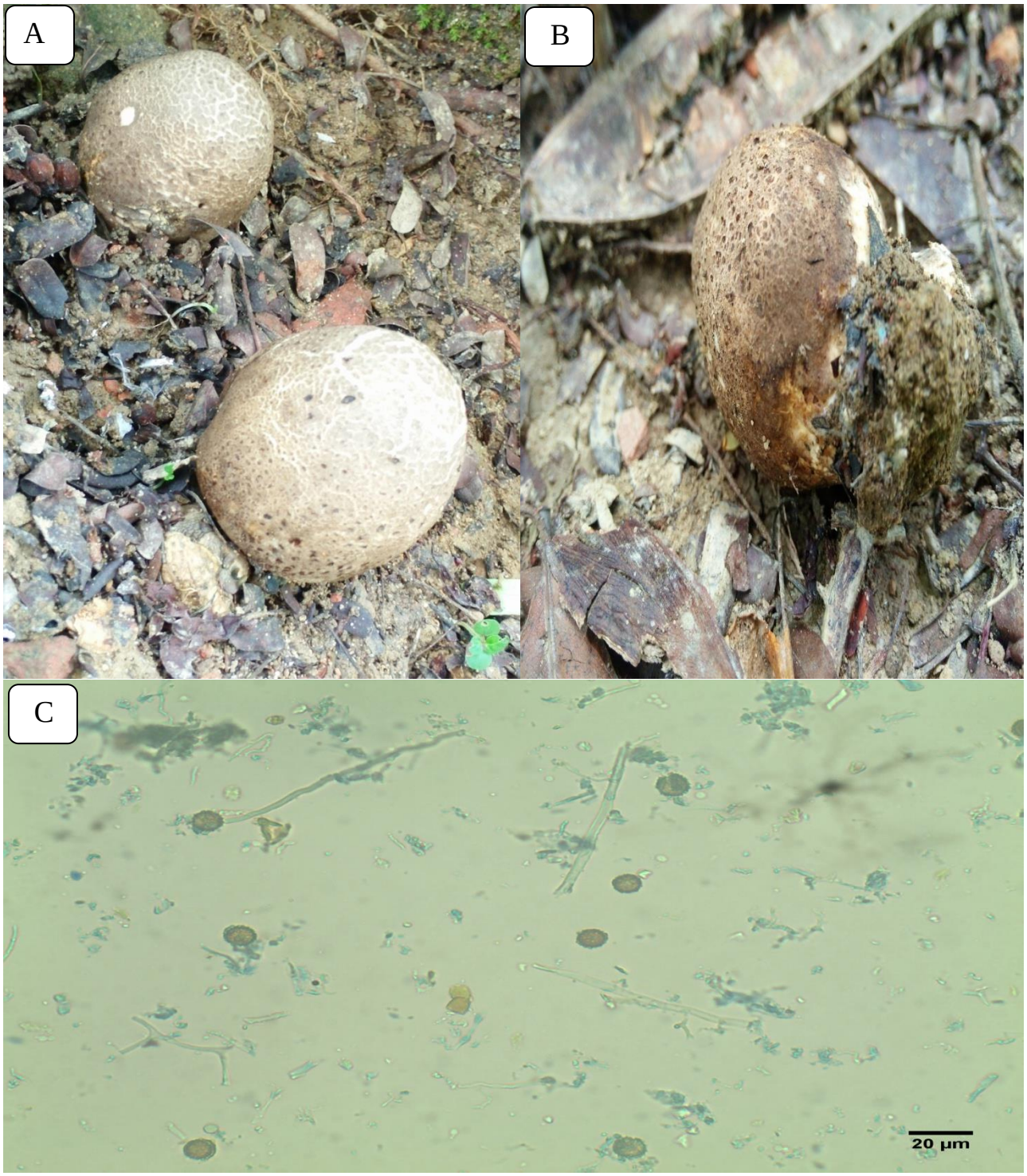

PLATE5. *Calvatia* sp.; Mature fruiting body (A,B), Spores (C).

4.4. Morphology, habitat and biodiversity of *Leucocoprinus bimbaumii*

4.4.1. *Leucocoprinus bimbaumii*

Common name : Flowerpot parasol and Plantpot dapperling

Family : Agaricaceae

Location : Kaptai, Rangamati

Macroscopic character

Pileus shape : Conical , Color : Yellow

Length : 4.8 to 5.5 cm, Width : 0.8 to 1.0 cm

Surface character and zonation : Less moist weather

Margin : Regular in shape

Texture of the fruiting body : Soft and spongy with glabrous and rough

Spore bearing surface under cap : Gills

Gills color : Yellow

Gills spacing : Less crowded and distant

Stipe : Present

Spore morphology

Spore size (Average): Length : 8.7 μm ; Width: 4.9 μm

Spore shape : Moderately thick walled, smooth and ellipsoid, Oval, Color: Hyaline and Brown

Ecological features

Habitat : On the soil surface. Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was less dry weather.

Biodiversity : *Leucocoprinus bimbaumii* was found in Rangamati of Chittagong hill tracts. Only one number of mushrooms were found during collection.The frequency of its presence was 11.11% and the density was 2.78%.

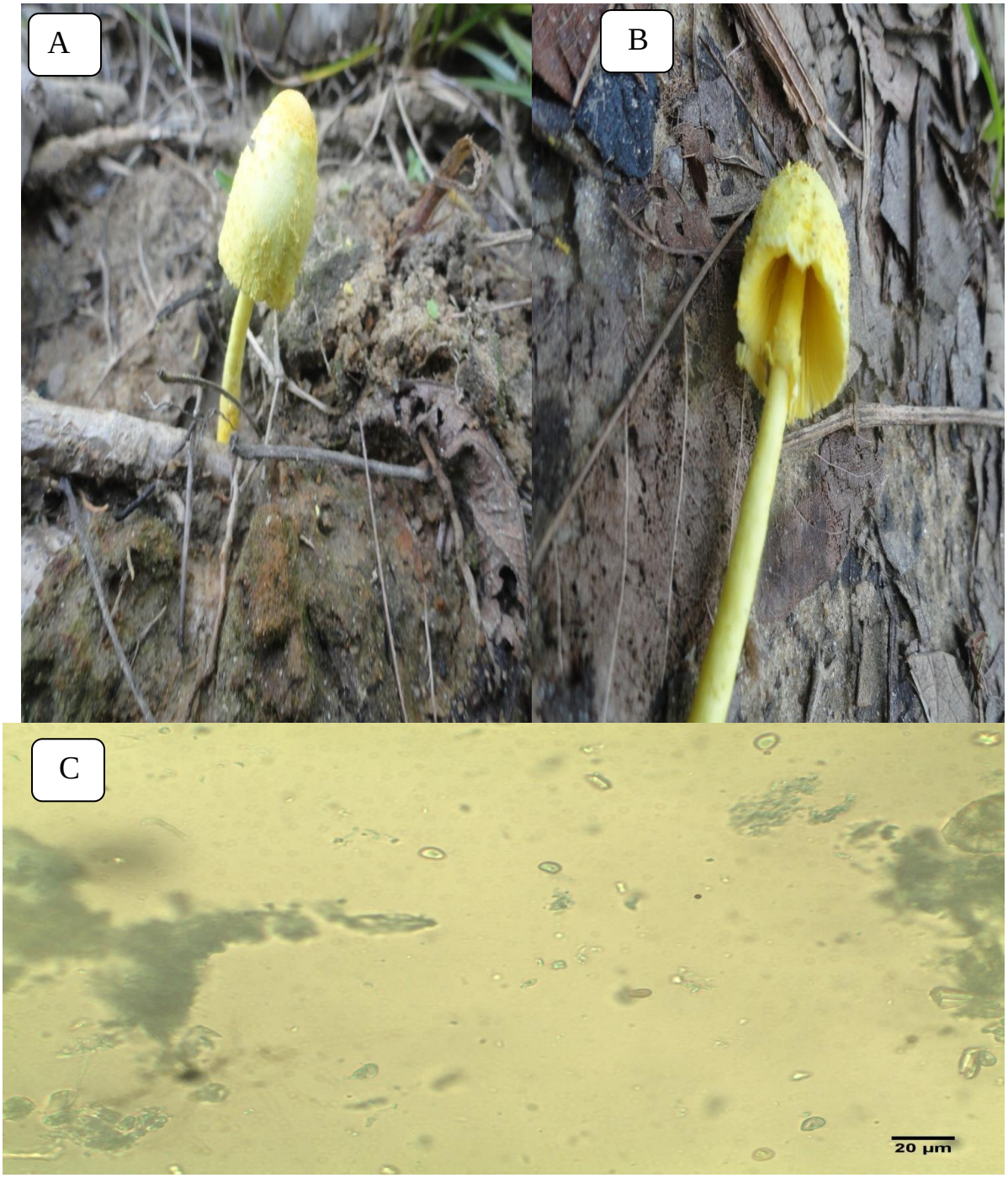

PLATE 6. ***Leucocoprinus bimbaumii*;** Mature fruiting body (A), Gills (B), Spores (C).

4.5. Morphology, habitat and biodiversity of *Volvariella* sp.

4.5.1. *Volvariella pusilla*

Family : Pluteaceae

Location : Chittagong University Campus, Chittagong

Macroscopic character

Pileus shape : Ball shaped, Color : White

Length : 4.3 to 5.4 cm, Width : 0.6 to 1.3 cm

Surface character and zonation : Moderately moist in nature

Margin : Regular in shape with scale

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : White

Gills spacing : crowded

Stipe : Present

Volva : Present

Spore morphology

Spore size (Average): Length : 9.8 μm ; Width: 9.6 μm

Spore shape: Moderately thick walled, smooth, round, Color: Hyaline and Brown.

Ecological features

Habitat : On the humus and soil surface. Habit : Scolitary and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to clay loam; factor affecting their distribution was moderately moist weather.

Biodiversity : *Volvariella pusilla* was found in Chittagong sadar. Only one number of mushrooms were found during collection. The frequency of its presence was 11.11% and the density was 2.78%.

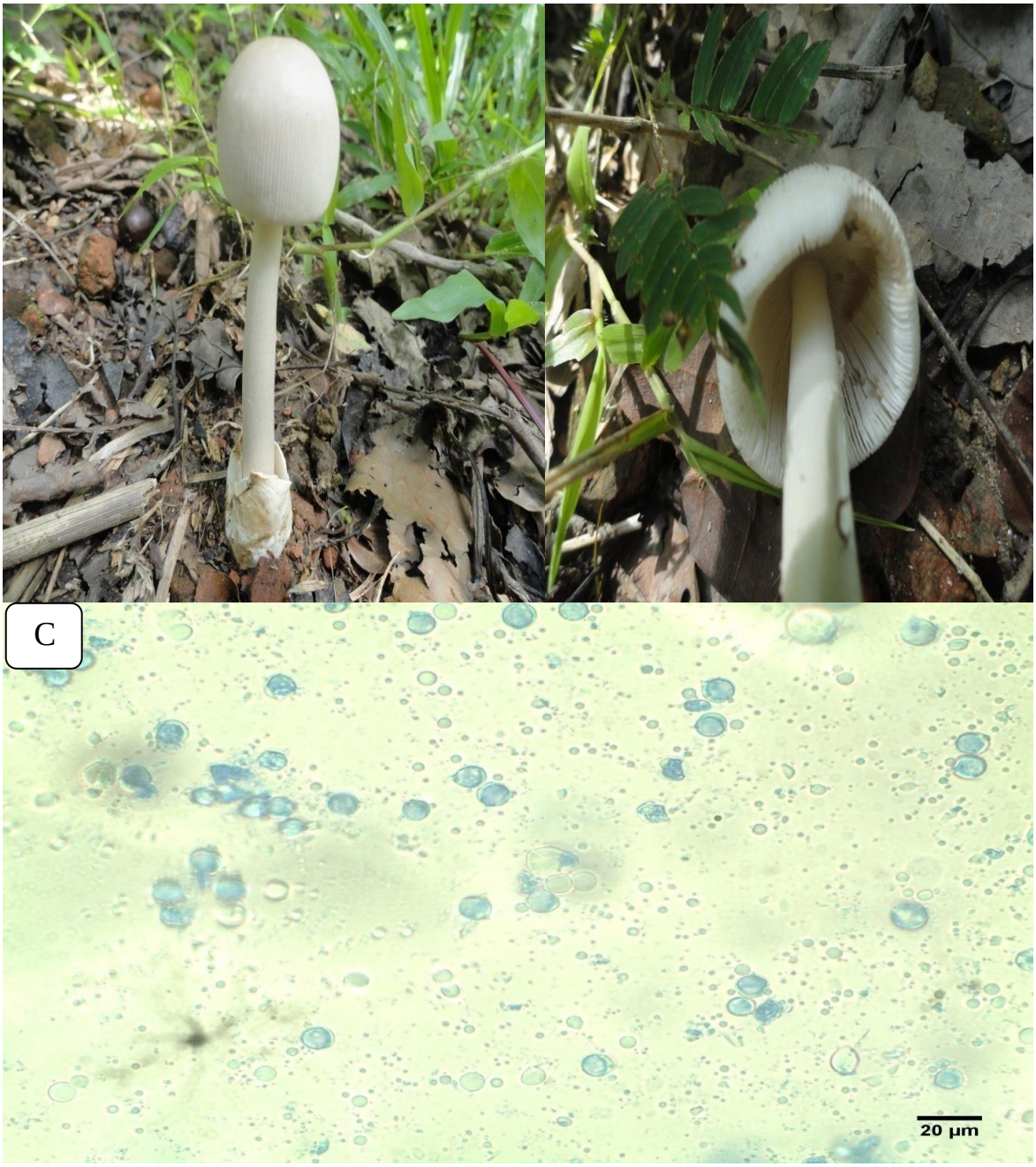

PLATE 7. ***Volvariella pusilla*****;** Mature fruiting body (A), Gills (B), Spores (C).

4.5.2. *Volvariella nigrovolvacea*

Family : Pluteaceae

Location : Kaptai, Rangamati

Macroscopic character

Pileus shape : Flat and convex , Color : White and black in center

Length : 4.2 cm, Width : 2.1 cm

Surface character and zonation : Moist in nature

Margin : Regular in shape, smooth and round

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Brown and creamy

Gill spacing : Distant and less crowded

Stipe : Present

Spore morphology

Spore size (Average): Length : 7.8 μm ; Width: 4.3 μm

Spore shape : Moderately thick walled, smooth, oval and ellipsoid, Color: Hyaline and Brown

Ecological features

Habitat : On the root of the dead log of Sisso (*Dalbergia sisso*) tree. Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was loamy; factor affecting their distribution was moderately moist weather.

Biodiversity : *Volvariella nigrovolvacea* was found in Rangamati of Chittagong hill tracts. Only one number of mushrooms were found during collection.The frequency of its presence was 11.11% and the density was 2.78%.

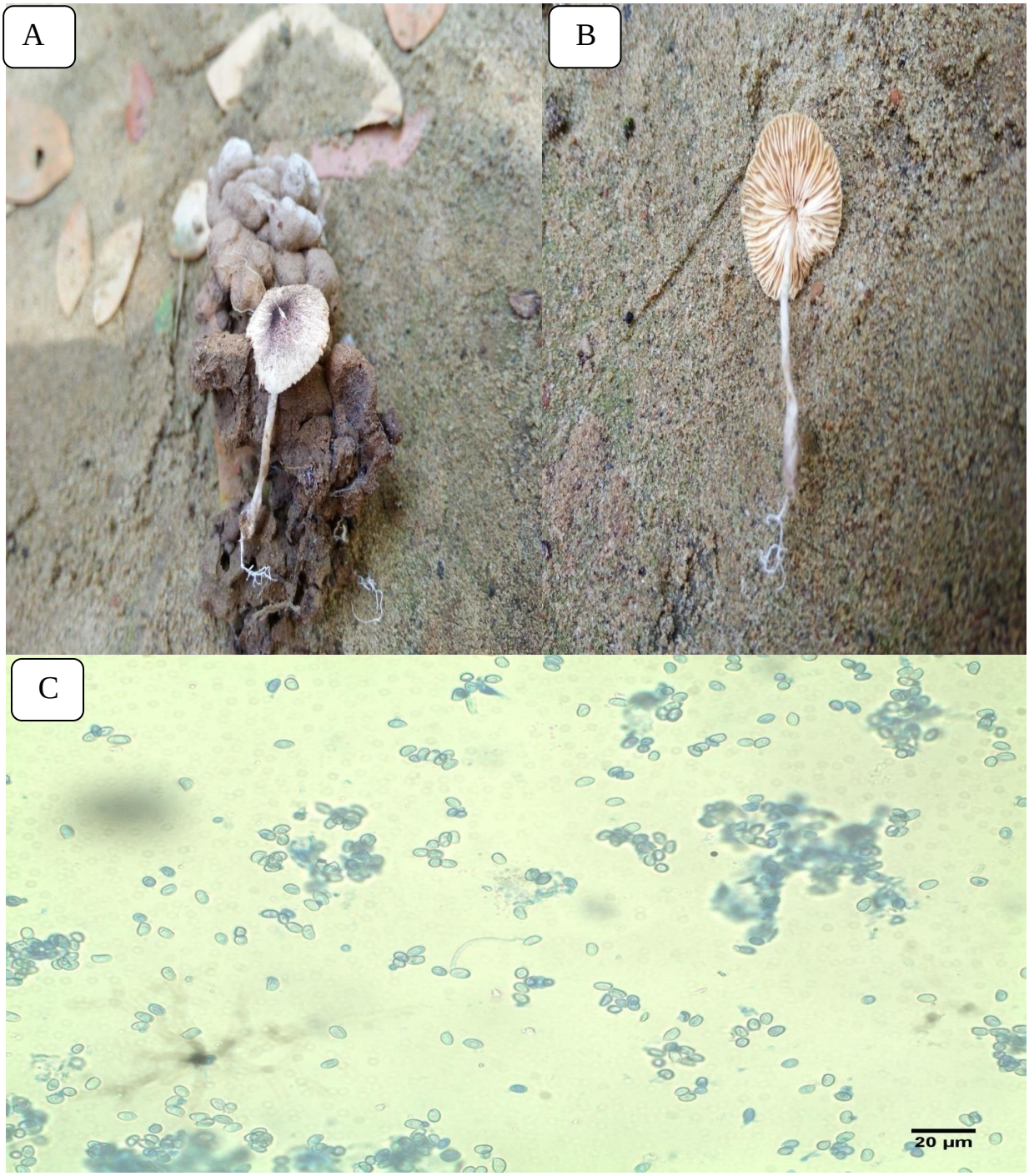

PLATE 8. ***Volvariella nigrovolvacea*;** Mature fruiting body (A), Gills (B), Spores (C).

4.5.3. *Volvariella gloiocephala*

Common name : Big sheath mushroom, rose-gilled grisette, or stubble rosegill

Family : Pluteaceae

Location : Kawkhali, Rangamati

Macroscopic character

Pileus shape : Flat and velvety , Color : Creamy

Length : 8.0 cm, Width : 3.0 cm

Surface character and zonation : Moist in nature

Margin : Regular in shape, smooth and round

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Creamy and light brown

Gills spacing : Less crowded and distant

Stipe : Present

Spore morphology

Spore size (Average): Length : 14.1 μm ; Width: 8.2 μm

Spore shape : Moderately thick walled, smooth, oval and ellipsoid, Color: Deep yellow and Brown

Ecological features

Habitat : On the humus. Habit : Solitary and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was moderately moist weather.

Biodiversity : *Volvariella gloiocephala*was found in Rangamati of Chittagong hill tracts. Only one number of mushroomswere found during collection. The frequency of its presence was 11.11% and the density was 2.78%.

PLATE 9. ***Volvariella gloiocephala*;** Mature fruiting body (A), Gills (B), Spores (C).

4.5.4. *Volvariella bombycina*

Common name : Silky sheath, silky rosegill, silver-silk straw mushroom, or tree mushroom,

Family : Pluteaceae

Location : Rowangchhari, Bandarban

Macroscopic character

Pileus shape : Convex, Color : Dark brown with black spot on the top of cap

Length : 4.8 cm, Width : 2.3 cm

Surface character and zonation : Less moist in nature

Margin : Regular in shape with scale

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Creamy

Gills spacing : Crowded

Stipe : Present

Spore morphology

Spore size (Average): Length : 6.7 μm ; Width: 4.1 μm

Spore shape : Thick walled, smooth and oval, Color : Deep yellow

Ecological features

Habitat : On the root zone of the Mahogony (*Macrophyla mahogoni*) tree. Habit : Solitary and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to clay loam; factor affecting their distribution was less moist weather.

Biodiversity : *Volvariella bombycina* was found in Bandarban of Chittagong hill tracts. Only one number of mushroomswere found during collection.The frequency of its presence was 11.11% and the density was 2.78%

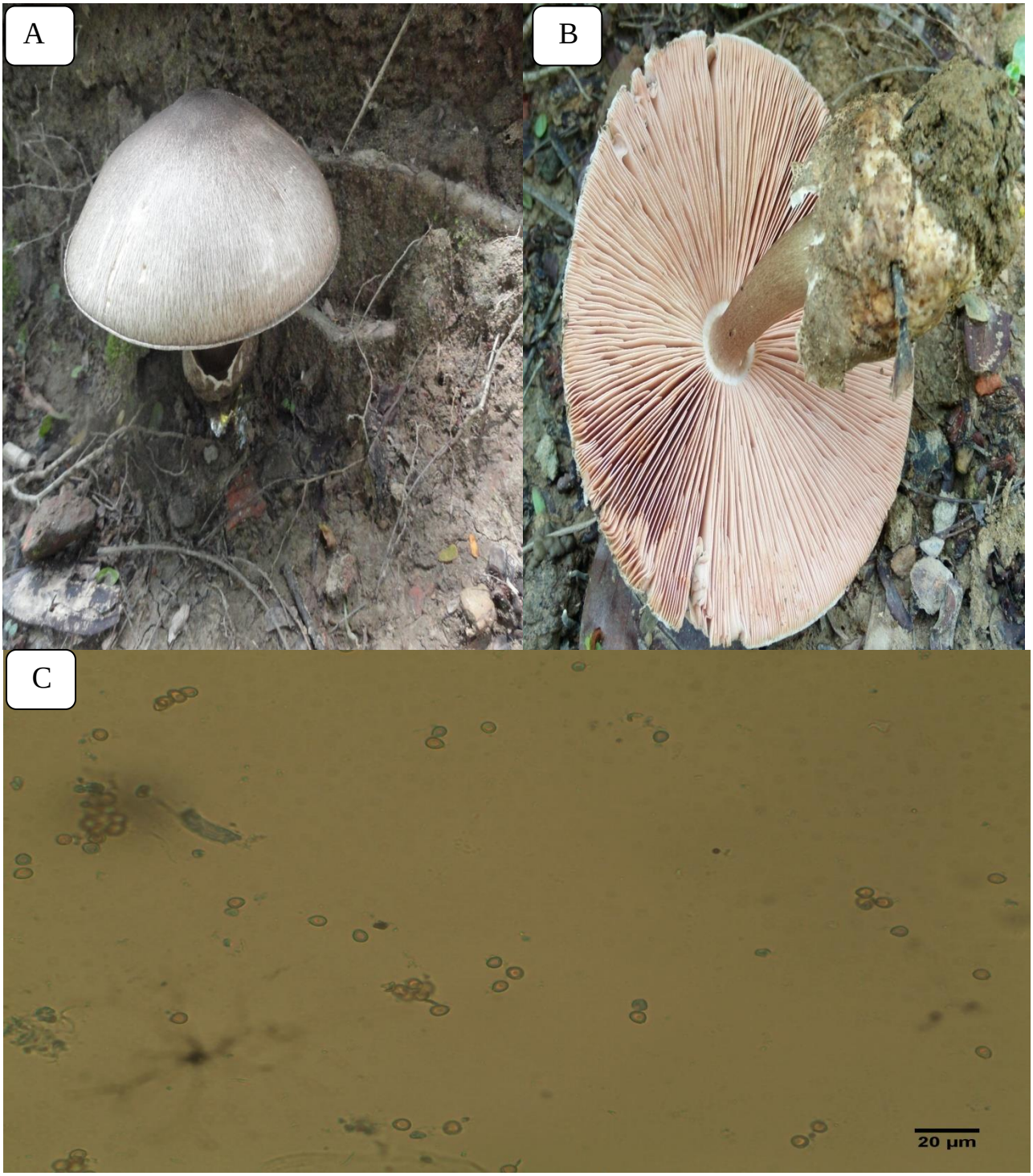

PLATE 10. ***Volvariella bombycina*****;** Mature fruiting body (A), Gills (B), Spores (C).

4.6. Morphology, habitat and biodiversity of *Ganoderma* sp.

4.6.1. *Ganoderma zonatum*

Common name : Lingzhi or Reishi mushroom

Family : Ganodermataceae

Location : Kaptai, Rangamati

Macroscopic character

Pileus shape : Flat , Color : White

Length : 2.5 cm, Width : 2.6 cm

Surface character and zonation : Less dry in nature

Margin : Regular in shape, smooth and round

Texture of the fruiting body : Tough and woody

Spore bearing surface under cap : Pores on hymenium

Pores color : White

Pore spacing : Crowded with micro pores

Stipe : Pesudostipe present

Spore morphology

Spore size (Average): Length : 4.6 μm ; Width: 3.1 μm

Spore shape : Moderately thick walled, smooth and oval, Color : Hyaline and Brown

Ecological features

Habitat : On the root of the Teak/Segun(*Tectona grandis*) tree. Habit : Solitary and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was less moist weather.

Biodiversity : *Ganoderma zonatum* was found in Rangamati of Chittagong hill tracts. Only one number of mushrooms were found during collection.The frequency of its presence was 11.11% and the density was 2.78%.

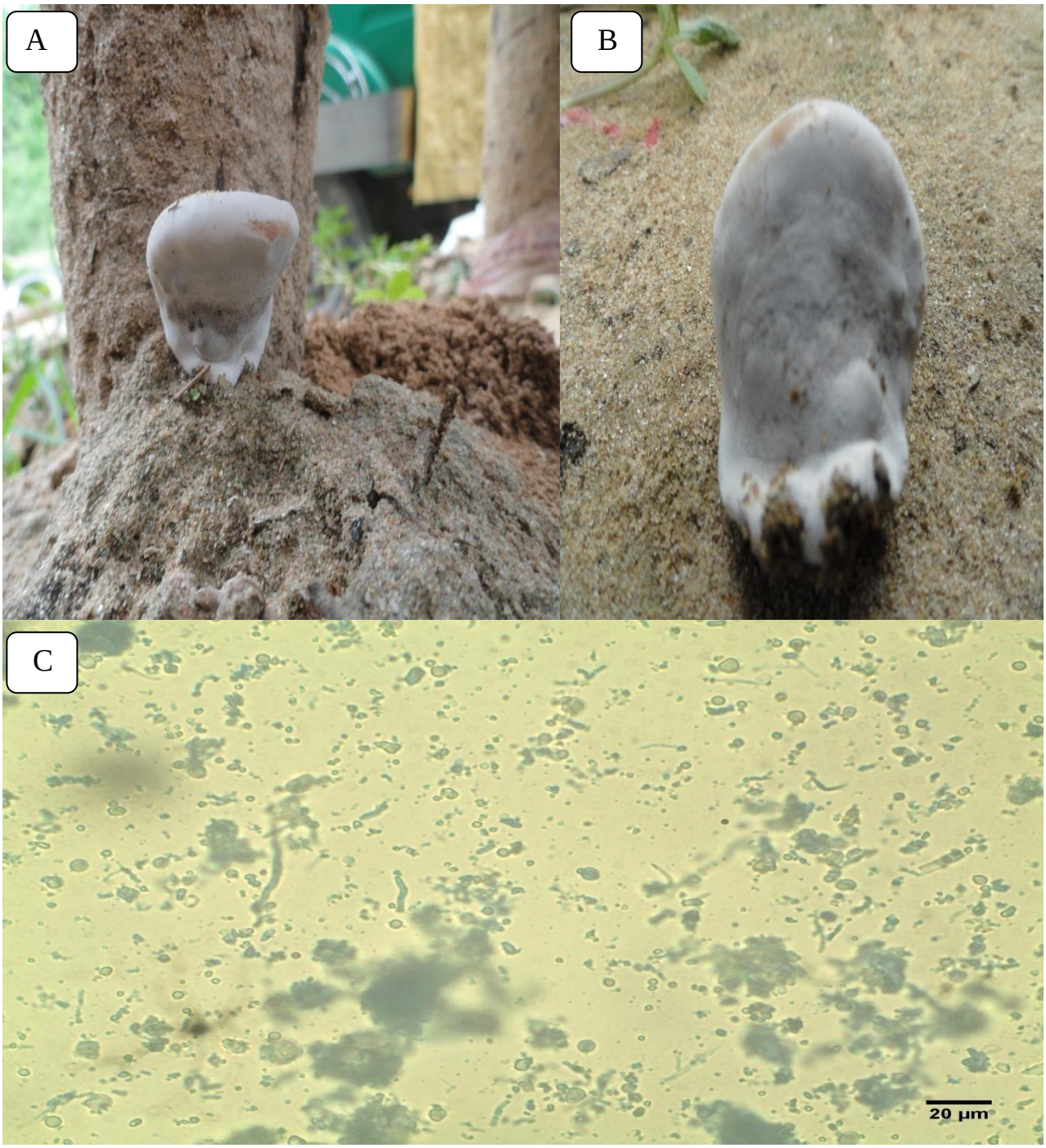

PLATE 11. ***Ganoderma zonatum*;** Mature fruiting body (A), Pores (B), Spores (C).

4.6.2. *Ganoderma* sp.

Family : Ganodermataceae

Location : Lama and Ruma, Bandarban

Macroscopic character

Pileus shape : Flat, Color : White and brown

Length : 6.5 cm, Width : 4.0 cm

Surface character and zonation : Dry in nature

Margin : Irregular in shape and scale with wavy margin

Texture of the fruiting body : Tough, Brittle and woody

Spore bearing surface under cap : Pores on hymenium

Pores color : White

Pore spacing : Crowded micro pores

Stipe : Absent

Spore morphology

Spore size (Average): Length : 6.3 μm ; Width: 5.2 μm

Spore shape : Moderately thick walled, smooth and oval, Color : Black and Brown

Ecological features

Habitat : On the root of the Teak/Segun (*Tectona grandis*) tree. Habit : Scolitary and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to clay loamy; factor affecting their distribution was moderately moist weather.

Biodiversity : *Ganoderma* sp.was found in Bandarban of Chittagong hill tracts. A total four number of mushrooms were found during collection.The frequency of its presence was 22.22% and the density was 11.11%.

PLATE 12. ***Ganoderma*** **sp. ;** Mature fruiting body (A), Pores (B), Spores (C).

4.6.3. *Ganoderma lucidum*

Common name : Lingzi mushroom

Family : Ganodermataceae

Location : Rangunia, Chittagong

Macroscopic character

Pileus shape : Flat , Color : Brick red

Length : 13.o cm, Width : 17.0 cm

Surface character and zonation : Dry in nature

Margin : Irregular and wavy

Texture of the fruiting body : Tough, Brittle and woody

Spore bearing surface under cap : Pores on hymenium

Pores color : White

Pore spacing : Crowded micro pores

Stipe : Present

Spore morphology

Spore size (Average): Length : 8.3 μm ; Width: 6.3 μm

Spore shape : Thick walled, smooth and oval, Color : Deep yellow

Ecological features

Habitat : On the root of the Mahogony (*Macrophyla mahogoni*) tree. Habit : Scolitary and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to clay loam; factor affecting their distribution was less dry weather.

Biodiversity : *Ganoderma lucidum* was found in Chittagong sadar. A total three number of mushrooms were found during collection. The frequency of its presence was 11.11% and the density was 8.33%.

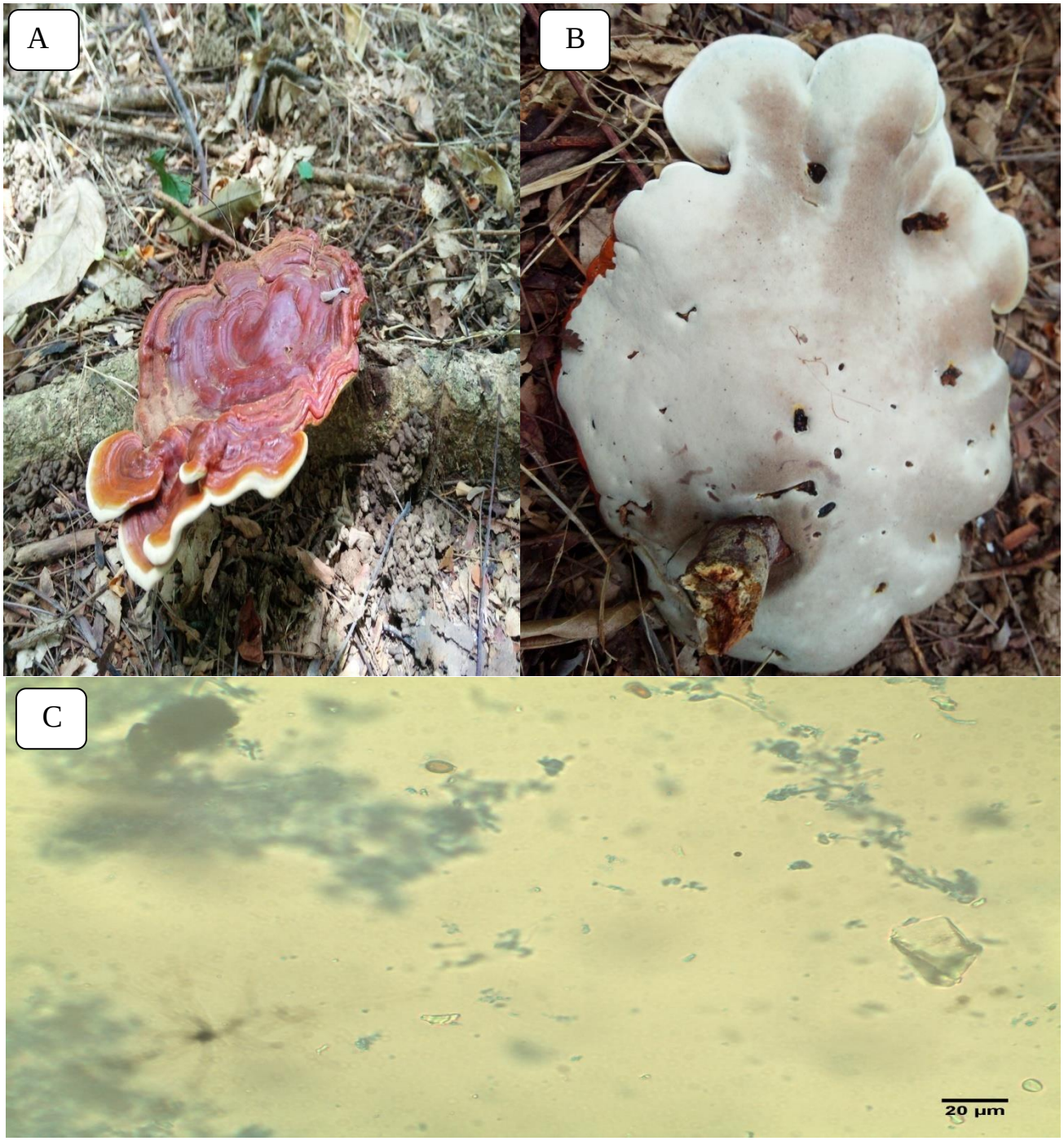

PLATE 13. ***Ganoderma lucidum*;** Mature fruiting body (A), Pores (B), Spores (C).

4.7. Morphology, habitat and biodiversity of *Marasmius* sp.

4.7.1. *Marasmius rotula*

Common name : The pinwheel mushroom, the pinwheel marasmius, the little wheel, the collared parachute, or the horse hair fungus.

Family : Marasmiaceae

Location : Kaptai, Rangamati

Macroscopic character

Pileus shape : Ovate, Color : Milky white

Length : 2.5 cm, Width : 0.6 cm

Surface character and zonation : Less moist in nature

Margin : Regular in shape ,crenate and wavy margin

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Split-gills

Gills color : White

Gills spacing : Distant

Stipe : Present

Spore morphology

Spore size (Average): Length : 11.3 µm ; Width: 6.7 µm

Spore shape : Thick walled, smooth and ellipsoid, Color : Black and Brown

Ecological features

Habitat : On the soil surface. Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to clay loam; factor affecting their distribution was less moist weather.

Biodiversity : *Marasmius rotula* was found in Rangamati of Chittagong hill tracts. A total three number of mushroomswere found during collection. The frequency of its presence was 11.11% and the density was 8.33%.

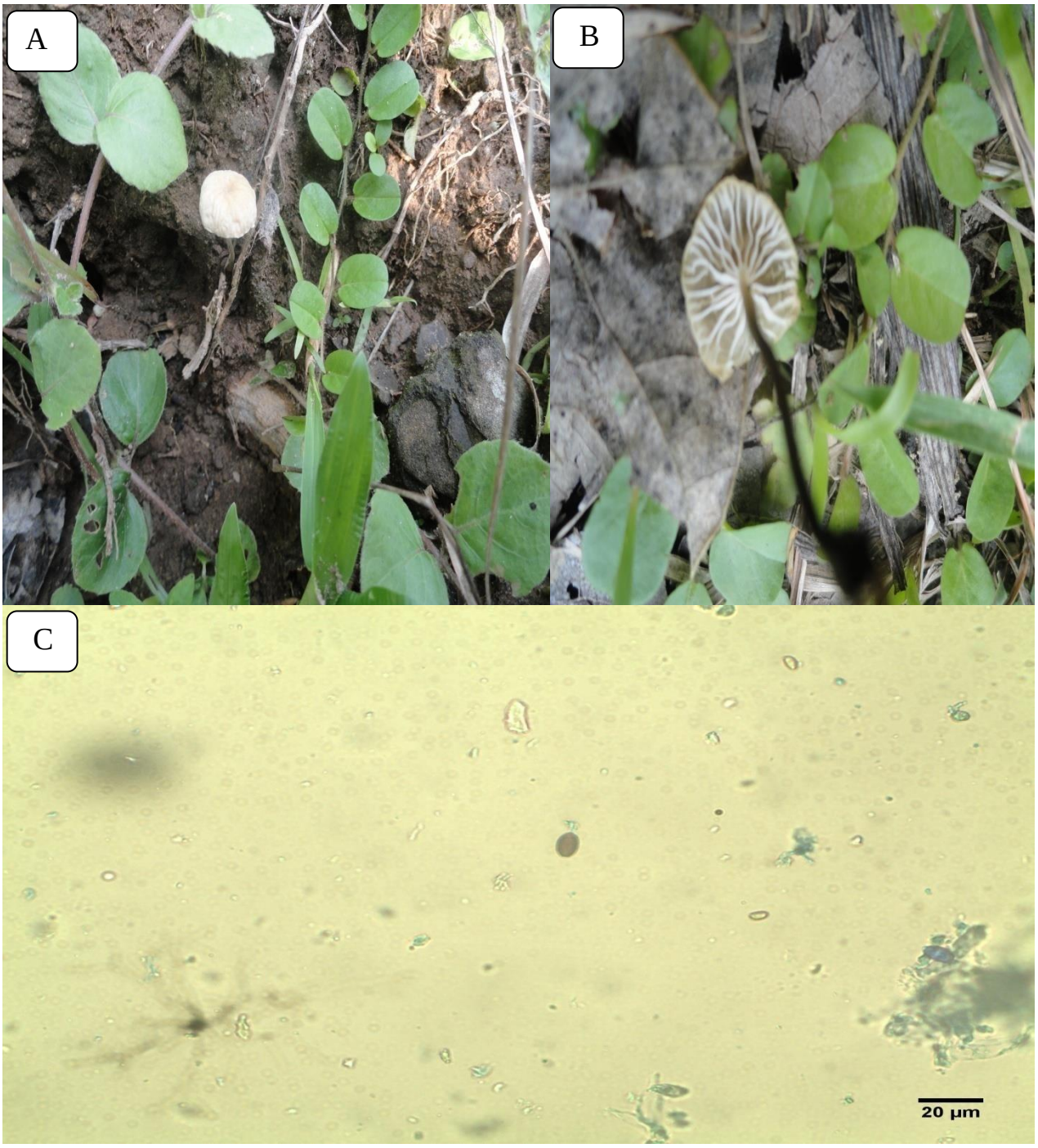

PLATE 14. ***Marasmius rotula*****;** Mature fruiting body (A), Gills (B), Spores (C).

4.8. Morphology, habitat and biodiversity *Marasmiellus* sp.

4.8.1 *Marasmiellus candidus*

Family : Marasmiaceae
Location : Matiranga ,Khagrachari

Macroscopic character

Pileus shape : Ovate, Color : White

Length : 1.1 to 1.1 cm, Width : 0.7 to 1.0 cm

Surface character and zonation : Smooth and Less dry in nature

Margin : Regular in shape and wavy margin

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Split-gills

Gills color : White

Gills spacing : Distant and split

Stipe : Present

Spore morphology

Spore size (Average): Length : 4.8 μm ; Width: 4.6 μm

Spore shape : Moderately thick walled, smooth and round, Color : Brown

Ecological features

Habitat : On the root of the Sisso (*Dalbergia sisso*) tree. Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was clay to clay loam; factor affecting their distribution was moderately moist weather.

Biodiversity : *Marasmiellus candidus* was found in Khagrachari of Chittagong hill tracts. A total five number of mushrooms were found during collection. The frequency of its presence was 22.22% and the density was 13.89%.

PLATE 15. ***Marasmiellus candidus*;** Mature fruiting body (A), Gills (B), Spores (C)

4.8.2. *Marasmiellus* sp.

Family : Marasmiaceae

Location : Chittagong University Campus, Chittagong

Macroscopic character

Pileus shape : Convex, Color : Dark bown
Length : 1.8 to 2.1 cm, Width : 1.0 to 1.2 cm
Surface character and zonation : Smooth and less moist in nature
Margin : Regular in shape and round
Texture of the fruiting body : Soft and spongy
Spore bearing surface under cap : Split-gills
Gills color : Light yellow
Gills spacing : Distant
Stipe : Present

Spore morphology

Spore size(Average) : Length : 5.2 μm ; Width: 4.8 μm

Spore shape : Moderately thick walled, smooth and round, Color : Brown

Ecological features

Habitat : On the root of the *Chapalish tree* (*Artocarpus chaplasha*) tree. Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was moderately moist weather.

Biodiversity : *Marasmiellus* sp. was found in Chittagong Sadar. A total three number of mushrooms were found during collection. The frequency of its presence was 11.11% and the density was 8.33%.

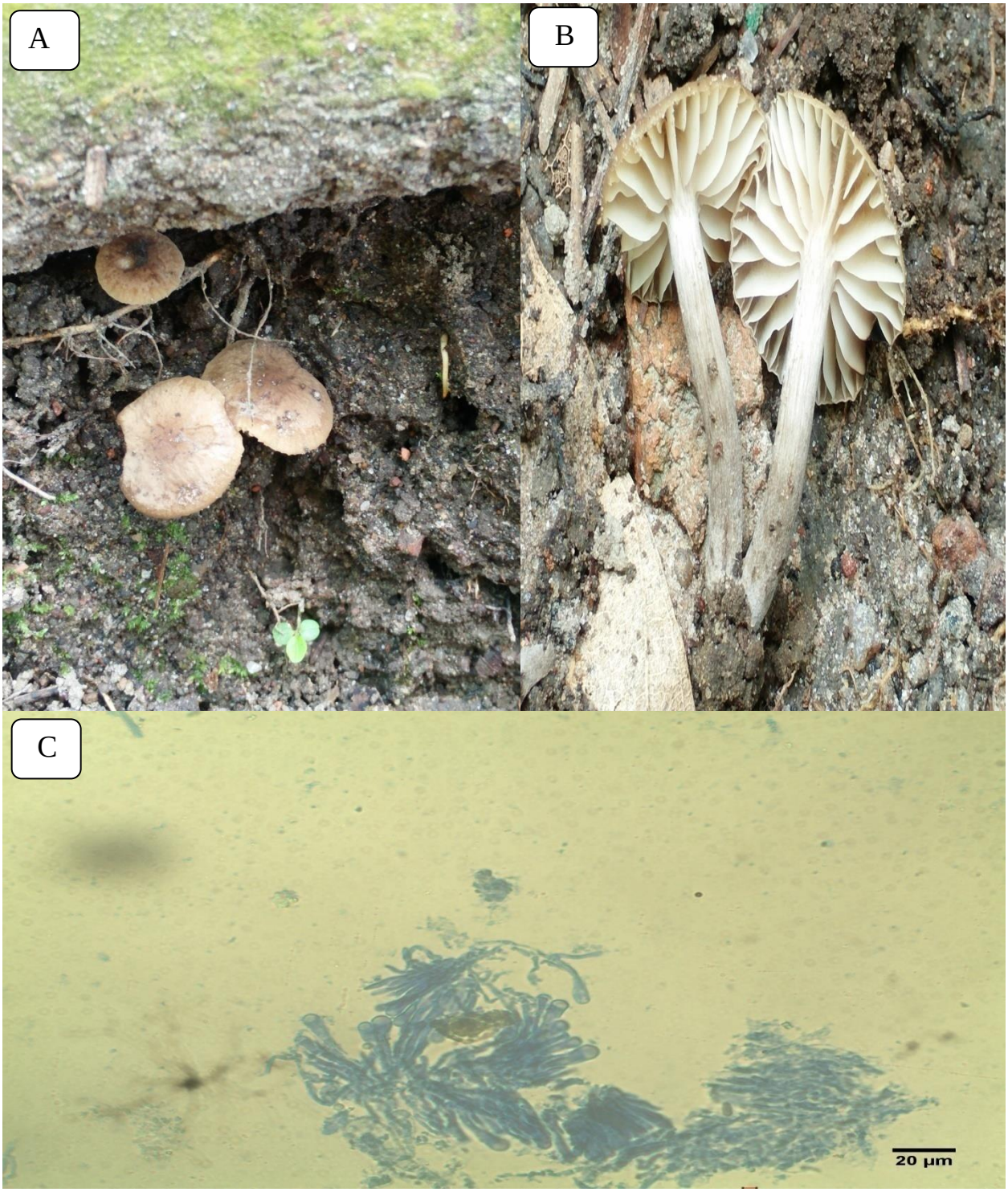

PLATE 16. ***Marasmiellus*** **sp.;** Mature fruiting body (A), Gills (B), Spores (C).

4.9. Morphology, habitat and biodiversity *Polyporus* sp.

4.9.1. *Polyporus arcularius*

Common name : Spring polypore.

Family : Polyporaceae

Location : Kaptai, Rangamati

Macroscopic character

Pileus shape : Flat, Color : Light brown

Length : 2.5 cm, Width : 1.5 cm

Surface character and zonation : Rough and less dry in nature

Margin : Regular in shape and wavy

Texture of the fruiting body : Tough and Brittle

Spore bearing surface under cap : Pores on hymenium

Pores color : Light brown

Pore spacing : Macro pores are not crowded

Stipe : Present

Spore morphology

Spore size (Average): Length : 10.4 µm ; Width: 6.3 µm

Spore shape : Single walled, rough and oval, Color : Brown

Ecological features

Habitat : On the root of the Koroi (*Albizzia procera*) tree. Habit : Solitary and constancy of occurrence in specific habitat was not abundant. Type of soil was clay to clay loam; factor affecting their distribution was less moist weather.

Biodiversity : *Polyporus arcularius* was found in Rangamati of Chittagong hill tracts. Only one number of mushrooms were found during collection.The frequency of its presence was 11.11% and the density was 2.78%.

PLATE 17. ***Polyporus arcularius*;** Mature fruiting body (A), Pores (B), Spores (C).

4.10. Morphology, habitat and biodiversity of *Microporus* sp.

4.10.1. *Microporus xanthopus*

Common name : Yellow-footed Tinypore

Family : Polyporaceae

Location : Chittagong University Campus and Rangunia, Chittagong

Macroscopic character

Pileus shape : Funnel shaped, Color : Brown and white

Length : 1.5 cm, Width : 1.0 cm

Surface character and zonation : Smooth and dry in nature

Margin : Regular in shape and wavy white margin

Texture of the fruiting body : Tough, brittle and woody

Spore bearing surface under cap : Pores on hymenium

Pores color : White

Pore spacing : Crowded micro pores

Stipe : Present

Spore morphology

Spore size (Average) : Length : 10.6 μm ; Width: 8.4 μm

Spore shape : Thick walled, smooth and oval, Color : Brown

Ecological features

Habitat : On the root of the Rain tree (*Albizia lebbeck*). Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was less moist weather.

Biodiversity : *Microporus xanthopus* was found in Chittagong Sadar . A total six number of mushrooms were found during collection. The frequency of its presence was 22.22% and the density was 16.67%.

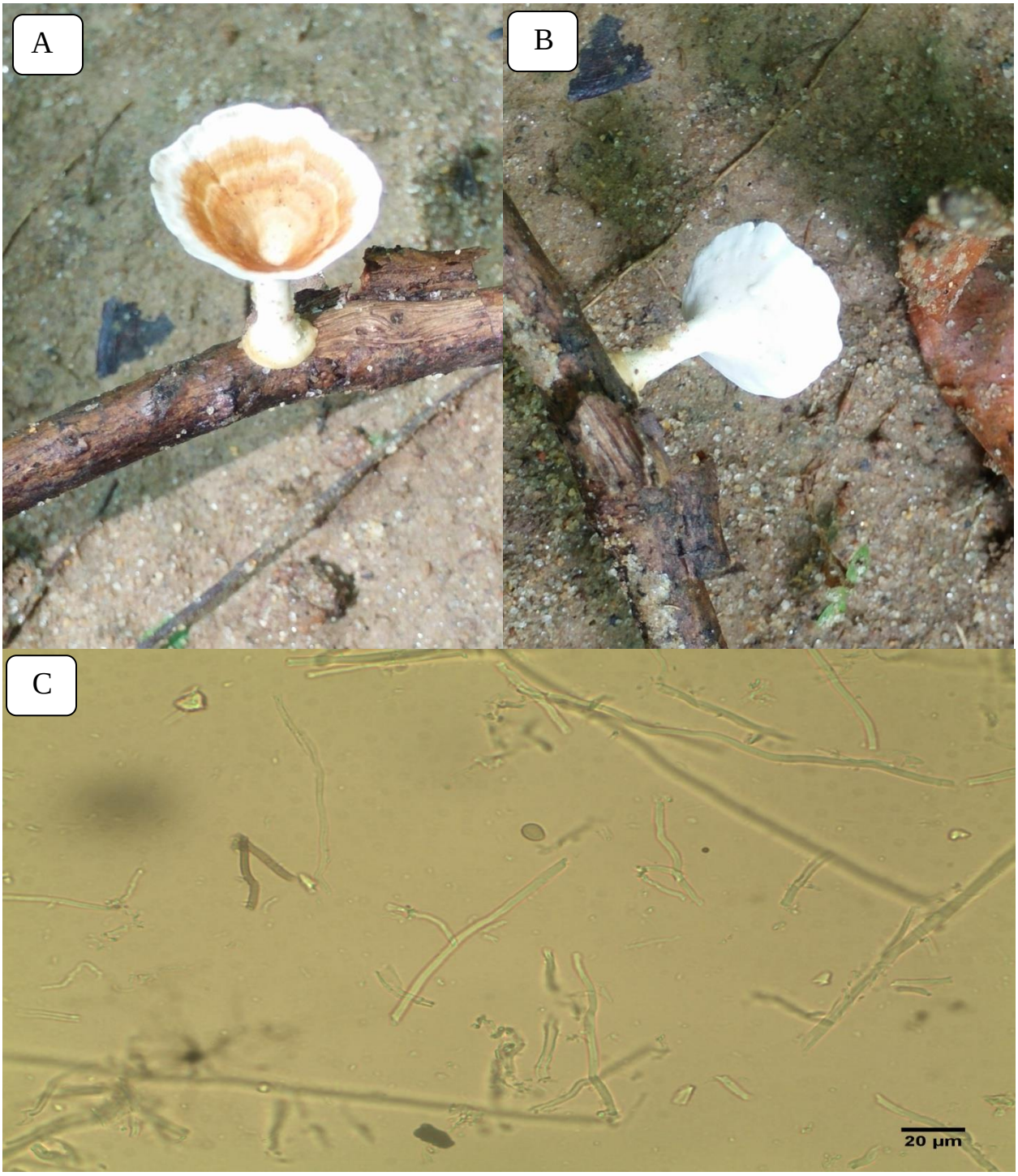

PLATE 18; ***Microporus xanthopus*****;** Mature fruiting body (A), Pores (B), Spores (C).

4.10.2. *Cerrena unicolor*

Common name : The mossy maze polypore
Family : Polyporaceae
Location : Kaptai and Kawkhali, Rangamati

Macroscopic character

Pileus shape : Flat, Color : Green and brown

Length : 2.6 to 3.5 cm, Width : 4.3 to 7.0 cm

Surface character and zonation : Rough and less dry in nature

Margin : Regular in shape and wavy green margin

Texture of the fruiting body : Tough and woody

Spore bearing surface under cap : Pores on hymenium

Pores color : Brown

Pore spacing : Crowded with micro pores

Stipe : Absent

Spore morphology

Spore size (Average): Length : 7.4 μm ; Width: 4.2 μm

Spore shape : Moderately thick walled, smooth and ellipsoid Color : Deep yellow

Ecological features

Habitat : On the root of the Sisso (*Dalbergia sisso*) tree. Habit : Clustered and constancy of occurrence in specific habitat was abundant. Type of soil was sandy to clay loamy; factor affecting their distribution was moderately moist weather.

Biodiversity : *Cerrena unicolor* was found in Rangamati of Chittagong hill tracts. A total ten number of mushrooms were found during collection.The frequency of its presence was 22.22% and the density was 27.78%.

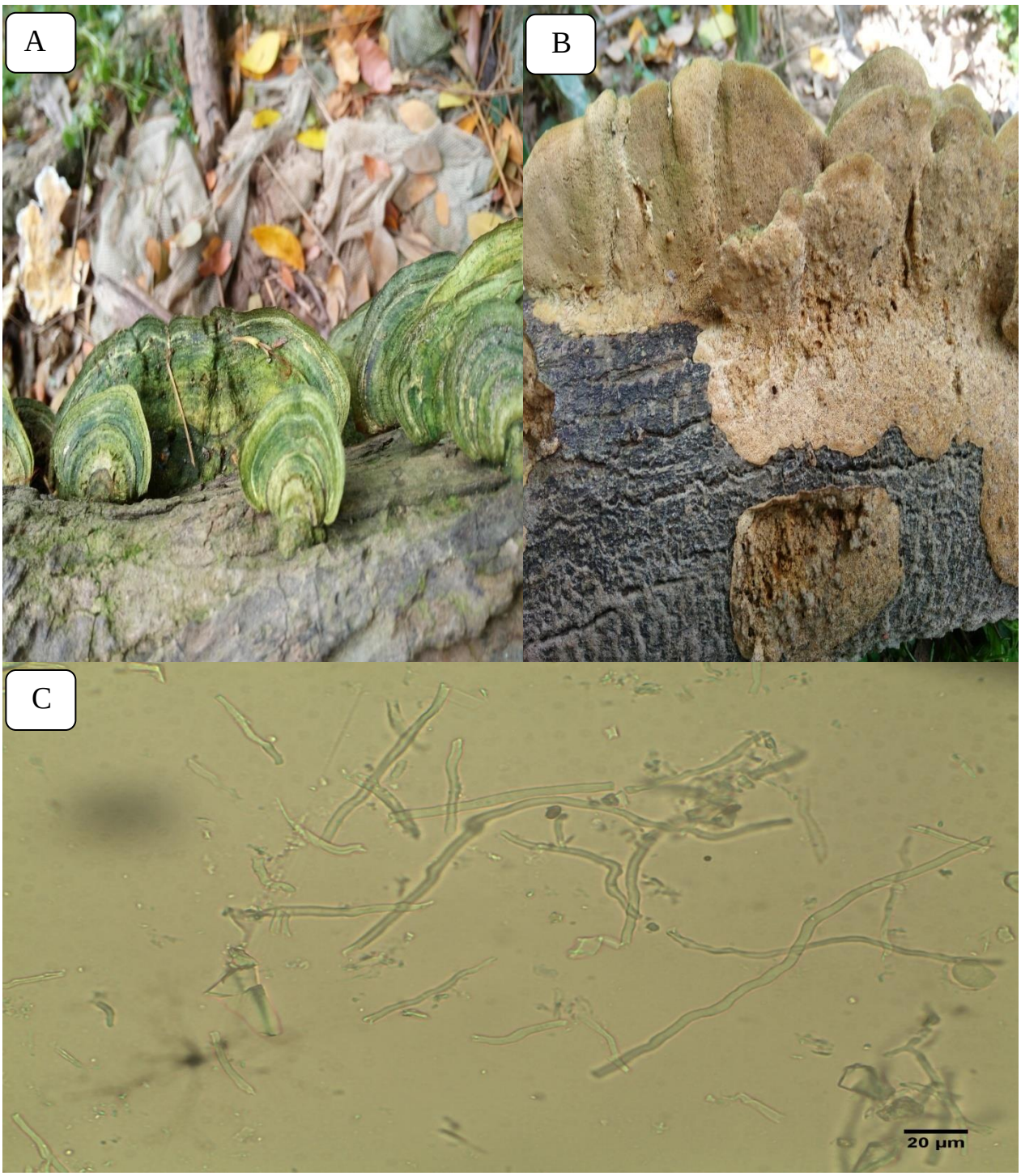

PLATE 19. ***Cerrena unicolor*****;** Mature fruiting body (A), Pores (B), Spores (C).

4.10.3. *Trametes* sp.

Family : Polyporaceae

Location : Kaptai, Rangamati

Macroscopic character

Pileus shape : Flat, Color : white and brick red

Length : 5.8 to 8.5 cm, Width : 3.9 to 4.5 cm

Surface character and zonation : Leathery and less moist in nature

Margin : Irregular in shape and wavy margin

Texture of the fruiting body : Tough and Brittle

Spore bearing surface under cap : Pores on hymenium

Pores color : White

Pore spacing : Crowded macro proes

Stipe :

Spore morphology

Spore size (Average) : Length : 12.3 μm ; Width: 8.6 μm

Spore shape : Single walled, rough and oval, Color : Brown and light yellow

Ecological features

Habitat : On the root of the Rain tree (*Albizia lebbeck*). Habit : Scattered and constancy of occurrence in specific habitat was abundant. Type of soil was clay to clay loamy; factor affecting their distribution was moderately moist weather.

Biodiversity : *Trametes* sp. was found in Rangmati of Chittagong hill tracts. A total five number of mushrooms were found during collection.The frequency of its presence was 22.22% and the density was 13.89%.

PLATE 20.*Trametes* sp. ; Mature fruiting body (A), Pores (B), Spores (C).

4.11. Morphology, habitat and biodiversity of *Xylaria* sp.

4.11.1. *Xylaria hypoxylon*

Common name : The candlestick fungus, the candlesnuff fungus, carbon antlers,or the stag's horn fungus
Family : Xylariaceae
Location : Kaptai, Manikchhari and Lama

Macroscopic character

Pileus shape : Finger like , Color : Brown and white

Length : 3.8 to 6.0 cm, Width : 0.3 to 0.6 cm

Surface character and zonation : Smooth, glabrous and less moist in nature

Margin : Absent

Texture of the fruiting body : Tough and Brittle

Spore bearing surface under cap : Pores on hymenium

Pores color : White

Pore spacing : Crowded micro pores

Spore morphology

Spore size (Average): Length : 16.1 μm ; Width: 12.1 μm

Spore shape : Moderately thick walled, smooth and round, Color : Light Brown

Ecological features

Habitat : On the root of the Mahogony (*Macrophyla mahogoni*) tree. Habit : Scattered and constancy of occurrence in specific habitat was abundant. Type of soil was clay to clay loam; factor affecting their distribution was moderately moist weather.

Biodiversity : *Xylaria hypoxylon* was found in Rangamati, Khagrachori, Bandarban A total ten number of mushrooms were found during collection. The frequency of its presence was 33.33% and the density was 27.78%.

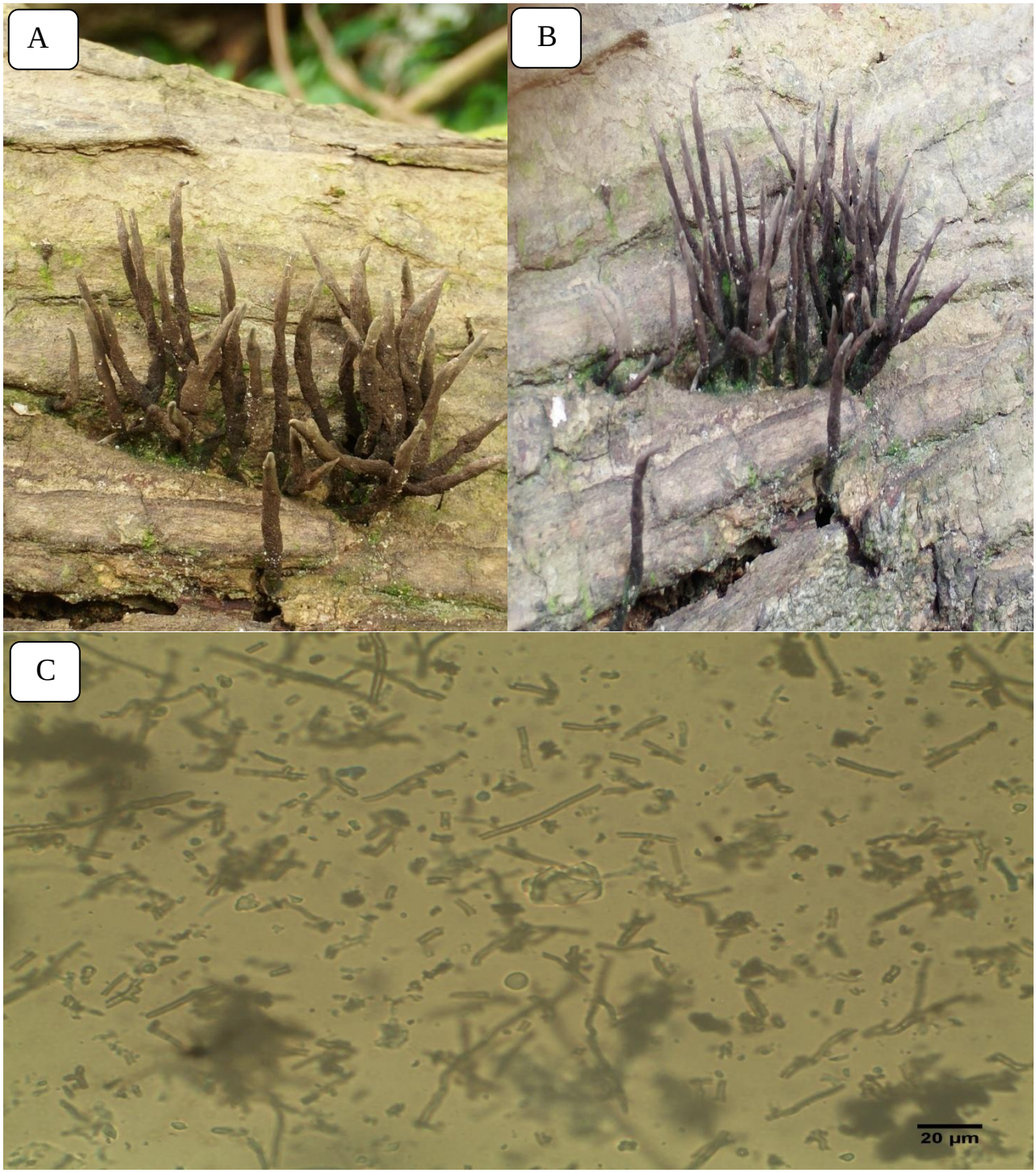

PLATE 21. ***Xylaria hypoxylon*;** Mature fruiting body (A,B), Spores (C).

4.11.2. *Xylaria polymorpha*

Common name : Dead man's fingers

Family : Xylariaceae

Location : Rangunia, Kaptai, Manikchhari and Ruma

Macroscopic character

Pileus shape : Finger like , Color : Black

Length : 1.8 to 2.5 cm, Width : 0.3 to 0.5 cm

Surface character and zonation : Smooth and less dry in nature

Margin : absent

Texture of the fruiting body : Tough and Brittle

Spore bearing surface under cap : Pores on hymenium

Pores color : Black

Pore spacing : Crowded with micro pores

Spore morphology

Spore size (Average): Length : 8.3 μm ; Width: 8.1 μm

Spore shape : Moderately thick walled, smooth and ellipsoid, Color : Light and deep Brown

Ecological features

Habitat : On the root of the Sisso (*Dalbergia sisso*) tree. Habit : Scattered and constancy of occurrence in specific habitat was abundant. Type of soil was clay to clay loam; factor affecting their distribution was moderately moist weather.

Biodiversity : *Xylaria polymorpha* was found in different location of Chittagong hill tracts. A total twenty number of mushroomswere found during collection.The frequency of its presence was 44.44% and the density was 55.56%.

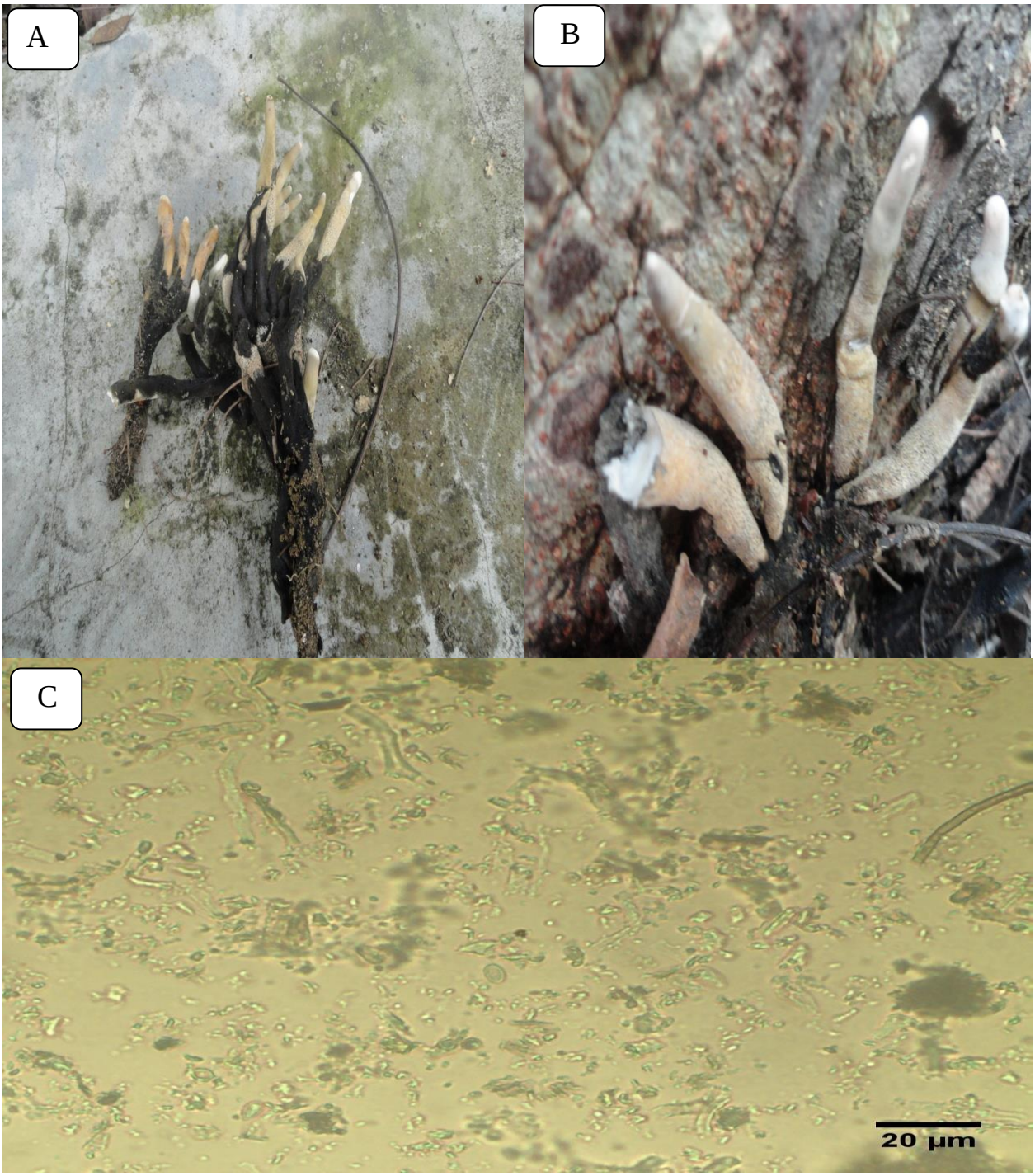

PLATE 22. ***Xylaria polymorpha;*** Mature fruiting body (A,B), Spores (C).

4.12. Morphology, habitat and biodiversity *Parasola* sp.

4.12.1. *Parasola lactea*

Family : Psathyrellaceae
Location : Lama, Bandarban

Macroscopic character

Pileus shape : Flat, Color : Light blue

Length : 3.7 to 5.0 cm, Width : 2.1 to 2.5 cm

Surface character and zonation : Rough and less dry in nature

Margin : Regular in shape and wavy

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Black and brown

Gills spacing : Less crowded and distant

Stipe : Present

Spore morphology

Spore size (Average): Length :9.8 μm ; Width: 4.7 μm

Spore shape : Thick walled, smooth and oval, Color : Black and deep yellow

Ecological features

Habitat : On the root of the Gamari (*Gmelina arborea*) tree. Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil wassandy to sandy loamy; factor affecting their distribution was less moist weather.

Biodiversity : *Parasola lacteal* was found in Bandarban of Chittagong hill tracts. Only two number of mushroomswere found during collection. The frequency of its presence was 11.11% and the density was 5.56%.

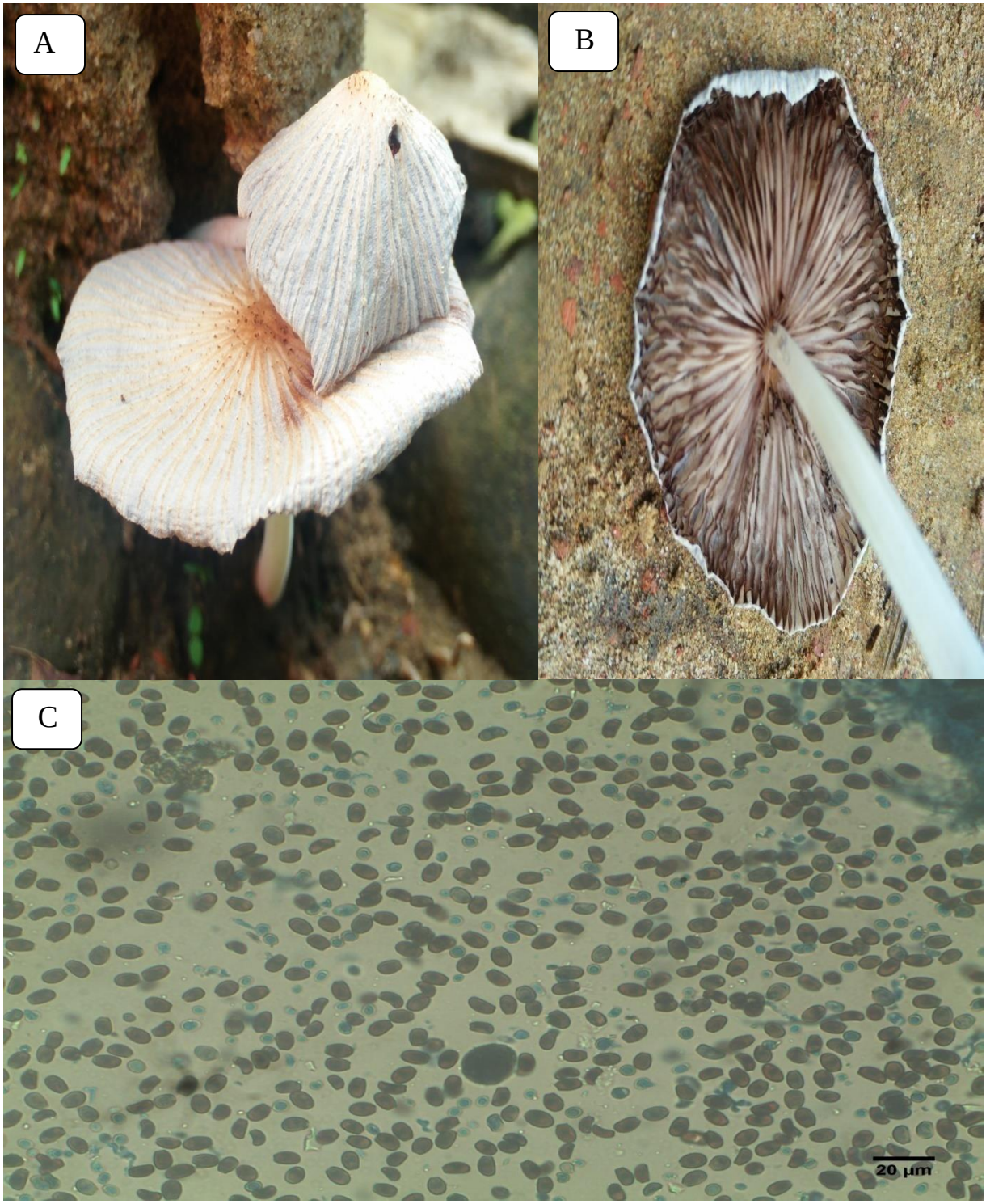

PLATE 23. ***Parasola lactea*;** Mature fruiting body (A), Gills (B), Spores (C).

4.13. Morphology, habitat and biodiversity *Coprinellus* sp.

4.13.1 *Coprinellus domesticus*

Common name : The firerug inkcap

Family : Psathyrellaceae

Location : Kaptai, Rangamati

Macroscopic character

Pileus shape : Convex, Color : Brown with brick red color in top of the cap

Length : 2.8 to 3.6 cm, Width : 1.3 to 1.9 cm

Surface character and zonation : Smooth, glabrous and less dry in nature

Margin : Regular in shape

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Light creamy

Gills spacing : less crowded and distant

Stipe : Present

Spore morphology

Spore size (Average): Length : 10.1 μm ; Width: 6.2 μm

Spore shape : Thick walled, smooth, oval and ellipsoid, Color : Brown

Ecological features

Habitat : On the soil surface. Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was less moist weather.

Biodiversity : *Coprinellus domesticus* was found in Rangamati of Chittagong hill tracts. Only one number of mushroomswere found during collection.The frequency of its presence was 11.11% and the density was 2.78%.

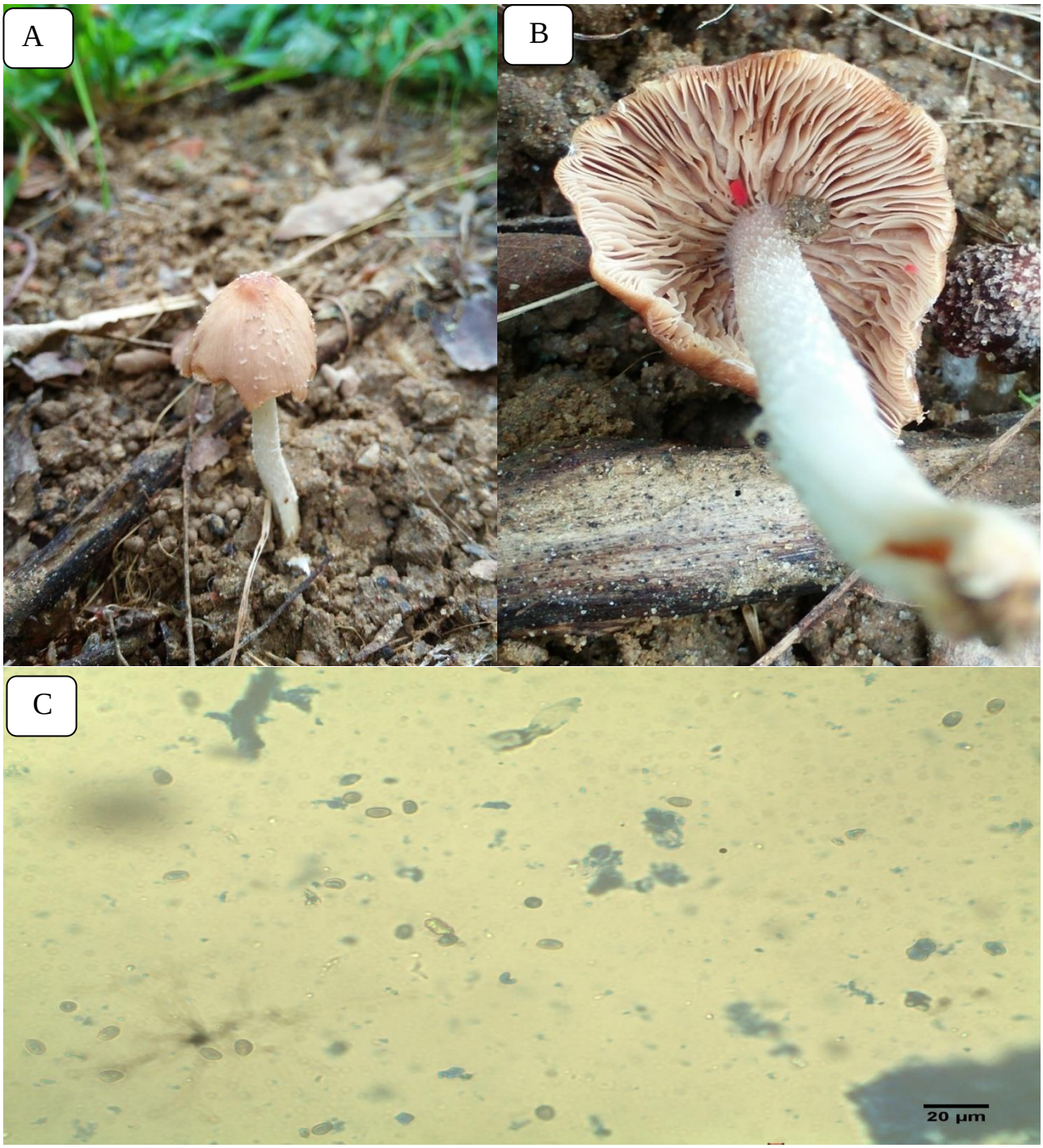

PLATE 24. ***Coprinellus domesticus*****;** Mature fruiting body (A), Gills (B), Spores (C).

4.14. Morphology, habitat and biodiversity of *Russula* sp.

4.14.1 *Russula emetica*

Common name : The sickener, emetic russula, or vomiting russula

Family : Russulaceae

Location : Chittagong University Campus, Chittagong

Macroscopic character

Pileus shape : Flat , Color : Brick red

Length : 5.0 cm, Width : 4.0 cm

Surface character and zonation : Smooth, glabrous and less dry in nature

Margin : Regular in shape and wavy

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : White

Gills spacing : Less crowded and distant

Stipe : Present

Spore morphology

Spore size (Average): Length : 9.7 μm ; Width: 5.4 μm

Spore shape :Thick walled, rough and oval, Color : Brown

Ecological features

Habitat : On the soil surface. Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was less moist weather.

Biodiversity : *Russula emetic* was found in Chittagong Sadar. A total eight number of mushroomswere found during collection.The frequency of its presence was 11.11% and the density was 22.22%.

PLATE 25. ***Russula emetica*****;** Mature fruiting body (A), Gills (B), Spores (C).

4.15. Morphology, habitat and biodiversity of *Amanita* sp.

4.15.1. *Amanita flavoconia*

Common name : Yellow patches, yellow wart, orange Amanita, or yellow-dust Amanita

Family : Amanitaceae

Location : Matiranga Khagrachari,

Macroscopic character

Pileus shape : Convex and Ovate, Color : Yellow

Length : 5.0 cm, Width : 2.8 cm

Surface character and zonation : Less dry in nature

Margin : Regular in shape

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Yellow

Gills spacing : Less crowded and distant

Stipe : Present

Spore morphology

Spore size (Average): Length : 16.2 μm ; Width: 13.4 μm

Spore shape : Single walled, rough and oval, Color : Brown

Ecological features

Habitat : On the soil surface ; Habit : Solitary and constancy of occurrence in specific habitat was unabundant. Type of soil was sandy to clay loam; factor affecting their distribution was moderately moist weather.

Biodiversity : *Amanita flavoconia* was found in Khagrachari of Chittagong hill tracts. Only one number of mushrooms were found during collection.The frequency of its presence was 11.11% and the density was 2.78%.

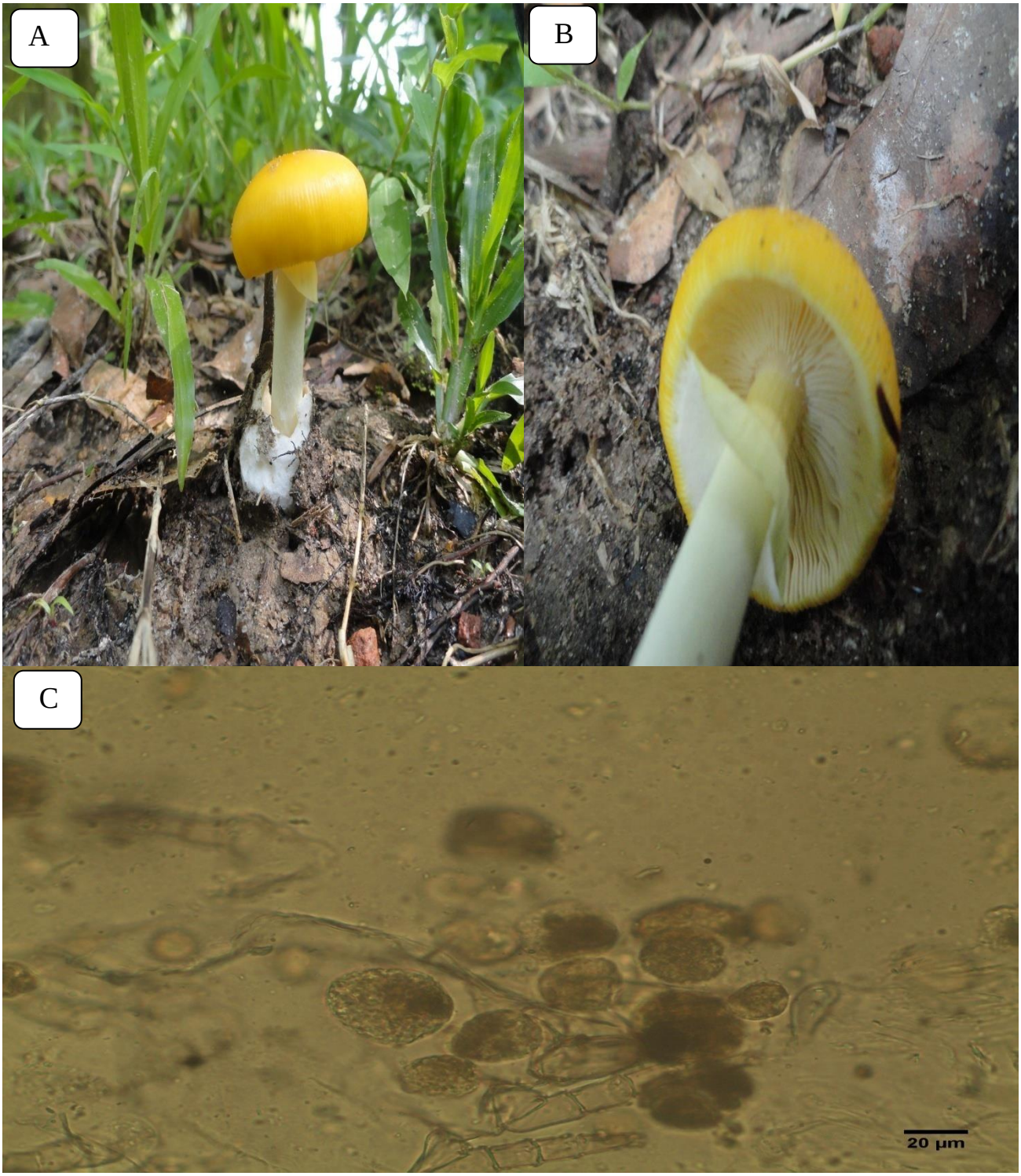

PLATE 26. ***Amanita flavoconia*****;** Mature fruiting body (A), Gills (B), Spores (C).

4.16. Morphology, habitat and biodiversity of *Auricularia* sp.

4.16.1. *Auricularia cornea*

Common name : The Jew's ear, wood ear, jelly ear

Family : Auriculariaceae

Location : Kaptai and Kawkhali, Rangamati

Macroscopic character

Pileus shape : Ear like , Color : Purple

Length : 1.8 to 2.3 cm, Width : 1.2 to 2.1 cm

Surface character and zonation : Moist in nature

Margin : Irregular in shape

Texture of the fruiting body : Jelly, soft and also spongy

Spore bearing surface under cap : Pores on hymenium

Pores color : Purple

Pore spacing : Extremely crowded

Stipe : Pseudostipe present attached with host

Spore morphology

Spore size (Average): Length : 11.4 μm ; Width: 8.2 μm

Spore shape : Moderately thick walled, smooth and oval, Color : Dark Brown

Ecological features

Habitat : On the root of Bamboo (*Bambusa vulgaris*) tree. Habit : Clustered and constancy of occurrence in specific habitat was not abundant. Type of soil was clay to clay loam; factor affecting their distribution was moderately moist weather.

Biodiversity : *Auricularia cornea* was found in rangamati of Chittagong hill tarcts. A total fourteen number of mushrooms were found during collection. The frequency of its presence was 22.22% and the density was 38.89%.

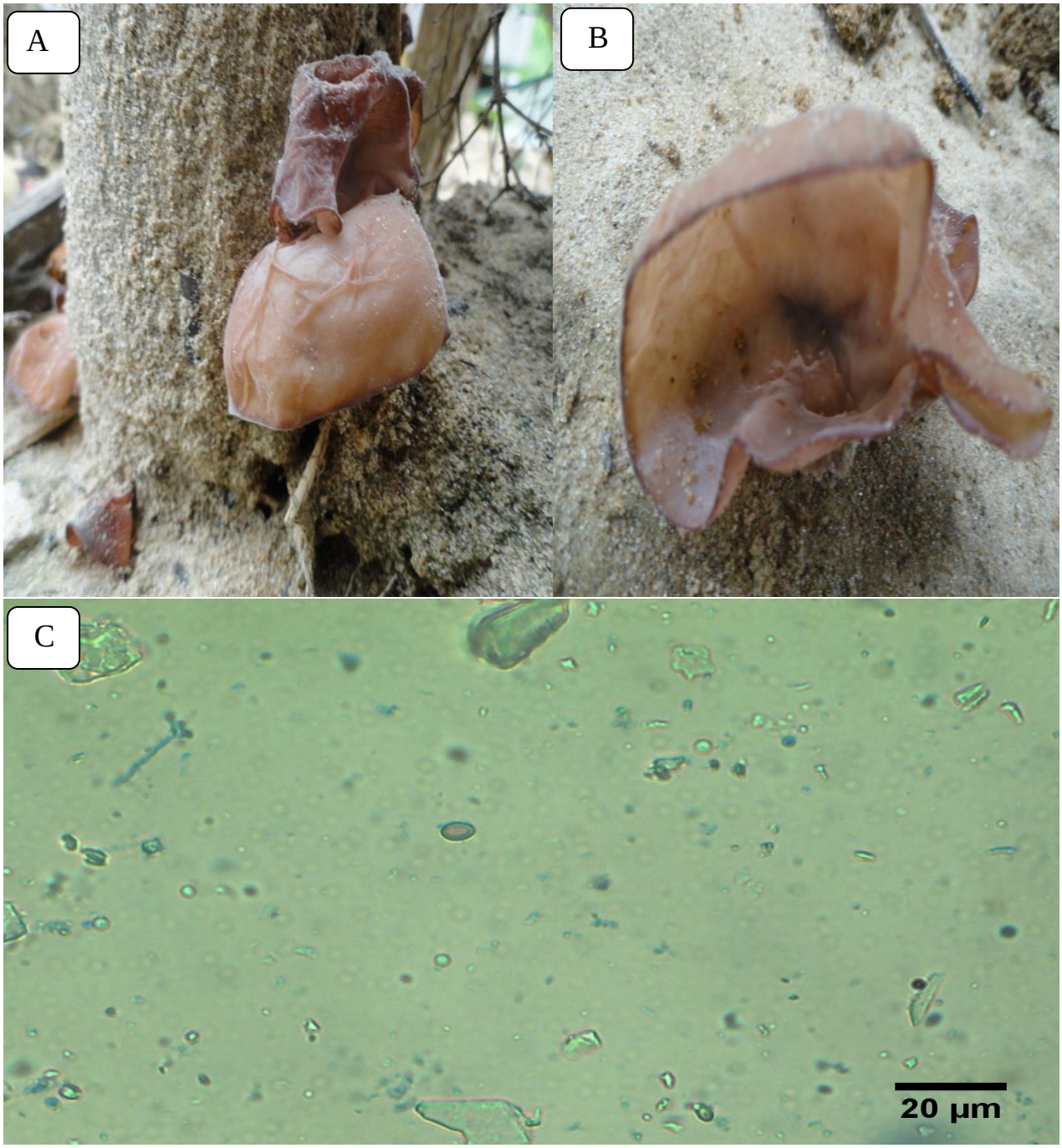

PLATE 27. ***Auricularia cornea*****;** Mature fruiting body (A), Pores (B), Spores (C).

4.17. Morphology, habitat and biodiversity of *Clitopilus* sp.

4.17.1. *Clitopilus prunulus*

Common name : The miller or the sweetbread mushroom
Family : Entolomataceae
Location : Kaptai, Rangamati

Macroscopic character

Pileus shape : Umbilicate, Color : Milky white

Length : 3.3 to 4 cm, Width : 2.4 to 3.1 cm

Surface character and zonation : Moist in nature

Margin : Regular in shape

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Milky white

Gills spacing : Less crowded and spacing

Stipe : Present with light brown color and also powdery substance present

Spore morphology

Spore size (Average): Length : 9.2 μm ; Width: 7.3 μm

Spore shape : Single walled, rough and oval, Color : Brown and hyaline

Ecological features

Habitat : On the soil surface. Habit : Clustered and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to clay loam; factor affecting their distribution was less moist weather.

Biodiversity : *Clitopilus prunulus* was found in Rangamati of Chittagong hill tarcts. A total five number of mushroomswere found during collection.The frequency of its presence was 11.11% and the density was 13.89%.

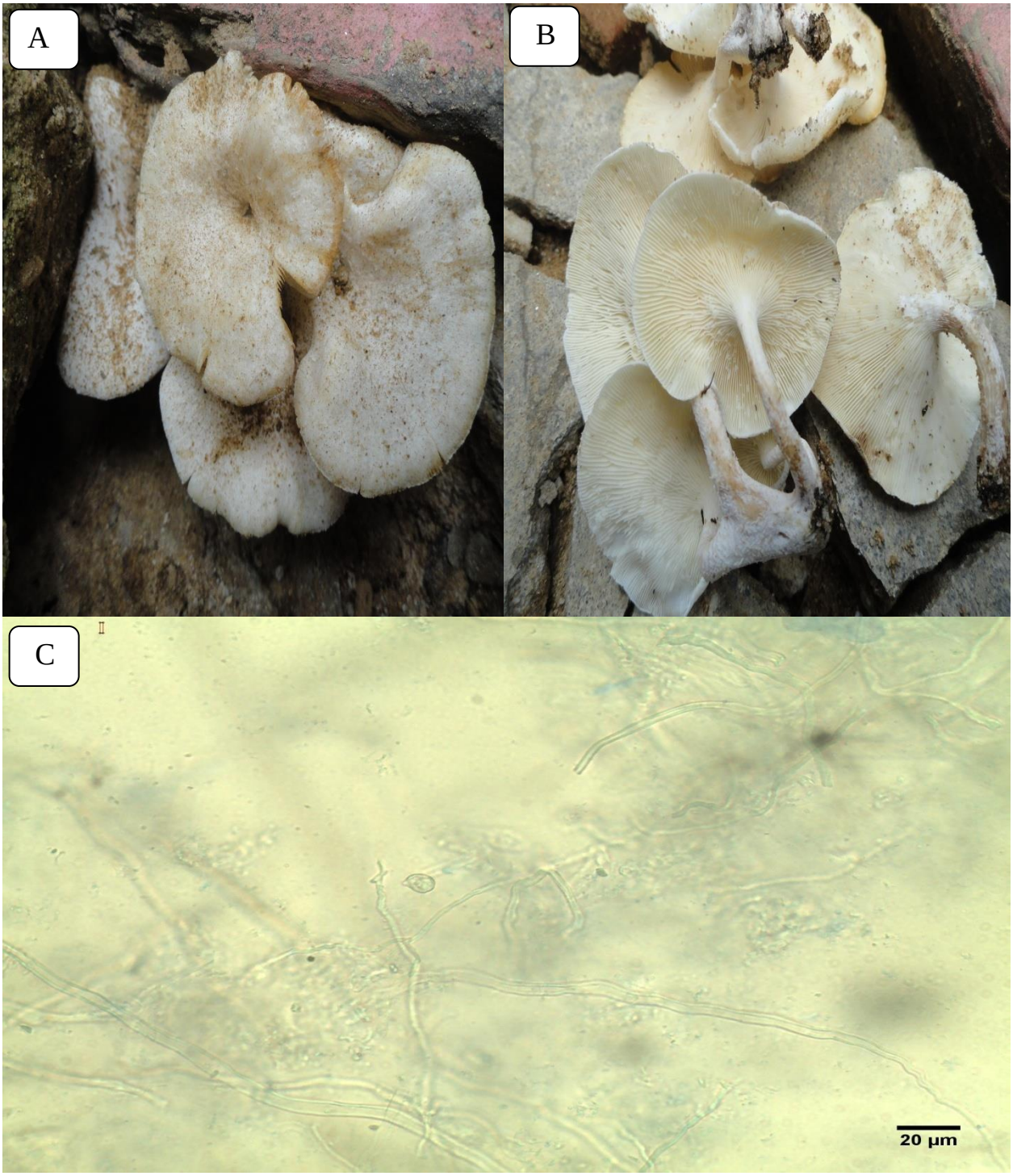

PLATE 28. ***Clitopilus prunulus*;** Mature fruiting body (A), Gills (B), Spores (C).

4.18. Morphology, habitat and biodiversity of *Mycena* sp.

4.18.1. *Mycena* sp.

Family : Mycenaceae
Location : Kaptai, Rangamati

Macroscopic character

Pileus shape : Conical, Color : Light brown with black color

Length : 4.6 to 6.8 cm, Width : 1.2 to 1.5 cm

Surface character and zonation : Less moist in weather

Margin : Regular in shape

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Black

Gills spacing : spacing and less crowded

Stipe : Present

Spore morphology

Spore size (Average): Length : 12.3 μm ; Width: 8.4 μm

Spore shape : Moderately thick walled, smooth, oval and ellipsoid, Color : Deep Black.

Ecological features

Habitat : On the soil surface. Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was moderately moist weather.

Biodiversity : *Mycena* sp. was found in Rangamati of Chittagong hill tarcts. A total two number of mushrooms were found during collection. The frequency of its presence was 11.11% and the density was 5.56%.

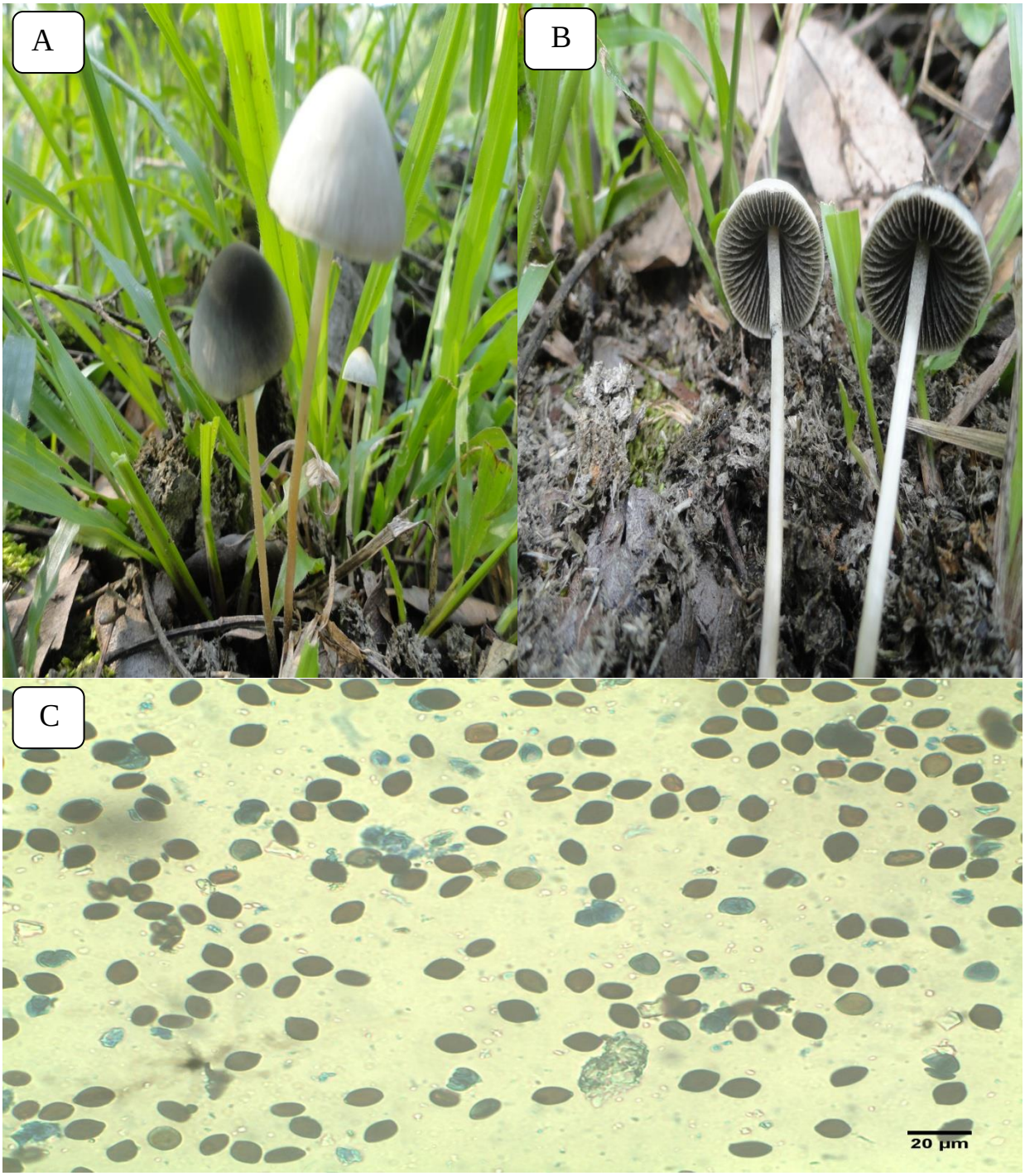

PLATE 29. ***Mycena*** **sp.;** Mature fruiting body (A), Gills (B), Spores (C).

4.19. Morphology, habitat and biodiversity of *Innonotus* sp.

4.19.1. *Inonotus dryadeus*

Common name : Oak bracket, warted oak polypore, weeping polypore or weeping conk
Family : Hymenochaetaceae
Location : Manikchhori, Khagrachari

Macroscopic character

Pileus shape : Flat with round, Color : White

Length : 1.5 cm, Width : 2 cm

Surface character and zonation : Less dry in nature

Margin : Regular in shape

Texture of the fruiting body : Tough and woody

Spore bearing surface under cap : Pores on hymenium

Pores color : White

Pore spacing : Crowded

Stipe : Pseudostipe present

Spore morphology

Spore size (Average): Length : 9.2 μm ; Width: 9.1 μm

Spore shape : Single walled, smooth and round, Color : Brown and hyaline

Ecological features

Habitat : On the root of the Koroi (*Albizzia procera*) tree. Habit : Solitary and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to clay loam; factor affecting their distribution was moderately moist weather.

Biodiversity : *Inonotus dryadeus* was found in Khagrachari of Chittagong hill tracts. Only one number of mushrooms were found during collection.The frequency of its presence was 11.11% and the density was 2.78%.

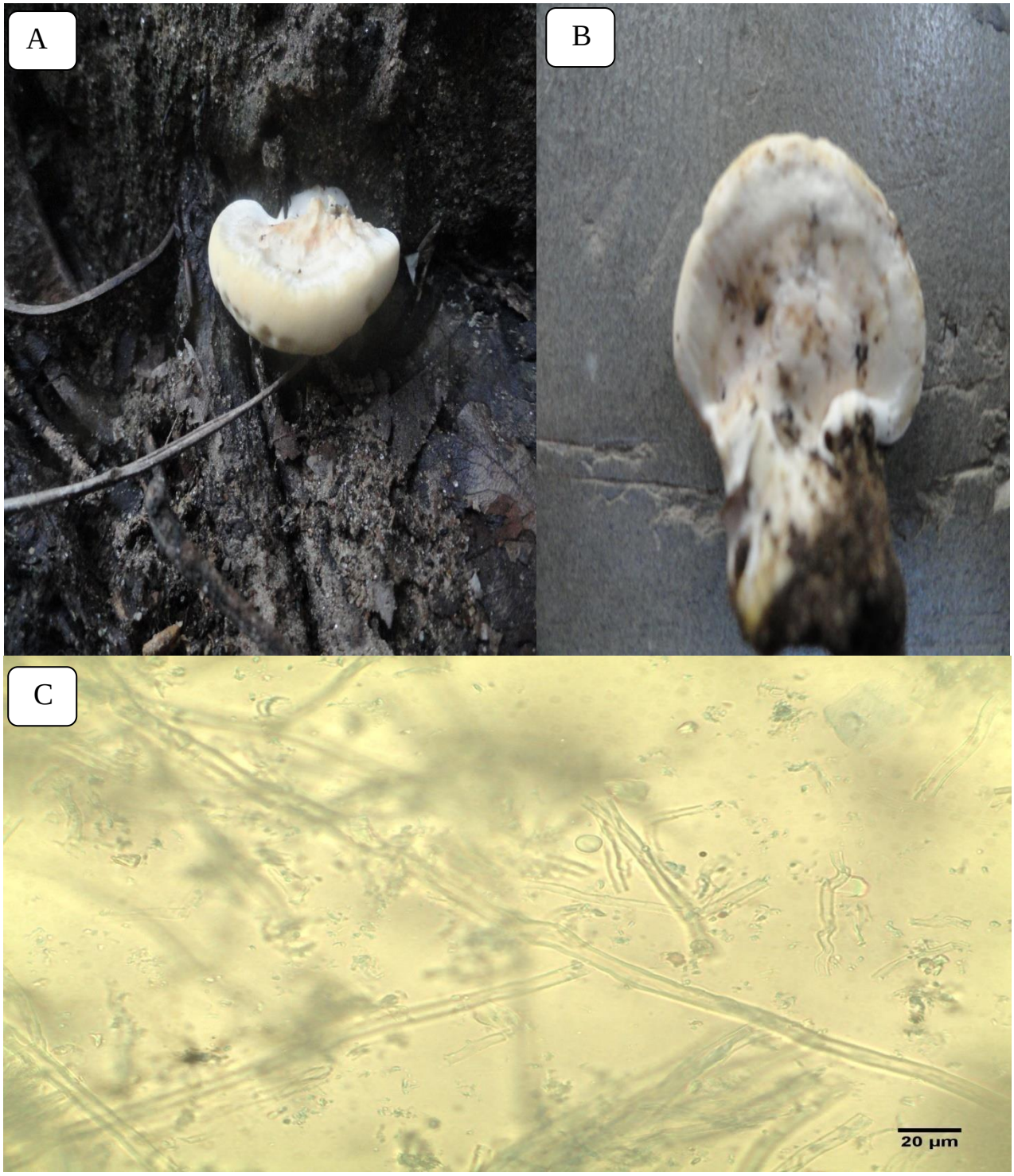

PLATE 30. ***Inonotus dryadeus*****;** Mature fruiting body (A), Pores (B), Spores (C).

4.20. Morphology, habitat and biodiversity of *Steccherinum* sp.

4.20.1. *Steccherinum ochraceum*

Common name : Ochre spreading tooth
Family : Steccherinaceae
Location : kaptai, Rangamati

Macroscopic character

Pileus shape : Flat , Color : White

Length : 7.1 cm, Width : 12.2 cm

Surface character and zonation : Dry in nature

Margin : Irregular in shape

Texture of the fruiting body : Brittle and tough

Spore bearing surface under cap : Teeth

Teeth color : Milky white

Teeth spacing : crowded

Spore morphology

Spore size (Average): Length : 16.3 μm ; Width: 10.2 μm

Spore shape : Thick walled, rough and ellipsoid, Color : Brown and hyaline

Ecological features

Habitat : On the root of the *Chapalish tree* (*Artocarpus chaplasha*) tree; Habit : Solitary and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to loamy; factor affecting their distribution was dry in weather.

Biodiversity : *Steccherinum ochraceum* was found in Rangamati of Chittagong hill tracts. Only one number of mushrooms were found during collection. The frequency of its presence was 11.11% and the density was 2.78%.

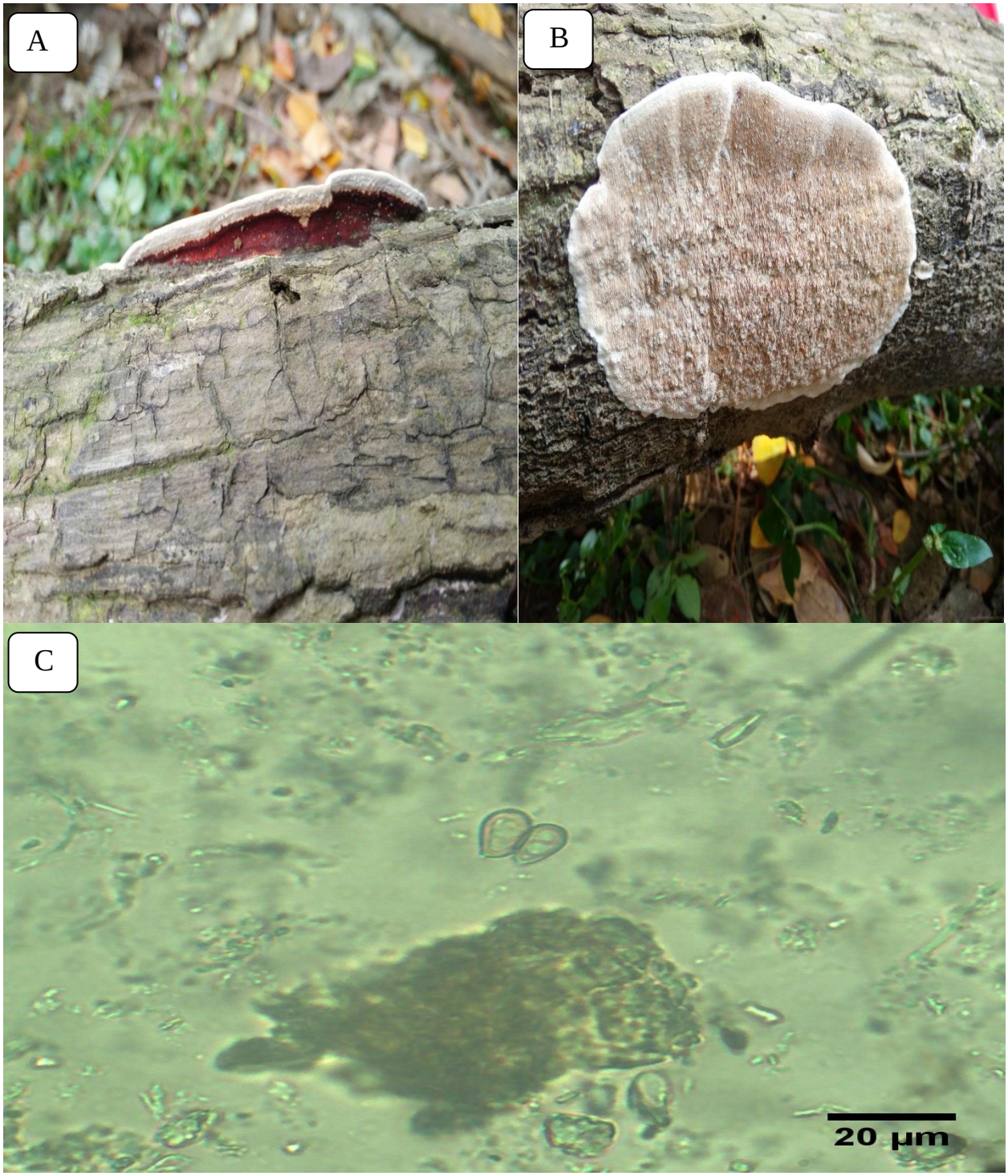

PLATE 31. ***Steccherinum ochraceum*****;** Mature fruiting body (A), Teeth (B), Spores (C).

4.21. Morphology, habitat and biodiversity of *Pleurotus* sp.

4.21.1 *Pleurotus sapidus*

Family : Pleurotaceae
Location : Chittagong University Campus, Rangunia, and Matiranga

Macroscopic character

Pileus shape :Curve , Color : Cremey

Length : 1.8 to 2.1 cm, Width : 2.2 to 2.5 cm

Surface character and zonation : Less dry in nature

Margin : Regular in shape

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : White with brown

Gills spacing : distant

Stipe : Pseudostipe present

Spore morphology

Spore size (Average): Length : 10.1 μm ; Width: 6.2 μm

Spore shape : Thick walled, rough and ellipsoid, Color : Black

Ecological features

Habitat : On the bark of Sisso (*Dalbergia sisso*) tree. ; Habit : Scattered and constancy of occurrence in specific habitat was abundant. Type of soil was sandy; factor affecting their distribution was dry in weather.

Biodiversity : *Pleurotus sapidus* was found in different location of Chittagong hill tracts. A total fifteen number of mushrooms were found during collection. The frequency of its presence was 44.44% and the density was 41.67%.

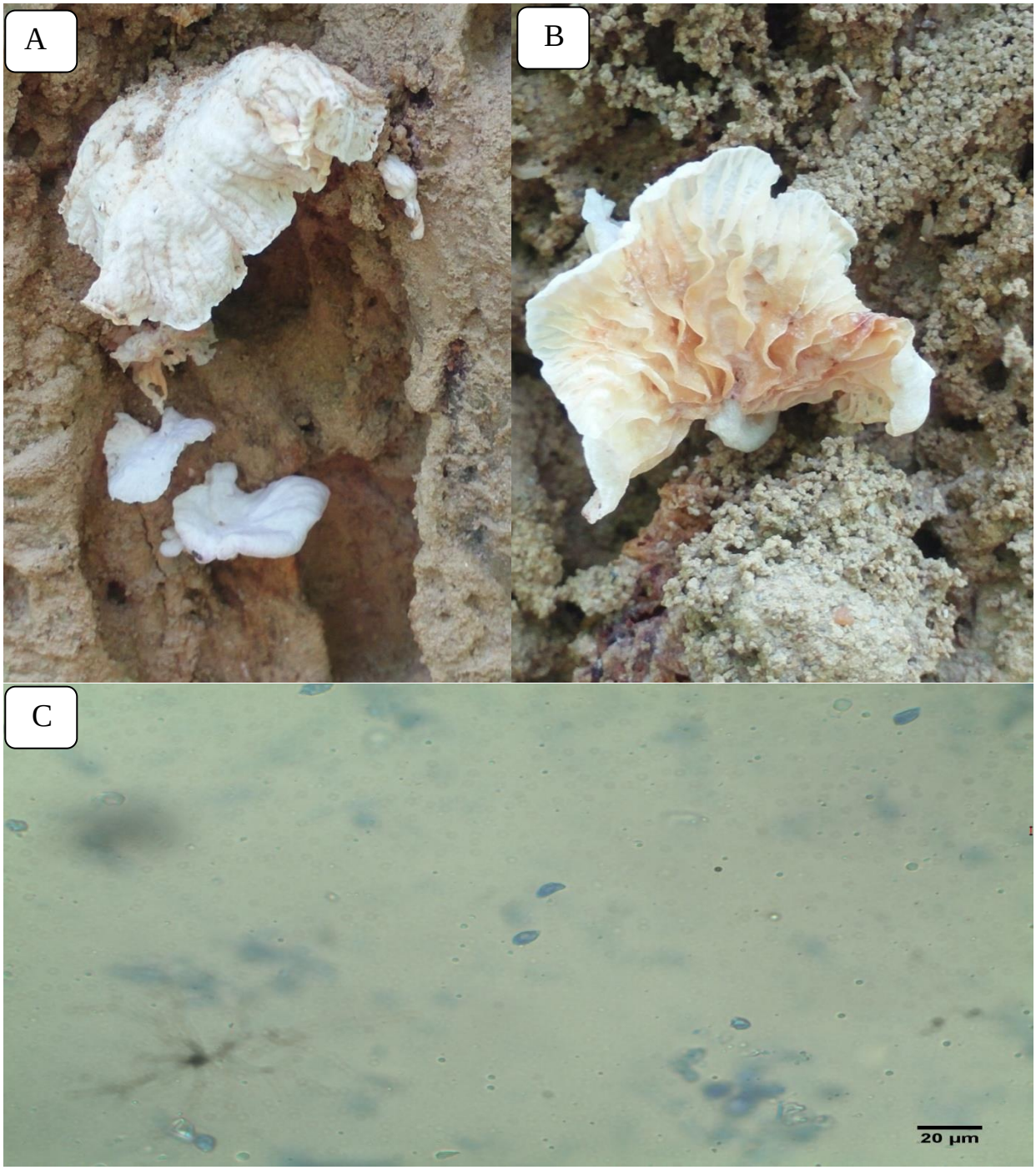

PLATE 32. ***Pleurotus sapidus;*** Mature fruiting body (A), Gills (B), Spores (C).

4.22. Morphology, habitat and biodiversity of *Calvulina* sp.

4.22.1. *Calvulina coralloides*

Family : Clavulinaceae

Location : Kaptai, Manikchhari and Kawkhali

Macroscopic character

Pileus shape : Complex and beranched, Color : White,

Length : 4.8 to 6.3 cm, Width : 3.4 to 5.3 cm

Surface character and zonation : Moist in nature

Margin : Irregular in shape

Texture of the fruiting body : Soft, tough and brittle

Spore bearing surface under cap : Pores on hymenium

Pores color : White

Pore spacing : Crowded tiny micro pores

Spore morphology

Spore size (Average): Length : 7.3 μm ; Width: 4.8 μm

Spore shape : Thick walled, rough and ellipsoid, Color : Brown

Ecological features

Habitat : On the soil surface.; Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was loamy; factor affecting their distribution was moderately moist weather.

Biodiversity : *Calvulina coralloides* was found in Rangamati and Khagrachari of Chittagong hill tracts. A total six number of mushroomswere found during collection. The frequency of its presence was 30.56% and the density was 16.67%.

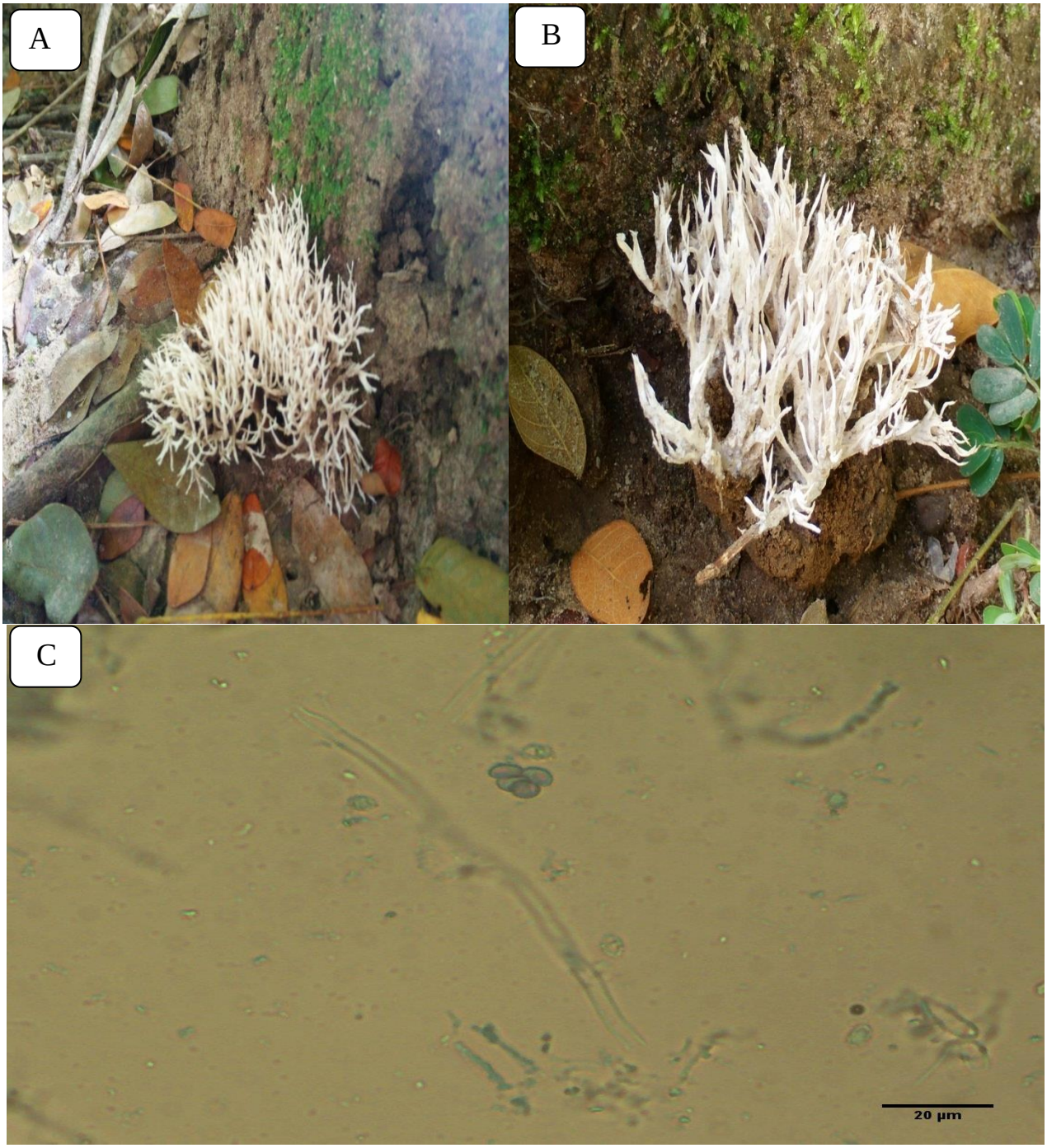

PLATE 33. ***Calvulina coralloides*****;** Mature fruiting body (A,B), Spores (C).

4.23. Morphology, habitat and biodiversity of *Gomphus* sp.

4.23.1. *Gomphus clavaticus*

Common name : Pig's ears or the violet chanterelle
Family : Gomphaceae
Location : Kaptai, Rangamati

Macroscopic character

Pileus shape : Infundibuliform, Color : Light brown with margin

Length : 5.6 cm, Width : 3.4 cm

Surface character and zonation : Scaly and dry

Margin : Dark yellow margin with regular in shape

Texture of the fruiting body : Brittle and tough

Spore bearing surface under cap : Pores on hymenium

Pores color : Light yellow

Pore spacing : Crowded micro pores

Spore morphology

Spore size (Average): Length : 10.4 μm ; Width: 8.6 μm

Spore shape : Moderately thick walled, smooth and round, Color : Brown and hyaline

Ecological features

Habitat : On the root of the Rain tree (*Albizia lebbeck*). Habit : Solitary and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy; factor affecting their distribution was dry in weather.

Biodiversity : *Gomphus clavaticus* was found in Rangamati of Chittagong hill tracts . Only one number of mushrooms were found during collection. The frequency of its presence was 11.11% and the density was 2.78%.

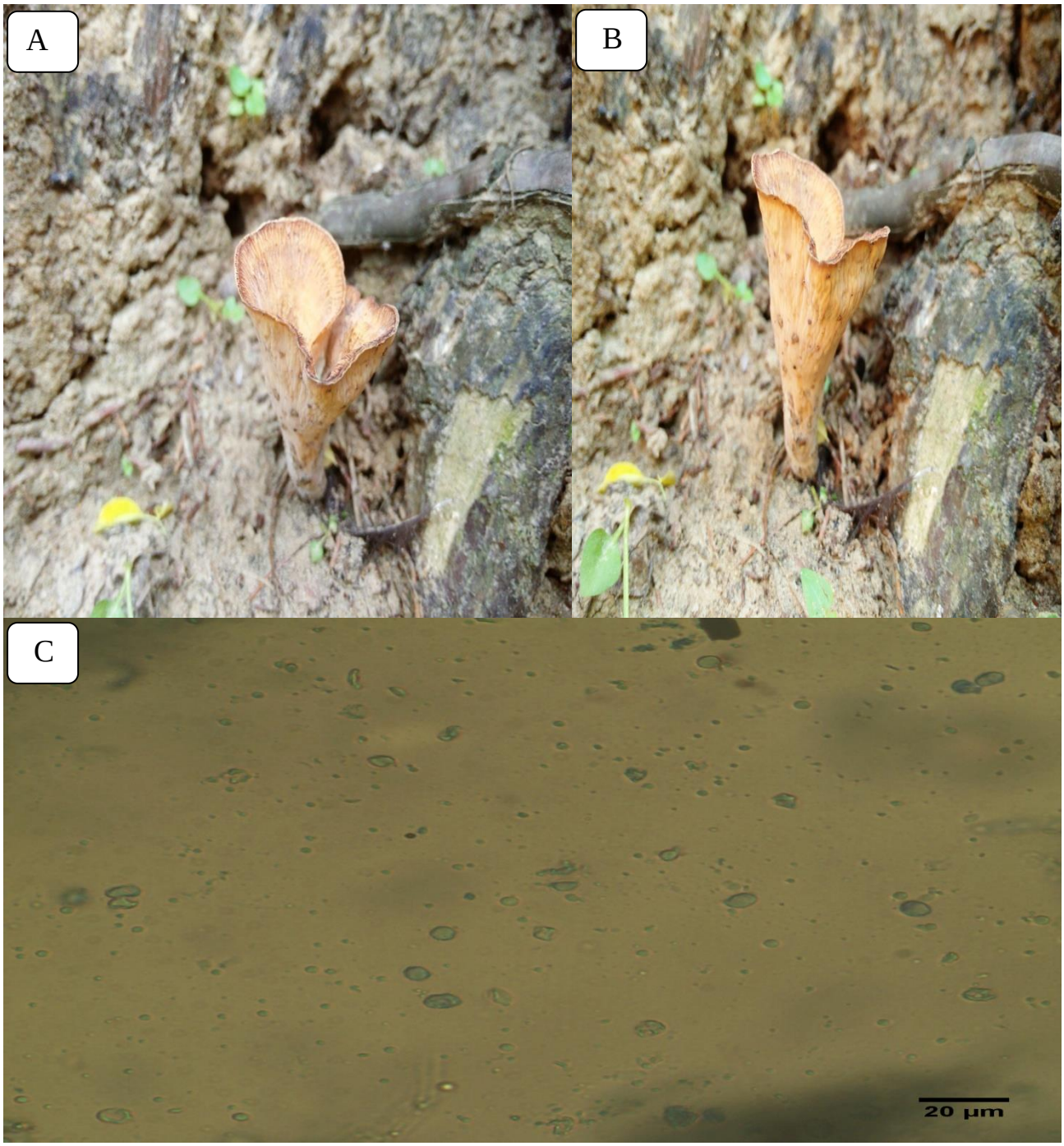

PLATE 34. ***Gomphus clavaticus*;** Mature fruiting body (A), Pores (B), Spores (C).

4.24. Morphology, habitat and biodiversity of *Laccaria* sp.

4.24.1. *Laccaria* sp.

Family : Hydnangiaceae
Location : Rowangchhari, Bandarban,

Macroscopic character

Pileus shape : Convex, Color : Dark brick red

Length : 3.4 cm, Width : 1.8 cm

Surface character and zonation : Moderately moist weater

Margin : Regular in shape

Texture of the fruiting body : Crack and spongy

Spore bearing surface under cap : Gills

Gills color : Light brown

Gills spacing : Less crowded

Stipe : Poresent with pale color

Spore morphology

Spore size (Average): Length : 9.8 μm ; Width: 6.1 μm

Spore shape : Moderately thick walled, rough, oval and ellipsoid, Color : Deep Brown

Ecological features

Habitat : On the root of the Sisso (*Dalbergia sisso*) tree. Habit : Solitary and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy; factor affecting their distribution was less moist weather.

Biodiversity : *Laccaria* sp. was found in Bnadarban of Chittagong hill tracts. Only one number of mushrooms were found during collection. The frequency of its presence was 11.11% and the density was 2.78%.

PLATE 35. ***Laccaria*** **sp. ;** Mature fruiting body (A), Gills(B), Spores (C)

4.25. Morphology, habitat and biodiversity of *Cantharella* sp.

4.25.1. *Cantharella* sp.

Common name : Chanterelles
Family : Cantharellaceae
Location : Kaptai, Rangamati

Macroscopic character

Pileus shape : Depressed , Color : Dark yellow

Length : 2.1 to 3.6 cm, Width : 1.1 to 1.8 cm

Surface character and zonation : Less dry weater

Margin : Regular in shape

Texture of the fruiting body : Soft and spongy

Spore bearing surface under cap : Gills

Gills color : Yellow

Gills spacing : Less crowded

Stipe : Present with brown color

Spore morphology

Spore size (Average): Length : 12.3 μm ; Width: 12.1 μm

Spore shape : Thick walled, smooth and round, Color : Black

Ecological features

Habitat : On the root of the Mahogony (*Macrophyla mahogoni*) tree. Habit : Scattered and constancy of occurrence in specific habitat was not abundant. Type of soil was sandy to sandy loam; factor affecting their distribution was less dry in weather.

Biodiversity : *Cantharella* sp. was found in Rangamati of Chittagonh hill tracts. A total five number of mushroomswere found during collection.The frequency of its presence was 13.88% and the density was 11.11%.

PLATE-36: ***Cantharella*** **sp.;** Mature fruiting body (A), Gills (B), Spores (C).

During investigation, 66 macrofungi samples were collected and 36 species under 18 families were identified. Six species of macrofungi were recorded under Agaricaceae family in Chittagong University Campus, Rangamati and Bandarban of Chittagong Hill Tracts in Bangladesh. Two species of *Agaricus* viz *Agaricus aungustus* and *Agaricus moelleri* were identified on the soil surface and humus with the frequency of 33.33 and 22.22 % respectively and density of 22.22 and 16.67%, respectively in Chittagong University Campus and Bandarban. During the collection the temperature was 30^0c to 32^0c.These species was also reported for Bangladesh in tropical moist deciduous forest which was recorded in associated with Sissoo (*Dalbergia sissoo*) tree (Rumainul *et al.,* 2015) and India (Mohanan, 2011; Thiribhuvanamala *et al.,* 2011; Hansen, 1992).

Two species of *Coprinus* namely *Coprinus disseminatus* and *Coprinus* sp. were found with the frequency of 11.11and 33.33% and density of 5.56 and 52.78, respectively in Rangamati district.One species of *Calvatia* viz *Calvatia* sp. was found on the soil surface with the frequency and density of 22.11 and11.11%, respectively and the teperature of 32^0c to 34^0c. One species of *Leucocoprinus bimbaumii* was identified in Rangamati in soil surface with the frequency and density of 11.11and 2.78%, respectively. These species of macrofungi were not reported previously from forest regions of Bangladesh.

Moreover, four species of *Volvariella* were detected in in Chittagong University Campus and Rangamati on soil surface and also in humus such as *Volvariella pussila, Volvariella nigrovolvacea, Volvariella gloiocephala and Volvariella bombycina* were found with the same frequency of 11.11 and density of 2.78%, respectively. During the collection of these speceis the temperature was 31^0c to 35^0c with the less moist weather. These species were found on the soil surface, humus, Sissoo (*Dalbergia sissoo*)

and Mahogony (*Macrophyla mahogoni*). *Volvariella nigrovolvacea* and *Volvariella gloiocephala* were reported previously on humus from south western regions of Bnagladesh (Rahaman *et al.*,2016).

Three species of *Ganoderma*, namely *Ganoderm azonatum*, *Ganoderma lucidum* and *Ganoderma* sp. were found in Rangamati, Bandarban and Chittagong during investigation with the frequency of 11.11, 22.22 and 11.11 respectively and density of 2.78, 11.11 and 8.33%, respectively. Even these species were collected from the predominant Teak/Segun (*Tectona grandis*), Gamari (*Gmelina arborea*) and Mahogony (*Macrophyla mahogoni*) tree, respectively. During the collection of *Ganoderma* species the weather was dry in nature and the temperature range were 34 to 36^0c. *Ganoderma* were also found at Rajshahi, Pabna, Jaipurhat, and Dhaka districts of Bangladesh in tropical moist deciduous forest (Rumainul *et al.,* 2015). It was also reported in China (Wang *et al.*, 2012) and in India (Dwivedi *et al*., 2012; Thiribhuvanamala *et. al.*, 2011; Ram *et al.,* 2010; Cooper *et al.,* 2011; Kinge *et al.*, 2011&2015). On the other hand, *Ganoderma* sp. was also reported in India (Bhosle *et al.*, 2010).

Three species of *Marasmius* were identified from Rangamati and Chittagong University Campus, viz *Marasmius rotula*, *Marasmiellus candidus* and *Marasmiellus* sp. associated with the soil surface, Sisso (*Dalbergia sisso*), and Chapalish tree (*Artocarpus chaplasha*) tree, respectivbely. These species of macrofungi were found in the moist weather with the range of 29 to 30^0c temperature. This species was also previously reported from Bangladesh in tropical moist deciduous forest at Dhaka (Rumainul *et al.*, 2015). Even it was also reported in madagascar as well as the Mascarenes (Antonin and Buyck, 2006).

Four species macrofungi were found under the Polyporaceae family such as *Polyporus arcularius*, *Microporus xanthopodus*, *Cerrena unicolor* and

Trametes sp. with the highest frequency of 22.22 and density of 27.78 for *Cerrena unicolor*. The Polyporaceae family was reported by Roy *et al*., (1998) in India. These mushrooms under Polyporaceae family were collected from the dominant tree in Chittagong Hill Tracts, such as Koroi (*Albizzia procera*), Rain tree (*Albizia lebbeck*), Sisso (*Dalbergia sisso*) and Mahogony (*Macrophyla mahogoni*) tree with the temperature range of 31 to 35^0c.

Two species of *Xylaria*, such as *Xylari ahypixylom and Xylaria polymorpha* were found in Rangamati with the frequency of 33.33, 44.44 and density of 30.56, 55.56% respectively. Two species were identified under the family Psathyrellaceae, viz *Parasola lactea* and *Coprinellus domesticus* associated with the soil surface and Gamari (*Gmelina arborea*) tree in Bandarban and Rangamati districts.

One species of *Russula* was detected from the Chittagong University Campus as *Russula emetic* with the frequency of 11.11 and density of 22.22% in moderately moist weather at 30^0c. This species was not previously reported from any forest regions of Bangladesh.

The genus *Russula* sp. was also reported in India (Mohanan, 2011). Pala *et al*. (2012) reported 7 species of *Russula* in Southern Kashmir Himalayas. Two ectomycorrhizal species of genus *Russula* have been characterized and identified from Kashmir Himalaya using morphanatomical and molecular methods targeting its DNA (Itoo *et al*.,2013).

One species of *Amanita* was collected from the Chittagong University Campus as *Amanita flavoconia* in soil surface with the frequency and density of 11.11 and 2.78%, respectively. During the collection of this macrofungi the temperature was 31^0c. This species was also reported in Bangladesh by Rumainul *et al.,* (2015) and Hosen *et al.,* (2015).

One species of *Auricularia cornea* was found in Rangamati associated with the Bamboo (*Bambusa vulgaris*) tree of frequency 22.22 and density of 38.89%. *Clitopilus prunulus* was collected from soil surface in Rangamti with the frequency of 11.11 and density of 13.89% in moist in weather with the temperature range of 28 to 29^0c.

Mycena sp. was also identified on soil surface in Rangamti with the frequency of 11.11 and density of 5.56%. This species was also reported from tropical moist deciduous forest of Bangladesh(Rumainul *et al.,* 2015).

Two speciesof mushrooms under the family of Hymenochaetaceae, viz *Innonotus dryadeus* and *Steccherium ochraceum* were collected from the dominant Koroi (*Albizzia procera*), Chapalish tree (*Artocarpus chaplasha*) tree with the frequency of 11.11and density of 2.78%, respectively in dry weather at 34^0c.

Furthermore, One species of *Pleurotus sapidus* was identified from Chittagong University Campus on the bark of Sisso (*Dalbergia sisso*) tree with the frequency of 44.44 and density of 47.67% in moderately moist in weather with the temperature of 29 to 32^0c. One species of *Pleurotus* was identified by Change *et al.* (1988).

One species of each *Clavulina coralloides* and *Gomphus clavaticus* were detected from Rangamati on soil surface and on the root of Rain tree (*Albizia lebbeck*) with the frequency of 30.56 and 11.11, and density of 33.33 and 2.78%, respectively. One species of *Laccaria* sp. was identified on the root zone of Sisso (*Dalbergia sisso*) tree in Chittagong University campus with the frequency of 11.11 and density of 2.78%. During the collection time the temperature range of 32 to 33^0c.

Cantharella sp. was collected from Rangamati on root of Mahogony (*Macrophyla mahogoni*) tree with the frequency and density of 11.11% in moderately moist in weather with the range of 29 to 31^0c. This species was not previously reported from any forest regions of Bangladesh.

CHAPTER V

SUMMARY AND CONCLUSION

Now-a-days, Macrofungi have been considered as an objects of much curiosity and speculation. They are an important component of the ecosystem. Their edibility, poisonous nature, psychotropic properties, mycorrhizal and parasitic association with the trees makes them economically important and interesting to study. Mushrooms are of ancient lineage, omnipresent, remarkably beautiful and diverse in their form, in their interaction with biota. The mushrooms grown in the wild plays an important role to maintain the forest health besides their medicinal importance and nutritional value. Therefore, it becomes quite necessary to explore, document and conserve this natural wealth.

For the investigation of bio-diversity, habitat and morphology of mushroom a survey was conducted in Chittagong Hill Tracts of Bangladesh. After morphological study in both field and laboratory and spore ornamentation under microscope the following 36 different species Viz. *Agaricus aungustuswere* , *Agaricus moelleri*, *Coprinus* sp, *Coprinus disseminates, Calvatia* sp., *Leucocoprinus bimbaumii, Volvariella pusilla* ,Volvariella *nigrovolvacea, Volvariella bombycina, Ganoderma zonatum, Ganoderma* sp., *Ganoderma lucidum* , Marasmius rotula, *Marasmiellus candidus, Marasmiellus* sp, *Polyporus arcularius, Microporus xanthopus, Cerrena unicolor, Trametes* sp., *Xylaria hypoxylon, Xylaria polymorpha, Parasola lacteal, Coprinellus domesticus, Russula emetica, Amanita flavoconia, Auricularia cornea, Clitopilus prunulus*, *Mycena* sp., *Inonotus dryadeus, Steccherinum ochraceum, pleurotus sapidus, Calvulina coralloides, Gomphus clavaticus, Laccaria* sp., *Cantharella* sp. found from the selected location.

Macrofungi were grown in different location association with the soil surface and also with or and root zone of the trees during their growing season. The biodiversity of these fungi was amazing just because of their distribution and morphological characterization. This growing condition proved that the Chittagong hill tracts and also different forest regions of our country are favorable for the growth and development of macro fungi. The identification and use of wild edible mushrooms play a vital role in enrichment of the socio-economic life of a nation. The current environmental issues of global warming and climate change would adversely affect the regeneration and growth pattern of the delicate fungi which requires a specific micro-climate. Consequently, the high nutritional quality and unique flavor of these mushrooms are likely to be lost if these wild edibles are not properly documented.

In the present study, 66 macrofungi samples were collected and 36 species were identified under 18 families with the following a detailed study in the Chittagong hill tracts. The predominat species were found under the families of Agaricaceae, Pleutaceae, Ganodermataceae, Marasmiaceae, Polyporaceae, Xylariaceae, Psathyrellaceae and Hymenochaetaceae. Among the collected species, the highest frequency was 44.44% and density of 55.56% for *Xylaria polymorpha* and *Pleurotus sapidus* followed by the frequency of 33.33% for *Agaricus aungustus, Coprinus disseminatus* and *Xylaria hypoxylon* and then 22.22% and 11.11% for the rest of the species.The lowest frequency and density for different species were 11.11% and 2.78% respectively. Macrofungal species in dominant trees were associated with Teak/Segun (*Tectona grandis*), Gamari (*Gmelina arborea*), Koroi (*Albizzia procera*), Rubber (*Hevea brasiliensis*), Mahogony(*Macrophyla mahogoni*), Sisso (*Dalbergia sisso*), Bamboo (*Bambusa vulgaris*), Chapalish tree (*Artocarpus chaplasha*) and Rain tree

(*Albizia lebbeck*). This is the first report of macro fungi biodiversity and their distribution in the Chittagong Hill Tracts of Bangladesh. Further study is needed to obtain more species in different season and consecutive year. So, Bangladesh has huge prospects of mushroom cultivation.

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