STUDIES ON THE DIVERSITY AND ETHNOMYCOLOGY OF WILD MUSHROOMS IN SOME AREAS OF DISTRICT KISHTWAR (J&K)

Thesis Submitted for the Award of the Degree of

DOCTOR OF PHILOSOPHY

in

BOTANY

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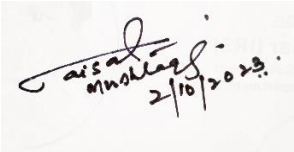
2023

DECLARATION

I, hereby declared that the presented work in the thesis entitled "**Studies on the Diversity and Ethnomycology of wild mushrooms in some areas of district Kishtwar(J&K)"** in fulfilment of degree of **Doctor of Philosophy (Ph. D.)** is outcome of research work carried out by me under the supervision **Dr. Ashish Vyas** working as **Professor** in the **School of Bioengineering and Biosciences** of Lovely Professional University, Punjab, India. In keeping with general practice of reporting scientific observations, due acknowledgements have been made whenever work described here has been based on findings of other investigator. This work has not been submitted in part or full to any other University or Institute for the award of any degree.



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CERTIFICATE

This is to certify that the work reported in the Ph. D. thesis entitled ""**Studies on the Diversity and Ethnomycology of wild mushrooms in some areas of district Kishtwar(J&K)"** submitted in fulfillment of the requirement for the reward of degree of **Doctor of Philosophy (Ph.D.)** in the **School of Bioengineering and Biosciences** is a research work carried out by **Faisal Mushtaq, 42000450** , is bonafide record of his original work carried out under my supervision and that no part of thesis has been submitted for any other degree, diploma or equivalent course.

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ACKNOWLEDGEMENT

The day has finally come, by the grace of Almighty Allah, when I am bestowed with a sense of accomplishment and contentment for having finished my research work and submitted the write up on the given topic. First and foremost, I bow my head in humility and adoration to Almighty Allah , who has graciously bestowed HIS blessings on me in the form of wisdom , knowledge and in countless other ways to enable me to finish this Ph.D thesis.

I would like to express my gratitude to my supervisor Dr. Ashish Vyas , Professor , Department of Microbiology ,School of Bioengineering and Biosciences for his scientific approach , scholarly supervision ,creative ideas, constructive criticism , affectionate help and for his encouragement to improve the quality of my research. Without his direction and support, this endeavour would not have been possible. Special thanks to my Co-Supervisor Dr. Sanjeev Kumar for his selfless cooperation, necessary guidance and sustaining interest in the progress of my research work.

I sincerely place on record my thanks to Prof. Y. P Sharma , former Head of the Department of Botany, University of Jammu for instilling in me a passion for active scientific research and explorations

Words fall short to acknowledge my research colleagues Dr Kanad Das, Dr. Tahir Mehmood, Dr. Dyutiparna Chakraborty, Dr. R.K Manhas , Dr. Komal Verma,Dr. Uzma, Dr. Roshi Sharma, Mrs. Mamta Verma, Mr. Sushil Kumar Mr. Syed Azhar Hashmi, Mr. Anil Kumar, Mr. Tasir Iqbal,Mr. Wasim Sajjad, Ms. Shinny Singh, Ms.Shewata, Mr. Masood Ahmad for their sincere support and endless help .All of you helped me keep my sanity and perspective when the going was not rosiest.

I owe a debt of gratitude to my father Sh.Mushtaq Ahmad Kichloo and my loving mother Mtr. Tasleema Begum for the selfless love,care ,pain and sacrifices you did for me. My siblings Fozia and Fahad have also been the best of my friends along this journey.

Words are insufficient to verbalize my gratefulness towards my loving family - my better half Humeera Faisal, my daughters Ayesha Fatima(presently in 5^{th} standard),Aqdas

Fatima (presently in 3rd standard) and my son Ibraheem Faisal (presently in UKG) for their loads of love, unfailing encouragement and inspiration throughout my research work and lifting me uphill during this phase of my life. I owe everything to them.

I shall also express my deep gratitude to all those people whose name could not figure out in this acknowledgement but who knowingly or unknowingly helped me during my investigation and final compilation.

ABSTRACT

Wild mushrooms (macrofungi) are a diverse group of heterotrophic macrofungi that can be seen with the unaided eye and produce either epigeous or hypogeous fruiting bodies. They consist of an enormous network of microscopic filaments that resemble threads (hyphae), which, when exposed to suitable conditions and enough moisture, develops one or more fruiting bodies. In addition to their global distribution, mushrooms have distinct nutritional and ecological demands. Mushrooms have been categorised as bracket fungus, agarics, cup fungi, boletes, stinkhorns, jelly fungi, truffles, puffballs, bird's nest fungi, etc. to reflect the diversity of their external appearance. Mushrooms are classified as humicolous (growing on humus and soil), lignicolous (i.e. growing on wood), and coprophilous (growing on dung) because they depend on substrates for their growth and sustenance. Many macofungi form advantageous mycorrhizal relationships with forest trees, especially gymnospermic species. Agaricomycotina and Pezizomycotina, two sub-divisions of the divisions Basidiomycota and Ascomycota, respectively, have recently been created to categorise mushrooms. The three classes of Agaricomycotina are Agaricomycetes, Dacrymycetes, and Tremellomycetes, whereas the two classes of Pezizomycotina are Pezizomycetes and Leotiomycetes.

Macrofungi have been generally identified in the bases of their macro-morphological and microscopic characteristics but there are many complex macrofungi which have been identified on the bases of molecular technologies in addition to macro and microscopic characteristic features. Wild edible macrofungi offer a variety of uses as food and medicines in addition to their ecological and ethnomycological role. The study of diversity of wild macrofungi from district Kishtwar has been chosen to study the diversity of wild macrofungi because mushroom diversity has never been studied so far from the area. The current study has been planned keeping in view the following objectives:

1. Collection, identification & morphological characterization of collected specimens from different sites of study area.

2. To study the distributional pattern , habitat preference of wild mushrooms with regard to topography, vegetation cover & anthropogenic activities.

3. To explore, survey, documentation of ethno-mycological and ethno-myco-taxonomical aspects of macrofungi.

The methodology involved in the current study included collection of wild edible mushrooms, morphological Characterization, preservation of collected specimens, microscopic details, chemical colour reactions, identification of collected wild mushrooms and ethnomycological studies.

During the extensive fungal forays undertaken at various areas in district Kishtwar (J&K), 47 macrofungal species from 33 genera, 8 orders, 23 families were identified from the total 71 collections. 25 species reported first time the study area. 10 taxa belonging to 4 genera distributed over 2 families were newly reported from Jammu and Kashmir. Two taxa belonging to different families have been reported for the first time from India .

Chingaam, one of the study sites, was found to have the highest number of species (up to 25), followed by Chatroo (21 species), Sarthal (18 species), Bindraban (8), Ikhala, Dachan (12 species), Mugalmaidan (10 species), Nagseni (16 species), and Kishtwar city (4). With only two species present, Sinthan Top exhibits the least amount of wild mushroom occurrence. According to the type of habitat and substrate, the macrofungal species collected from various sites varied greatly, showing an uneven distribution across the study area. The majority of macrofungal species were substrate-specific, growing exclusively on one type of substrate, and none of them collectively colonised two or more substrates. 16 species of the 47 wild macrofungal taxa that have been collected, named, and recorded from the study area have been classified as Humicolous, 23 species as ectomycorrhizal, 6 species as lignicolous and only 2 species have been found to be coprophilous. For ethnomycological studies ,surveys regarding the collection of wild mushrooms were conducted. Elderly people, significant informants, and the village chief were all questioned using unique, self-created questionnaires. Semi-structured interviews, casual talks, and firsthand observations with tribal members, hakeems, nomads, old people, local informants, as well as the distribution of questionnaires to the general public, have all been used to obtain information and indigenous knowledge about the wild macrofungi. 24 species out of 47 have been found to be edible.

This is the first comprehensive investigation on wild mushrooms carried out in district Kishtwar. Wild mushrooms were found to be numerous and diverse in the research region due to the unique topography, climatic conditions, and dense forest cover, which provided a perfect environment for their luxuriant growth and dissemination. There is still a strong likelihood that the region harbours many more interesting species of wild mushrooms. As a result, more investigation is needed in the near future to find some noval mushrooms species as well as new genera in the area. The current investigation suggests that research be conducted to characterise and identify edible and medicinally significant mushroom species, as well as their potential for large-scale production to improve the rural economy and assure food security.

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CHAPTER ONE

1.0 Introduction

Wild mushrooms (macrofungi) constitute a wide range of heterotrophic macrofungi , producing either epigeous or hypogeous sporocarps and can observed by unaided eyes (Chang and Miles, 2004). They are made up of a vast network of microscopic filaments that resemble threads (hyphae), which when exposed to favourable temperatures and sufficient moisture, give rise to one or more fruiting bodies (Roody, 2003). Besides cosmopolitan in distribution, mushrooms vary specifically with respect to their nutritional and ecological preferences. During monsoon season, favourable season, they occupy diverse niches in forest ecosystem (Pushpa and Purushothama, 2012). The mycelial filaments of wild mushrooms are invisibly underground, but the fruiting bodies are diverse and either upper or lower (Vishwakarma et al., 2017). The presence of favourable conditions during most part of the year, the variety and variability of vascular plants creating niches, many ecotones and microhabitats for fungi contribute to the global prevalence of fungi in tropical areas rather than temperate regions. (Kark, 2007). In order to reflect the diversity of their morphology, mushrooms have been categorised as bracket fungi, agarics, cup fungi, boletes, stinkhorns, jelly fungi , truffles, puffballs, bird's nest fungi, etc. (Karwa and Rai, 2010; Andrew et al., 2013).

Mushrooms have specific nutritional needs thereby extensive areas were colonized by these organisms and the substrates on which they grow indicate that macro-fungi (mushrooms) include saprophytic, commensal and parasitic species. (Dwivedi et al., 2017). Mushrooms are dependent upon the substrates for their growth and nutrition and accordingly they are classified as humicolous (growing on humus and soil) e .*g Morchella* sp., *Gyromitra* sp. , *Agaricus* sp., *Apioperdon* sp., *Lycoperdon* sp., *Lepiota* sp., *Macrolepiota* sp.,etc. , lignicolous (i.e growing on wood) e.g species of *Schizophyllum, Laetiporus , Auricularia,* etc., coprophilous (growing on dung) e.*g Panaeolus* sp. , *Coprinus* sp. , etc. In addition, several larger fungi form beneficial mycorrhizal associations with forest trees including gymnospermic taxa. This beneficial association amplify ecological processes like water absorption, nutrient uptake and play an significant role in ecosystem diversity (Das, 2010; Pushpa and Purushothama, 2012). Saprophytes

and ectomycorrhizal fungi are characteristic and hyperdiverse symbiotic guilds of forest ecosystems that contribute to soil organic matter degradation and nutrient mobilization (Taylor et al., 2014; Uroz *et al*., 2016). These attributes are due to the extracellular production of oxidases and hydrolases, the large absorption surface in the form of filamentous hyphae, and the direct absorption of nitrogen and phosphorus (Hodge, 2017).

Recently Mushrooms have been grouped into two sub–divisions *viz*. Pezizomycotina and Agaricomycotina of the division Ascomycota and Basidiomycota respectively. Agaricomycotina constitute three classes i.e. Agaricomycetes, Dacrymycetes and Tremellomycetes where as Pezizomycotina has been divided into two classes Pezizomycetes and Leotiomycetes (Kirk *et al*., 2008). In Agaricomycotina, Agaricomycetes is the most heterogenous group of fungi having 17 orders with 100 families. Order Agaricales of Agaricomycetes is the most diverse and further subdivided into three sub orders i.e Agaricineae, Boletineae and Russulineae with 17 families comprising of 230 genera and 7000 species worldwide, Singer(1986) .In order Agaricales, Krik et al (2008) mentioned 33 families consisting of 413 genera and 13,233 species. Boletales, Russulales, polyporales are the other prominent orders of Agaricomycetes. There are many species of order Agaricales which are either lignicolous, humicolous ,fungicolous or saprobic, mycorrhizal and rarely parasitic on plants or fungi including several edible, poisonous and hallucinogenic forms (Kirk et al., 2008). Prior to genetic and evolutionary relatedness of distinct species, the order was classified based on the gills and shape of sporocarps. However, after genetic and evolutionary studies, the order Agaricales has been expanded to include many non-gilled mushrooms, particularly gasteriods, in addition to gilled species. (Binder *et al*., 1997'; Matheny and Bougher, 2006). As for as another order called Boletales is concerned, there are around 1316 species with wide variety of fruiting body types (Kirk *et al*., 2008). It was formerly discovered to solely contain tube fungi, however a significant number of non-tubular species, such as lamellate and gasteroid forms, have been later on confirmed to also belong to order Boletales based on micro-morphological and molecular phylogenetic traits (Binder and Hibbett, 2006). It differs from the poroid Aphyllophorales in having tubes that are easily separable from the pileus as well as a soft, fleshy basidiocarp comparable to that of the Agaricales (Hawksworth *et al*., 1995). *Russula* and *Lactarius* genera, as well as their corticoid and

polyporoid relatives, are members of the Russuloid group of fungus, which belongs to the order Russulales , the members of which are primarily saprotrophs but also include ectomycorrhizal taxa and root parasites (Miller *et al*., 2006; Kirk *et al*., 2008). The two families Elasmomycetaceae and Russulaceae, with 10 genera and 484 species , were placed in order russulales by Hawksworth et al. in 1995. Later on , the number of species increased to 1767 , belonging to 80 genera and 12 families (Kirk et al., 2008). Morphologically, the russulales order is the most distinctive comprising of number of sporophore forms like clavarioid, discoid, resupinate, pileate or gasteroid and have smooth, hydnoid , poroid to lamellate hymenophore. Funnel-shaped or pileate sporocarps with wrinkled, smooth or folded hymenophores bearing smooth, inamyloid and hyaline basidiospores are also a member of the class Agaricomycetes. These macrofungi have been classified as members of the order Cantharellales, which has 544 species belonging to 38 genera and 7 families (Pine *et al*., 1999; Kirk *et al*., 2008). In addition to chanterelles (Cantharellaceae) , this order also contains some tooth fungi (Hydnaceae), clavarioid varieties (Aphelariaceae and Clavulinaceae), and corticioid mushrooms (Botryobasidiaceae).

In Pezizomycotina (Ascomycetous fungi), order Pezizales of Pezizomycetes are saprobic, mycorrhizal or parasitic on plant and consist of 16 families which include Morchellaceae, Pezizaceae, Halvellaceae, Pyronemataceae etc. Pezizales refers to a class of ascomycetous fungi with enormous, disc shaped, spherical or cupulate fruiting body (apothecia) which are occasionally stalked and bear elongated, thin-walled operculate asci that opens by a lid or operculum at the tip. The ascospores are commonly ellipsoidal , clear to strongly pigmented and with ornamentations. The pezizales are either saprobic, mycorrhizal or parasitic on plants and comprise of 1029 species of 177 genera and 17 families (Hawksworth *et al*., 1995). But later on the number of species have been increased to 1683 belonging to 199 genera and around 16 families (Kirk *et al*. 2008). Pezizaceae , Helvellaceae , Ascobolaceae , Morchellaceae, , Pyronemataceae etc. are the common families of this order.

The estimated number of fungal species is around 2.2–3.8 million (Hawksworth and Lucking, 2017) with only a little over 150,000 species having been discovered,

recognised so far (Antonelli *et al*., 2020). According to Willis,2018, 97% of all fungal species are contributed by Ascomycota and Basidiomycota phyla in the kingdom fungi. The largest phylum in the kingdom fungi is Ascomycota with over 80,000 species belonging to around 6540 genera (Sarbhoy , 2014) while the number of species in Basidiomycota is 30,000 belonging to 1589 genera (Dai *et al*., 2015; Wijayawardene *et al*., 2017, 2018).

More than 27,000 different species of mushrooms are said to exist in the world (Cannon *et al*., 2018; Kumar *et al*., 2021b; Verma *et al*., 2021b; Altaf *et al*., 2021b) out of which edible mushrooms belong to 2700 species and mushrooms of therapeutic value belongs to 700 species(Chang and Wasser, 2017; Li *et al*., 2021). Hawksworth and Lucking (2017) , based on scientific evidence ,provided an updated measure of global fungal diversity, including extrapolation of plant/fungal proportions. Ascomycota and Basidiomycota account for over 97% of all fungal species in the kingdom Fungi (Willis, 2018). The largest phylum in the fungal kingdom, Ascomycota, is highly diverse, containing 6540 genera with an estimated of over 80,000 species occupying various niches (Sarbhoy, 2014).

Some macrofungi are complex and diverse, hence necessitating the use of molecular technologies to distinguish and identify them in their habitat. The internal transcribed spacer (ITS) region of nuclear ribosomal DNA is the most often utilised molecular marker for this purpose . The identification of a wide range of macrofungal species through various sequence-based investigations has significantly increased the diversity of known macrofungi. By incorporating the molecular analyses for complex macrofungi,the conflicting morphological characterization, discrepancies, and problems of discrimination between macrofungal species often associated with traditional taxonomic strategies can be mitigated . This technique makes use of genetic markers, often nuclear rDNA genes available in various copies, that may distinguish between particular non-coding or coding portions of the macrofungal genome. Similarly ,the evolutionary links of species are made clearer through genetic markers (Cui et al., 2011; Siddique et al., 2015). Various studies confirm that the expanded and extensive use of DNA barcoding can overcome obstacles in morphology-based identification and identification of previously

unidentified macrofungal species. By continually adding information from DNA sequences into ongoing studies , the description of the fungal kingdom has been continuously increased and updated (Wijayawardene *et al*., 2020).

Four major groups of macrofungi include edible, medicinal, poisonous and miscellaneous, where the properties are less well defined. Out of these , wild edible macrofungi , in addition to playing important ecological roles, have a variety of uses as food and medicines. Early days of civilization witnessed the use of mushrooms mainly for their palatability and unique flavours .Because they have a high nutritional content that is nearly twice that of any vegetable, mushrooms have been valued as an excellent source of food since ancient times. (Chauhan et al.,2014). In addition to having significant levels of proteins, carbohydrates, and dietary fibre, edible mushrooms are also found to contain certain important antioxidants(Wani *et al*., 2010, Keles *et al*., 2011). Mushrooms contain considerable amounts of bioactive compounds that have antioxidant effect , therefore eating them as a dietary source can help the body meet its need for antioxidants.To reduce oxidative stress, These dietary antioxidant sources maintain a balance (Carocho and Ferreira, 2013; Boonsong *et al*., 2016).

Mushrooms represents worlds greatest resource of nutraceuticals (Dundar *et al*.,2008) and are considered as good source of proteins rich in lysine and leucine amino acids , polyunsaturated fatty acids, vitamins like calciferol, riboflavin, and niacin, crude fibre, and minerals(K, P, Ca, Na, Mg) but low in fat content and calories (Aletor, 1995; Dundar *et al*., 2008; Manjunathan and Kaviyarasan, 2011, Cheung, 2013; Lalotra *et al*., 2016; Sharma *et al*., 2019; Khatua and Acharya, 2019; Dasgupta *et al*., 2019; Altaf *et al*., 2020). Wild edible mushrooms besides having high nutritional value , have been found to contain components like phenolic compounds, polysaccharides, terpenes, tocopherols etc., with antioxidant and antiradical activity. (Lindequist *et al*., 2005 ; Ma *et al*., 2018; Sharma *et al*., 2019; Maity *et al*., 2021). Mushrooms are advised for athletes and are utilised in treating many illnesses, including diseases related to modern lifestyles. Interest in mushrooms has increased significantly due to their ability to prevent a number of ailments and diseases.(Chandresekaran *et al*., 2016; Chatterjee *et al*., 2017; Duan *et al*., 2021; Maity *et al*., 2021). The physiological processes of mushrooms have received a lot of attention as

a result of growing health concerns in recent years. As a result, market emergence has been observed in variety of health-promoting products like dietary supplements, designer foods, pharmaceuticals, etc.(Rathore *et al*., 2017; Taofiq *et al*., 2019). Mushrooms have been utilised as feed additives to cure illnesses or promote the health of pets, domestic animals, and wildlife (Pohleven *et al*., 2016). As a natural source of numerous and distinct compounds with anti-bacterial, antiviral, anti-HIV, anti-inflammatory, anti-cancer, hypocholesterolemic, anti-diabetic, hepatoprotective potential and other properties, mushrooms have recently gained widespread interest (Chang and Buswell, 1996; Ajith and Janardhanan, 2007; Das, 2010; Veena and Pandey, 2012).

The study of indigenous knowledge, folklore and traditional usage pattern of mushrooms as medicine, food and recreational objects as well as an aid to seasonal household economies is known as Ethnomycology (Orijel et al.,2012), which has become another research area to study the interrelationship between human social structures and macrofungi . People have used wild mushrooms for medicine, food and cosmetics, as well as other economic and cultural uses, since decades. Collecting fungi from the wild exist since ages. Pharaohs prized mushrooms as delicacies and considered 'Food of Gods' by Romans. Thousands of years, back Wild edible mushrooms have been collected and consumed by people , but consumption of wild macro fungi was first observed in China (Aaronson, 2000, FAO, 2004). Strong interrelationship between macrofungi and people have also been observed in Central Africa, Spain, China, Turkey, Japan and Mexico. (Li *et al*., 2021). Since ancient times, wild macrofingi (mushrooms) have been worshipped and consumed as hallucinogens by Egyptians, Greeks and Romans (Kumari *et al*., 2012).

Since ancient times, as a source of food and medicine ,people in India have included mushrooms in their everyday diet . Based on their own experiences and the experiences of the older people, the men and women gather these wild macrofungi (mushrooms), especially during the rainy season (Kumar and Sharma, 2009; Atri *et al*., 2012. Old works and writings including the Vedas, Chinese and roman convictions , which suggest mushrooms as having quality and life-power-supplying capacity, have cited this traditional information. The Mexican Indians employed mushrooms for healing purposes, as hallucinogens, in religious rituals and witchcraft (Chang and Miles, 1988, 2004; Kumari *et*

al., 2012; Rahi and Malik, 2015). Mushrooms have been depicted in rock paintings, religious practices and rituals (Wasson, 1969; Samorini, 2001). There are several mushrooms which are consumed uncooked after cleaning and washing. Among these, species of *Termitomyces*, *Cantharellus*, *Calvatia*, *Lentinus*, *Geopora*, *Pleurotus*, *Morchella*, *Agaricus* etc. constitute the prime edible and commercially valuable mushrooms (Sharma, 2009; Kotwal, 2010; Wani *et al*., 2010; Kumar and Sharma, 2011). Food and Agricultural Organisation (FAO) has advised the use of edible mushrooms use as a food supplement for the protein-deficient population of developing and impoverished nations (Hayes, 1975).

Mushrooms have been well documented from several regions of the world (Baroni *et al*., 2018 ; Li *et al*., 2012; Roody WC ,2003, Reid DA ,1980).Various researchers have given their marked contribution on survey, distribution and mycological aspect of mushrooms from different states of India (Bhattacharya and Baruah, 1953; Atri *et al*., 2003; Natarajan *et al*., 2005; Dar *et al*., 2009; Vrinda *et al*., 1997; Veena and Pandey, 2012; Kumari *et al.*, 2013). In addition, researchers throughout the world have studied the antioxidant and biochemical activity of different edible mushroom (Wani *et al*., 2010a, b; K; Gan *et al*., 2013).

According to the literature, the Union Territory of Jammu and Kashmir has been recognised as one of the hotspots for biodiversity, including mushrooms and taxonomy of mushrooms have been studied by several mycologist in recent times in the past (Cooke, 1870, 1876; Berkeley, 1876; Murrill, 1924; Watling and Gregory, 1980; Abraham *et al*., 1981, 1984; Kaul, 1981; Abraham and Kaul, 1985, 1988; Watling and Abraham, 1986; Abraham, 1991; Dar *et al*., 2010; Beig *et al*., 2011; Pala *et al*., 2014). In Jammu and Kashmir , many researchers including the researchers from Department of Botany (Mushroom Research Lab), University of Jammu have made their marked contribution with respect to diversity and ethnomycology of macrofungal groups (Kumar, 2009; Sharma, 2009; Kotwal, 2010; Kumar and Sharma, 2011, Dorjey et al.,2013, 2013a, b; Kumar *et al*., 2014; Sharma *et al*., 2017, 2020; Kour *et al*., 2013, 2015a, b, 2016, 2017; Kumar *et al*., 2021b; Verma *et al*., 2021a, b). This lab is now surveying the state's macrofungal diversity and has so far been successful in revealing the occurrence of numerous wild mushroom

species that were earlier unknown in the area (Kumar and Sharma, 2007, 2008, 2009; Sharma and Sharma, 2012; Dorjey et al., 2015, 2016a, 2017; Yangdol et al., 2015, 2016 a, b, 2017, 2018). These investigations show that Jammu and Kashmir, with its high biodiversity, served as the nursery for these species, indicating the likelihood of many more of these macrofungal species in the region. Such studies are found wanting in Kishtwar district of Jammu and Kashmir . Kishtwar , the newly created district of Jammu province, was chosen for the current study because the diversity of mushrooms has never been studied or discovered so far. Furthermore, considering the vegetation and climatic characteristics of the area, it was predicted that this area would be home to a number of unique and interesting macrofungal species with high edibility potential .

Following objectives were proposed and fulfilled during the course of investigation:

1. Collection, identification & morphological characterization of collected specimens from different sites of study area.

2. To study the distributional pattern, habitat preference of wild mushrooms with regard to topography, vegetation cover & anthropogenic activities.

3. To explore, survey, documentation of ethno-mycological and ethno-myco-taxonomical aspects of Macrofungi.

CHAPTER TWO

Review of Literature:

Wild mushrooms are achlorophyllous heterotrophic organisms forming fruiting bodies and producing large number of spores . They can be lignicolous, coprophilous, bryophilous, fungicolous, parasitic, humicolous, etc. depending on the substrate on which they grow. Every season has a characteristic macrofungal flora but in rainy season, these macrofungi flourish predominantly. Several factors affecting their distribution include climate, geographical location and type of vegetation etc. Edibility status of various macrofungi (mushrooms) have been reported through the northern hemisphere, South Africa and New Zealand (Wang *et al*., 1995). Because they include bioactive components, mushrooms are currently also being thoroughly researched for their medicinal effects. Knowledge on utilization of wild mushrooms by the local communities have been documented by many researchers. Sufficient information across the world in general and India in particular, is available on significance of macrofungi to human society and many researchers have reported extensively on their ethnomycological aspects. (Kamat , 1999; Sagar *et al*., 2005; Ellen, 2008; Kumar, 2009).

Mushrooms have been divided into two sub-divisions, Agaricomycotina and Pezizomycotina, belonging to the kingdoms Basidiomycota and Ascomycota, respectively. The three classes of Agaricomycotina are Agaricomycetes, Dacrymycetes, and Tremellomycetes, while Pezizomycotina include Pezizomycetes and Leotiomycetes (Kirk *et al*., 2008). According to Hawskworth *et al*. (1995), macrofungi or macromycetes belong to the classes Ascomycetes and Basidiomycetes of the subdivisions Ascomycotina and Basidiomycotina. In Agaricomycotina, Agaricomycetes is the most heterogenous group of fungi(mushrooms) having 17 orders with 100 families. . Agaricales Boletales, Russulales, polyporales are the prominent orders of Agaricomycetes.

The Order Agaricales of Agaricomycetes is the most diverse and further subdivided into three sub orders i.e Agaricineae, Boletineae and Russulineae with 17 families comprising of 230 genera and 7000 species worldwide, Singer (1986). Numerous mycologists have carried out thorough research on variety of features of Agaricales world

wide (Singer, 1951, 1986; Pegler 1972, 1983, 1988; Smith and Sundberg, 1979; Zang, 1981; Pegler and Vanhaecke, 1994; Vellinga and Huijser, 1997; Thongbai et al., 2018; Vellinga, 2002, 2003, 2007, 2010; Sieger, 2003;; Wang, 2005; Ferreira and Cortez, 2012; Edler *et al* .,(2021) .Similarly characteristics of gilled agarics have been studied by a number of researchers around the world(Singer and Digilio, 1951; Lange and Smitha, 1953; Dennis et al., 1960; Pegler, 1977; Arenas *et al.* , 2009; Le *et al.* , 2007 ; Doveri, 2010; Gierczyk *et al.* , 2011). In order Agaricales, Krik et al (2008) mentioned 33 families consisting of 413 genera and 13,233 species . Due to varied morphology, ecology, and economic significance, the order Agaricales has received significant attention over the past few years. Agaricaceae, Cortinariaceae, Schizophyllaceae, Pluteaceae , Psathyrellaceae, Amanitaceae, , Inocybaceae, Strophariaceae, Pleurotaceae , Clavariaceae, Entolomataceae, Hydnangiaceae, Lyophyllaceae, Marasmiaceae and Tricholomataceae are some of the significant families in this order.

Family Agaricaceae , a collection of widespread saprotrophic fungi with 85 genera and 1340 species , includes secotoid, agaricoid and gasteroid taxa, exhibits incredible variation in pileus form, structure of pileus covering and spore colour (Singer, 1986; Kirk *et al*., 2001,2008; Moncalvo *et al*., 2002; Vellinga, 2004). Symbiotic, edible, poisonous and many medicinal species of mushrooms belong to this family (Singer, 1986). There are four tribes within this Agaricaceae: Agariceae, Cystodermateae, Lepioteae, and Leucocoprineae. By sequence analyses, Cystodermateae was later on excluded (Moncalvo *et al*., 2002). Several non-gilled agarics, including different species of the genera *Lycoperdon, Bovista, Nidularia, Calvatia, , Crucibulum and Cyathus* have been documented from Europe, North America, China and Mexico in addition to gilled mushrooms (Brodie, 1975; Yang *et al.,* 2002; Bates *et al*., 2009). 55 species of coprinoid mushrooms including 28 new species were described and illustrated from Poland by Gierczyk et al in 2011 . Similarly from Italy and Ukraine more than 90 species of coprophilous agaricoids, including many species of Psilocybe, Coprinus and Panaeolus have been reported (Doveri, 2004, 2010; Prydiuk, 2011). Based on collections taken , Justo et al. in 2015 reported two new species of Lepiota, *Lepiota sosuensis* and *L. squamulodiffracta* from Dominican Republic.Two new genera have been added to agaricaceae by Vellinga *et al* in 2011. Ammirati et al. found and gave a detailed account

of a new genus of Agaricales called *Cleistocyb*e from the United States in 2007. *Agaricus duplocingulatoides,* a new species of *Agaricus* from Eastern India, was described by Tarafder *et al* in 2018.

Another family of macrofungi that has been studied from many locations throughout the globe is the Amanitaceae. It is a widely distributed family that mostly consists of ecologically significant ectomycorrhizal species that create symbiotic relationships with numerous plant groups (Reid, 1980; Yang, 2005; Neville and Pourmarat, 2009;; Davison *et al*., 2017). Some members of this family are saprotrophic, but others are edible and hence consumed around the world (Boa, 2004). Historically, the family Amanitaceae comprised of various genera, including *Amanita, Termitomyces, Volvariella, Limacella, Pluteus, Rhodotus,* and *Lepiota* . However, *Amanita* and *Limacella* are the only members of this family, according to Pouzar (1983) and Singer (1986. The Amanitaceae family has 1000 species that have been identified worldwide so far. It has been found that approximately 95% of the species are contained within the genus *Amanita* alone (Kumar et al., 1990; Neville and Pourmarat, 2004; Yang, 2005). In a monograph on the genus *Amanita,* Jenkins in 1986 included descriptions of 128 species native to North America. *Amanita* has been divided into subgenera and many sections viz Vaginatae, Amidella, Phalloideae, and Lepidella by Corner and Bas (1962) and Singer (1986). Four new species were described in genus *Amanita* from the eastern Himalaya and surrounding areas of southwestern China by Yang *et al.(*2004). *Amanita lippiae, as a new species* from the semi-arid Coatinga area of northeastern Brazil, was identified by Wartchow *et al.* (2009) . Zhang *et al.* (2015) provided an overview of the phytogeography, population genetics and diversity of *Amanita* mushrooms. Nine species of *Amanita* , new to science , were discovered by Thongbai *et al.* in 2018 . *Amanita harkonemiana* and *Amanita bweyeyensis* are two new *Amanita* species from Tropical Africa, which were described and illustrated by Fraiture *et al.* in 2019.

As for as the family Clavariadelphaceae is concerned , it consist of only two genera i.e *Beenakia and Clavariadelphus* . Avila *et al*., in 2016 described the only species of genus *Beenakia* and that is *Beenakia fricta* . From India and China , Methven (1989) described the species *Clavariadelphus yunnanesis* and *C. himalayensis* . Hanif *et al*. in

2014 and Sher *et al.* in 2018 described two new species of *Clavariadelphus* from Pakistan. Species of *Clavariadelphus* genus like *Clavariadelphu khinganensis*, *Clavariadelphu gansuensis, Clavariadelphu amplus and C. alpinus* were described in detail by Huang et al(2020) from China .

Kirk *et al*. in 2008 found that there are 112 species divided among seven genera in the family Auriculariaceae belonging to order Auriculariales. These include *Fibulosebacea*, *Auricularia*, *Exidia*, *Elmerina, Exidiopsis Eichleriella* and *Heterochaete* . Majority of the species belonging to genus *Auricularia* have been described from China and Thailand. The first description of *A. auricula-judae* came from Europe. According to reports, this species has been found to be widely distributed throughout the Northern Hemisphere (Lowy, 1951; Montoya-Alvarez *et al*., 2011). In Thailand and China, extensive phylogenetic and morphological studies of the genus *Auricularia* has been conducted (Bandara *et al*., 2015; Wu *et al*., 2014).

The molecular examination of the evolutionary history of 1050 species distributed among eight genera of family Inocybaceae has revealed that it is made up of seven distinct main lineages that seem to have a common palaeotropical ancestor (Matheny *et al*., 2009). Significant genera of Inocybaceae include *Tubariomyces, Nothocybe, Auritella, Pseudosperma*, *Mallocybe* and *Inosperma*, (Matheny and Bougher, 2006; Matheny *et al*., 2017).

Russulaceae , established in 1876 , is another important family of macrofungi , belonging to order Russulales and include genera *Russula* and *Lactarius.* According to Miller *et al*.(2006) it mostly includes the species having ectomycorrhizal associations and variety of basidiocarp shapes , ecological behaviours. With nearly 2000 species, the Russulaceae family dominates the the order Russulales (Looney *et al*., 2018).Species of *Russula* like *Russula myrmecobroma, R. paxilliformis, R. gelatinivelata*, and *Lactarius subiculatus* were described from the Pakaraima Mountains in Guyana by Miller et al in 2012. New species of *Russula* and *Lactarius* were from china (Chen, *et al.,* in 2022; Wu *et al.,* 2022). From Indian Himalaya, Ghosh *et al*. (2017) reported a new species of *Russula* called *R. sarnarii* . Lebel (2003) reported 11 new species of *Cystangium* from Australia. Li et al. (2018) proposed two gasteroid species from China i.e *Russula vinosobrummeola*

and *Lactarius sulphosmus,* only species from North America and Europe were place in the section *Lactifluus*. However, more recent discoveries of several Asian species from this section have increased its known distribution throughout the Northern Hemisphere (Le *et al*. , 2007: Xu *et al*. , 2023). Crop *et al.* (2019) identified the novel species *Lactifluus bicapillus*.Other workers who worked on Russulaceae include Niedzielski *et al*.,(2023),Ramirez *et al.*, (2022) , Nadjombe *et al*., (2022)From garhwal himalaya and northwest Himalaya in India .Nine species of the genus *Russula,* including *Russula pseudolepida, R. lepidicolor ,R. flocculosa, R. silvicola, , R. azurea* and *R. pulverulenta* were recently described for the first time from India (Bhatt *et al.,* 2007; Saini *et al.,* 2010). The association of some russulaceous mushrooms with higher plant roots have been reported by Bakshi (1974). A new species of Lactarius was reported from north west Himalayas, India (Verma *et al., 2023*).

Boletaceae of order Boletales (Basidiomycetes), a vast and diversified poroid group of fleshy fungi having soft and fleshy basidiocarp and tubes can be easily separated from pileus, with over 70 genera and almost 800 species, is another ecologically significant family (Kirk *et al*., 2008; Wu *et al*., 2014; Farid *et al*., 2017). Recent research studies, especially from Asia, suggests that there will likely be more species and genera belonging to family boletaceae because so many areas of the tropics and subtropics are yet unexplored or underexplored (Wu *et al*., 2016). Several studies have been conducted on various genera of boletaceae , including those from Thailand, China, North America, the United States, Brazil and Japan .These genera include *Suillus, Boletus, , Rhizopogon*, *Strobilomyces* and *Bothia* . Recently the evolutionary studies of Boletaceae family has been done intensively (Halling *et al*., 2007; Castellano *et al*., 2016; Wu *et al*., 2015; Parihar *et al*., 2018; Joa *et al*., 2019). The genus *Suillus* from Nepal was first of all reported by Cotter and Miller in 1987. Catcheside & Catcheside (2012) , reported and illustrated new species of *Boletus edulis* from Australia. Additionally, new species like *Boletus austroedulis* and *B. albobrunnescens* , were reported by Halling *et al*. (2017) from Thailand and Australia. The systematic research studies on Paxillaceae (gilled bolete), another family of the Boletales with 11 genera and 98 species, has been done from Turkey, Europe, China and Italy (Gelardi *et al*., 2014; Jargeat *et al.*, 2014; Sesli and Moreau, 2015). According to Hahn in 2000, *Paxillus involutus* and *P. rubincudulus* were the only species of genus *Paxillus*.

However, the use of a phylogenetic analyses and morphological markers on the members of *Paxillus* resulted in the identification of noval species (Vellinga *et al*., 2012; Gelardi *et al*., 2014; Jargeat *et al*., 2016). Based on morphological & genetic evidence, Gelardi *et al.* (2014) proposed *Paxillus orientalis* , a new species from South-Western China. From Northern Thailand, Kumla *et al.* in 2017 proposed the existence of the new ectomychorrizal fungus *Gyrodon suthepensis*.

The order Pezizales consists of majority of macro-fungi belonging to ascomycota . Numerous mycologists have conducted systematic investigations on the taxonomy and distribution of Pezizales (Abdel-Azeem and El-Fallal, 2012; Choi *et al*., 2013). There are several species in the genus *Scutellina , Morchella, Peziza* & *Geopora*, with more than 330 species mentioned in the Index fungorum. *Morchella gracilis, M. hispaniolensis , Morchella kaibabensis,* and *M. peruliana* are new species reported by Baroni et al. (2018) from America. Features of mitochondrial genome of *Morchella crassipes* from China was illustrated by Liu et al. in 2020. From Turkey, Colak et al. (2015) reported a unique record of *Peziza punctispora* . Zhuang (2010), described four taxa of family Pyronemataceae . From Darjeeling Hills of West Bengal Acharaya *et al.* described new *Helvella* records in 2005. The Pezizales of India have been the subject of extensive research, and several species from well-known genera, such as *Geopora, Morchella, Peziza, Geopyxis, Otidea* have been reported from a variety of locations, including the North West Himalaya, Kumaon Himalaya, Himachal Pradesh, Punjab, Central Himalayas, etc (Hennings, 1901; Llyod, 1904- 1919;Thind and Batra, 1957; Sohi et al., 1965; Kaul, 1971, 1981; Kaul et al., 1978; Abraham, 1991; Rai et al., 1999 ; 2009; Kumar and Sharma, 2010)

Due to its unique geographic location on the planet, India possesses a huge diversity of macrofungi, and multiple mycologists have made substantial contributions to the distribution and taxonomy of various wild macrofungi from different states of the India (Bhattacharya and Baruah, 1953; Vrinda *et* al., 1997; Atri *et al.,* 2003; Natarajan *et al.,* 2005; Baroni *et al.,* 2018; Dar *et al*., 2009; Veena and Pandey, 2012; Kumari *et al*., 2013).Linneaus was the first to do systematic research on macrofungi in the 19th century in India. The research work of Berkeley (1851, 1856) on Indian Agaricales in the Western and Eastern Himalayas was eventually expanded to other regions of the country.

Lakhanpal (1993), after his research on wild mushrooms, provided a thorough list of more than 180 macrofungal species found in the North-Western Himalaya. Mycologists from West Bengal, Uttar Pradesh, Punjab, Himachal Pradesh, Jammu & Kashmir, and Ladakh conducted significant research studies on macrofungi. In 1995, Saini and Atri reported 94 species of Agaricales and Gasteromycetes distributed among 24 genera. Joshi et al. (2012) provided a checklist on the family Russulaceae from Uttarakhand and described 50 species of genus *Russula* and 55 of genus *Lactarius.* Semwal et al. (2006) from Northern India reported a new record of *Amanita* species called *Amanita avellaneosquamosa.* From North India, Kumari et al. (2013) proposed a brand-new species called *Auricularia olivaceaus*. In Punjab, a variety of *Conocybe* species , found on dung(coprophilous) were described by Kaur *et al*., in 2015. Two *Inocybe* species were described by Yangdol *et al.* (2016a) from Himalayan region of Ladakh in India. *Tremella fusiformis, Exidia glandulosa* and other basidiomycetous species from West Bengal were described by Bera *et al.* (2018). In 2018, some species of *Calvatia* were described by Verma et al. from india. Mehmood *et al.,* in 2019) described ecology, distribituion and morphological characteristics of some species of *Amanita* from Uttarakhand. Eleven wild macrofungi including four new species were found by Debnath et al. in 2020 from Tripura.

The research studies on the monograph "South Indian Agaricales- a preliminary study on dark spored species" by Natarajan and Raaman (1983) paved the way for the study of more macrofungi from the southern states of India . From the Eastern and Western Ghats, they reported more than 80 species of macrofungi including dark spored agarics. Later, Manimohan et al. (1988, 2002, 2006) described 39 species including 26 new species from Kerala. Researchers have conducted ethnobotanical survey and described the use of epigeous gilled agarics in district Kinnaur of Himachal Pradesh (Sagar et al.,2005).From the Western Ghats, particularly from Kerala, several intriguing new species of macrofungi have been discovered (Vrinda et al. 2000; Manimohan et al. 2004; Pradeep et al. 2012).. New Inocybe species have been proposed by Pradeep et al. (2016) from tropical India. .From Kerala , Bijeesh *et al.* in 2019 reported a new species called *Hohenbuehelia odorata.*

The research studies on macrofungi from Jammu and Kashmir was started by Cooke(1876) and Berkeley(1876), both documented Kashmir and Himalayan fungi. A description of 20 macrofungal taxa from Kashmir was provided by Murill in 1924. In1 980.Watling andGregory found 119 species of agarics and related members from Kashm ir. Later on Abraham *et al.,* (1981, 1984) reported 10 more agaric species to enrich the Kashmir's macrofungal database . Abraham and Kaul (1985) described five macrofungal species that belonged to the *genera Coprinus, Lactarius, Leucoagaric, Leucopaxillus* and *Tricholoma*. The fruiting in larger fungi from the Kashmir region has been examined by Kaul (1981). Abraham (1991) provided a summary of the agarics found in Kashmir Valley. During an ectomycorrhizal survey in Kashmir's coniferous forests, *Collybia subsulphurea, Cortinarius bulliardi, Clitocybe gibba,* and *Lycoperdon pedicellatum* were discovered by Beig et al. in 2011. In addition, Wani *et al.,* (2010) has reported antioxidant properties of mushrooms from kashmir valley .Similarly Pala *et al.* (2011, 2012) reported 23 agaric species from Kashmir. *Pleurotus citrinopileatus and P. sapidus* were discovered in Kashmir's district of Anantnag by Altaf and Sharma in 2020. Altaf *et al.* (2021a) reported a new record of macrofungus called *Clavariadelphus pakistanicus* from Kashmir .

Numerous researchers from Mycology and Plant Pathology Laboratory , Jammu University have worked extensively on the distributional, morpho-taxonomical, and phenological aspects of wild mushrooms from diverse sites in Jammu Province (Kumar and Sharma , 2008, 2010, 2011a, b, c, d; Dorjey *et al*., 2013b ;Kour *et al*., 2017; Sharma *et al*., 2020 ; Verma *et al*., 2021a, b). Kour *et al.* (2015a, b, 2016) provided information on the variety of agarics that were new to Jammu and Kashmir. Nine species of family Psathyrellaceae were described by Kour *et al.* in 2017. Sharma *et al.* in 2017 reported six species of macrofungi from the Jammu province. Verma *et al.* (2019) have compiled a checklist of the Russulaceae species found in Jammu and Kashmir. Kumar *et al*. (2021a) provided an updated checklist of the family Amanitaceae native to India. *Amanita parvirufobrunnescens* and *Russula sarthalensis*, two new species, were described from Jammu region. (Verma et al., 2021b; Kumar et al., 2021b).

Table 2(A): Wild macrofungi of different orders & families described from different parts of India by various mycologists.

Macrofungal species reported	Family	Place/Region	References
Order Agaricales *Agaricus xanthoderma, A. placomyces, A. arvensis, A. augustus, , A. compestris, A. cupreobrunneus , A. duplocinulatoides, A. pattersoniae, A. micromegethus, A. sylvicola, A. vaporous, A. woodrowii .* *Calvatia cyathiformis , C. lycoperdoides, C. rubroflava, C. elata, C. fragilis, C. pachyderma, C. candida, Coprinus comatus* var. *caprimammillatus, C. cordisporus , Cyathus renweii, C. colensoi,* *Lepiota subincarnata, L. thrombophora, L. epicharis* var. *occidentalis, L. xanthophylla.* *L. leprica, L. subincarnata, L. thiersii, L. cristata, L. elaiophylla, L. erythrogramma, L. erythrosticta, L. apalochroa, L. echinaceaa, Leucoagaricus meleagris, L. leucothites, L. naucinus, Leucocoprinus cepistipes.* *Macrolepiota fuliginosa, M. excoriate, M. heimii .* *Pleurotus citrinopileatus, Pleurotus cornucopiae, Pleurotus cystidiosus, Pleurotus dryinus. Pleurotus columbines, P. ostreatus, P. flabellatus, P. membranaceus, P. pulmonarius, Hohenbuehelia odorata* *Pluteus americanus, P. brunneosquamulosus, P. chrysaegis, P. eupigmentatus, P. fastigiatus, P. velutinus*	Agaricaceae, Amanitaceae, Physalacriaceae, Pleurotaceae, Pluteaceae, Schizophyllaceae, Strophariaceae Inocybaceae	North East Hills. Punjab. Jammu & Kashmir. North India. Ladakh. Mysore. West Bengal Tripura. Kerala. Uttarakhand. Garhwal Himalaya. Nagaland. Tamil Nadu. Karnataka. Maharashtra. Telangana. Western Ghats. Uttar Pradesh. Punjab. Kerala.	Hennings (1901). Bose (1920). Trivedi (1972). Ghosh *et al*. (1974). Gupta *et al*. (1974). Chakraborty and Purkayastha (1976). Narendra and Rao (1976). Singh and Rajarathan (1977). Chavan and Barge (1978). Ray and Samajpati (1980). Watling and Gregory (1980). Manjula (1983). Natarajan and Raaman (1983, 1984). Verma *et al*. (1995). Bhavanidevi (1995). Pradeep *et al*. (1996). Bhavanidevi (1998). Atri *et al*. (2000). Thomas and Manimohan (2003). Roy *et al.*(2022)

Amanita avellaneosquamosa, A. caesaroides, A. concentric, A. constricta, A. flavipes, A. flavoconia var. *flavoconia, A. flavoconia var. inquinata, A. fritillaria, A. griseofolia, A. orientifulva, A. pallidorosea, A. parvipantherina, A. parvirufobrunnescens, A. pilosella* var. *pilosella, A. porphyria,* A. princeps, *A. konkanensis, A. vaginata, A. fulva, A. nauseosa, A. rubrovolvota, A. solitaria, A. velosa, A. verna.* *Coprinellus disseminatus, C. ephemerus, Coprinopsis nivea, C. radiata.* *Parasola psathyrelloides.* *Psilocybe bonetii, P.inquilina, P. fimetaria, P. merdaria.* *Panaeolus foeniseii, P. semioratus.* *Psathyrella lucipeta. Psathyrella myceniformis, P. trechispora, P. vanhermanii, P. fimicola, P. sphaerocystis, P. flocculosa, P. nana.* *Schizophyllum commune, S. radiatum.* *Agrocybe guruvayoorensis, A. karnatakensis, A. microspora, A. pediades.* *Hypholoma subviride.* *Stropharia semiglobata, S. bicolor, S. rugosoannulata, S. rubrobrunnea, S. stercoraria.* *Inocybe curvipes, I. sororia, I. gregaria, I. keralensis , I. wayanadensis, I. poonensis, I. indica*			Mohanan (2011). Pradeep *et al*. (2012) Kaur *et al*. (2013) Kumari *et al*. (2013) Senthilarasu and Singh (2013) Kaur *et al*. (2015) Sandhya *et a*l. (2015) Krishna *et al*. (2015) Ao *et al*. (2016) Deepna and Manimohan (2016) Toshinungla *et al*. (2016) Pradeep *et al*. (2016) Singh and Kaur (2016) Senthilarasu and Kumaresan (2016) Yangdol *et al*. (2016a) Tarafder *et al*. (2018) Yangdol *et al*. (2018) Ganga & Manimohan (2019) Mehmood *et al*. (2019) Altaf *et al*. (2020). Debnath *et al*. (2020) Altaf (2022) Kumar *et al*. (2021b)

Order Auriculariales *Auricularia auricula-judae, A. olivaceus , A. auricula, , A. elicata, A. mesentrica, Exidia glandulosa , Tremella fusciformis*	Auriculariaceae	Calcutta West Bengal Himachal Pradesh Manipur Odisha Rajasthan	Kumari *et al*. (2013) Devi *et al*. (2015) Bera *et al*. (2018)
Boletales *Boletus rubripes , Boletus aestivalis, Boletus edulis, Boletus fallax, Boletus recapitulates, Boletus rhodoxanthus, , Boletus rubrinellus, Boletus sharmae, Boletus varipes, Boletus recapitulatus,* *Caloboletus rubripes,* *Indosporus shorea,* *Retiboletus ornatipes.* *Suillus americanus, S. adhikarii, S. brevipes, S. indicus, S. pallidiceps, S. pictus, S. punctatipes, S. subluteus, S. triacicularis, S. variegatus, Suillellus luridus , S. luteus.* *Paxillus involutus, P. orientalis* *Rhizopogon luteolus, R. roseolus*	Boletaceae Suillaceae Rhizopogonaceae Paxillaceae	Himachal Pradesh Jammu & Kashmir Jharkhand Madhya Pradesh Meghalaya Western Himalayas North Western Himalayas Subalpine Himalaya Punjab Nagaland Sikkim Western Kashmir Himalaya Tamil Nadu Assam	Lakhanpal and Sagar (1989) Barua *et al*. (1998) Pala *et al*. (2011) Pyasi *et al*. (2012) Das (2013 a, b) Das *et al*. (2015) Verma and Reddy (2014. 2015) Parihar *et al*. (2018) Das *et al*. (2017) Thulasinathan *et al*. (2018) Altaf *et al*. (2020)
Cantharallales *Cantharellus himalayensis, Cantharellus cibarius, Cantharellus elongatipes, Cantharellus fibrillosus, C. natarajanii C. pseudoformosus, C. sikkimensis, C. umbonatus, Hydnum repandum, Pterygellus polymorphus*	Cantharellaceae	Himachal Pradesh Jharkhand Sikkim Uttarakhand	Viskwakarma *et al*. (2011) Das *et al*. (2015b)

Clavaridelphaceae *Clavariadelphus mirus, C. himalayensis, C. junceus, C. pakistanicus* and *C. truncatus.*		Meghalaya Mussoorie Shimla	Thind and Sukh Dev (1956). Thind and Anand (1956) Methven (1989) Altaf *et al*. (2021a)
Geastrales *Geastrum saccatum , G arenarium, G. archeri, G. fimbriatum, G. rufescens, G. saccatum, G. schweinitizii, G. pectinatum,* *G. Velutinum, G. hariotii.* *Sphaerobolus jaysukhianus*	Geastraceae	Himachal Pradesh Uttar Pradesh Jharkhand Karnataka Gurajat	Khare (1976) Thind and Thind (1982)
Pezizales *Helvella crispa , H. acetabulum, H. lacunose, H. elastica, H. pezizoides* *Morchella augusticeps, M. conica, M. crassipes, M. deliciosus, Morchella esculenta, M. hybrida, M. semilibera, M. vulgarius.* *Aleuria aurantia, Geopora arenicola, G. sumneriana, Pulvinula convexella, P. miltina, Gyromitra esculenta.*	Helvellaceae Morchellaceae Pyronemataceae Discinaceae	Ladakh West Bengal Uttarakhand Jammu & Kashmir Nagaland Ladakh	Acharya *et al*. (2005) Dorjey *et al*. (2013b) Lalotra *et al*. (2016) Yangdol *et al*. (2017 Semwal and Bhatt (2019) Altaf *et al*. (2020).
Phallales *Phallus atrovolvatus, P. duplicatus P. hadriani, P. macrosporus, P. merulinus, P. multicolor, P. rubicundus, Mutinus caninus* var. *caninus, M. caninus* var *albus*	Phallaceae	West Bengal Western Ghats Jammu & Kashmir	Dutta *et al*. (2012) Kour *et al*. (2016) Karun and Sridhar (2019)
Polyporales	Polyporaceae	Allahabad Odisha	Arulpandi and Kalaichelvan (2013)

Ganoderma lucidum , G. applanatum, Mycoleptodonoides sharmae, Fomes annosus var. *indicus, , G. tsugae, Lentinus alpacas, L. concentricus, L. fasciatus, L. megacystidiatus, , P. hookerianus, P. tephroleucus, P. velutinus, Podoscypha petaloides, Polypyrus indicus var. depauperatus, Pycnoporus cinnabarinus, Datronia mollis, , Panus natarajanus*		Sikkim South Gujarat Western Ghats West Bengal Kerala	Das *et al*. (2013) Tripathy *et al*. (2015).
Russullales *Lactarius vesterholti, L. alloradii, L. angustifolius, L. corrugis, L. drassinus, L., L. hygrophoroides var. hygrophoroides, L. proximallus, L. sariflus, L. subuetrnalis* var. *albo-ochraceae, L. L. volemus, L. acicularis, L. crocatus, L. indovolemus,L. himalayanus., R aerugenis, R. albida, R. amoenotens, R. atropurpurea, R., R. dissimulans, R. emetica, R. fragilis, R. fragrantissima, R. fuelitii, R. heterophylla, R. kanadii, R. nigricansR. romelli, R. sarthalensis, R. solaris, R. velemvoskyi, R. versicolor, R. vesterholtii, R. virescens, R. xerampelina , , R. nitida,* *Hericium yumthangense ,H. bharengense, H. cirrhatum, H. rajendrae.*	Russulaceae Hericiaceae	Garhwal Uttar Pradesh Himachal Pradesh Jammu & Kashmir Nagaland North India West Bengal Arunachal Pradesh Sikkim Uttarakhand Western Ghats	Saini and Atri (1989, 1993) Bhatt *et al*. (1995) Bhatt and Lakhanpal (1988) Kamal *et al*. (1990) Das *et al*. (2011,2013,2014,2017) Pala *et al*. (2012) Vishwakarma *et al*. (2012) Dutta *et al*. (2015) Singh & Das (2019) Bera and Das (2021) Verma *et al*. (2021b)
Gomphales *Clavariadelphus mirus, C. himalayensis, C. junceus, C. pakistanicus* and *C. truncatus.*	Clavariadelphaceae	Meghalaya Mussoorie Shimla	Thind & Sukh Dev (1956) Thind & Anand (1956) Methven (1989) Altaf *et al*. (2021a)

According to Beluhan and Ranogaje (2011), mushrooms typically have four functions i.e high-quality nutritional values, delicious qualities, medicinal properties and cultural traits. Wild mushrooms ,in addition to macronutrients and antioxidant ability, possess considerable amounts of vitamins and non-nutrients (phenolics) (Obodai *et al*., 2014) .In some hills of Meghalaya, Murugkar and Subbulakshmi (2005) performed the ground-breaking work on nutritional analysis of wild edible mushrooms . Recently ,mineral composition of *Lactariu*s and *Russula* mushroom species were reported (Niedzielski *et al.,* 2023) . Research on the nutritional makeup of wild *Cantharellus* species in the Northwest Himalayas was done in 2011 by Kumari et al. In Boletus edulis , for the first time the trace elements such as Beryllium, Hafnium, Indium, Lithium etc., were analysed (Falandyz, 2022).

For years, people have harvested and utilized variety of wild edible macrofungi for culinary purpose. Several researchers have carried out studies on the history of usage of wild mushrooms by the people and their economic importance around the world (Corner, 1950; Atkinson, 1961; Krieger, 1967; Zoberi, 1972 ; Phillips, 1981; Singh and Singh, 2002). Since prehistoric times, edible mushrooms have been utilised for sustenance, as stimulants, and to treat illnesses mostly associated with rituals and spiritual practises (Guzmán, 2008). They have been enjoyed as a delicacy since ages for their delicate flavour and appealing aroma, but now , they are also consumed for their nutritional benefits (Das *et al*., 2010). Due to the fact that wild mushrooms have qualities helpful in therapeutic treatments, they have also been utilised in modern medicine (Barros et al., 2008). In their treatise, "Indian Edible Mushrooms," Purkayastha & Chandra (1976) compiled information on 122 species of edible mushrooms from India. Later on , in "Manual of Indian Edible Mushrooms," they gave a brief description of 261 edible mushrooms and listed 22 additional species. There have been studies and reports on edible mushrooms from several states of India and parts of the Indian subcontinent, including Meghalaya, West Bengal, Assam, Arunachal Pradesh, Kashmir, Madhya Pradesh and other places of the North Western Himalayas. (Lakhanpal,1993; Lakhanpal and Sagar, 1989; Kumar and Sharma,2008,2009,2010; Boruah et al., 1997; Sharda et al., 1997; Vrinda et al., 2005). The extensively used edible wild mushrooms in these places *include Geopora spp., Agaricus spp., Leucocoprinus meleagris , Auricularia spp., Coprinus spp., Pleurotus ostreatus, ,*

Termitomyces robusta , Tricholoma sulphureum, Clavaria spp., Lepiota procera .Since palaeolithic and neolithic periods , mushrooms find their usage in medicine (Samorini, 2001). But scientists looked at the fundamentals of the health-promoting mushrooms only in 1960s . Nutritional profiling and antioxidant property of wild mushrooms has been reported from north east India.(Khummlianlal et al., 2022) . *Ganoderma lucidum* has long been used in traditional Chinese medicine, and it is believed to be a cure-all for number of diseases, including hepatopathy, chronic hepatitis, insomnia, bronchitis, asthma, nephritis, hypertension, hyperlipidemia, arthritis, neurasthenia, leukopenia, diabetes. gastric ulcer and arteriosclerosis (Chen and Yu, 1993; Kim et al., 1994;). Likewise, some commonly consumed mushrooms like *Trametes, Schizophyllum, Tramella , Auricularia, Ganoderma, Agaricus, Flammulina, Grifola , Hericium , Lentinula* and *Pleurotus* have been found to have great medicinal potential (Saini and Atri, 1999; Ooi and Liu, 2000). Some edible mushrooms have been found to have the ability to promote health due to the presence of some medicinal compounds (Wasser, 2002; Ajith & Janardhanan, 2007). The nutritional potential edible *Russula* species has been reported (Nadjombe *et al.,* 2022). Recently *Russula lakhanpalli* was found to have antibacterial, antioxidant and nutraceutical potential.(Gangwar *et al*., 2023)

Ethnomycology is the study of indigenous knowledge, folklore, and traditional patterns of using mushrooms for food, medicine, recreational purposes, and as a help to seasonal family economies (Orijel *et al.*, 2012). There are reports of gathering mushrooms by people since ancient times . Mushrooms were regarded by Pharaohs as delicacies and were known as "Food of the Gods" by Romans. People have been gathering and consuming wild mushrooms for thousands of years, but the practise of eating them was first recorded in China (FAO, 2004). Ethnomycological studies of edible and medicinal mushrooms have also been documented by reseachers around the world (Sitotaw et al.,2020; Kinge et al.,2017; Yangdol, 2017). Indigenous people all around the world have employed macrofungi for religious and spiritual functions, artistic endeavours, intoxication and enjoyment, body adornments and charms to ward off black magic (Zent et al., 2004). According to some reports, Puffballs were reportedly burned as incense to ward off ghosts , and puffball figures were reportedly covered on tepees (mushroom caps) to keep spirits away (Burk, 1983). Mexican Indians, Egyptians, Greeks, and Romans all venerated and

used mushrooms as hallucinogens (Kumari et al., 2012). In ceremonies, religious practises, and rock art, mushrooms have been portrayed (Samorini, 2001). Tibhuwa (2012) provided information on the use of mushrooms and folk taxonomy in some communities around Tanzania's Ngorongaro and Sorengeti National Parks, noting that locals were educated about the folk classification and edibility of Termitomyces species. Bradai et al. (2015) reported local knowledge and traditional usage and of truffles among the local people of Algeria near sahara desert.. Robles-Garcia et al. (2016) published the first ethnomycological record of *Fistulinella wolfiana* as an edible species showing excellent antioxidant activity. The ethnomycology of macrofungi belonging Hymenochaetaceae Meripilaceae, Ganodermataceae and Polyporaceae was reported by Khastini et al. in 2018. Kinge *et al*. (2017) used questionnaires , pictorial presentations and group discussions to describe the species richness and indigenous information of wild macro-fungi in the fifteen communities. The ethnomycological knowledge of the native Maya inhabitants of the Guatemalan Highlands, who commercialised 40 kinds of edible mushrooms, was reported by Ponce et al. (2019). The genera *Cantharellus, Lactarius, Russula and Boletus* were the most often commercialised. Sitotaw *et al.* (2020) reported an ethnomycological investigation of 20 edible and therapeutic mushrooms in Ethiopia, with large number of species belonging to Lyophyllaceae , followed by the family Agaricaceae .

Numerous mycologists from various parts of India have reported on ethnomycological usage (Boruah *et al.* , 1997; Harsh *et al*. , 1993; Atri *et al*., 2003; Giri and Rana, 2008; Dutta and Acharya, 2014). *Cyathus olla* (Birds nest fungus,), popularly known as "Nasi-baangah," was described during the research survey on ethnomycological studies from the Ladakh region (Dorjey et al., 2013b). Chauhan et al. (2014) identified 12 wild edible mushrooms from the Kinnaur district of Himachal Pradesh, along with their vernacular names and usage pattern. Basumatary and Gogoi (2016) reported the use of a few wild mushrooms, including *Lentinus polychrous, Termitomyces eurrhizus* and *Volvariella volvacea* by the Bodo population in the Kokrajhar area of Assam, India. In the desert of Ladakh, Yangdol et al. (2014) reported new edible mushroom *Laetiporus sulphurious*, called Chasha locally . Kumar et al. in 2017 , after ethnomycological survey in Chakrata, Dehradun presented culinary practices of the native people. Ethnomycological information of three indigenous communities, Khelmas, karbis and Biates of Assam, India,

was reported by Borah *et al.* (2018). Debnath *et al.* in 2019 reviewed the ethnomedical uses of wild macrofungi by indigenous tribes in India. The perception of local communities regarding the different wild edible mushroom taxa was reviewed by Schunko et al. (2022) and concluded that the main reason for decrease in abundance was change in land use pattern and direct exploitation was the most frequently perceived change.

In Jammu and Kashmir, Kumar and Sharma (2009) reported on the edibility status of a number of wild mushrooms, including *Geopora arenicola, Termitomyces striates, Cantharellus cibarius, Ramaria formosa, Coprinus comatus,* etc. *Morchella* species were reportedly traded extensively at high prices, ranging from Rs 5000 to 7000 per kg, due to its culinary potential (Kumar and Sharma, 2010). The traditional names, culinary applications, palatability, and preservation methods of 62 wild edible mushrooms survey, documentation of ethno-mycological and ethno-myco-taxonomical aspects of were recorded by Kumar and Sharma (2011a). Children and women were found to be more active than men when it came to mushroom collection (Kumar and Sharma, 2011a). Pala *et al.* (2013) & Malik *et al.* (2017) provided ethnomycological investigations of wild mushrooms ,that have nutritional and therapeutic benefits, from the Kashmir Himalaya . According to Lalotra et al. (2016a), some wild macrofungal species, including *Sparassis crispa, Boletus edulis*, and *Morchella deliciosus*, were found to be edible among the locals. The sociobiological and nutritional characteristics of wild edible macrofungi in the North-West Himalaya, including J&K, were reported by Sharma et al. (2020). They found the local population primarily collected wild mushrooms like *Termitomyces, Morchella, Hericium, Pleurotus* and *Geopora* during the monsoon season for food and to improve their economic condition.

CHAPTER THREE

3.1 RESEARCH OBJECTIVES

1. Collection, identification & morphological characterization of collected specimens from different sites of study area.

2. To study the distributional pattern, habitat preference of wild mushrooms with regard to topography, vegetation cover & anthropogenic activities.

3. To explore, survey, documentation of ethno-mycological and ethno-myco-taxonomical aspects of macrofungi.

CHAPTER FOUR

HYPOTHESIS

Wild mushrooms are a diverse group of heterotrophic macrofungi that can be observed with the unaided eye and produce either epigeous or hypogeous fruiting bodies. They consist of a huge network of microscopic filamentous and thread liker structures called hyphae which give rise to fruiting bodies under favourable conditions and enough moisture. In addition to having a worldwide distribution, mushrooms have different nutritional and ecological demands. During monsoon season, considered a suitable time, they occupy a variety of niches in the forest environment. Mushrooms have been divided into various categories to represent the diversity and it includes bracket fungus, agarics, cup fungi, boletes, stinkhorns, jelly fungi, truffles, puffballs, bird's nest fungi. Based on substrate, mushrooms are classified as lignicolous (i.e. growing on wood) , coprophilous (growing on dung) , humicolous (growing on soil), ectomycorrhizal(growing in association with the roots of higher plants). Wild edible macrofungi, in addition to playing important ecological roles, have a variety of uses as food and in medicine. Mushrooms were used in ancient civilizations primarily for their high palatability . People have recognised mushrooms as a superior food source because they have a high nutritional content that is approximately twice that of any vegetable . Eating mushrooms has been proven to have significant amount of dietary fibres , proteins , carbohydrates in addition to some major antioxidants. Ethnomycology involves the study of indigenous knowledge, folklore, and traditional uses of wild macrofungi (mushrooms) as food, medicine, as well as a means of supporting household economics.It has become another area of research to study interrelationship between macrofungi and humans. The current study will focus on the collection, identification, morphological characterization, distributional pattern , habitat preference of wild mushrooms and documentation of ethnomycological aspects of macrofungi. District Kishtwar of J&K was chosen for the current study because the diversity of mushrooms has never been studied so far in this region and considering the vegetation and climatic characteristics of the area, it can be predicted that this area would be home to a number of unique and interesting macrofungal species with high edibility potential.

CHAPTER FIVE

RESEARCH METHODOLOGY

5.1 Area of Exploration

Kishtwar, a newly created district of J&K, is located in the Jammu Division. Earlier it was a part of District Doda and was given the status of district in 2007. The total surface area of the district is 7737 square kilometres. It is surrounded by district Chamba in the south, Anantnag and Doda district in the west, and Kargil district in the east and north respectively. The Chenab river flows through the area, creating the Chenab valley in its southern portions. .Altitudinal variation of district Kishtwar is from 1500 to 6500 masl and average rainfall is around 102-170 cm. The district comprises of eleven tehsils viz Kishtwar , Chhatroo , Marwah , Paddar , Warwan , Nagseni , Drabshalla , Bunjwah , Mughalmaidan , Dachhan and Machail . It is a well-liked tourist destination due to its many alluring landscapes like Bindraban, Mugalmaidan , Chingam , Famber valley, Singpora, Sinthan, etc. It is surrounded on one side by Zanskar range and on other side by Sapphire mountains in the Pir Panjal range. Climatologically, the area lies in the temperate zone. The district has one of the National Park called Kishtwar high altitude park situated at an altitude of 1700 to 4600 m above sea level with an area of 400sq.km and is a rich repository of fauna and flora.

The topography of the region is both hilly and flat, interspersed with majestic mountains, plush meadows, and thick forests. Clay, sand, and loamy soils make up the majority of the soils in the district. The natural attractions include ancient monuments, antique temples, historic Mosques, shrines, historic places and a lofty grassland called chowgan located in the heart of city. Four distinct seasons, namely spring, summer, autumn, and winter are experienced in the area due to the district's peculiar climate.

Kishtwar is renowned for its abundance of natural resources, particularly its diverse forest ecosystem, which supports a number of untapped biological resources that could be used for socioeconomic gains. This Himalayan district is an example of a place with a high potential for producing wild mushrooms since it is rich in forest resources, including both

pure coniferous forests and broad-leaved deciduous trees. Forests of *Cedrus deodara, Pinus wallichiana, Abies pindrow, Picea simithiana and Pinus gerardiana* etc are dominant in the district . Other tree species found include *Juglans regia, Platanus orientalis, Salix alba, Ulmus wallichiana, Betula* sp., *Populus alba* etc. Shrubs prevalent in the district include *Berberis lyceum , Indigofera heterantha, Ficus carica, Viburnum grandiflorum* and herbs include *Taraxacum officinale ,Atropa belladonna, Medicago longifolia , Trifolium repens, Oxalis acetosula, , Bunium persicum* etc.

Local inhabitants including elderly communities, livestock rearers, nomadic tribes have been interviewed for the local use of wild edible mushrooms. Since several regions of Kishtwar district are characterized by marked variation in topography, climate, altitude, edaphic conditions, and types of forest vegetation and hence it was selected for the present investigation.

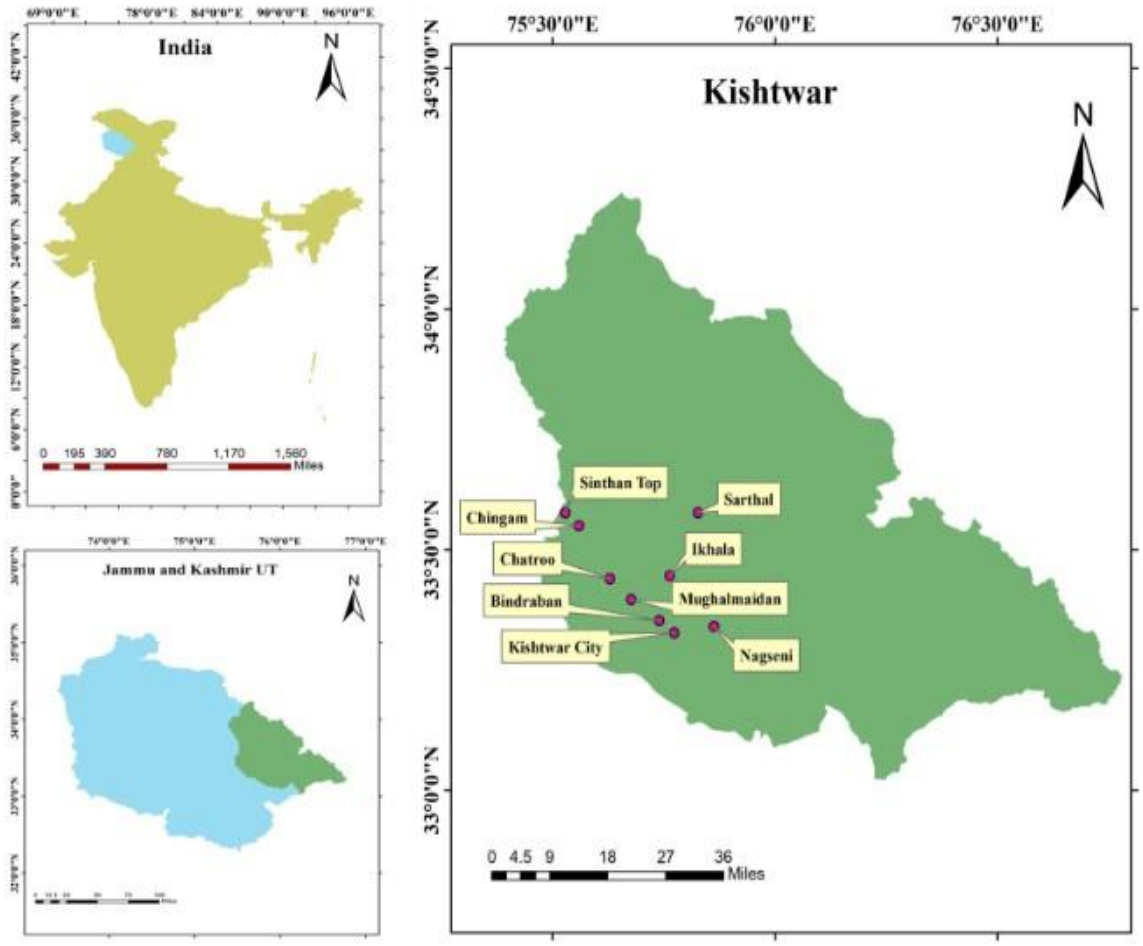

Figure 5.1: Map of India , Kishtwar (J&K) showing different collection sites.

5.2 Collection of wild edible mushrooms

Standard methods of collection, preservation and macroscopic investigations have been used for the collection of wild macrofungi (mushrooms) (Atri *et al*., 2003; Kumar *et al*., 1990; Smith *et al*., 1981) in .Fields trips were conducted from oct, 2021 to march, 2023 to selected sites of the district including Kishtwar , Bindraban, Mugalmaidan, Chatroo, Chingam , Sinthan, Nagseni , Sarthal , Ikhala taking all the essential gadgets like DSLR camera for photography, altimeter, magnifying lens, polythene bags ,paper bags, wooden basket for carrying collected fruiting fruiting bodies, aluminium foil, sharp knife, ,note pad, trowel for detaching mushrooms from trees, brown paper bags and paper for spore print, hand gloves, etc.

During the collection precise field notes were made, including macromorphological descriptions of pileus and stipe size, texture, colour, odour, ornamentation, margin shape, associated hosts including habitat observations. The presence or absence of latex and its colour, notably in *Lactarius* species was also noted. Some chemical tests involving NH_4OH , $FeSO_4$ and KOH on fresh fruiting bodies were also performed. By bruising of some specimens, colour changes were noted and written down. In natural day light, colour of fruiting bodies was observed and noted in accordance with Kornerup and Wanscher (1978). To avoid mixing of collected samples, the fruiting bodies wrapped in brown paper bags and aluminium foil have been marked by a specific number. Finally, the samples were dried and stored for eventual identification in brown paper bags with naphthalene balls as an insect repellant.

5.3 Morphological Characterization

At the time of collection, the Morphological characters of mushrooms have been noted . These characters include

1. **Habit:** solitary, gregarious, scattered, caespitose, associated host.
2. **Pileus:** shape, size, scaly, colour, powdery, wet, dry, sticky, marginal characters, ribbed or furrowed etc.
3. **Hymenium:** Gills, pores and teeth.
4. **Stipe:** shape, size, position, colour, position, smooth/scaly, striated/fibrillose, solid/hollow.

5. **Gills:** attachment, spacing (crowded, distant, sub-distant), colour, equal/unequal, colour changes, etc., if any.

6. **Context:** colour, colour change on cutting and bruising, consistency etc., if any.

7. Absence or presence of annulus and volva

5.4 Preservation of collected Specimens

For maintaining herbarium records and microscopic studies, the collected mushrooms were preserved dry preservation methods. In dry preservation the specimens were first sundried by keeping them on a white paper/sheet for 3-4 days till the fruiting bodies become moisture free and then dried in hot air dryer at 40-50˚C. The dried samples were then put in brown paper bags with the collection number, name, and date of collection. Each package also contained naphthalene balls to prevent any form of insect invasion.

5.5 Microscopic details

Features and measurements observed from the sections from dried specimens after the latter is revived in 5% ethanol, then in 3% KOH for 10-15 minutes and stained with different dyes and reagents (1% Congo red, lactophenol, 3% KOH, 2% Iodine solution and Melzer's reagent) were recorded for each character with the help of calibrated ocular micrometer for the description of average dimensions. Several microscopic characteristics were observed using the Olympus CH20i at various magnifications. The average basidiospore size was taken as average. The shape of basidiospores was determined by using spore shape quotient (Q) = length/width ratio. Microscopic line drawings were made with the help of camera lucida .

Following microscopic structures and characteristic features were recorded;

1. **Asci/Basidia:** Size, shape , wall thickness , colour, sterigmata(number) and arrangement of basidiospores on them, apical pore and arrangement and number of ascospores in ascus.

2. **Basidiospores/Ascospores**: Shape, size, colour, truncation, wall thickness, smooth or ornamentation, hyaline or coloured, amyloid or inamyloid, presence or absence of germ pore and oil bodies etc.

3. **Cystidia/Paraphyses**: shape, size, coloured/hyaline, thick/thin walled, ornamentation, aseptate or septate paraphyses etc.

4. **Hyphae (pileus/stipe hyphae):** Hyaline or coloured, width, thin or thick walled, branched or unbranched, septate or aseptate.

5. Presence or absence of Clamp connections .

6. Universal veil: presence/absence. shape, size.

5.6 Chemical colour reactions

In the field, different parts of fruiting bodies of various macrofungi such as pileus and stipe surface, flesh, lamellae and spores after reacting with certain chemicals provide important information which helps in the identification of these taxa at generic as well as species level. In addition, a variety of micro-chemical tests were employed in the lab to observe spores (ascospores/basidiospores), asci/basisia, paraphyses/cystidia . The List of chemicals used in the field are as

1. 5 % Ammonium hydroxide (NH_4OH).
2. 3% KOH (3gm Potassium hydroxide + 97ml distilled water).
3.. 10% KOH (10gm Potassium hydroxide + 90ml distilled water).
4. 25% Ammonium hydroxide (NH4OH).
5. 5% Ferrous sulphate (FeSO4).

Similarly, following microscopic chemical tests were performed in the laboratory and the list of chemicals used are :

1. Meltzer's reagent (1.5g Potassium iodide + 0.5g Iodine + 22g Chloral hydrate + 20ml distilled water).
2. 1% Congo red (1gm Congo red + 99ml distilled water).

5.7 Identification of collected wild mushrooms

Identification of macrofungi was done by using relevant literature, keys, monographs and books (Smith, 1951; Dissing 1964, 1966; Kempton and Wells 1970; Corner,1972, Zoberi, 1972; Purkayastha and Chandra, 1976, 1985; Pegler, 1977, 1986; Dennis, 1978; Christensen, 1981; Smith *et al.* , 1981; Natarajan and Raman, 1983; Arora, 1986; Singer,

1986; Kumar *et al*. , 1990; Guzman, 1995; Bessette *et al.* , 1997; Kaul, 1997; Yao *et al.* , 1998; Bates *et al*. , 2009; Bougher and Matheny, 2011; Mohanan, 2011; Liang et al., 2011; Dias and Cortez, 2013; Jargeat *et al.*, 2014; Orstadius *et al*., 2015). Details of several wild macrofungi were taken from Ainsworth and Bisbys Dictionary Of Fungi by Kirk *et al* (2008). Several mycological experts and mushroom specialists were consulted to authenticate the identification of mushrooms. The scientific names of the wild macrofungal species in the current study were based on the Index Fungorum (www.indexfungorum.org) and were categorised in accordance with Kirk et al. (2008)

5.8 Ethnomycological studies

For ethnomycological studies, information regarding wild mushrooms was collected through semi-structured interviews, discussions and personal observations with tribals, Amchis (the local medicine practioners), old experienced persons, local informants and by distributing the questionnaire among local populace in different sites of the study area. They were interviewed in local kishtwari, Kashmiri, paadry and gojri language to get their views on historical background, traditional usage, abundance of particular mushrooms, knowledge , method of cooking , health benefits ,palatability, vernacular names, and modes of preservation etc. of the wild mushrooms. More data was collected by showing the original specimens, printed photographs. A total of 79 informants (33 males and 46 females) were involved in this study. The collected data from informants was analysed by applying indices like Use value index (UV) and Cultural Significance index of wild edible mushrooms(EMCSI). UV to be calculated by the formula:

$$UV=\sum U/n$$

where U refers to the number of use reports cited by each informant for a given taxa and n is the total number of informants.

Using eight cultural variables or sub-indices, the cultural significance index of the wild edible macrofungi (mushrooms) eaten by the local population was evaluated by the following formula.

$$\mathbf{EMCSI = (TSAI+PAI+ EI + KTI +FUI+ MFFI + HI) QI}$$

TSAI = Taste score appreciation index.

PAI = Perceived abundance index.

EI = Economic Index.

KTI = Knowledge transmission index.

FUI= Frequency of use index,

HI = Health index.

MFFI = Multifunctional Food index.

QI = Mention index.

EMCSI = Cultural significance index of edible mushrooms.

QI = (Amount of mentions/Number of informants) × 10

For Taste score appreciation index, informants were asked about the taste of particular mushroom species.

For Perceived abundance index., informants were asked about the abundance of wild edible macrofungi (mushrooms) in the forest.

For Economic Index, informants were asked whether they sold/bought edible mushrooms from market and at what price.

For Knowledge transmission index, informants were asked about number of generation of particular family in Kishtwar picking and using wild edible mushrooms. They were asked whether a particular species was used by their parents or not.

For frequency of use index, informants were asked how often do they eat the particular mushroom species?

For Multifunctional food index, informants were asked about the cooking process of a particular mushroom species.

For health Index, informants were asked whether it is safe for them to eat a particular mushrooms species and can its consumption be harmful?

For the calculation of EMCSI(cultural significance index of edible mushrooms), all cultural variables were based on a scale from 0-10 value. 0-10 scale. All the sub-indices *viz*., PAI, FUI, MFFI,TSAI, KTI, HI and EI for a particular species are calculated on the bases of average of values given by informants regarding . The the values of every answer in each variable is give in Table.

Table 5(A): Sub indices , their values for EMCSI.

Sub index	Answer	Value
TSAI	No Taste	**0**
	Good	**3.33**
	Very Good	**6.67**
	Delicious	**10**
PAI	Not found	**0**
	Rare	**2.5**
	Uncommon	**5**
	Abundant	**7.5**
	Very abundant	**10**
EI	He/She do not sell or buy it	**0**
	He/She have sold or buy it occasionally at low prices	**3.33**
	He/She have sold or buy it regularly	**6.67**
	He/She have sold or buy it at high prices	**10**
KTI	New use, discovered by itself	**0**
	Non-native	**2.5**
	Some town people (friend, job partner)	**5**
	Father or mother, and he/she did not teach to his/her children	**7.5**
	Three or more generations involved (grandfathers, fathers, sons)	**10**
FUI	Never	**0**
	Not every year	**2.5**
	Every year once	**5**
	2-3 times a year	**7.5**
	4 or more a year	**10**
MFFI	Do not know	**0**
	Always mixed in a stew with other mushrooms and meat.	**2.5**
	In a stew not as its principal element, mixed with mushrooms/ vegetables, not with meat.	**5**
	Cooked alone not in stew: roast, fried in butter.	**7.5**
	If it is eaten raw or conserved for future consumption.	**10**
HI	Not consumed but confused to a toxic one.	**0**
	Consumed but suffered ill consequences.	**3.33**
	Eaten with confidence and provided health benefits.	**6.67**
	Consumed but good to health (medicinal values).	**10**

Table 5 (B): Table showing the number of respondents gender wise for ethnomycological information.

S.No.	Gender(M/F)	No. of Respondents
1	Male	33
2	Female	46
	Total	**79**

Table 5 (C): Table showing the number of respondents age interval wise for ethnomycological information.

S.No	Category (Age wise in years)	Number of Respondents
1	0-20	5
2	0-40	41
3	40-60	22
4	Above 60	11
		79

Table 5 (D): Table showing the number of respondents gender wise and age interval wise for ethnomycological information.

S. No	Category (Age wise in years)	Number of Respondents
FEMALES		
1	0-20	2
2	0-40	22
3	40-60	15
4	Above 60	7
	Total	**46**
MALES		
1	0-20	3
2	0-40	19
3	40-60	7
4	Above 60	4
	Total	**33**

Richness indices

Richness of the macrofingal species was estimated using three indices viz. alpha diversity, Margalef's index (R1), and Menhinick index (R2).

Species richness or alpha diversity of wild macrofungal species was determined as the total number of species observed by drop count method.

Margalef's index (R1): Margalef index given by Margalef (1958) was the second richness index used in the present study. This index was calculated as:

$$R1 = S - l/\ln(n)$$

Where R1 is Margalef's index; S is the total no. of individuals of all species; ln = natural log, and n is the total number of individuals observed in a site.

Menhinick index (R2): This is another famous index proposed by Menhinick (1964). The Menhinick's index evaluates the relationship between the number of species measured and the square root of the observed individual population. The index is calculated by using following formula:

$$R2 = S/\sqrt{n}$$

where R2 is Menhinick's index, and S and n are same as Margalef's index.

Diversity indices

Shannon's index (H′): The Shannon's index (Shannon and Weaver, 1949) is a measure of species (macrofungal species) diversity that takes uniformity into account. It is based on the premise that increased diversity equates to greater uncertainty when selecting a particular species at random and is an application of information theory. It considers both the species' abundance and uniformity within the sample, and its value rises along with diversity. This was calculated as:

$$H' = -\sum_{i=1}^{s} \text{pi x ln(pi)}$$

where, H′ is the Shannon's index, S is the species with known proportional abundance, pi is the proportional abundance calculated as number of individuals of a species divided by the total number of individuals of all the species.

Simpson's diversity index: The Simpson's index (Simpson, 1949) was calculated to access the degree of concentration or for the observation of strongest control of species over space in different sites. The index is represented by the following formula i.e.

$$Cd = \sum_{i=1}^{s} (pi)^2$$

where, Cd is the Simpson's index or concentration of dominance, S is the species with known proportional abundance, pi is the proportional abundance of i^{th} species, calculated as number of individuals of a species divided by the total number of individuals of all the species.

Evenness index

Evenness (J′) was calculated following the formula given by Pielou (1966), which reads:

$$J' = \frac{H'}{\ln(s)}$$

where, H´ is the Shannon-Wiener diversity index and s is the number of species.

5.9 Equipments Used

1. Roll of aluminium foil and brown paper bags.
2. Magnifying hand lens and altimeter.
3. DSLR camera for field photography.
4. Notepad, permanent markers and ball pen.
5. Spore print cards.
6. Sharp hunting knife for digging fruiting bodies.
7. Scissors, forceps and needles.
8. Wooden basket and collection bag.
9. Small glass bottles for delicate macrofungi.

10. Rubber gloves.
11. Some chemicals for field test.
12. Petri plates and a bundle of wrapping papers.

5.10 Molecular analyses of wild mushroom(macrofungi)

5.10.1 DNA isolation, PCR amplification and DNA sequencing

Following the instructions, dried fruiting bodies of macro fungi were utilised to separate nuclear genomic DNA using the NucleoSpin® Plant II Kit (Macherey-Nagel). The universal primer pairs LR0R & LR5 primers(Vilgalys and Hester 1990) of partial sequence of the ribosomal large subunit of RNA (nrLSU) was used for LSU amplification. The ITS area was amplified and enhanced using ITS 1F/ITS 4R.For amplification reaction , PCR thermal cycler was programmed for 2 min at 96°C, followed by 30 cycles of 30 sec. at 96°C, 40 seconds at 50°C and a final stage of 4 min at 60°C. QIAquick Gel Extraction Kit (QIAGEN, Germany) was used for the purification of PCR products and then the products were placed in an automated DNA sequencer (ABI3730xl DNA Analyzer, Applied Biosystems, USA) for Sanger sequencing using the same primers used for amplification. Both strands of the PCR fragments were sequenced in ABI 3500 DNA Analyzer (Applied Biosystems) using the amplifying primers. All generated LSU sequences obtained were deposited in GenBank and accession numbers procured and accordingly shown in the results.

Phylogenetic analysis

Species level information was obtained after BLAST searching of consensus sequences using NCBI GenBank database. The dataset comprised of nrLSU sequences and reference sequences obtained from a BLAST Search (Altschul et al. 1997) in GenBank (Clark et al. 2016) and relevant published phylogenies. Using MAFFT v.7 (Katoh and Standley 2013) with minimal editing in BioEdit v.7.2.5 (Hall 1999), multiple sequence alignment was performed. Based on maximum likelihood (ML) in MEGA 6.0 (Tamura et al. 2013), a phylogenetic analysis was undertaken. 1000 bootstrap replicates were analysed to obtain nodal support values. The nrLSU sequence generated from our specimen was deposited in the GenBank (http://www.ncbi.nlm.nih.gov/Genbank/) to procure accession number.

CHAPTER SIX

Results & Discussion

A total of seventy one (71) collections of wild macrofungi were made during the thorough fungal forays conducted at various sites in district Kishtwar (J&K). Out of them, forty seven (47) macrofungal species from thirty three (33) genera, eight (8) orders, and twenty three (23) families were found (Table).The species identified from the study area include *Helvella (*2 species), *Morchella* (1 species), *Geopora (1* species), *Gyromitra* (1species), *Agaricus (*1 species), *Apioperdon* (1 species), *Lycoperdon* (1 species), *Lepiota* (1 species), *Macrolepiota (*1 species), *Bovista* (1species), *Coprinus* (1 species), *Amanita* (8 species), *Flammulina (*1 species), *Pleurotus* (1 species), *Pluteus* (1 species), *Coprinellus* (1 species), *Panaeolus (*1 species), *Schizophyllum* (1 species), *Pholiota* (1 species), *Sparassis* (1 species), *Laetiporus* (1 species*), Auricularia* (1 species), *Boletus* (1 species), *Veloporphyrellus* (1 species), *Suillus* (1species), *Cantharellus*(1 species*), Geastrum* (1 species), *Ramaria* (1 species), *Lepista* (1 species), *Hericium*(1 species), *Lactarius* (5 species), *Lactifluus* (1 species), *Russula* (3 species). The table below contains a list of the taxa that have been identified along with their orders, families, location of collection, preferred substrates, and accession numbers.

Table 6.(A): List of total wild macro-fungi (mushrooms) collected and identified from the study area along with site of location, their substrate preference and Accession number.

S.No.	Macrofungal species	Site of Location	Substrate Preference	Accession number
Phylum	**Ascomycota**			
Order	**Pezizales**			
Family	**Helvellaceae**			
1.	*Helvella crispa* (Scop.) Fr.	Chingam, Nagseni, Sarthal	Ectomycorrhizal	**HBJU/M/03**
2.	*H. elastica* Bull.	Chatroo, Chingam, Nagseni	Ectomycorrhizal	**HBJU/M/04**
Family	**Morchellaceae**			

3.	*Morchella esculenta* (L.) Pers.	Mugalmaidan Chingam, Nagseni	Humicolous	**HBJU/M/05**
Family	**Pyronemataceae**			
4.	*Geopora arenicola* (Lév.) Kers	Chatroo, Nagseni, Ikhala	Ectomycorrhizal	**HBJU/M/06**
Family	**Discinaceae**			
5.	*Gyromitra esculenta* (Pers.) Fr.	Chatroo, Chingam Nagseni,	Humicolous	**HBJU/M/07**
Phylum	**Basidiomycota**			
Order	**Agaricales**			
Family	**Agaricaceae**			
6.	*Agaricus campestris* (Bull.) Pers.	Kishtwar, Bindraban, Mugalmaidan Chingam, Nagseni, Ikhala.	Humicolous	**HBJU/M/08**
7.	*Apioperdon pyriforme* (Schaeff .) Vizzini	Kishtwar, Bindraban, Mugalmaidan Chatroo, Chingam, Sarthal, Sinthan Top.	Humicolous	**HBJU/M/09**
8.	*Lycoperdon perlatum* Pers.	Chatroo, Sarthal.	Humicolous	**HBJU/M/10**
9.	*Lepiota cristata* (Bolton) P.Kumm.	Nagseni, Sarthal.	Humicolous	**HBJU/M/11**
10.	*Macrolepiota procera* (Scop.) Singer	Chingam.	Humicolous	**HBJU/M/12**
11.	*Bovista plumbea* Pers.	MugalmaidanNagseni, Ikhala, Sarthal.	Humicolous	**HBJU/M/13**
12.	*Coprinus comatus* (O.F. Müll.) Pers.	Bindraban, Sarthal.	Coprophilous	**HBJU/M/14**
Family	**Amanitaceae**			
13.	*Amanita flavipes* S. Imai	Bindraban, Chatroo,	Ectomycorrhizal	**HBJU/M/15**

		Nagseni, Sarthal.		
14.	*Amanita orsonii* Ash. Kumar & T.N. Lakh.	Chingam	Ectomycorrhizal	**HBJU/M/16**
15.	*Amanita pakistanica* Tulloss, S.H. Iqbal & Khalid	Chingam, Nagseni.	Ectomycorrhizal	**HBJU/M/17**
16.	*Amanita griseofusca* J. Khan & M. Kiran	Chingam	Ectomycorrhizal	**HBJU/M/18**
17.	*Amanita subglobosa Zhu L. Yang*	Chatroo	Ectomycorrhizal	**HBJU/M/19**
18.	*Amanita orientigemmata* Zhu L. Yang & Yoshim	Chatroo, Chingam, Ikhala	Ectomycorrhizal	**HBJU/M/20**
19.	*Amanita griseopantherina* Y.Y. Cui, Q. Cai & Zhu L. Yang	Chatroo.	Ectomycorrhizal	**HBJU/M/21**
20.	*Amanita garhwalensis*	Chingam.	Ectomycorrhizal	**HBJU/M/22**
Family	**Physalacriaceae**			
21.	*Flammulina velutipes* (Curtis) Singer	Bindraban, MugalmaidanSarthal.	Lignicolous	**HBJU/M/23**
Family	**Pleurotaceae**			
22.	*Pleurotus ostreatus* (Jacq. Ex. Fr.) P. Kumm	Mugalmaidan Ikhala.	Lignicolous	**HBJU/M/24**
Family	**Pluteaceae**			
23.	*Pluteus cervinus* (Schaeff.) P. Kumm.	Chatroo, Nagseni, Sarthal.	Humicolous	**HBJU/M/25**
Family	**Psathyrellaceae**			
24.	*Coprinellus micaceus* Lange	Kishtwar Mugalmaidan Chatroo Nagseni Sarthal.	Humicolous	**HBJU/M/26**
25.	*Panaeolus papilionaceus* (Bull.) Quél.	Chatroo, Chingam, Nagseni,	Coprophilous	**HBJU/M/27**

Family	**Schizophyllaceae**			
26.	*Schizophyllum commune* Fr.	Kishtwar	Lignicolous	**HBJU/M/28**
Family	**Strophariaceae**			
27.	*Pholiota squarrosa* (Oeder) Kumm.	Chingam	Humicolous	**HBJU/M/29**
Order	**Polyporales**			
Family	**Sparassidaceae**			
28.	*Sparassis crispa* (Wulfen) Fr.	Chingam, Ikhala Sarthal	Humicolous	**HBJU/M/30**
Family	**Fomitopsidaceae**			
29.	*Laetiporus sulphureus* (Bull.) Murill	Sinthan Top	Lignicolous	**HBJU/M/31**
Order	**Auriculariales**			
Family	**Auriculariaceae**			
30.	*Auricularia auricula-judae* (Bull.) Quel	Chatroo	Lignicolous	**HBJU/M/32**
Order	**Boletales**			
Family	**Boletaceae**			
31.	*Boletus edulis* Bull	Chatroo Chingam Nagseni	Humicolous	**HBJU/M/33**
32.	*Veloporphyrellus latisporus* J . Khan & S.Ullah	Bindraban	Ectomycorrhizal	**HBJU/M/34**
Family	**Suillaceae**			
33.	*Suillus americanus* (Peck) Snell	Chatroo Nagseni Sarthal	Ectomycorrhizal	**HBJU/M/35**
Order	**Cantharallales**			
Family	**Cantharellaceae**			
34.	*Cantharellus cibarius* Fr.	Bindraban, Mugalmaidan Chatroo Chingam	Ectomycorrhizal	**HBJU/M/36**
Order	**Geastrales**			
Family	**Geastraceae**			
35.	*Geastrum saccatum* Fr.	Chatroo Chingam Sarthal	Humicolous	**HBJU/M/37**

Order	**Gomphales**			
Family	**Gomphaceae**			
36.	*Ramaria Formosa* (Pers.) Quel.	Chingam Ikhala	Humicolous	**HBJU/M/38**
Family	**Tricholomataceae**			
37.	*Lepista sordida* (Schumach) Singer	Bindraban Ikhala	Humicolous	**HBJU/M/39**
Order	**Russullales**			
Family	**Hericiaceae**			
38.	*Hericium yumthangense* Das, Stalpers & Stielow	Chingam	Lignicolous	**HBJU/M/40**
Family	**Russulaceae**			
39.	*Lactarius laeticolor* (S. Imai)	Chatroo Chingam Sarthal	Ectomycorrhizal	**HBJU/M/41**
40.	*Lactarius sanguifluus* (Paulet) Fr.	Mugalmaidan Nagseni Sarthal	Ectomycorrhizal	**HBJU/M/42**
41.	*Lactarius scrobiculatus* (Scop.) Fr.	Nagseni Ikhala Sarthal	Ectomycorrhizal	**HBJU/M/43**
42.	*Lactarius zonarius* (Bull.) Fr.	Chingam Ikhala	Ectomycorrhizal	**HBJU/M/44**
43.	*Lactarius abieticola* X.H. Wang	Chatroo	Ectomycorrhizal	**HBJU/M/45**
44.	*Lactifluus volemus* (Fr.) Fr.	Chingam Ikhala Sarthal	Ectomycorrhizal	**HBJU/M/46**
45.	*Russula pseudoamoinicolor* A.Ghosh, K.Das,Baghela & R.P Bhatt	Chingam	Ectomycorrhizal	**HBJU/M/47**
46.	*Russula lakhanpalii* A.Ghosh, K.Das & R.P Bhatt	Chatroo Chingam	Ectomycorrhizal	**HBJU/M/48**
47.	*Russula densifolia* sensu NCL	Chatroo Chingam	Ectomycorrhizal	**HBJU/M/49**

6.1. Taxonomic description of mushrooms (macrofungi) collected and identified from the study area.

Phylum *Ascomycota*

Order *Pezizales*

6.1.1. Family *Helvellaceae*

1. Helvella crispa (Scop.) Fr., Syst. mycol. (Lundae) 2(1): 14 (1822) [Figure 6(1)]

Specimen examined: India, Jammu and Kashmir, District Kishtwar, Chingam, Nagseni , scattered, growing in association with *Cedrus deodara* and *Picea smithiana*. Faisal Mushtaq & Ashish Vyas. Collection number FM22-001, Accession number HBJU/M/03. Jan-March 2022.

Pileus 28-48 mm long, 2-5 lobed, Light creamish to light grey (1A1-1C1) , irregular shaped with wrinkled surface, margins rolled inwards , undulate and minutely contorted ; **Stipe** 42-76 × 12-26 mm, off white (8A1), hollow from inside , width narrows towards apex, dry,ribbed and furrowed; **Asci** 218.0-258.0 × 14.0-29.2 µm**,** 8 spores in each ascus, smooth , thin-walled, hyaline; **Ascospores** 9.1-13.5 × 7.8-11.6 µm (avL=11.3, avW=9.7, Q = 1.16), broadly ellipsoidal , hyaline, placed obliquely ,smooth, thin-walled, with no oil droplet; **Paraphyses** 7.8-11.5 µm wide, with pointed apex , septate smooth and hyaline; **Stipe hyphae** 2.4-5.2 µm wide, clear and smooth.

Distribution: Firstly Malik *et al*., 2017, reported it from Jammu and Kashmir.

Edibility: Edible in the study area.

Remarks: Creamish pileus with wrinkled surface and ribbed stipe make this species unique and different from *Helvella elastica.*

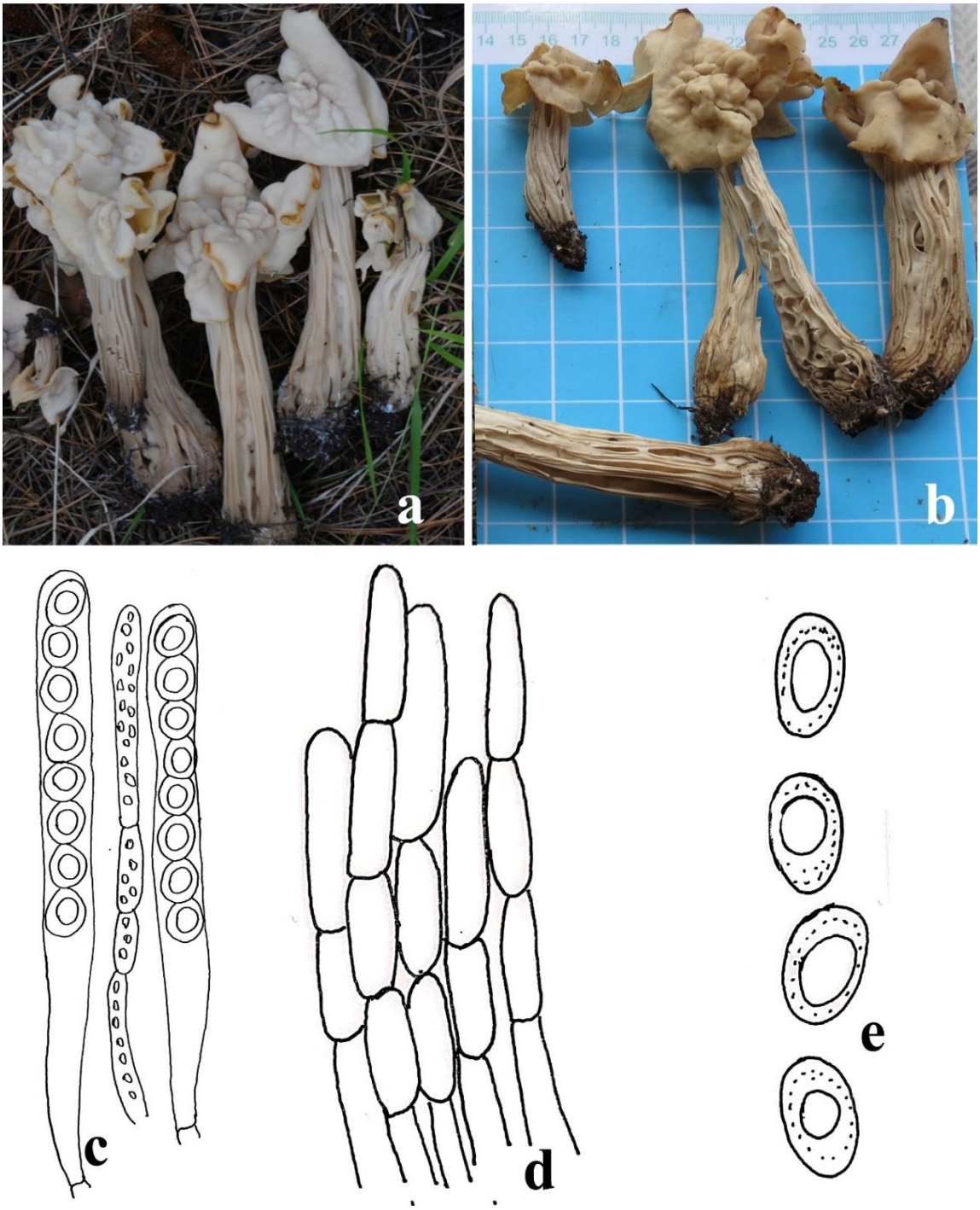

Fig 6(1): Helvella crispa

a-b Fresh Ascomata in the forest; c. Asci; d. Paraphyses; e. Ascospores; (Scale bars: a-b = 50 mm; c-e=10 µm.)

2. *Helvella elastica* Bull ., herbier de la Frannce 6:tab.242(1785) [Figure 6 (2)]

Specimen Examined: India, Jammu and Kashmir, District Kishtwar, Chatroo, Chingam, Nagseni , scattered, growing in association with *Cedrus deodara* and *Pinus wallichiana.* Faisal Mushtaq & Ashish Vyas. Collection number FM22-004, Accession number HBJU/M/04. Jan-March 2022.

Pileus: 28-42 ×5-16mm wide, light brown to brown(7D4-7E4), under surface creamish white to light brown(7A1-7D6) , saddle or irregular shaped with incurved margins, ,smooth, **Stipe:** 18-48 ×8-24 mm ,smooth, white (6B1),hollow from inside , non-ribbed , soft and equal ;**Asci**:204-238×12.4-16.6µm,eight spored, apex obtuse, clear; **Ascospores**; 13.8-18.8 ×9.0-12.3 µm (avL=16.3, avW=10.65, Q = 1.53) , narrowly ellipsoidal, uniseriate, sub-hyaline, smooth , guttulate having oil droplet ;**Paraphyses**:4.8-17.5 µm wide, hyaline, with septae and granular contents, apices club shaped.

Distribution : Firstly reported from West Bengal by Kar and Maity,1970 and from J&K by Yangdol in 2017.

Edibility: Not consumed in the study area.

Remarks: The stipe of *H. elastica* is smooth and non ribbed as compare to that of *H. crispa*.

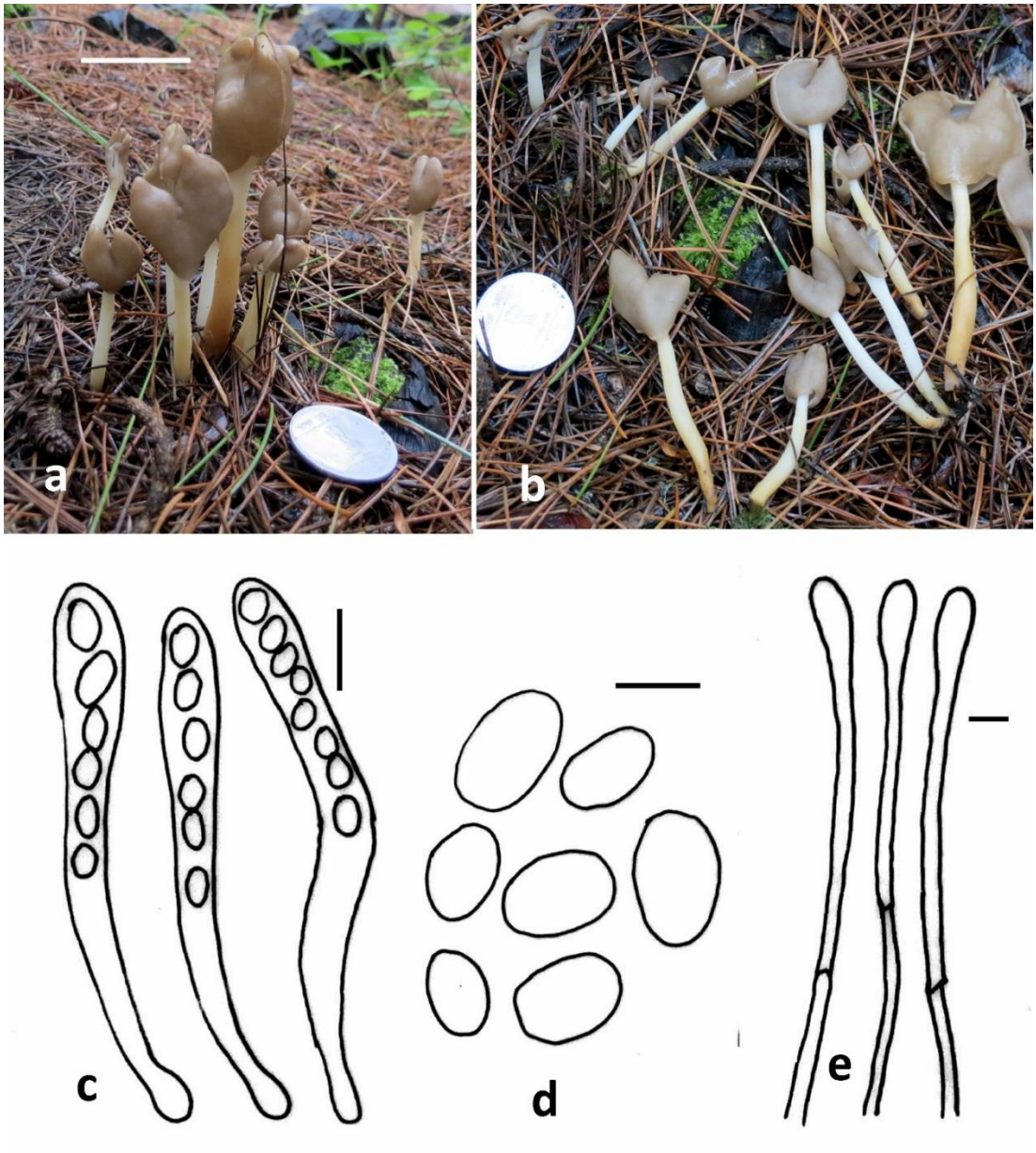

Fig 6(2): ***Helvella elastica***

a-b. Fresh Ascomata in the forest; c. Asci; d. Ascospores; e. Paraphyses
(Scale bars: a-b = 50 mm; c-e =10 μm)

6.1.2 Family Morchellaceae

3. ***Morchella esculenta*** (L.) Pers., Syn. meth. fung. (Göttingen) 2: 618 (1801) [Figure 6 (3)]

Specimen examined: India, Jammu and Kashmir, District Kishtwar, Mugalmaidan , Chingam, Nagseni , scattered, growing in humus rich soil. Faisal Mushtaq & Ashish Vyas. Collection number FM22-006, Accession number HBJU/M/05. Jan-March 2022.

Pileus: 40-60 × 18- 45 mm , Olive Brown to yellowish brown(4E5-5D8) become greyish brown (5F3) on drying. oval, hollow from inside, broad base and narrow apex , surface rough and pitted, angular pits ; **Stipe**: Yellowish white (1A2), hollow from inside , base broad, inflated and narrow towards apex. ; **Asci:** , 224-288 x 18-30 µm, eight Spored ,placed obliquely. **Ascospores:** hyaline, 13.5-21.5× 9.0-13.8 µm (avL=17.5, avW=11.4, Q = 1.54), narrowly ellipsoidal in shape , arranged in single series, absence of oil droplets.; **Paraphyses:** 5.0-12.0 µm wide, Hyaline, smooth, with septa. **Stipe hyphae:** 5.2-11.1 µm wide , branched, inflated, clear and smooth.

Distribution: Earlier reported from Jammu and Kashmir (Abraham, 1991; Kumar and Sharma, 2009) ; Kashmir by Sayeed *et al* (2018)

Edibility: consumed in the study area.

Remarks : This species was found to come out solitary, sometimes in bunch, on slopes of forests.

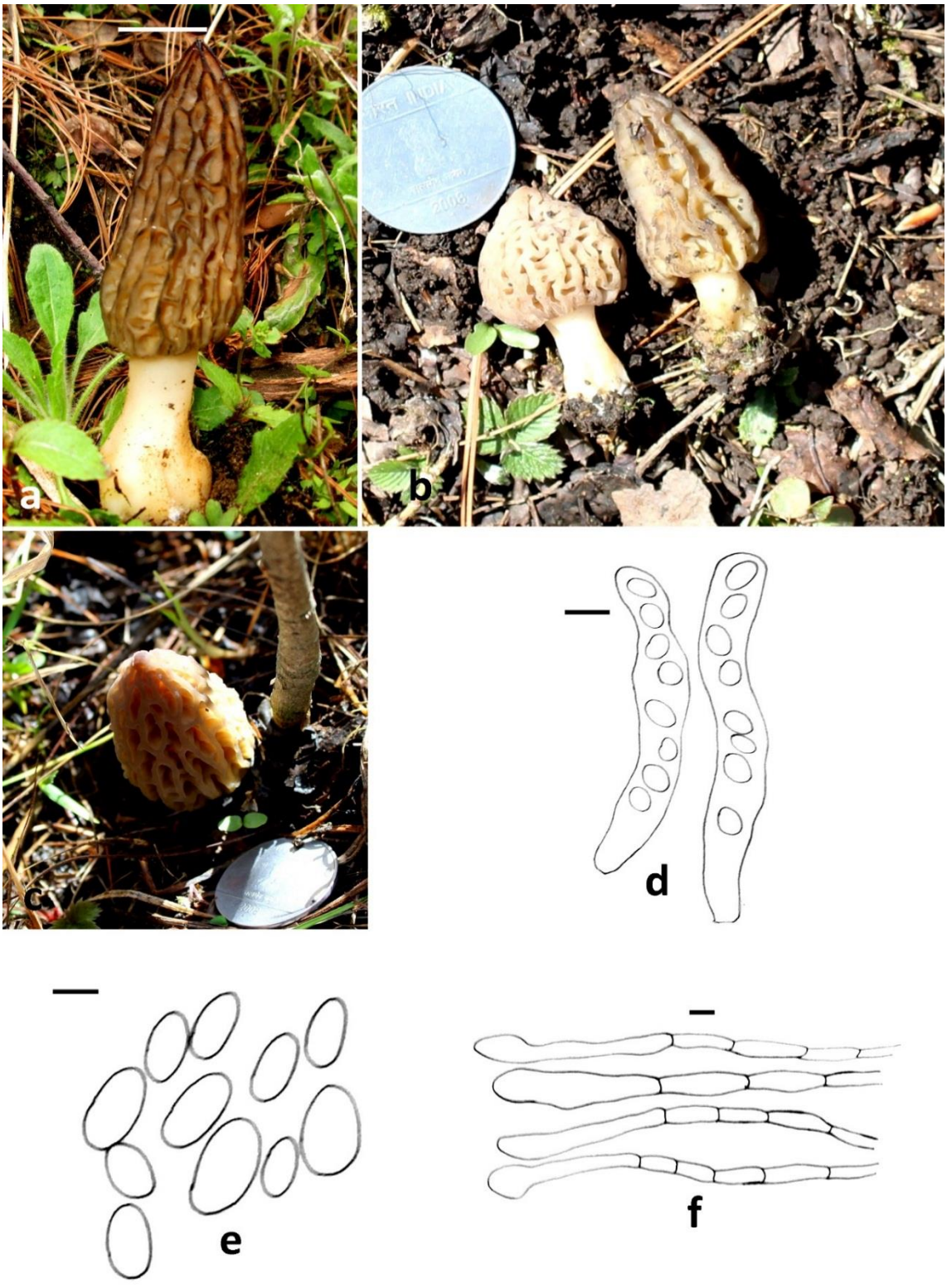

Fig.6 (3) ***Morchella esculenta***

a-c. Fresh Ascomata in the forest; d. Asci; e. Ascospores; f. Paraphyses;
(Scale bars: a-c= 50 mm; d-f =10 μm)

6.1.3 Family Pyronemataceae

4. *Geopora arenicola* (Lév.) Kers, *Svensk Bot. Tidskr*. 68(3): 345 (1974) [Figure 6 (4)]

Specimen examined: Jammu and Kashmir , District Kishtwar ,Chatroo, Ikhala ,Nagseni. growing scattered to gregarious in association with *Cedrus deodara* and *Abies pindrow* . Faisal Mushtaq & Ashish Vyas. Collection number FM22-007, Accession number HBJU/M/06. Jan-March 2022,2023.

Fruiting Body: 15-60 mm in diameter, bowl or cup shaped, colour is brownish beige to dark brown(6E3)on outer surface while yellowish white (4A2-7F6) from inside, without any stipe/sessile, near about 20 - 30 mm deep inside soil; **Asci:** Cylindrical, enlarged and rounded apex, narrow below, 208-315 µm long, 11.5-30 µm wide, 8 spored. **Ascospores:** 22.0-34.0 × 14.0-19.0 µm (a_v L = 28.0 µm, a_v W = 16.5 µm, Q = 1.69) , oval shaped, clear, smooth, thin walled, arranged in single series and placed obliquely. **Paraphyses:** 2.8-7.5 µm wide, thin walled, smooth , septate.

Distribution: First reported from Jammu and Kashmir (Kaul *et al*., 1978: Abraham, 1991; Kumar and Sharma, 2009), and Ladakh by Yangdol *et al*. in 2017.

Edibility: widely edible in study area.

Remarks: It is new record from the study area.

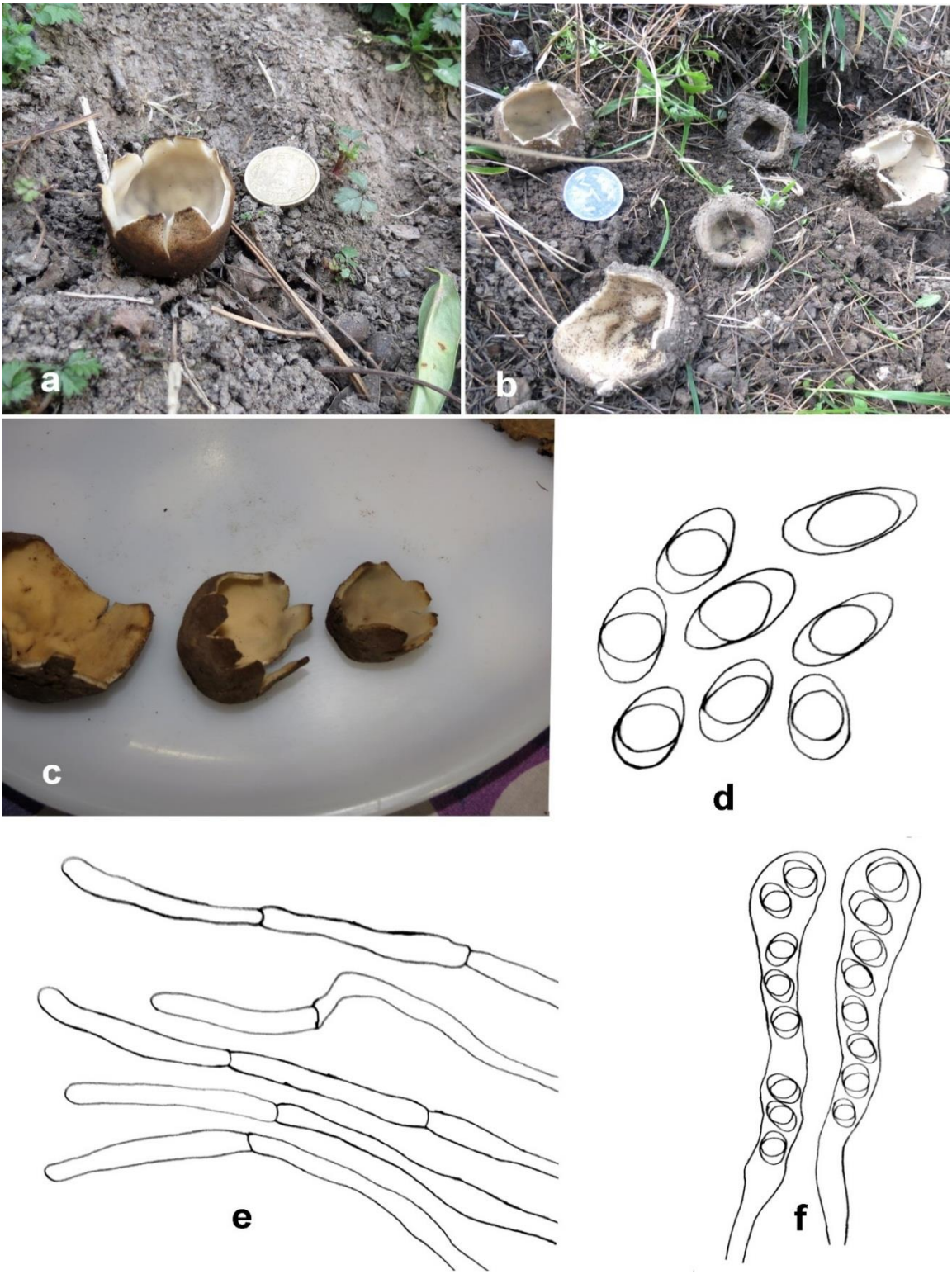

Fig. 6 (4) *Geopora arenicola*

a-c. Fresh Apothecia in the forest; d. Ascospores; e. Paraphyses; f. Asci.
(Scale bars: a-c= 50 mm; d-f =10 μm).

6.1.4 Family Discinaceae

5. ***Gyromitra esculenta*** (Pers.) Fr., *Summa veg. Scand.*, Sectio Post. (Stockholm): 346 (1849) [Figure 6 (5)]

Specimen examined: Jammu and Kashmir, District Kishtwar, Chatroo, Chingam, Nagseni. Humicolous, Solitary to scattered . Faisal Mushtaq & Ashish Vyas. Collection number FM22-008, Accession number HBJU/M/07. Jan-March 2022.

Fruiting Body: 50-105 mm height and pileate; **Pileus**: 35-48 mm long and 20-40 mm wide Reddish brown(8E6) to Light brown (6D5) , sub globose, lobed randomly,without any regularity , fusion with stipe at various points ; **Stipe:** white (6B1) to creamish white , 25-40mm , enlarged or inflated at the base & narrow towards the apex , smooth ; **Flesh:** creamish, brittle,clear, glassy, strong odour; **Asci:** 150-290 x 12.8-17.5µm wide at the top and middle and 10.5 µm wide at the base, cylindrical , apex obtuse, spores eight and arranged in single series; **Ascospores:** 15-24.5 x 10.7-17.0 µm (a_v L = 19.75µm, a_v W = 13.85 µm, Q = 1.43) ellipsoidal, mono to biguttulate, smooth; **Paraphyses:** 150-178x 9.0-14.0 µm wide, thin- walled , smooth & without septa

Edibility: Edible in the study area.

Remarks: It is new record from the study area.

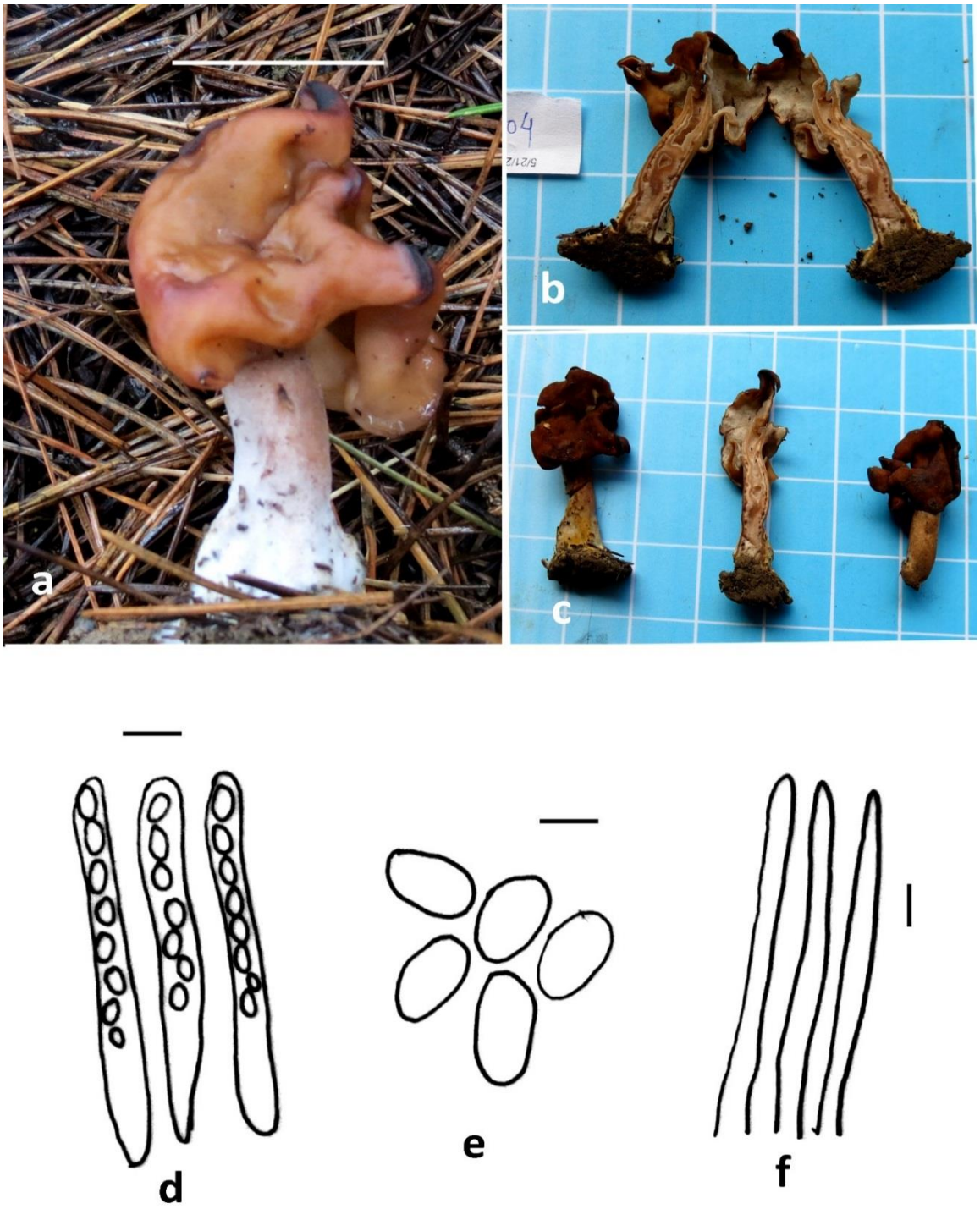

Fig. 6 (5*) Gyromitra esculenta*

a-c. Fresh basidiomata in the forest; d. Asci; e. Ascospores; f. Paraphyses; Scale bars: a-c = 50 mm; d-f =10 μm.

Phyllum *Basidiomycota*

Order *Agaricales*

6.1.5 Family *Agaricaceae*

6. *Agaricus campestris* L. [as 'campester'], Sp. pl. 2: 1173 (1753) [Figure 6 (6)]

Specimen examined: India, Jammu and Kashmir, District Kishtwar, Kishtwar city, Bindraban, Mugalmaidan, Chingam, Nagseni, Ikhala. Scattered to gregarious to caespitose, common, growing in open field and in forest of *Cedrus deodara* and *Pinus wallichiana.* Faisal Mushtaq & Ashish Vyas. Collection number FM22-009, Accession number HBJU/M/08 , April-June 2022.

Pileus 38–95 mm wide, white to snow white (1A1), initially globose than convex and finally plane, surface dry, smooth, light brownish scales develop at maturity , margins entire and appendiculate, flesh thick. **Lamellae** dull red to pinkish (8B4-8A2) at younger stage , turns dark brown (6F4) or Greyish brown (8E3) and black finally , crowded, absence of forkation. **Stipe** 32–63 × 9–18 mm, white to snow white, cylindrical, thick, smooth and soft above the ring and fibrillar below, presence of annulus **Stipe context** snow white and solid. **Annulus** off white**,** single, membrane like , lower surface with woolly tufts, upper surface smooth , not persistent . **Basidiospores** 6.2–7.8 × 3,4–5.9 µm (a_v L = 7 µm, a_v W = 4.65 µm, Q = 1.51) , narrowly ellipsoidal, clear, smooth , absence of germ pore , guttulated . **Basidia** 15–22 × 6.0–7.5 µm, narrowly cylindrical to clavate , clear, smooth; **Sterigmata** 2.5-5.0 µm long, 3-4 in number **Pileus hyphae** 3.5–12 µm wide, thin walled, hyaline, septate , constrictions at septa in few hyphae, absence of clamp connections ; **Stipe hyphae** 5.7–11.6 µm wide, smooth, clear, thin walled, septate, absence of clamp-connections .

Distribution: First reported from Jammu and Kashmir (Watling and Gregory, 1980). Atri *et al*., reported it from Punjab in groups along roadside in 2001.

Edibility: Edible in the study area.

Remarks: Widely prevalent and consumed in the study area .

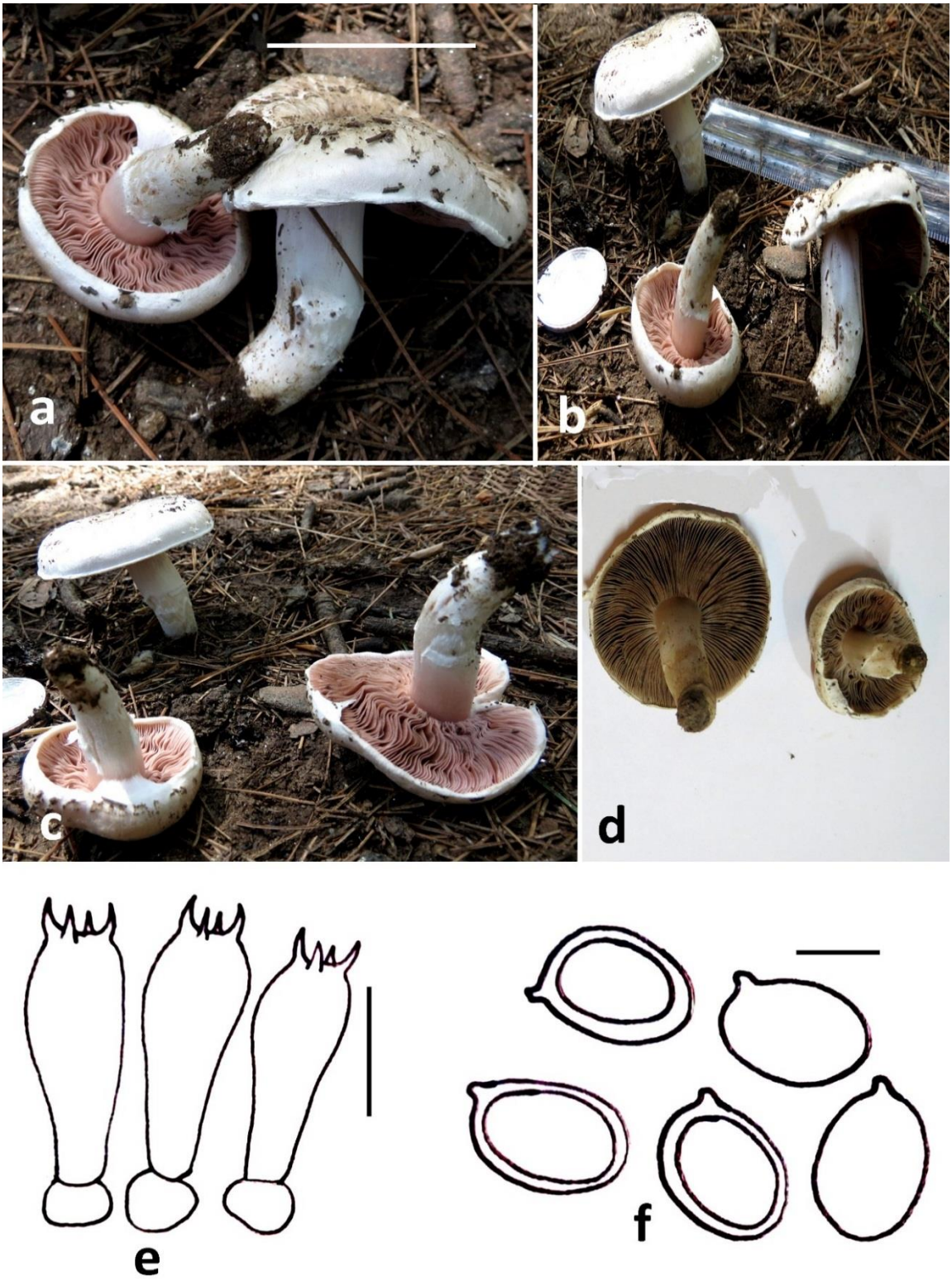

Fig. 6 (6) ***Agaricus campestris***

a-d. Fresh basidiomata in the forest; e. Basidia; f. Basidiospores .
Scale bars: a-d = 50 mm; e-f =10 μm.

7. *Apioperdon pyriforme* (Schaeff.) Vizzini, in Vizzini & Ercole, *Phytotaxa* **299**(1): 81 (2017) [Figure 6 (7)]

Specimen examined: Jammu and Kashmir , Kishtwar, Bindraban, Mugalmaidan, Chatroo, Chingam, Sarthal ,Sinthan top, humicolous, scattered and common in open fields and in coniferous forests of *Cedrus deodara* and *Pinus wallichiana* . . Faisal Mushtaq & Ashish Vyas. Collection number FM22-012, Accession number HBJU/M/09. April-June 2022.

Basidiomata: 15-35 x 10-30 mm, pear shaped to sub-globular; stipe short. 8-15mm long and remain attached to the substratum : white (1A1) peridium initially and at maturity it turns brownish(6D5),opening present in mature specimen through which spore dust comes out, **Gleba**: white powder form initially and brownish at maturity, solid initially and powdery at maturity; **Basidiospores:** globose, 2.8-4.9x 3.0-3.4 µm (a_v L = 3.85 µm, a_v W = 3.2 µm, Q = 1.20) , broadly ellipsoidal ,thick walled, smooth , guttulated ; **Exoperidial hyphae** 1.6-5.4µm wide, clear, smooth, thin walled, septate; **Capillitium threads:** 2.6-7.5µm wide, brown in colour, branched , thick walled , clear, aseptate.

Distribution: Abraham, 1991; Altaf *et al.*, 2020 reported it from Jammu and Kashmir and Jha et al. 2011 from Uttar Pradesh
Edibility: Not consumed in study area.

Remarks: The species is commonly found in open fields and coniferous forests in the form of clusters or groups. It is new record from the study area.

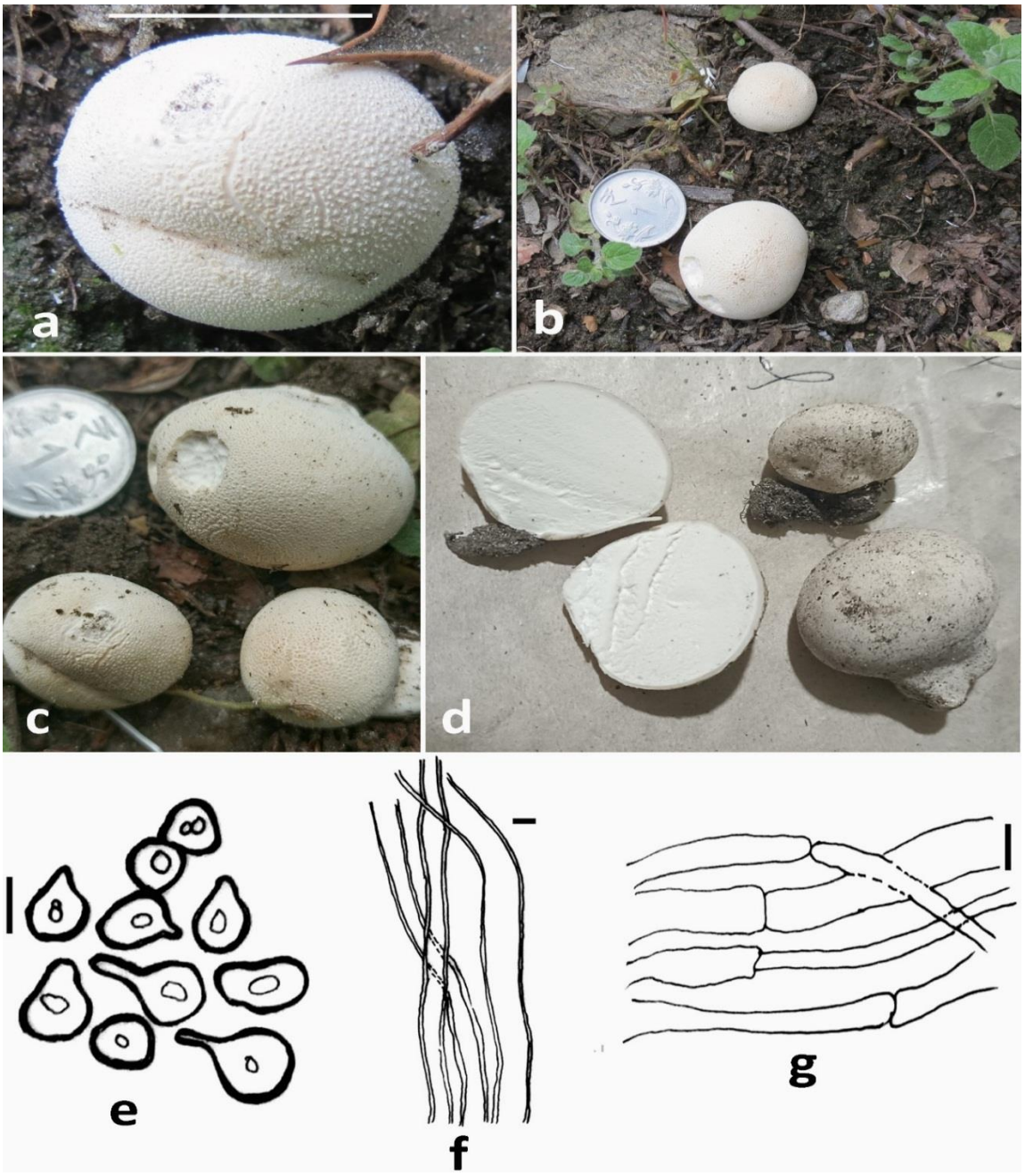

Figure 6 (7)] ***Apioperdon pyriforme***

a-d. Fresh basidiomata in the forest; e. Basidiospores; f. Capillitium threads; g. exoperidial hyphae. Scale bars: a-d = 50 mm; e-g =10 μm; f. 5 μm.

8. Lycoperdon perlatum Pers., Observ. Mycol. (Lipsiae) 1: 145 (1796). [Figure 6 (8)]

Specimen examined: Jammu and Kashmir, District Kishtwar, Chatroo , Sarthal . Humicolous , solitary to scattered to gregarious. Faisal Mushtaq & Ashish Vyas .Collection number FM22-014 , Accession number HBJU/M/10.April-June 2022.

Basidiomata 20–50 mm high , 12 -30 mm in diameter, subglobose, obovoid to pyriform, pseudostipitate; pseudostipe attached at base by white, fine, abundant, branched rhizomorphs.. **Exoperidium** snow white(1A1) initially , becoming light yellowish white (4A2) , pale yellow to greyish yellow (4A3-4A4) , covered with light grey to white , long , conical spines(up to 4 mm in length) . **Endoperidium** yellowish white (4A2), often covered with reticulate pattern. **Gleba** white when immature, becoming light brown to pale brown and powdery at maturity, cottony . **Basidiospores** globose, 3.5–5.1 × 3.3-4.7 µm (a_v L = 4.2µm, a_v W = 4.0 µm, Q = 1.05), sub globose, ornamented, thick walled , deep rusty brown (in iodine); **Capillitium threads** aseptate, 3–5.5 µm wide, hyaline to brown, branched with presence of septae.

Distribution: First reported from Uttar Pradesh by Vishwakarma and Tripathi in 2019.

Edibility: Not edible in study area, although reported to be edible from other parts (Krieger, 1967; Phillips, 1981; Purkayastha and Chandra, 1985).

Remarks: It differs from other alike genera by showing the presence of apical pore at maturity.

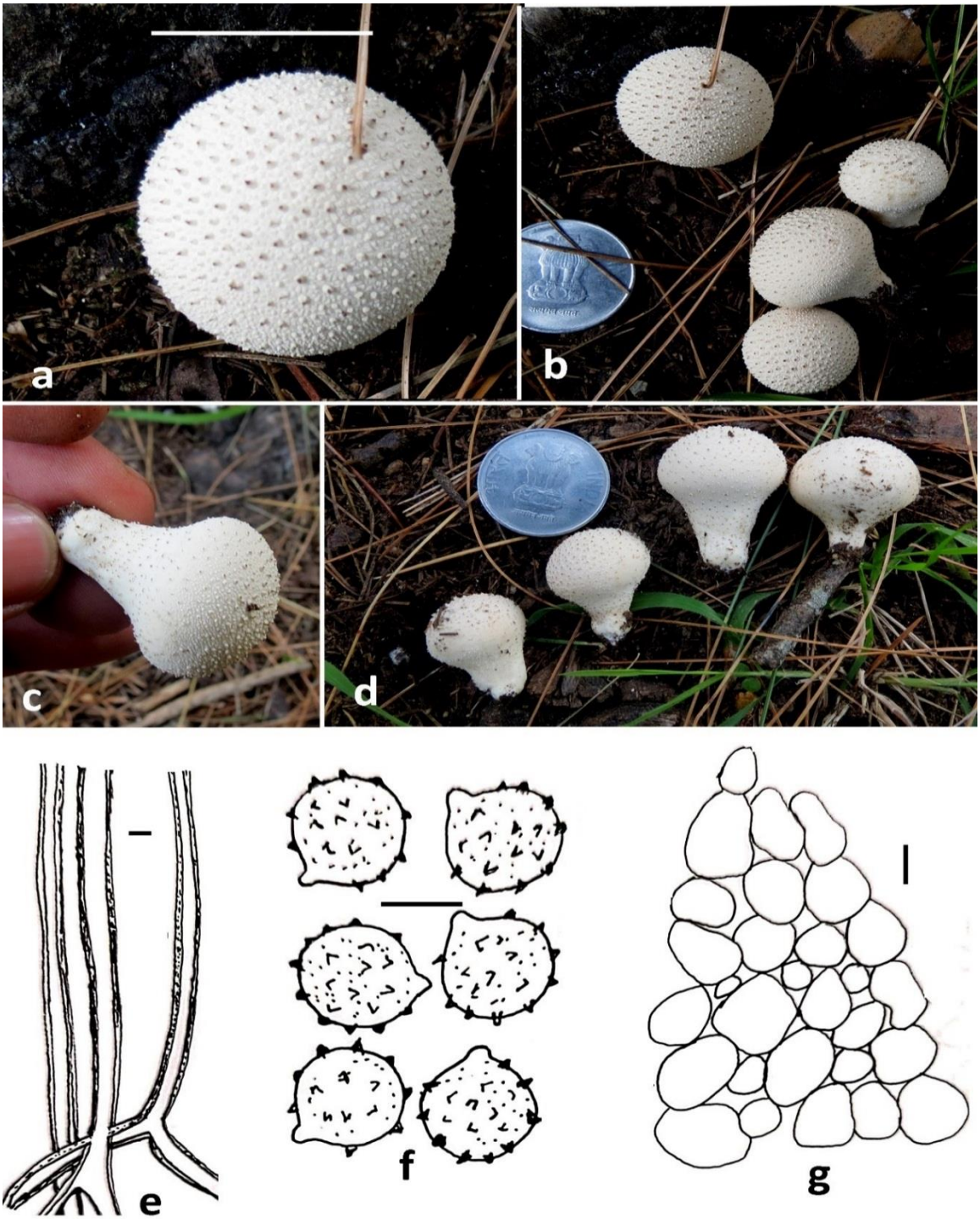

Figure 6 (8) ***Lycoperdon perlatum***

a-d. Fresh basidiomata in the forest; e. Eucapillitium; f. basidiospores; g. Exoperidium; Scale bars: a-d= 20 mm; e-g =10 µm.

9. Lepiota cristata Barla , Flore mycologigue illustree. Les champignons des Alpes-Maritimes: 57 (1888).[Figure 6(9)].

Specimen Examined; Jammu and Kashmir, District Kishtwar, Nagseni , Sarthal , humicolous, scattered to gregarious . Faisal Mushtaq & Ashish Vyas. Collection number FM22-017, Accession number HBJU/M/11. April-June 2022.

Pileus : White(1A1) with dark brownish umbo, brownish scales present in circles around the umbo ,30-45mm wide, slightly convex to plano-convex, , margins irregular ; **Gills**: closely associated ,equal;**Stipe**:26-40mm long and 1.5- 4 mm wide, pure white (1A1) ,equal; **Basidia**: Club shaped ,guttulated,20 -29.5 × 5.8- 8.2µm; **Sterigmata**: 4 in number,2.4-4.3 µm long; **Basidiospores**:3.5-6.9×3.4- 6.2µm (a_v L = 5.25 µm, a_v W = 4.8 µm, Q = 1.09) , sub-globose to ellipsoidal ,clear, wall thin double walled; **Pileus hyphae**:3.6-7.8µm wide, hyaline, clear, smooth , absence of clamp connection .

Edibility: Not edible in the study area.

Remarks: It is new record from study area.

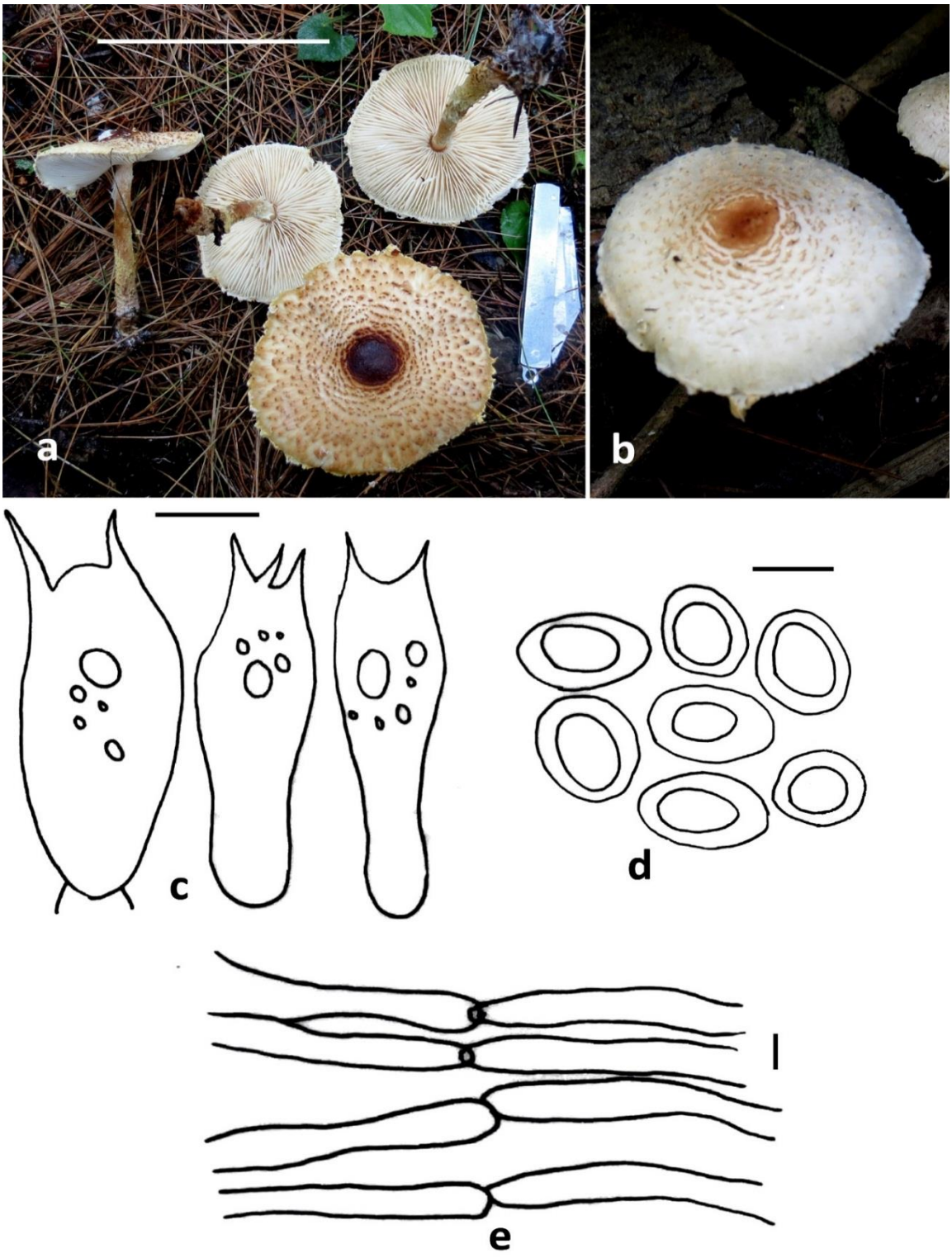

Figure 6(9) ***Lepiota cristata***

a-b. Fresh basidiomata in the forest; c. Basidia; d. Basidiospores; e. Hyphae; Scale bars: a-b = 50 mm; c-e =10 μm.

10. ***Macrolepiota procera*** (Scop.) Singer, *Pap. Mich. Acad. Sd.* 32: 141 (1948) [1946] [Figure6(10)]

Specimen examined: Jammu and Kashmir, District Kishtwar, Chingam , humicolous, scattered in mixed forest of conifers and *Populus* sp. Faisal Mushtaq & Ashish Vyas. Collection number FM22-20, Accession number HBJU/M/12. April-June 2022

Pileus: 68-144 mm in diameter, off white (1A1) with significant brown scales on surface, ,initially oval, then convex and flat finally , brownish umbo, flesh white with agreeable odour ; **Gills:** upto 7m m wide, crowded, free, unequal. wavy, concolourous with pileus, brownish at maturity; **Stipe:** 115 – 150 mm long and 20mm wide, off white to creamy white (1A1) , central, equal, solid, smooth, swollen at the base; **Annulus:** creamish to light brownish , thin, membranous, superior, movable : **Basidiospores:** 9.8-14.6 x 6.8-10.2 µm (a_v L = 12.2µm, a_v W = 8.5 µm, Q = 1.43), ellipsoidal to subglobose, , with oil droplets, smooth, slightly thick walled, apiculus upto 1.6 µm; **Basidia:** clavate, 29.5-35.5 x 10.5-12.8 µm, sterigmata 2 to 4, narrow at base and broader at apex. **Pileus and Stipe hyphae:** 5.2-10.8 µm wide, septate, branched with clamp connection, clear.

Edibility: Edible in the study area. Earlier reported to be edible (Atkinson, 1961; Krieger, 1967; Purkayastha and Chandra, 1985) from India and abroad.

Distribution: Reported from various parts of India including Uttar Pradesh, Calcutta, Himachal Pradesh, Karnataka and West Bengal (Banerjee, 1947; Ghosh and Pathak, 1965) and Jammu & Kashmir (Kour, 2013).

Remarks: A new record from the study area..

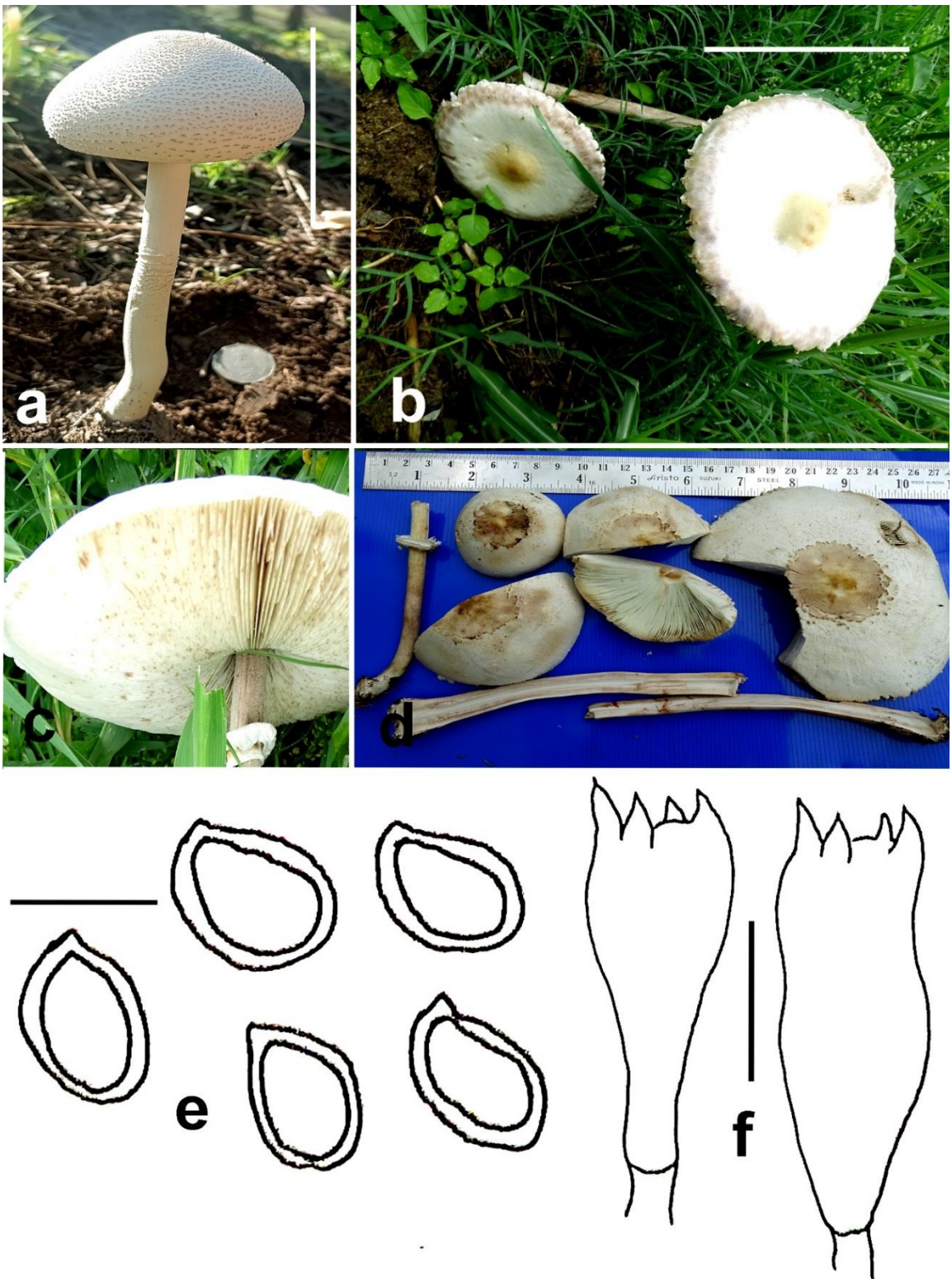

Figure 6 (10)] ***Macrolepiota procera***

a-d. Fresh basidiomata in the forest; e. basidiospores; f. Basidia.
Scale bars: a-d = 50 mm; e-f=10 μm.

11. *Bovista plumbea* Pers., *Ann. Bot. (Usteri)* 15: 4 (1795) [Figure6(11)]

Specimen examined: Jammu and Kashmir, District Kishtwar, Mugalmaidan, Nagseni,,Sarthal. humicolous, scattered in open grassland . Faisal Mushtaq & Ashish Vyas. Collection number FM22-21, Accession number HBJU/M/13. April-June 2022

Sporophore: 19-33mm in diameter and 22-32mm in height, rounded , initially white in young condition then turns brown (6D7) at maturity, anchored to substratum by rhizoids; surface becomes slightly rough, at maturity , exoperidium peels off , endoperidium smooth; **Gleba:** white (1A1) and fleshy when young turning into brown powdery mass at maturity; **Basidiospores:** 4.6-6.2 × 3.8-4.5 µm (a_v L = 5.4µm, a_v W = 4.15 µm, Q = 1.30), ellipsoidal, thick walled, monoguttulate; pedicel (9.2-13.8 µm in length) attached to spore, pointed towards tip; **Capillitium thread:** 5.8-15.8 µm wide, thick walled , hyaline, aseptate; **Exoperidium hyphae:** 3.7-11.6 µm wide, thin walled, hyaline, septate, sometimes enlarged with branching.

Distribution: Earlier reported from Uttar Pradesh, Himachal Pradesh and Jammu and Kashmir (Hennings, 1901; Ahmad, 1941; Kaul *et al*. 1978; Thind and Thind, 1982; Kumar, 2009)

Edibility: Not consumed in study area .

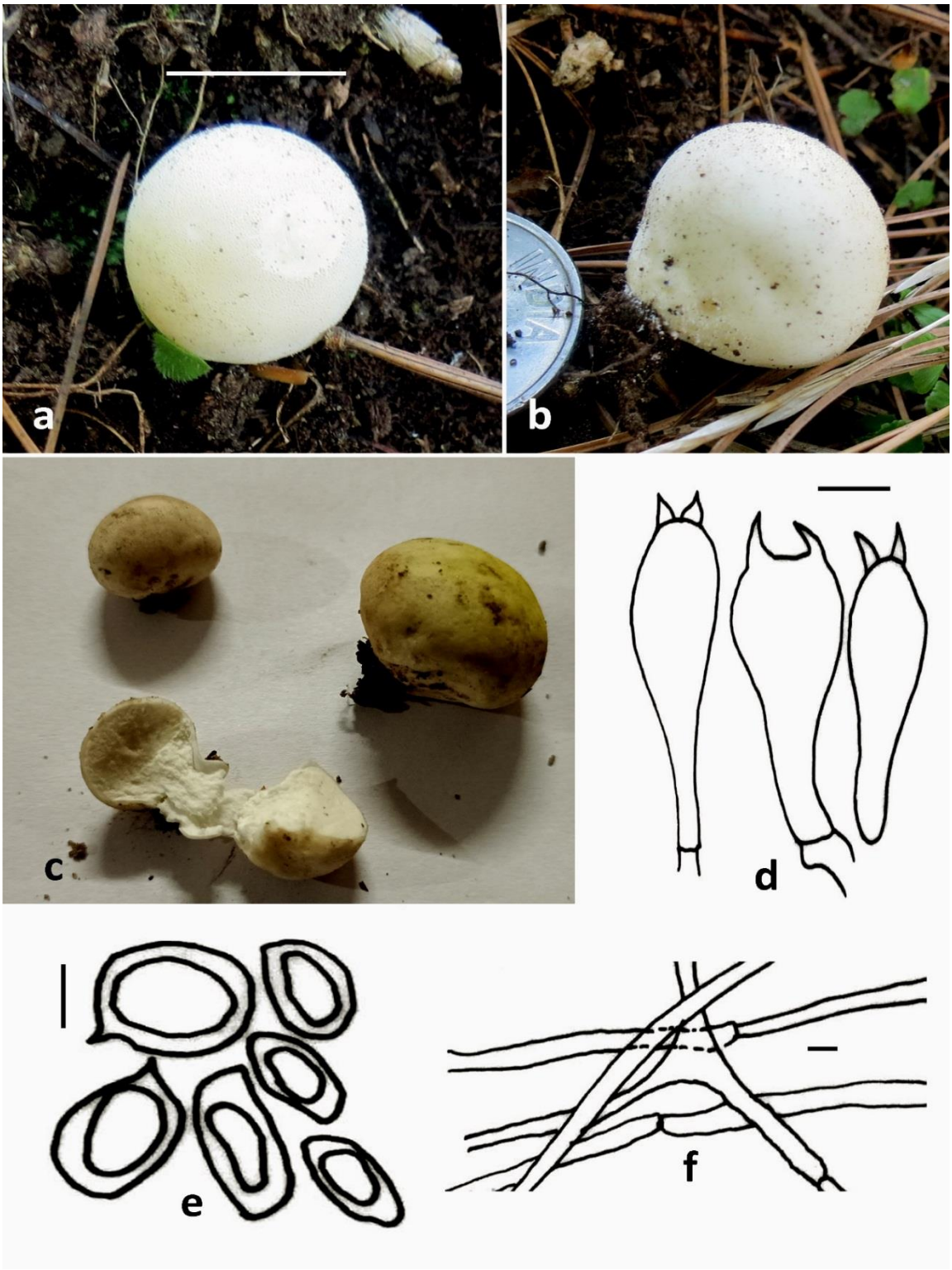

Fig. 6(11) ***Bovista plumbea***

a-c. Fresh basidiomata in the forest; d. Basidia; e. Basidiospores; f. Exoperidial hyphae. Scale bars: a-c = 50 mm; d-e =10 μm; f.5 μm.

12. Coprinus comatus (O.F. Müll.) Pers., Tent. disp. meth. fung. (Lipsiae): 62 (1797). [Figure6(12)]

Specimen examined: India, Jammu and Kashmir, District Kishtwar, Bindraban, Sarthal. Coprophilous , Solitary to scattered. Faisal Mushtaq & Ashish Vyas. Collection number FM22-23, Accession number HBJU/M/14. April-June 2022

Fruiting Body 240 mm long, well developed**,** fragile, ; **Pileus** 45-68 mm wide, snow white (1A1) covered with light brownish scales mostly circular pattern mostly at apex , surface rough and dry, fibrillose , initially rounded to oval , turns conical at maturity. **Context** 4-12 mm wide, initially whitish (1A1) , turns dark brownish (6F6) on maturity. **Lamellae** 4-6 mm wide, free, off white (1A1) in younger specimens then becoming light grey and on maturity turns black . **Stipe** 180-230 × 4-10 mm, snow white to light yellowish , equal, long, inflated or bulbous at base , dry, hollow, smooth, fibrillar. **Basidia** 26.8-37.1 × 8.8-14.0 µm, clavate, thin walled, smooth ; **Sterigmata** 1.2-3.0µm long; 4 in number; **Basidiospores** 6.8-11.6 × 4.6-7.8 µm (a_v L = 9.2 µm , a_v W = 6.2 µm, Q = 1.48) narrowly ellipsoidal, black coloured, wall thick with apical germ pore ; **Pileus cuticle hyphae** 1.8-7.8 µm in width, clear, thin walled, smooth, clear, septate with absence of clamp connections .

Distribution: Widely reported on humus from various parts of country including Jammu and Kashmir (Kumar and Sharma, 2009) and Ladakh in association with mosses (Dorjey *et al.*, 2014).

Edibility: Immature fruiting bodies consumed in the study area.

Remarks. new report from the study area.

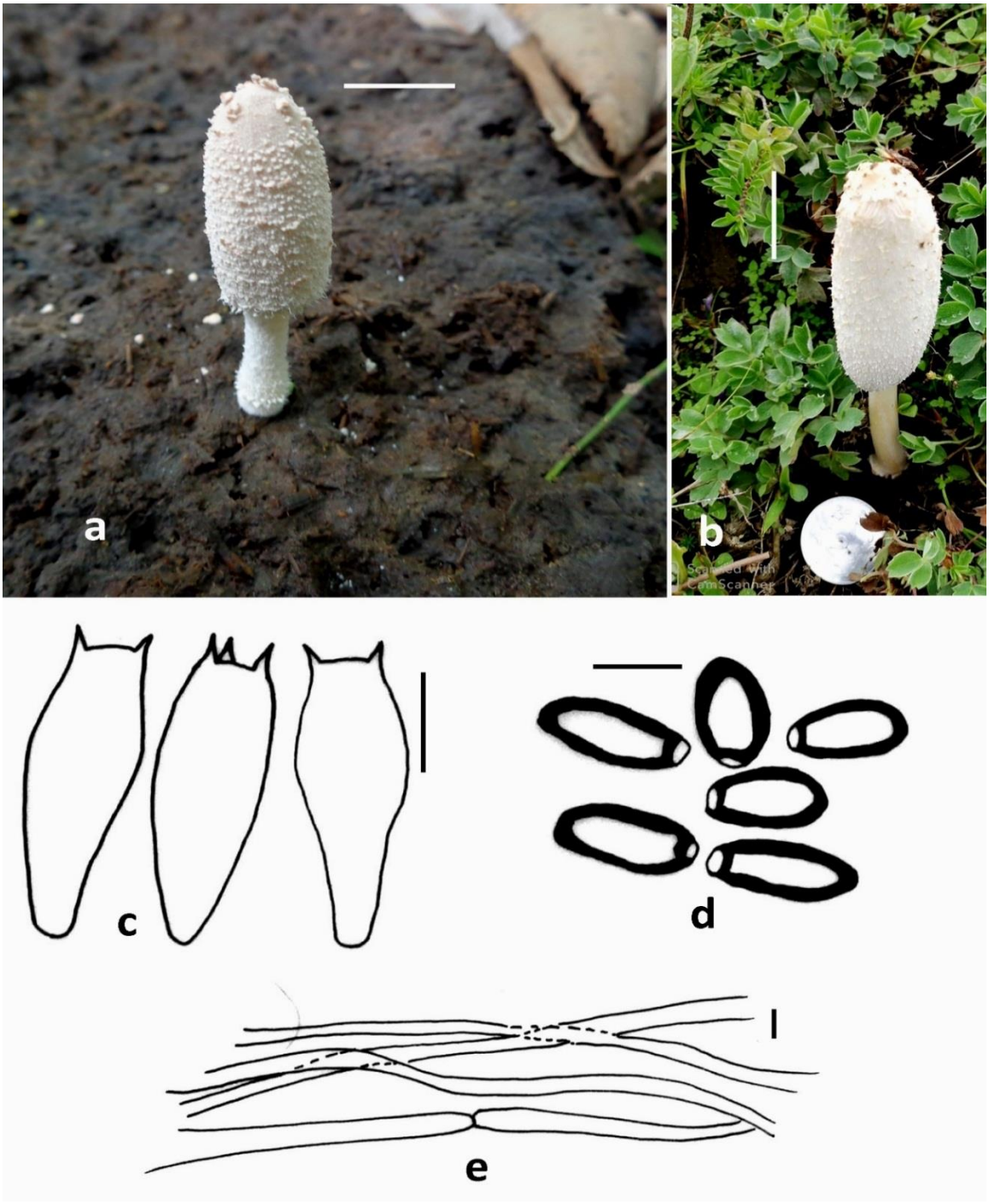

Fig. 6(12) ***Coprinus comatus***

a-b. Fresh basidiomata in the forest; c. Basidia; d. Basidiospores; e. Exoperidial hyphae. Scale bars: a-b = 50 mm; c-d =10 μm; d = 5 μm.

6.1.6 Family *Amanitaceae*

13. Amanita flavipes S. Imai, Bot. Mag., Tokyo 47: 428 (1933). [Figure 6(13)]

Specimen examined: India, Jammu and Kashmir, District Kishtwar, Bindraban , Chatroo, Nagseni, Sarthal . Solitary to scattered, uncommon, ectomycorrhizal growing in the association with *Abies pindrow*. Faisal Mushtaq & Ashish Vyas. Collection number FM22-026 , Accession number HBJU/M/15, July-September 2022.

Pileus 45-82 mm wide, light yellowish to yellow (4A5-3A7) , remnants of universal veil present on pileus and are whitish to yellowish ,initially sub globular to convex then planoconvex and plane at maturity , glabrous and shiny , longitudinal striation present on margins, context light yellowish to whitish (3A5-1A1). **Lamellae** 8-12 mm wide, off white to light yellowish (1A1-3A5), adnate, close to each other ,narrowing towards margin, varying lengths of lamellulae present; **Stipe** 80-115 × 16-28 mm, light yellowish, narrowing towards apex and broader at the base , annulus present, hanging downwards and disappears finally , context whitish and fibrous ; **Volva** upto 35 mm long and 22-34 mm wide, offwhite to creamish , after bruising changes to brownish colour ; **Basidia** 38.0-40.0 × 9.0-11.6 µm, clavate, clear,smooth, guttulated ; **Sterigmata** 1.8-3.5 µm long, 3-4 in number; **Basidiospores** 4.5-9.2 × 4.6-7.8 µm (a_v L = 6.85µm, a_v W = 6.2 µm, Q = 1.10) broadly ellipsoidal, thin-walled, apiculated, mono-guttulated, smooth, hyaline ; **Pileus hyphae** 4.5-15.9 µm wide, smooth, with branches ,presence of inflated cells ; **Stipe hyphae** 3.6-7.8 µm wide, hyaline, thin-walled, septate; **Annulus** consist of hyphae 2.4-6.7 µm wide, hyaline, branched, thin-walled, smooth; **Universal veil remnants** comprise of globose to subglobose cells 25.8-55.5 × 21.5-48.7 µm which are smooth, thin-walled and hyaline.

Distribution: First reported from Jammu and Kashmir and Uttarakhand by Mehmood et al in 2018

Edibility: not consumed in the study area.

Remarks: Powdery remnants of universal veil present on the volva and *Amanita flavipes* is found to grow luxuriantly on coniferous needles. It is new record from the study area.

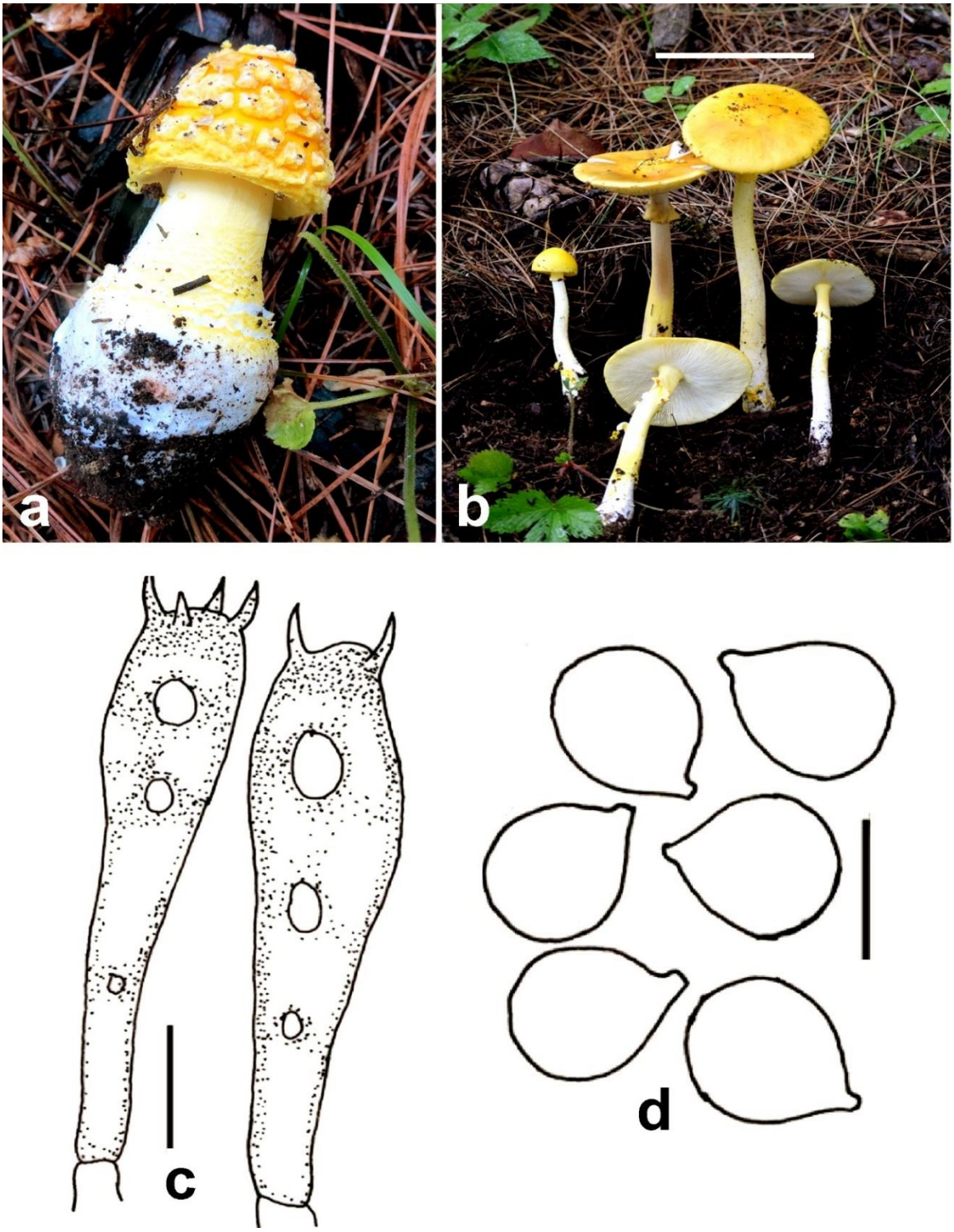

Fig.6(13) ***Amanita flavipes***

a-b. Fresh basidiomata in the forest; c. Basidia; d. Basidiospores.
Scale bars: a-b = 10 mm; c-d =10 μm.

14 . ***Amanita orsonii*** Ash. Kumar & T.N. Lakh., *Amanitaceae* of India (Dehra Dun): 75 (1990). [Figure6(14)]

Specimen examined: India, Jammu and Kashmir, district Kishtwar, Chingam. Solitary to scattered, uncommon, ectomycorrhizal growing in the association with *Abies pindrow*. . Faisal Mushtaq & Ashish Vyas. Collection number FM22-028 , Accession number HBJU/M/16, July-September 2022.

Pileus 80–111 mm in width, first hemispherical ,then convex and planoconvex at maturity, light to medium brownish (7D6-7D7), margins entire, turn pale orange to golden yellow (5B7) after bruising , universal veil remnants (warts) present on pileus surface and concentrated mostly at centre, white, floccose to sub-pyramidal , context 3–5 mm wide and white; **Lamellae** 9–10 mm wide, free, white (1A1), crowded, tapering towards margin, varied lengths of lamellulae present; **Stipe** 95–120 × 10–22 mm, tapering towards apex , context fibrous, stuffed, white , volva 21–23 × 18–21 mm, white, Partial veil white, membranous; **Basidiospores** 6.5–9.7 × 4.9–7.4 µm (a_v L = 8.1µm, a_v W = 6.15 µm, Q = 1.32) , broadly ellipsoid, amyloid, mono-guttulated, apiculated, smooth, thin walled **;** **Basidia** 22–30 × 8.0–11 µm, clavate to narrowly clavate, hyaline, thin-walled, smooth, multi-guttulated. **Sterigmata** 1.4–2.0 µm in length, 3-4 in number. **Pileus hyphae** 1.6–4.8 µm wide, smooth, hyaline, thin walled,septate; **Stipe hyphae** 4.8– 8.0 µm wide, smooth, septate, hyaline, thin-walled ; **Universal veil remnants or warts** comprise of subglobose to broadly ellipsoid cells up to75- 89 × 51-82 µm which are clear, thin-walled, smooth and hyphae 7.5– 15 µm in width , smooth, thin-walled, septate , **Clamp connection** not present.

Distribution: Previously reported from Uttarakhand (Semwal *et al.* 2020).

Edibility : not consumed in the study area.

Remarks : new regional record .

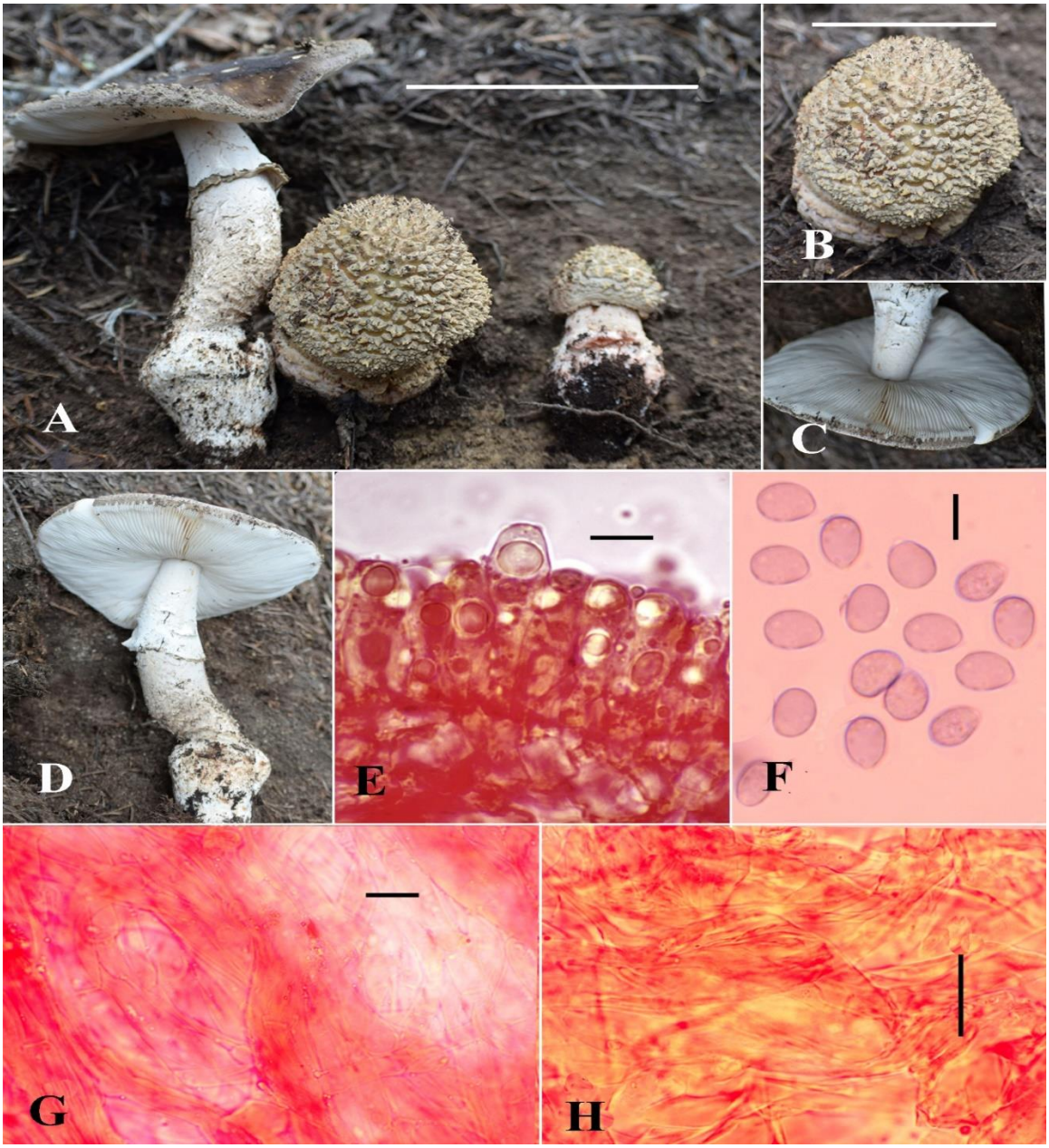

Fig.6 (14) ***Amanita orsonii***

a–**d.** Fresh basidiomata in the field; **e.** Basidia (LM); **f.** Basidiospores; **g.** Elements of universal veil from pileus surface; **h.** Elements of partial veil. Scale bars:**a-d** =50 mm; **e**–**h** =10 μm.

15. ***Amanita pakistanica*** Tulloss, S.H. Iqbal & Khalid, in Tulloss, Iqbal, Khalid, Bhatt & Bhatt, Mycotaxon 77: 458 (2001). [Figure6 (15)]

Specimen examined: India, Jammu and Kashmir, District Kishtwar, Chingam, Nagseni. Solitary, scattered, ectomycorrhizal growing in association with *Abies pindrow.* Faisal Mushtaq & Ashish Vyas. Collection number FM22-030 , Accession number HBJU/M/17, July-September 2022.

Pileus 42-82mm in diam., yellowish brown (5D5) at margins and brown (6D7) in the centre, universal veil remnants /warts present on the surface are light creamish in colour and on treatment with 10% KOH turns reddish brown, margins velvety, entire, non-appendiculate and shows the presence of striations ,context 1-5mm wide, snow white to off-white (1A1) and unchanging after bruising ,uplifted, velvety, margins uplifted, non-appendiculate, entire and striated; **Lamellae** 1-5 mm wide, off-white (1A1), crowded, free, edges concolorous and entire, absence of forkation , lamellulae of varying lengths present, tapering towards margins, **Stipe** 32-90 × 6-10 mm, creamish to yellowish white(1A2), narrowing towards apex, dry, smooth,central , smooth , annulus present, volva present, stipe context white, unchanging after bruising ; **Volva** yellowish white(1A2) , upto 30 mm wide; **Basidia** 35.5-45.8 × 9.5-11.5µm, thin walled,colourless, clavate to sub-clavate, multi-guttulated, hyaline, smooth, absence of basal clamps; **Sterigmata** 3-4 in number; **Basidiospores** 10.1-11.6 × 7.5-10.8 µm (a_v L = 10.85µm, a_v W = 9.15 µm, Q = 1.19) , broadly ellipsoidal, apiculus prominent, smooth, mono-guttulated ; remnants of universal veil on pileus consisting of cells upto 16 µm wide, mostly globose , sub globose to rarely cylindrical and hyphae 5.0-7.5 µm wide, branched, smooth, thin walled with septae.

Distribution: Earlier reported from Pakistan (Tulloss *et al.*, 2001).

Edibility: not consumed in the study area.

Remarks: new report from the study area.

Fig.6(15) ***Amanita pakistanica***

a. Fresh basidiomata in the forest; b. Basidia; c. Basidiospores.
b. Scale bars: a = 50 mm; b-c =10 μm.

16. ***Amanita griseofusca*** J Khan & M. Kiran,in Kiran, Khan, Sher, Pfister & Khalid,Phytotaxa;18 6 (2018). [Figure6(16)]

Specimen examined: India, Jammu and Kashmir, District Kishtwar, Chingam . Solitary, scattered, ectomycorrhizal growing in association with *Quercus sp* Faisal Mushtaq & Ashish Vyas. Collection number FM22-038 , Accession number HBJU/M/18, July-September 2022.

Pileus 28–75 mm dia., surface yellowish brown (5D4) at periphery and dark brown (6F5) in the centre, first plano-convex , then convex and finally plane at maturity with slight depression in the centre at maturity , viscid surface when moist , striation up to 15 mm long present at margins. Remnants of universal veil present as membranous patch, white, turning dark brown (5D3) with age. Context of pileus 25 mm thick, off white . **Lamellae** free, creamish white (1A1) at young stage turns orange white (5A2) at maturity, subcrowded , varying lengths of truncate Lamellulae ; **Stipe** 38–55 × 6–15 mm, off white (1A1) to pale yellowish, hollow to stuffed, narrowing towards the apex, fibrillose, fibrils whitish (1A1) , stipe context white. Annulus absent. **Volva** initially white and becomes brown (5D3) at maturity, non-coherent in the upper part, saccate . **Basidia** 35–45 × 8–14 µm, club shaped, sterigmata 3–4 , 4- spored , absence of basal clamp connections . **Basidiospores** 11-14× 10–12 µm (a_v L = 12.5µm, a_v W = 11 µm, Q = 1.14) , sub globose or broadly ellipsoidal . **Pileipellis** 95–145 µm thick, upper layer 30–55 µm , gelatinized, thick, consist of hyaline cells, 3–6 µm in diam., lower layer 50–90 µm thick, filamentous undifferentiated hyphae 2–6 µm wide, hyaline. **Volva at stipe** base two-layered, outer layer of undifferentiated, thin walled, compact and filamentous hyphae , subglobose to ellipsoidal inflated cells; inner layer of inflated cells subglobose to globose . Absence of Clamp in all parts of basidiomata.

Distribution : It was first described from Pakistan (Kiran *et al.*, 2018).

Edibility : not consumed in the study area.

Remarks : new regional record

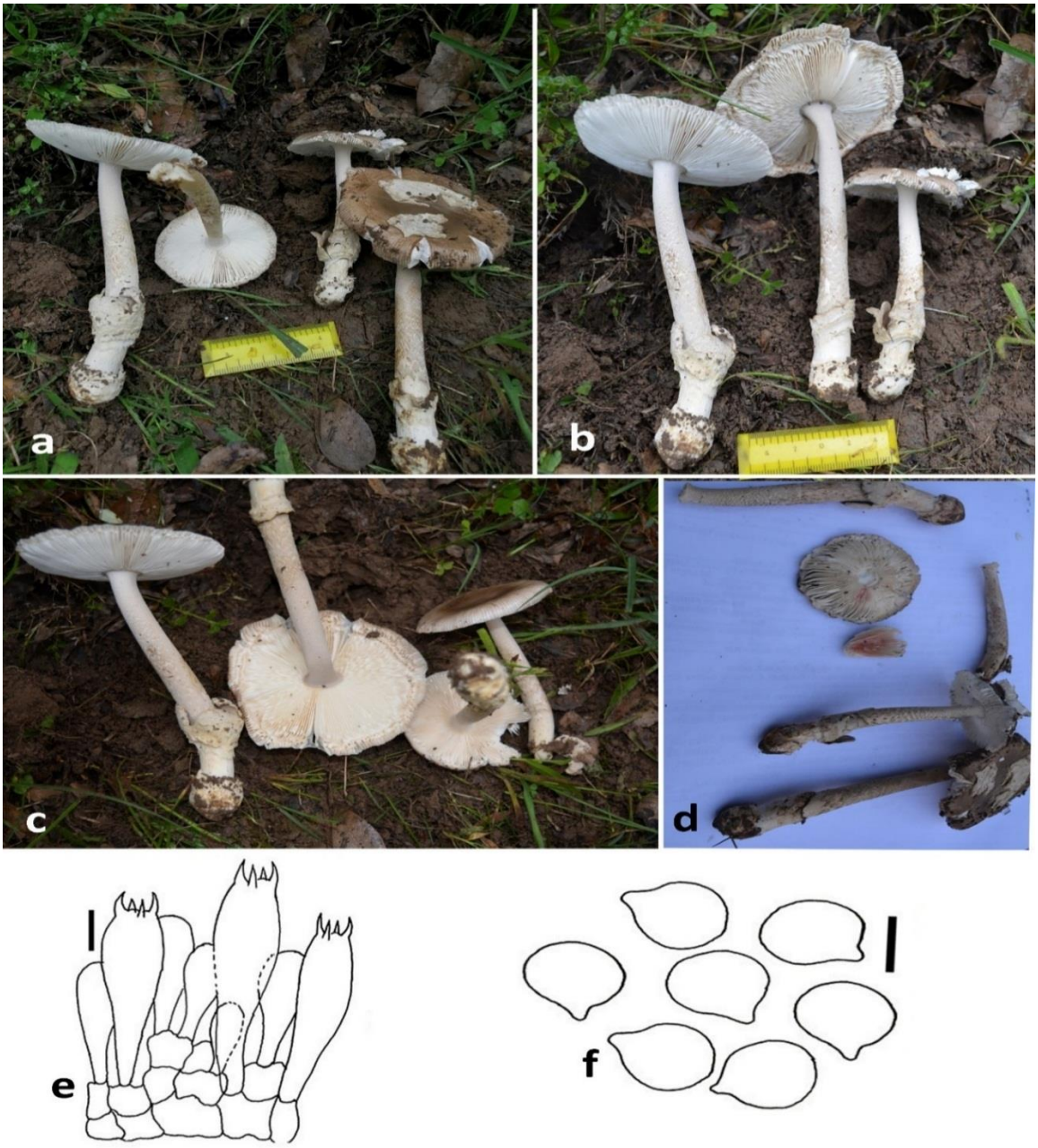

Fig.6(16) ***Amanita griseofusca*** a-d. Fresh basidiomata in the forest; e. Basidia; g. Basidiospores; Scale bars: a-d = 50 mm; e-f =10 μm.

17. ***Amanita subglobosa*** Zhu L. Yang, Bibliotheca Mycologica 170: 18 (1997). [Figure6(17)].

Specimen examined: India, Jammu and Kashmir, district Kishtwar, Chatroo . Solitary, scattered, ectomycorrhizal growing in association with *Quercus sp* Faisal Mushtaq & Ashish Vyas. Collection number FM22-040 , Accession number HBJU/M/19, July-September 2022.

Pileus 35–85 mm wide, firstly nhemispherical , then convex and finally plane, slight depression in centre, brown to tea brownish (6D5) at central area, light yellow (1A3) towards periphery; context 5– 7 mm thick, off white , not changing after bruising ;short striations present on margins, margins non-appendiculate, uplifted. **Remnants of Universal veil** on pileus as granular subfelted protuberances, dirty white to cream. **Lamellae** white colour (1A1) , free, crowded , unchanging, 2.5–7.5 mm broad; lamellulae subtruncate to truncate. Stipe 45–120 × 5–9.5 mm, narrowing upwards, stuffed, white. Partial veil white, pendent, subapical. Bulb 12–20 × 7.5–14.5 mm, subglobose, universal veil remnants white (1A1) with granular warts on top of the bulb. **Basidiospores** 9.5–10.5 × 7.5–8.5µm (a_v L = 10.0µm, a_v W = 8 µm, Q = 1.25), broadly ellipsoidal, thin walled, smooth , hyaline ,multi-guttulated. **Basidia** clavate, 4 spored, with thin wall , clear; **Sterigmata** 1.4–3.8 µm long, sometimes basal clamps connections present . **Pileus hyphae** 3.2-6.7 µm , clear , ellipsoidal cells with no colour. **Remnants of universal veil** on pileus irregularly arranged; consisting of filiform hyphae 3.7–4.8 µm wide, clear; with enlarged cells **.** Clamp connections present.

Distribution: It was first described from China, (Zhang *et al*. 2004) and then from Uttarakhand by Semwal *et al*. 2007 and Mehmood *et al.* 2018.

Edibility : Not edible in the study area.

Remarks : new regional record.

Fig. 6(17) ***Amanita subglobosa***

a–**c.** Fresh basidiomata in the forest; **d**–**e.** Basidia (LM); **f.** Light micrograph (LM) of Basidiospores; **g.** Elements of partial veil. Scale bars: **a–c** =50mm; **d–g** =10 μm.

18. ***Amanita orientigemmata Zhu L.*** Yang & Yoshim. Doi [as orientogemmata], Bull .natn. Sci. Mus., Tokyo, B 25(3):107 (1999). [Figure6(18)]

Specimen examined: India, Jammu and Kashmir, District Kishtwar, Chatroo, Chingam , Ikhala Solitary, scattered in association with *Cedrus deodara* and *Pinus wallichiana* . Faisal Mushtaq & Ashish Vyas. Collection number FM22-042. Accession number HBJU/M/20, July-September 2022.

Pileus 45-90 mm dia., surface light brown (6D6) at periphery, greyish yellow (3B5) towards the centre , becomes yellowish brown(5D4) at maturity, hemispherical initially and then plano-convex to convex , small depression at the centre may be present , whitish conical warts (2-5mm wide) present on the surface, short striations present on the margins, context white (1A1). . **Lamellae** offwhite to creamish white (1A1) coloured, free, varying lengths of truncate Lamellulae , **Stipe** 45-100 × 8–14 mm, off white (1A1) with fibrillose squamules, fibrils whitish (1A1) hollow to stuffed, tapering towards the apex, , stipe context white. Annulus white to yellowish. **Volva** short ,appressed limbate, saccate, initially white and becomes light brownish at maturity **Basidia** 30–50 × 6–15 µm, club shaped, sterigmata 2–4 , 4- spored , presence of basal clamp connections . **Basidiospores** 10-13× 9–11 µm (a_v L = 11.5µm, a_v W = 10 µm, Q = 1.15) , globose or broadly ellipsoidal.

Distribution : This species was originally described from Japan (*Zhu L.* Yang & Yoshim, 1999)

Edibility not consumed in the study area.

Remarks : new report from the study area.

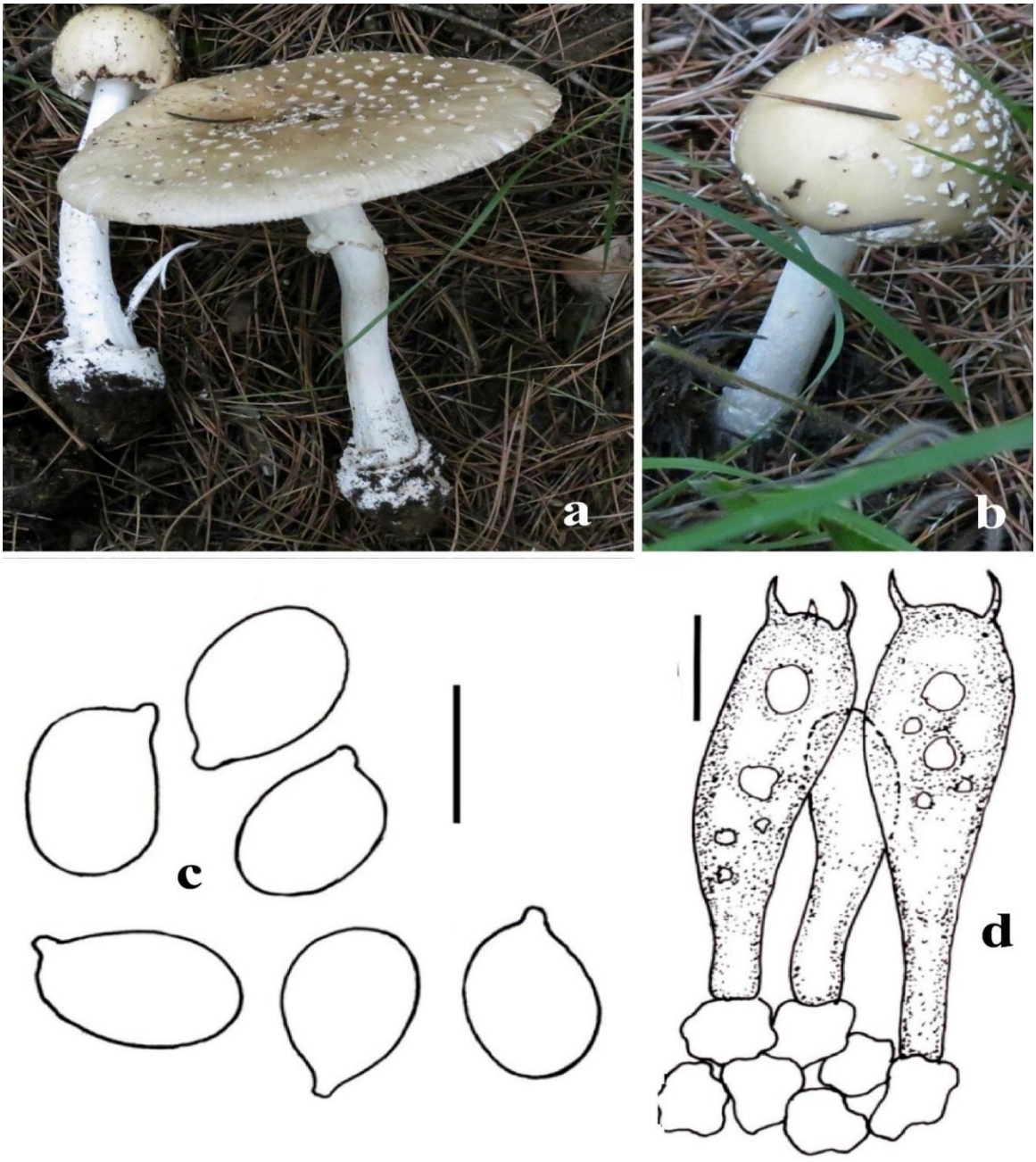

Fig. 6(18) ***Amanita orientigemmata***

a-b. Fresh basidiomata in the forest; c. Basidiospores; d. Basidia.
Scale bars: a-b = 50 mm; c-d =10 μm.

19. Amanita griseopantherina Y.Y. Cui, Q. Cai & Zhu L. Yang Fungal Diversity 91:5–230 (2018). [Figure6(19)]

Specimen examined: India, Jammu and Kashmir, district Kishtwar, Chatroo. Solitary, scattered, ectomycorrhizal growing in association with *Quercus* and *Pinus* species. Faisal Mushtaq & Ashish Vyas. Collection number FM22-044. Accession number HBJU/M/21, July-September 2022.

Pileus 55–75mm wide, greyish brown (4C2), Light brown (5D4) to dark brown (6D6–6F6), more darker at center , slight dark brown towards periphery , plano-convex , convex to applanate, small depression in the center,; remnants of volva on pileus off white to greyish white (5D1)**,** pyramidal, verrucose to granular warts., small striations at the margins. **Lamellae** white (1A1) , free, crowded, truncate lamellulae. **Stipe** 45–110 mm long, 2–5 mm wide, white (5A1) , cylindrical and tapering upwards, broader at apex , with presence of white (1A1) to brownish (6A3) small hair like structures ; context off white (1A1),hollow to stuffed ; subglobose basal bulb , 18–35 mm wide, snow white (1A1); Annulus persistent, white (1A1), apical ,. **Basidia** 50–75 × 10–14 µm, clavate to , 4-spored; sterigmata 3–5 µm long. **Basidiospores** 11.5–12.5 ×8.5–9.5 µm (a_v L = 12µm, a_v W = 9µm, Q = 1.33) , colourless, broadly to narrowly ellipsoidal. On pileus, volval remnants are of composed of irregularly arranged elements: filiform hyphae abundant, On stipe , volval remnants dominantly consist of longitudinally arranged elements: Clamps present in all parts of basidioma .

Distribution: It was first described from China (Cui et al. 2018)

Edibility: not consumed in the study area.

Remarks : New record from India.

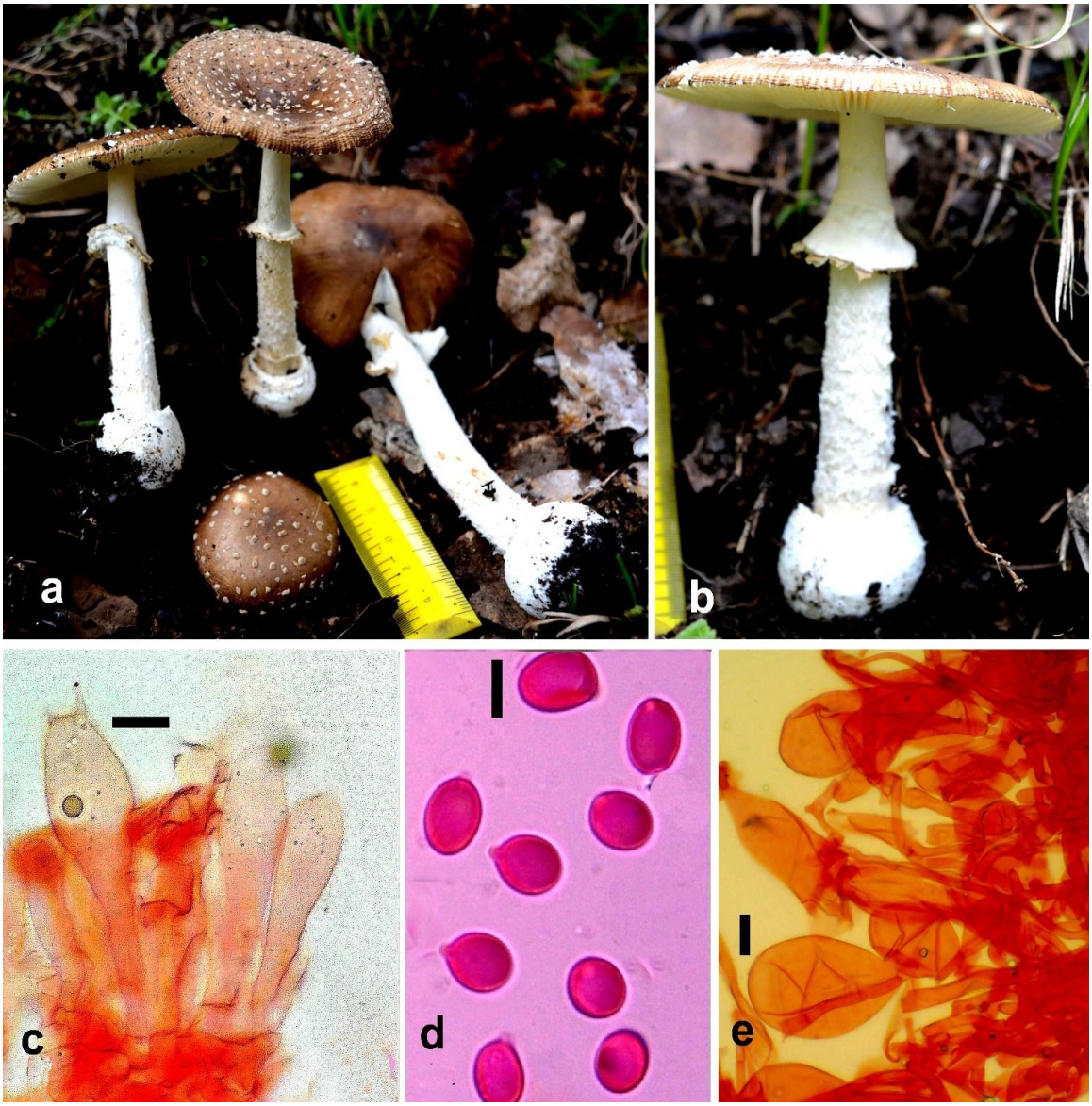

Fig. 6(19) ***Amanita griseopantherina***

a–b. Fresh basidiomata in the forest; c. Basidia; (LM). d. Light micrograph (LM) of Basidiospores ; e. Universal veil remnants on pileus surface; (Scale bars: c–e=10 μm)

20. Amanita sp. [Figure6(20)]

Specimen examined: India, Jammu and Kashmir, Kishtwar, Chingam. Solitary, scattered, ectomycorrhizal growing in association with *Quercus sp* . Faisal Mushtaq & Ashish Vyas. Collection number FM22-045. Accession number HBJU/M/22, July-September 2022.

Pileus 30–50 mm wide, slate grey or coal colour (3F1) at centre, brownish grey (9D2–3) or light grey (1C1) towards margin , first hemispherical, then convex and plane at maturity, slight depression in the centre , dry, Universal veil on pileus dark grey (1F1) to greyish black colour (6H1), felted or crust like patches, up to 3mm high, 4–10 mm wide, crowded and larger over centre, decreasing in size towards margin, tuberculate striations in the margins, context thick at centre, off white, not changing after bruising. **Lamellae** free,, crowded initially white becoming light grey (1B1) at maturity. **Stipe** 75–130 × 12–22 mm, narrowing upwards, white, becomes brownish grey (1F2-3) at maturity , covered by grey fibrillose squamules , Stipe context off white, hollow, unchanged after bruising . Absence of Partial veil. Basal bulb lacking. Universal veil at stipe base as floccose to verrucous patches, sometimes forming a complete belt at stipe base. **Basidia** 40–48 ×14–17 µm, clavate, thin-walled, colourless, hyaline, 2 to 4-spored; sterigmata 2-4; clamp connections not observed at the bases. **Basidiospores** 10.5–12.5 × 9.5-10.5 µm (a_v L = 11.5µm, a_v W = 10µm, Q = 1.15), globose , monoguttulate , hyaline, thin-walled, colourless with small , obtuse ,lateral to sub lateral apiculus. Pileus context filiform hyphae 2–10 µm in width , clavate. Universal veil on pileus surface and at base of stipe is similar Absence of Clamp connections in all parts.

Edibility: not consumed in the study area.

Remarks A new record . This species is unique from other species of *Amanita* sect. *Vaginatae* by number of features ;: small basidiomata, dark grey to coal coloured pileus centre and greyish brown to light grey margin, with olive brown ting with age, greyish black felted to crust like universal veil, stipe covered with grey fibrils that become darker where handled, globose to subglobose basidiospores, basidia 2-4 spored.

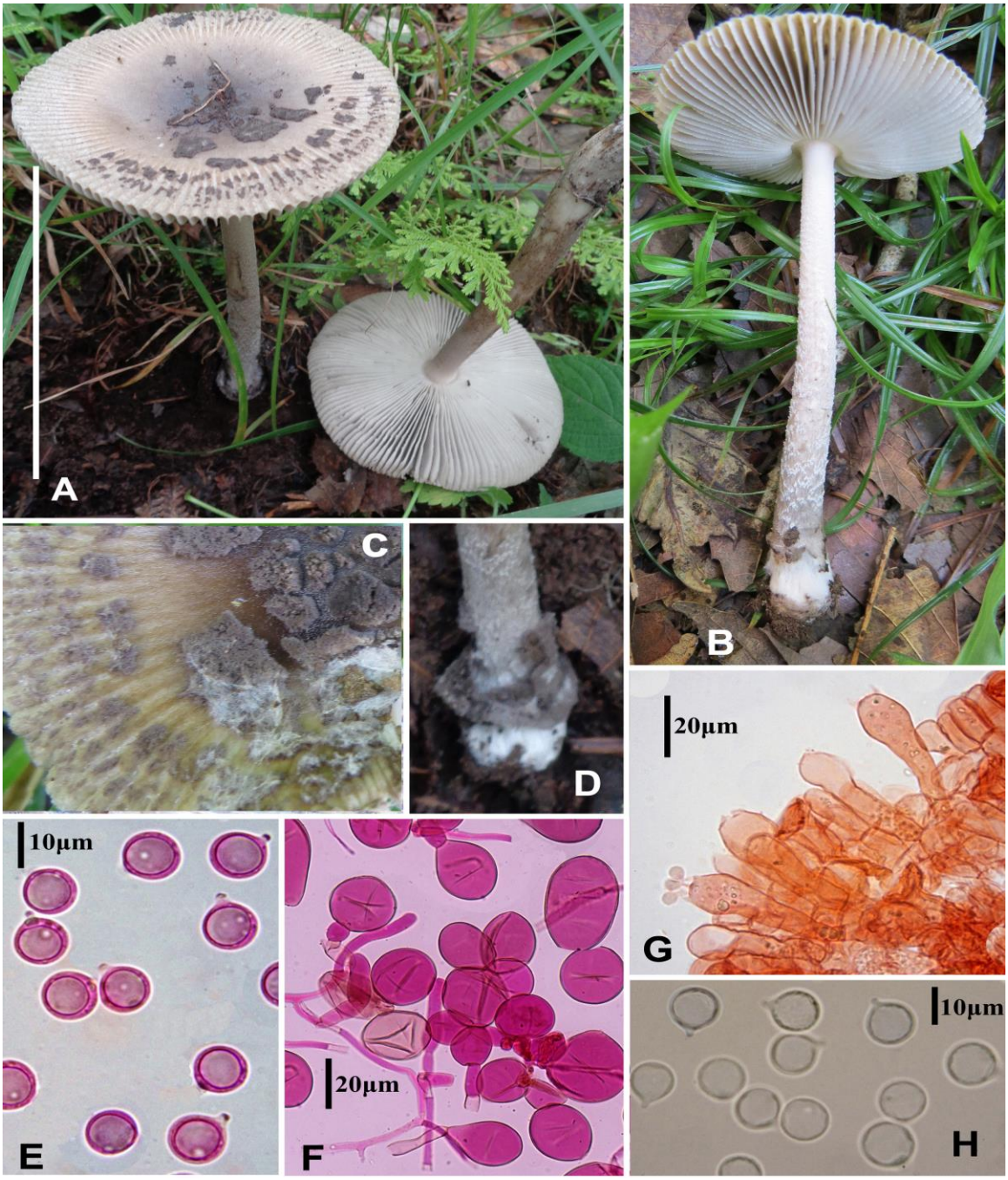

Fig. 6(20) *Amanita sp*.

a–b. Fresh basidiomata in the field: c. Pileus surface showing olive brown ting with age: d. Friable universal veil: e. & H. Basidiospores: f. Elements of universal veil from stipe base: g. Hymenium and subhymenium. Scale bars: A 50 mm, D & H 10 µm, F & G 20 µm.

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6.1.7 Family Physalacriaceae

21. Flammulina velutipes (Curtis) Singer, *Li/ba* 22: 307 (1951) [1949]. [Figure6(21)]

Specimen examined: India , Jammu and Kashmir, Kishtwar, Bindraban , Mugalmaidan , Sarthal . Lignicolous , found in dense clusters on the wood of *Cedrus deodara*.. Faisal Mushtaq & Ashish Vyas .Collection number FM22-047, Accession number HBJU/M/23 ,July-September 2022.

Pileus 6–40 mm, brownish orange (6C5) at centre, orange yellowed (4B8)at edges , initially convex then flat , lobate at maturity , cuticle smooth, with striations at margins , **Lamellae** Pale yellow (4A3) , crenate edges, crowded, lamellulae of varying lengths present, absence of forkation. **Stipe** 18–69 × 5–8 mm, cylindrical and slightly tapered towards base, curved or twisted, light yellow (4A5), velvety all over, quickly becoming blackish brown acropetally. **Context** pale yellow, fine, watery and soft in the cap, leathery and fibrous in the stipe; odour and flavour insignificant. **Basidia** 19.8–34.8 × 3.9–5.9 µm, tetrasporic, tetra sporic, hyalie , thin walled, sterigmata 3.7–5.8 µm in length .**Basidiospores:** 5–10 × 4–6.5 µm (a_v L = 7.5µm, a_v W = 5.25µm, Q = 1.43), narrowly ellipsoidal, hyaline, smooth.;. **Cystidia** 24.8-55.8 × 10.9-23.8 µm, hyaline. **Stipe hyphae** 3.1–8.2 µm wide, branched, septate with presence of clamp connection.

Distribution: Kumar in 2009 reported it from Jammu & Kashmir.

Edibility: consumed in the study area.

Remarks: New report from the study area.

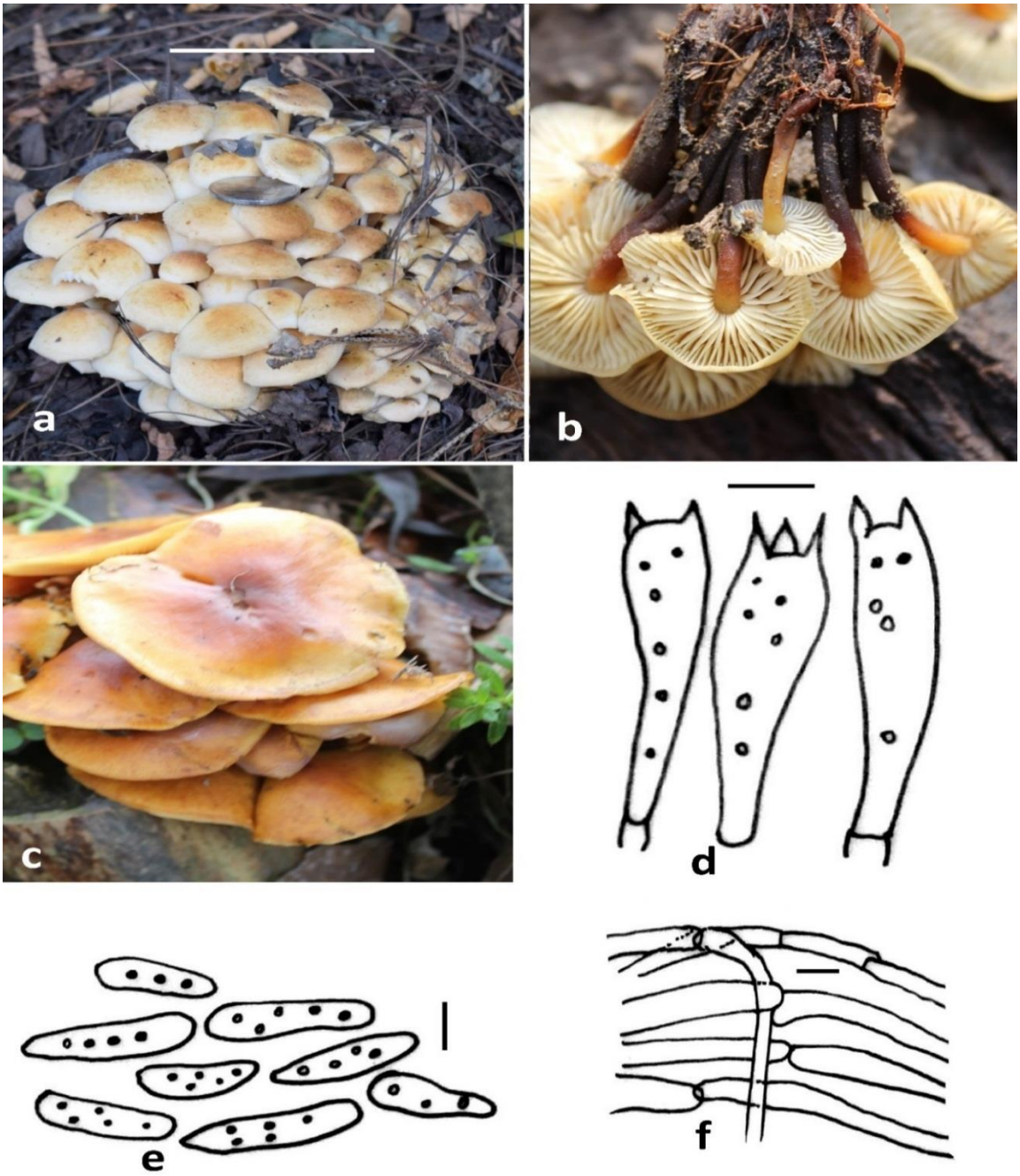

Fig. 6(21) ***Flammulina velutipes***

a-c. Fresh basidiomata in the forest; **d.** Basidia; **e.** Basidiospores; **f.** Pileus hyphae. Scale bars: **a-c** = 50 mm; **d-e** =10 μm; **f =** 5 μm.

6.1.8 Family Pleurotaceae

22. Pleurotus ostreatus (Jacq.) P. Kumm., Führ. Pilzk. (Zerbst): 104 (1871). [Figure 6(22)]

Specimen examined: Jammu and Kashmir, District Kishtwar, Mugalmaidan, Ikhala. Lignocolous, grow in clusters on wood of *Quercus* sp. Faisal Mushtaq & Ashish Vyas. Collection number FM22-048 , Accession number HBJU/M/24.July-Sep.2022.

Pileus: 18-65 mm wide, creamish white, brown at centre (6D7) and slightly light brownish (6D5) at margins, depressed infundibuliform , dimitate , margins inrolled; **Gills:** sub-decurrent, unequal, crowed at the margins, sub-distant at the base, wavy, concorolous; **Stipe:** eccentric to centric, 2.4-3.8 cm in length and 0.3-1.1 cm thick, short, slightly obclavate, concolorous with pileus; **Basidiospores:** 4.6-6.9 x 5.0 µm (a_v L = 5.75µm, a_v W = 5.0µm, Q = 1.15), apiculate, light greenish (in Congo red); **Basidia:** hyaline, 18.9-34.8 x 4.6-6.9 µm, clavate in shape, guttulated; **Pileus hyphae:** hyaline, 7.5-18.2 µm wide, branched, septate, clamp connections present; **Stipe hyphae**: hyaline, 7.8-19.8 cm wide, septate, branched, clamp connections present.

Edibility: consumed in the study area.

Remarks: new report from the study area.

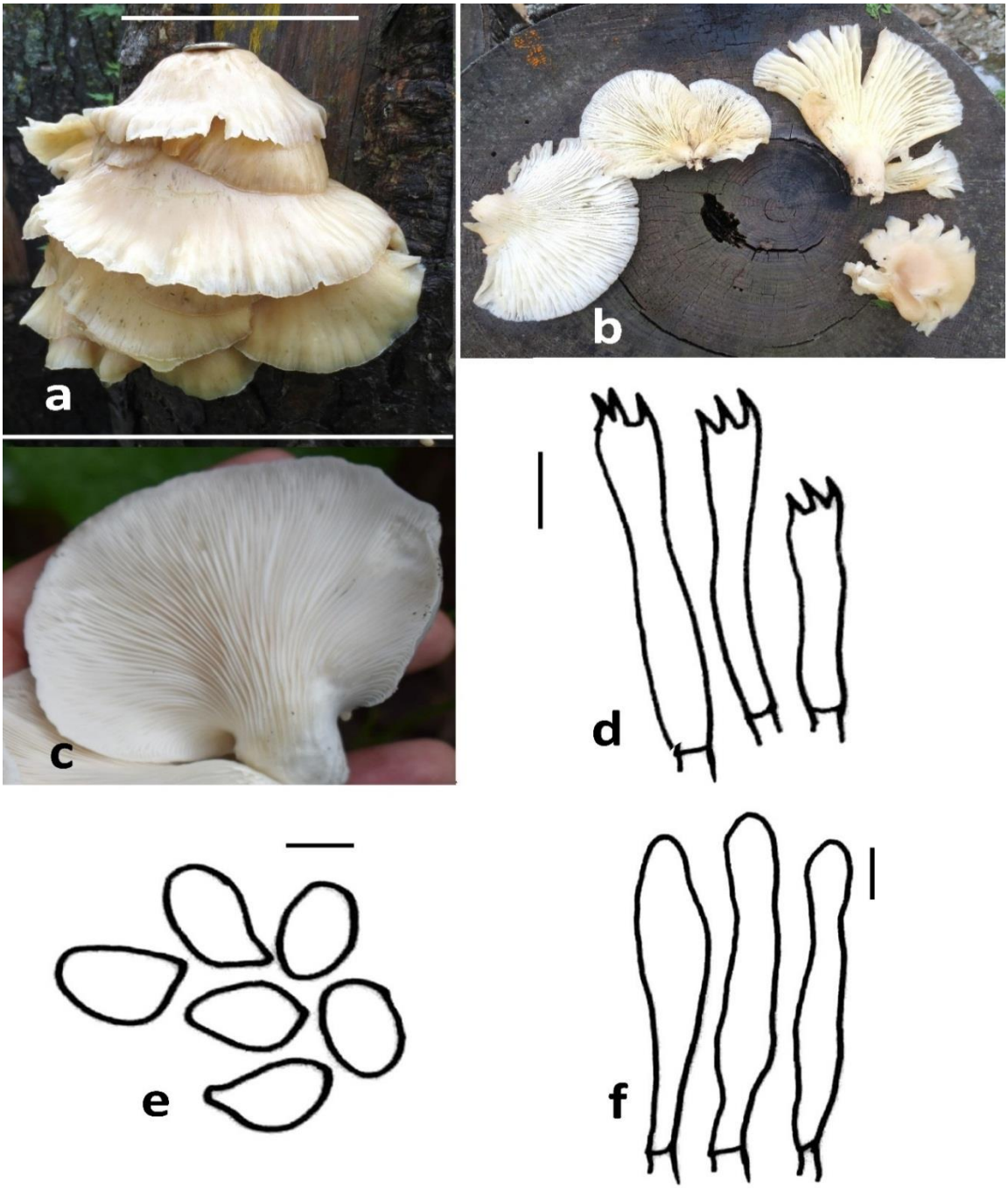

Fig. 6(22) ***Pleurotus ostreatus***

a-c. Fresh basidiomata in the forest; **d.** Basidia; **e.** basidiospores; **f.** Cystidia; Scale bars: **a-c**= 50 mm; **d-f**=10 μm.

6.1.9 Family Pluteaceae

23. ***Pluteus cervinus*** (Schaeff.) P. Kumm., Führ. Pilzk. (Zerbst): 99 (1871) [Figure6(23)]

Specimen examined: Jammu and Kashmir, District Kishtwar, Chatroo, Nagseni, Sarthal. Scattered to gregarious , commonly growing on humus rich soil. Faisal Mushtaq & Ashish Vyas. Collection number FM22-061 , Accession number HBJU/M/25. July-Sep.2022.

Pileus 45-90 mm in diam., light yellow(4A5) to light grey(3E1) , initially convex , then planoconvex, dry, surface radially silky-fibrillose, margin entire , context 2-4 mm wide, white (6A1),; **Lamellae** 1-2 mm wide, free, off white (1A1) initially, brownish gray (6C2) at maturity, crowded, concolorous edges, absence of forkation , lamellulae of various lengths present ; **Stipe** 55-95 × 65-80 mm, central, dry, surface fibrillose, light yellowish to light grey , cylindrical, equal, context white, solid, fibrous; **Basidia** 22.0-30 × 7.2-8.2 µm, subclavate to clavate, thin-walled, hyaline, clear, basal clamps absent , sterigmata 1.2-3.0 µm in length, 2-4 in number; **Basidiospores** 3.0-8.0 × 2.0-6.2 µm (a_v L = 5.5µm, a_v W = 4.1µm, Q = 1.34) , smooth, ellipsoidal , hyaline , mono-guttulated; **Pleurocystidia** 70.0-82.0 × 14.0-20.0 µm, metuloid, mostly on face of lamellae surface, not rough, fusoid with two apical horns, hyaline; **Cheilocystidia** 16.0-38.0 × 4.0-8.0 µm, clavate, gill edge sterile, hyaline, smooth, thin-walled; **Pileipellis** composed of elements 20.0-50.0 × 9.0-18.0 µm, elongated with tapered ends and hyphae 2.0-10.0 µm wide, smooth, thin walled, with septae, hyaline, clamp connections absent.

Distribution: Reported from Jammu and Kashmir (Altaf *et al*., 2022).

Edibility: consumed in the study area.

Remarks: new report from the study area.

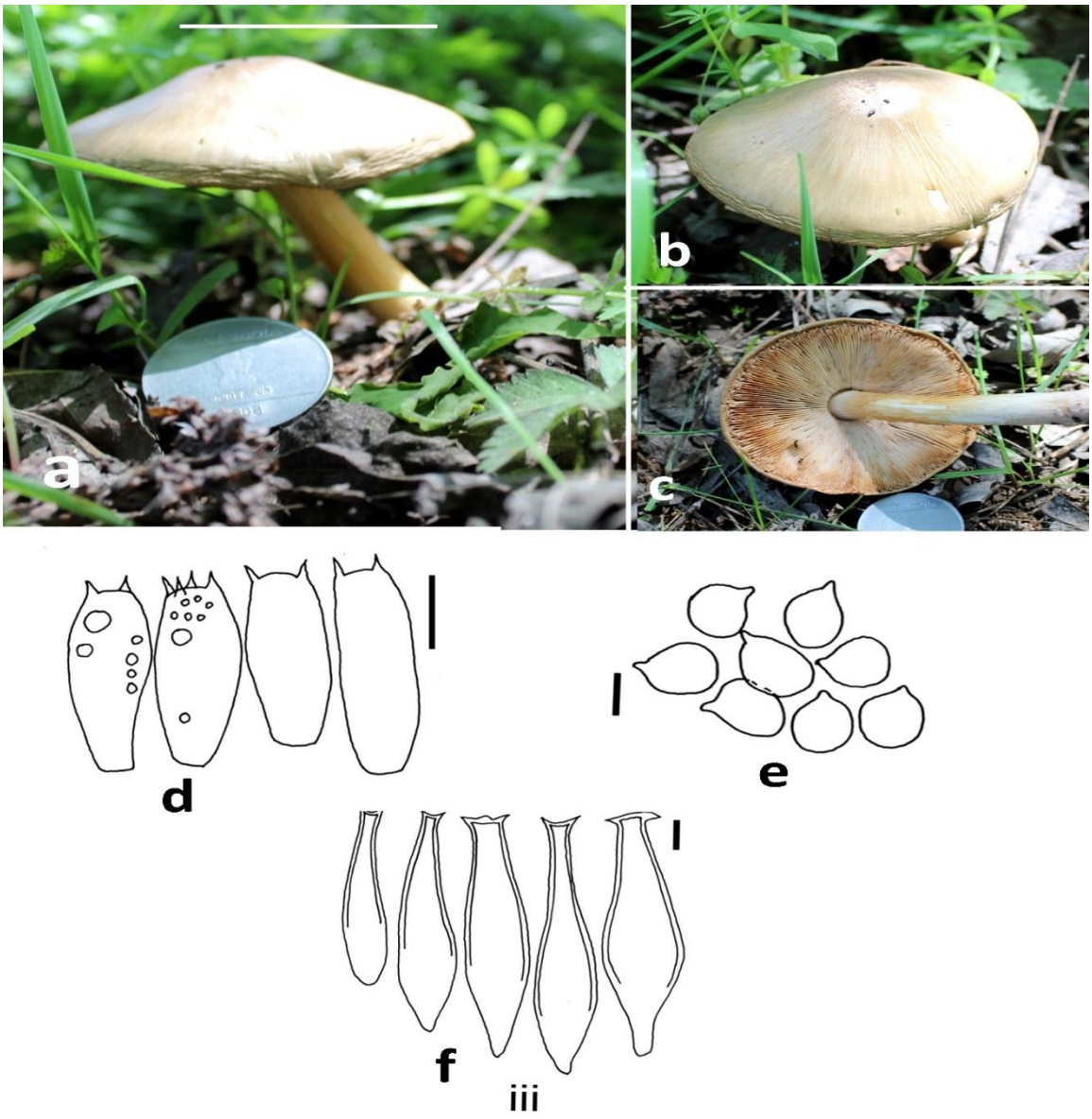

Fig.6(23) ***Pleutes cervinus***

a-c. Fresh basidiomata in the forest; **d.** Basidia; **e.** basidiospores; **f.** Pleurocystidia; Scale bars: **a-c**= 30 mm; **d-f**=10 μm.

6.1.10 Family Psathyrellaceae

24. Coprinellus micaceus (Bull.) Vilgalys, Hopple & Jacq. Johnson 2001. [Figure6(24)]

Collection examined: Jammu and Kashmir, District Kishtwar, Kishtwar city, Mugalmaidan, Chatroo, Ikhala , Sarthal. Fasciculate, Humicolous. . Faisal Mushtaq & Ashish Vyas. Collection number FM22-065, Accession number HBJU/M/26. July-Sep. 2022

Pileus 12–35 mm broad, off white or creamish whitish (1A1), yellowish brown (5D8) to light brown(5D5) at first, becoming dark brown (6F6) with maturity or when pileus deliquesces shiny , initially obtusely cylindrical then expanding to convex or campanulate at maturity, conspicuously striated , surface showing the presence of small, clustered granules at first which get diffused at maturity ; margin irregularly wavy-lobed , concolorous to disc at first, context up to 1 mm thick, concolorous to surface. **Lamellae** adnexed or free, crowded, white (1A1) at first, becoming dark brown, finally black with maturity; lamellulae numerous, of 2–4 lengths. **Stipe** 25–60 × 2–4 mm, equal or slightly tapered upwards, smooth to tomentose, equal, white, grayish brown (6E3) on bruising at base, hollow. Partial veil present, persistent. **Basidia:** 18–39 × 51–68 µm, hyaline, clavate; **Basidiospores** light brown in Congo red 5.6-8.0 × 4.0-6.4 µm (a_v L = 7.3µm, a_v W = 5.2µm, Q = 1.41), oval when young, expanding to convex or bell shaped at maturity , creamish , 5.1–6.6 µm, broadly to narrowly ellipsoidal , smooth with central pore, mono- to multi-guttulated . **Pileus hyphae** 5.3–10 µm wide , septate, clear ; **Stipe hyphae** 10-22 µm in width , septate , hyaline, smooth.

Distribution: Earlier reported on trees, stumps and fence posts from West Bengal (Banerjee, 1947), Lucknow, U.P (Ghosh *et al*., 1974) and Jammu and Kashmir (Sharma, 2009a, Altaf *et al*., 2022).

Edibility: Edible in some parts of study area.

Remarks: This mushroom grows in dense groups and is very common.

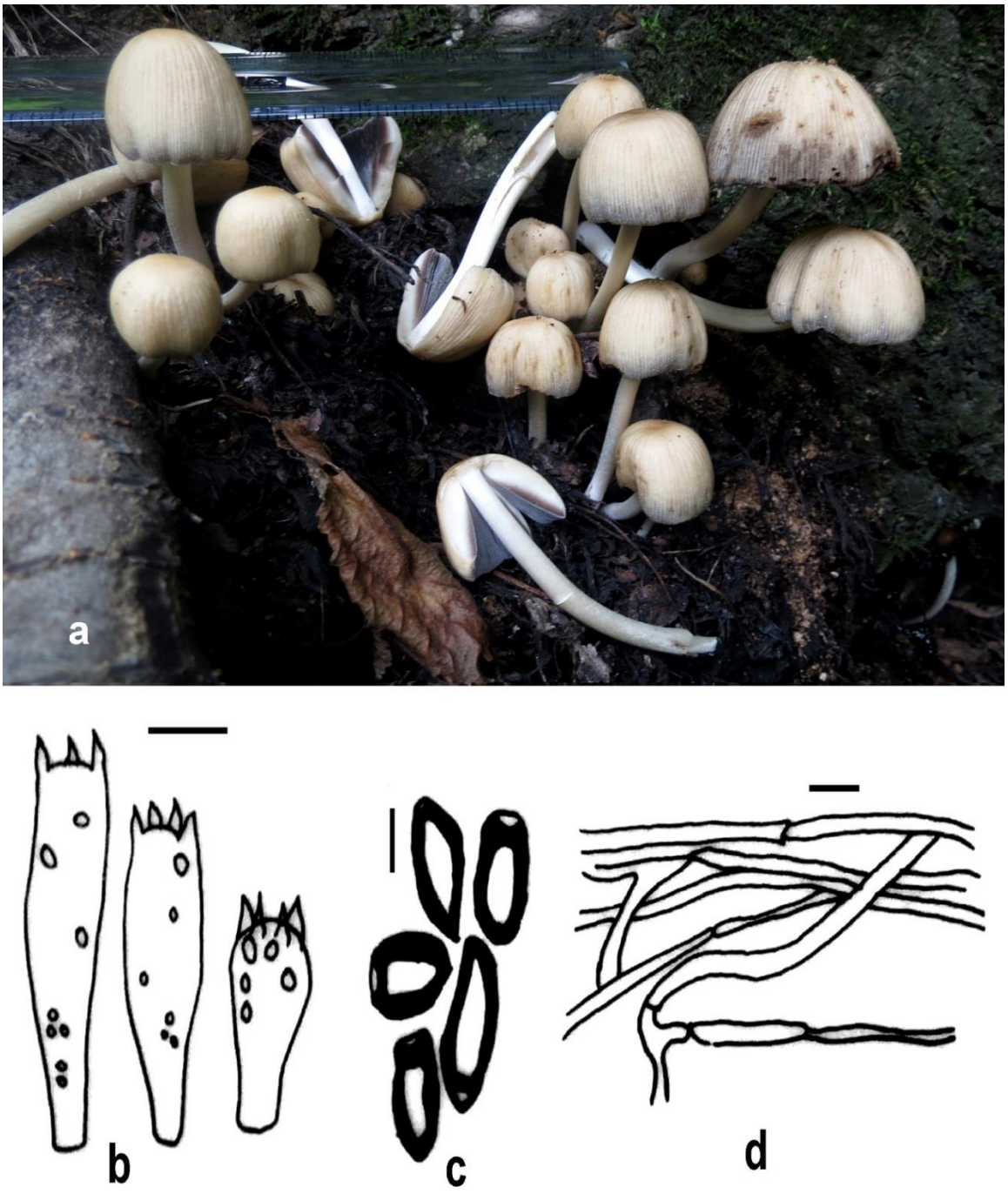

Fig. 6(24) ***Coprinellus micaceus***

a. Fresh basidiomata in the forest; **b.** Basidia; **c.** Basidiospores; **d.** Exoperidial hyphae. Scale bars: **a** = 50 mm; **b-c** =10 μm; d = 5 μm.

25. Panaeolus papilionaceus **(**Bull.) Quél., Mém. Soc. Émul. Montbéliard, Sér. 2 5: 152 [122 repr.] (1872). [Figure6(25)]

Specimen examined: Jammu and Kashmir, District Kishtwar , Chatroo , Chingam , Nagseni. Uncommon, solitary to scattered, coprophilous growing on cow dung. Faisal Mushtaq & Ashish Vyas. Collection number FM22-067, Accession number HBJU/M/27. July-Sep. 2022

Pileus 6-28 mm long, dark brown to grey (6F5-6D1) , surface dry, conical to bell shaped , appendiculate margins when young context fragile and thin; **Lamellae** 1-2mm wide**,** adnexed, dark grey when young ,becomes black at maturity , crowded, edges entire and concolorous , at margins are present lamellulae , presence of forkation ; **Stipe** 75-90 × 1-2 mm, dark brown to grey (6F4-6D1) , hollow, long, thin, fragile ; **Basidia** 18.8-29.5 × 13.2-17.0 µm, clavate, smooth, thin-walled, hyaline; **Sterigmata** 0.8-4.0 µm long, 3-4 in number; **Basidiospores** 9.5-17.0 × 7.8-10.8 µm, (a_v L = 13.25 µm, a_v W = 9.3 µm, Q =1.43), narrowly ellipsoidal, black, smooth, clear, minute germ pore present, thick-walled; **Stipe hyphae** 12.0-24.0 µm in width , thin-walled , smooth , with presence of septa.

Distribution: Reported from Jammu and Kashmir by Altaf *et al* in 2022 and Punjab (Kaur *et al*., 2014).

Edibility: not consumed in the study area.

Remarks: new report from the study area.

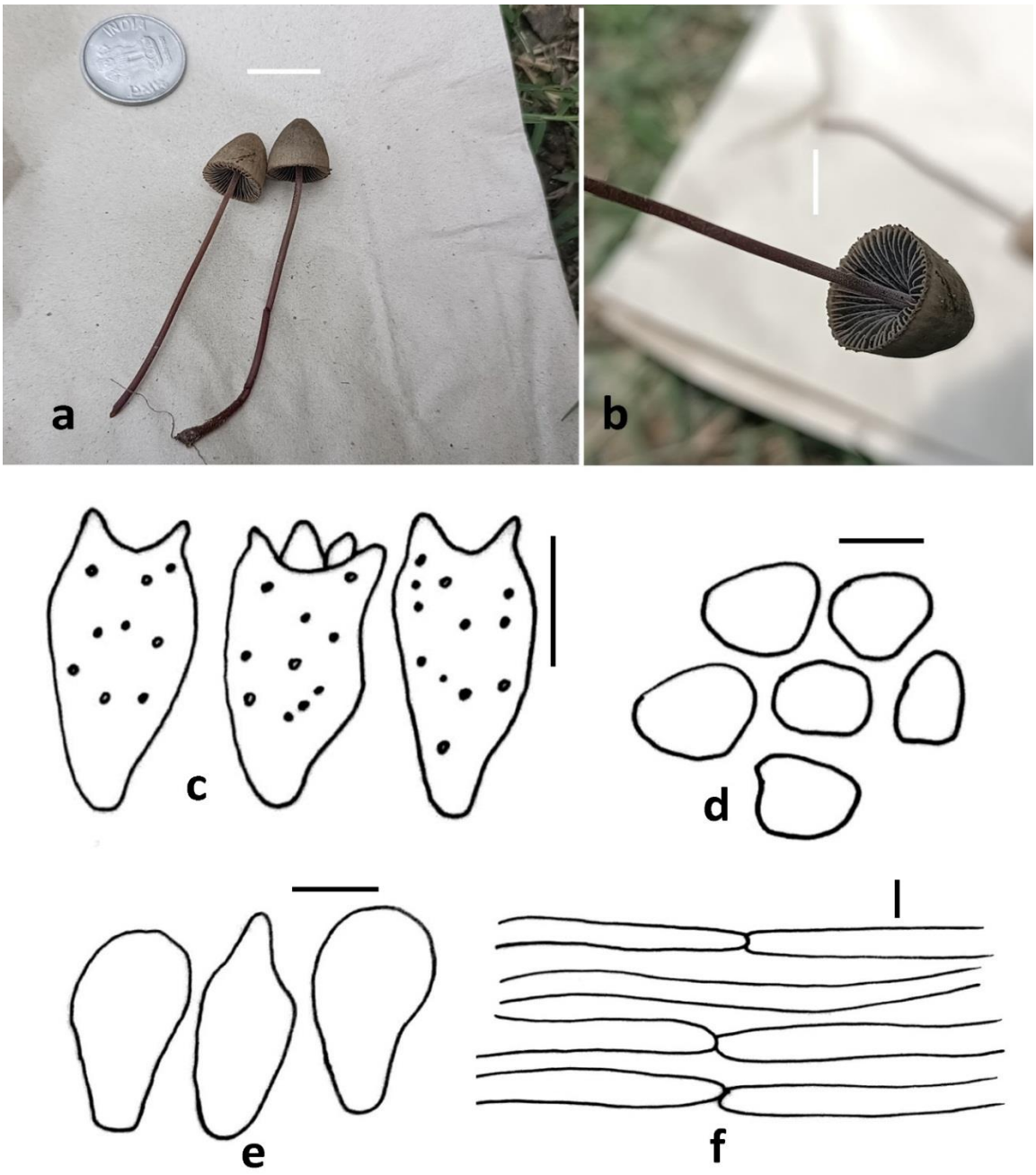

Fig. 6(25) ***Panaeolus papilionaceus***

a-b. Fresh basidiomata in the forest; **c.** Basidia; **d.** basidiospores; **e.** Cystidia; **f.** Stipe hyphae; Scale bars: **a-b**= 30 mm; **c-f** =10 μm.

6.1.11 Family Schizophyllaceae

26. Schizophyllum commune Fr. *Observ. Mycol*. (Havniae) 1: 103 (1815) [Figure6(26)]

Specimen examined: Jammu and Kashmir, District Kishtwar, Kishtwar city, Found in clusters, Iignicolous, growing on the dead wood of *Quercus sp*. Faisal Mushtaq & Ashish Vyas. Collection number FM22-069, Accession number HBJU/M/28. July-Sep. 2022.

Basidiomata annual, leathery, sessile , imbricate; **Pileus:** 5-28mm wide, off white (1A1) to light grey (6D1) ,fan to shell-like with dry surface, broadly convex to plane, very coarsely fibrillose, fibrils laterally agglutinated making pileus surface rimose, , wavy margins , context ligh grey ,leathery; Hymenium surface light pinkish; **Lamellae:** 1-3 mm radiating from the, thick , narrowing towards margins, splitting length wise, split being shallow forms a groove which divides each gill into two halves, lamellulae tapering towards centre; **Basidia:** clavate, 9.4-17.0 x 3.0-5.5 µm, 4- spored, clamps at the base; **Basidiospores:** oblong, ends obtuse, 3.5-4.6 × 1.0-1.8 µm(a_v L =4.01 µm, a_v W = 1.4 µm, Q = 2.86), hyaline, cylindrical, thin walled, smooth, inamyloid; **Pileus cuticle and context hyphae:** septate, 2.1-4.6 µm in width, with septae, thin walled but sometimes thick walled, clamped.

Distribution: Reported on dead wood from Darjeeling, Bihar, Sikkim, Andaman Islands, Mussoorie, Maharashtra (Berkeley, 1856; Hennings, 1901; Llyod, 1904- 1919), Calcutta, Allahabad, Ludhiana and Kashmir (Banerjee, 1947; Watling and Gregory, 1980).

Edibility: consumed in the study area.

Remarks: new report from the study area.

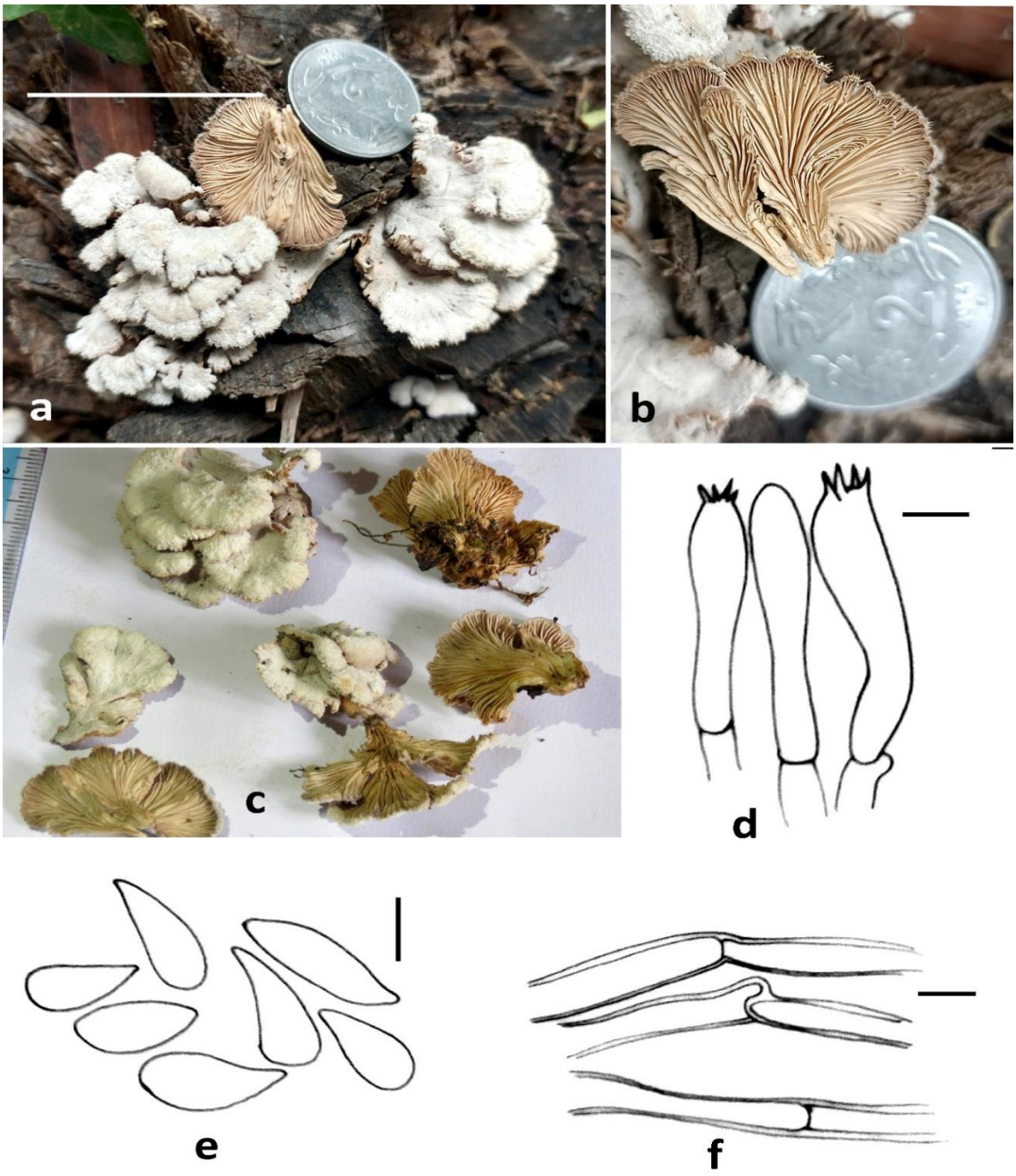

Fig. 6(26) ***Schizophyllum commune***

a-c. Fresh basidiomata in the forest; **d.** Basidia; **e.** basidiospores; **f.** Hyphae; Scale bars: **a-c**= 50 mm; **d-f**=10 μm.

6.1.12 Family Strophariaceae

27.Pholiota squarrosa (Fr.) Kummer, Der Führer in die Pilzkunde. p. 84. (1871). [Figure6(27)]

Specimen examined: Jammu and Kashmir, District Kishtwar, Chingam . Humicolous, gregarious to caespitose. Faisal Mushtaq & Ashish Vyas .Collection number FM22-071 , Accession number HBJU/M/29 , July-September 2022.

Pileus 40–110 mm diam, light yellow to yellow (3A5-3A7) covered with brownish recurved scales, rounded when young , becoming rounded with broad knob ; edge is almost bald, dry surface , veil remnants on appendiculate margin ; **Context** 6–9 mm in thickness, off-white, thick and soft. **Lamellae** adnate with decurrent line on stipe, crowded, pale yellowish (3A3) , initially , dark brown at maturity . **Stipe** 46 – 115× 7 – 14 mm in thickness , tapering toward base, dry, solid, yellowish (3A7), covered with brown upturned scales, context white ,solid. Partial veil floccose, pale yellowish and persistent. **Basidiospores** 6.2-7.4 x 3.8-5.2 um (a_v L = 6.8 µm, a_v W = 4.5µm, Q = 1.52), ellipsoidal , smooth, with distinct apical pore . **Basidia** clavate , hyaline, thin-walled, 3-4 sterigmata . **Pleurocystidia** 15–38 × 5–10 µm, clavate-mucronate. Clamp connections present.

Edibility: Not edible in the study area.

Remarks: A new report from the study area.

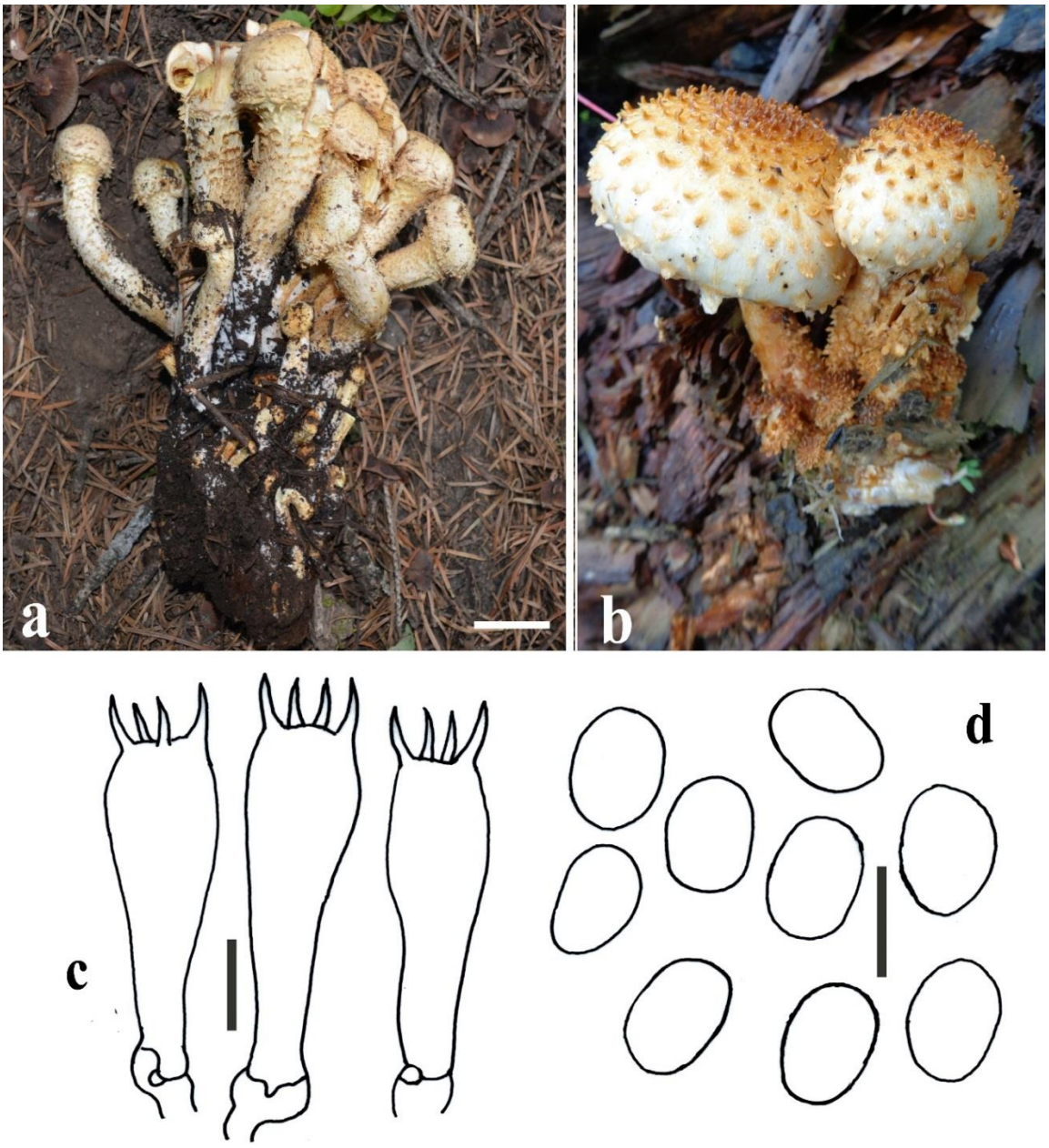

Fig. 6(27) ***Pholiota squarrosa***

a-b. Fresh basidiomata in the forest; **c.** Basidia; **d.** basidiospores; Scale bars: **a-b**= 50 mm; **c-d**=10 μm.

Order Polyporales

6.1.13 Family Sparassidaceae

28. Sparassis crispa (Wulfen) Fr.,Syst.mycol.(Lundae)1:465(1821). [Figure6(28)]

Specimen examined: Jammu and Kashmir, District Kishtwar, Chingam, Ikhala , Sarthal. Solitary to scaterred, growing in humus rich soil mostly in coniferous forest.. Faisal Mushtaq & Ashish Vyas .Collection number FM22-075 , Accession number HBJU/M/30, July-September 2022.

Basideocarp 148-230mm wide, light creamish to Light Yellow (4A5) , flat ,cauliflower like, branched arising from the solid base, margins brownish,**Stipe**:33-54mm long and 13-27 mm wide, solid, hard ,narrow towards the base **.Basidia**: 24.8-36.4 × 4.4-5.8µm,eight spored, hyaline, thick walled. **Sterigmata:** 1.8-3.5µm long; **Basidiospores**: 5.3-6 × 3.4-4.1µm(avL = 5.65, avW = 3.75, Q = 1.50), ellipsoidal,hyaline,smooth,elliptical ; **Cheilocystidia:** cylindrical to clavate, 19.5- 38 x 9.4-11.5 µm, hyaline; Hymenophoral trama compact and composed of parallel hyphae; Pileus and Stipe hyphae: 3.5- 7.8 µm in width , septate, thick-walled.

Distribution: **:** First reported from Jammu and Kashmir and Maharashtra (Sathe and Sansangam, 1977) and from Himachal Pradesh by Rana (2017).

Edibility consumed in the study area.

Remarks. It is widely eaten in the study area**.**

Fig.6(28) ***Sparassis crispa***

a-c. Fresh basidiomata in the forest; **d.** Basidia; **e.** Basidiospores; **f.** Clamped hyphae ; Scale bars: **a-c** = 50 mm; **d-f** =10 μm.

6.1.14 Fomitopsidaceae

29. Laetiporus sulphureus (Bull.) Murrill, Mycologia 12 (1): 11 (1920). [Figure6(29)]

Specimen examined: Jammu and Kashmir, district kishtwar, Sinthan Top. Found in clusters ,growing on the trunk of *Betula utilis*. Faisal Mushtaq & Ashish Vyas .Collection number FM22-080 , Accession number HBJU/M/31 , July-September 2022.

Basidiomata 178−345 × 190−375 mm, upper surface citric light orange (6A5) to orange red (8A7) when young, light brown at maturity or drying, pileate, imbricate with rudimentary or reduced stipe-like base, , glabrous or minutely tomentose, with zonation , radially furrowed with concolorous margin , often undulate; context white, azonate, brittle and succulent when fresh, chalky on drying, up to 22 mm thick. **Pore surface** sulphur yellow to creamish when fresh, fading to pale tan on drying, pores angular, 2−4 per mm. with thin dissepiments, quickly becoming lacerate. **Tubes** light yellowish to light sulphur yellow when fresh , up to 4.5 mm deep. Basidiospores: 4.4-5.8 × 2.8-5.1µm(avL = 5.1, avW = 3.95, Q = 1.29), narrowly ellipsoidal to ellipsoidal, thin walled, smooth with apiculus, smooth, monoguttulated, **Basidia** clavate to subclavate , clear , thin-walled with 3-4 sterigmata. Clamp connections absent

Edibility: widely consumed in the study area.

Remarks: new report from the study area.

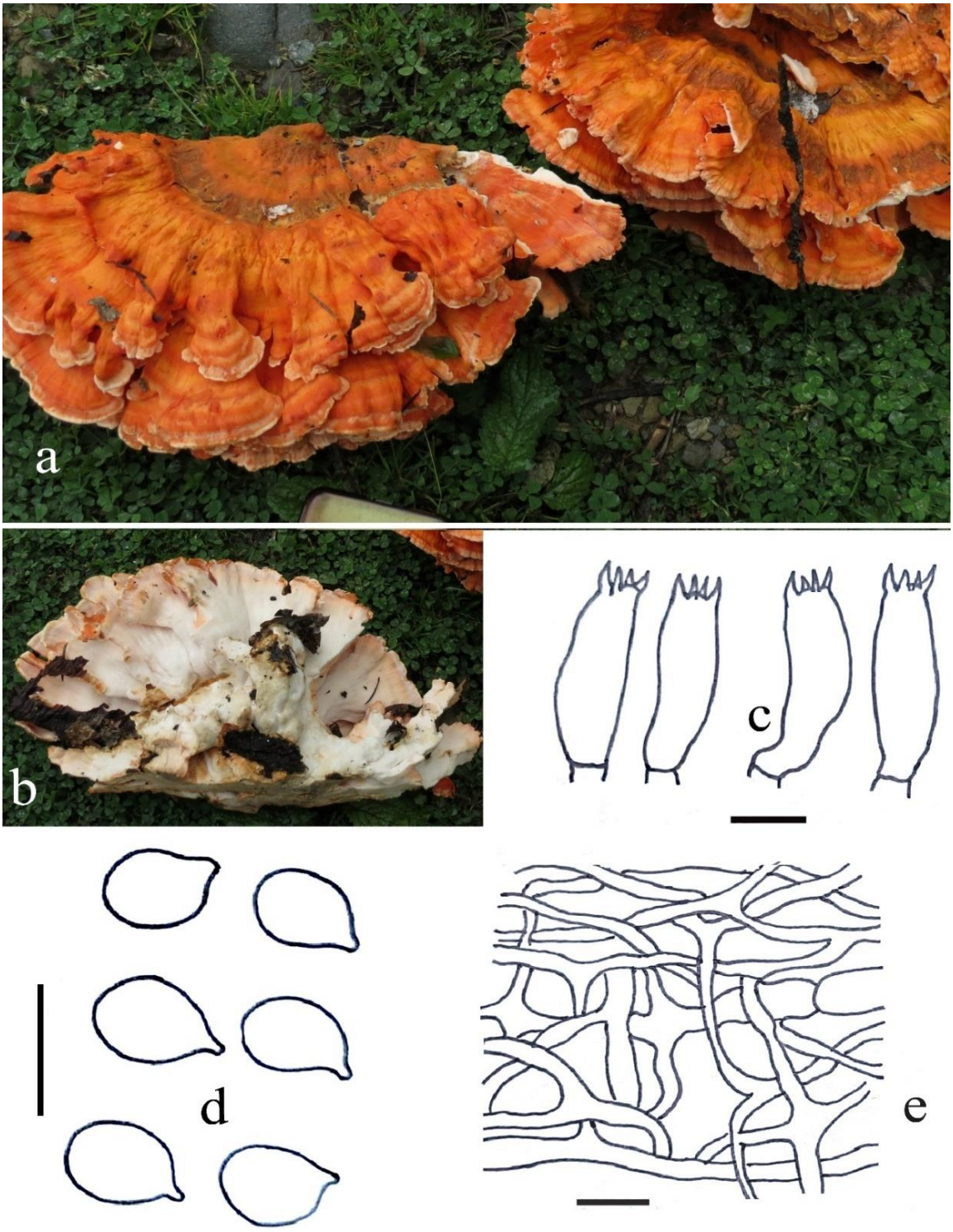

Fig.6(29) ***Laetiporus sulphureus***

a-b. Fresh basidiomata in the forest; **c.** Basidia; **d.** Basidiospores; **e.** Hyphae; Scale bars: **a-b** = 50 mm; **c-e** =10 μm.

Order Auriculariales

6.1.15 Family Auriculariaceae.

30. Auricularia auricula-judae (Bull.) QuéI., *Enchir. fung.* (Paris): 207 (1886). [Figure6(30)]

Specimen examined: Jammu and Kashmir, District Kishtwar , Chatroo. Lignicolous, gregarious, growing on the wood of *Juglans regia*. Faisal Mushtaq & Ashish Vyas. Collection number FM22-084, Accession number HBJU/M/32 ,July-Sep, 2022.

Basidiomata 22−112 mm broad, Light Yellow to Pale yellow (4A4-4A3) or light brown (6D5) , jelly like or gelatinous ,covered with fine greyish velvety hairs, slightly flattened to irregularly lobed , semi-transparent to opaque, sessile or sub-stipitate; initially with margin , becoming somewhat lobed with maturity; Hymenium veined, irregular often, lighty orange, context up to 14 mm, gelatinous , becoming hard on drying. **Basidia**: cylindrical, transversely septate 29−64.2 × 3.9−5.4 µm, **Basidiospores:** 9.3-13.5 x 5.4-6.6 µm (a_v L = 11.4 µm, a_v W = 6µm, Q = 1.90) , bi- to multi-gutullate, allantoid; Pileus and context hyphae septate to aseptate, up to 7.4 µm in width.

Distribution: Earlier reported from various regions of India (Banerjee, 1947;).

Edibility: Edible in the study area.

Remarks: Ear shaped mushroom hence called kankitch.

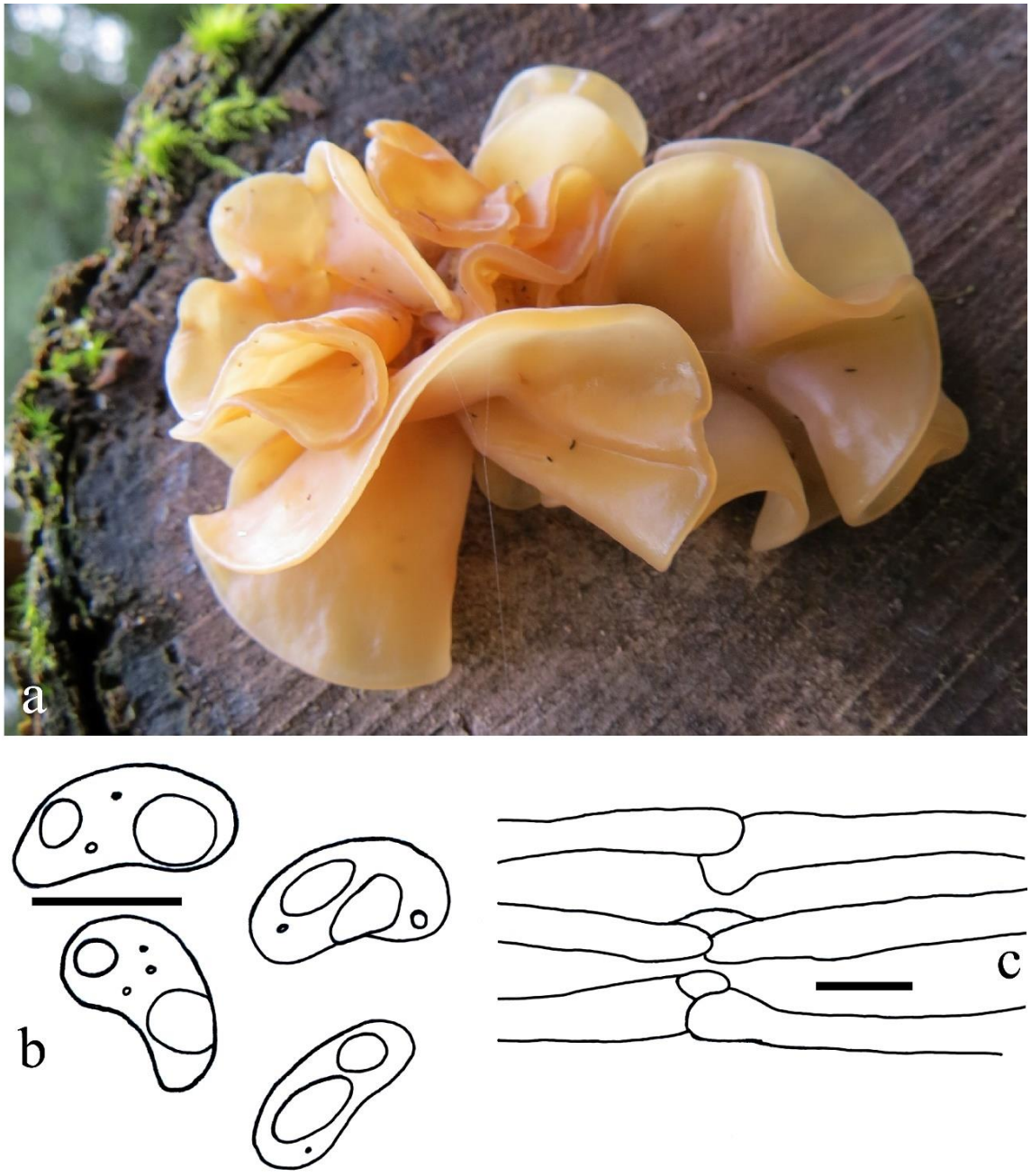

Fig. 6(30) ***Auricularia auricula***

a. Fresh basidiomata in the forest; **b.** Basidiospores; **c.** Hyphae. Scale bars: **a** = 50 mm; **b** =10 μm; **d** = 5 μm.

Oder Boletales

6.1.16 Family Boletaceae

31. *Boletus edulis* Bull., *Herbierde ía France* 2: tab, 60 (1782). [Figure6(31)]

Specimen examined: Jammu and Kashmir, Kishtwar, Chatroo, Chingam , Nagseni. Solitary to gregarious, humicolous. Faisal Mushtaq & Ashish Vyas. Collection number FM22-086. Accession number HBJU/M/33. July-Sep. 2022.

Pileus 16–38 mm wide, light brown to dark brown (6D5-6F5), convex, smooth. Pores small, round, initially off white finally turning light greenish. **Stipe** central, 29–77 × 14–25 mm, obclavate, solid, light yellowish (4A5) to brownish (6D5) with slight tinge of orange red at the base. Flesh white, unchanging. **Basidiospores:** ellipsoidal, 4.7-10.6 × 3.4- 5.0 µm(a_v L =7.65 µm, a_v W = 4.2µm, Q = 1.82) , smooth, bi-guttulate (yellowish in lactophenol); **Basidia** clavate,34.8×14.2 µm. **Pileus hyphae** 3.8–11µm, wide, septate. **Caulocystidia** 29–55 × 9.4-14.2 µm.

Distribution: Reported earlier from Central India by Verma and Pandro(2018).

Edibility*:* consumed in the study area.

Remarks*:* It is new record from the study area.

Fig. 6 (31) ***Boletus edulis***

a-c. Fresh basidiomata in the forest; **d.** Basidia; **e.** Basidiospores; **f.** Cystidia. Scale bars: **a-c** = 30 mm; **d-f** =10 μm.

32. *Veloporphyrellus latisporus* J. Khan & S. Ullah Nordic Journal of Botany 39(9): 10.1111/njb.03178 2021. [Figure6(32)]

Specimen examined: Jammu and Kashmir, District Kishtwar , Bindraban. Scattered to gregarious , common, growing in forest of *Cedrus deodara* and *Pinus wallichiana*. Faisal Mushtaq & Ashish Vyas .Collection number FM22-0010, Accession number HBJU/M/34, July-Sep, 2022.

Pileus50–78 mm broad, convex, plano-convex with age; margin plane, velar remnants present as a sterile flap of tissues, entire, sometimes cracked; smooth surface initially and slightly rough to areolate, cracked with maturity, reddish brown (8D–E4–7) to brownish red (10D4–7). **Pileus context** : 47 mm in thickness at the disc, thickness decreases towards the margin, pale yellow (3A2), not getting changed after bruising .**Tube** 3-5 mm deep, adnate, pinkish white; pore angular, 1–3 /mm. **Stipe** 60–90 × 10–14 mm, central, cylindrical, broader at base; surface dry, very finely striated, brownish red to reddish brown (8E7–8).**Stipe context** white, unchanging when cut bruised. **Basal Mycellium** white . **Basidiospores** 11.6–13.4 × 5.9–6.9 µm, (a_v L =12.5 µm, a_v W = 6.4µm, Q = 1.95), boletoid, appearing smooth under light microscope, pale olivaceous when observed in KOH and H_2O. **Basidia** 28–38 × 10–11 mm, clavate to subclavate, thin-walled, 4-spored. **Pleurocystidia** 38–63 × 6–10 µm, subclavate to narrowly clavate, fusoid to narrowly ventricose, thin-walled, mostly colourless in KOH and H_2O.**Cheilocystidia** 46–84 × 8–13 µm, Sub clavate to sub cylindrical, septate, abundant. **Clamp Connections** absent in all tissues.

Edibility: not consumed in the study area.

Remarks: new generic record from India.

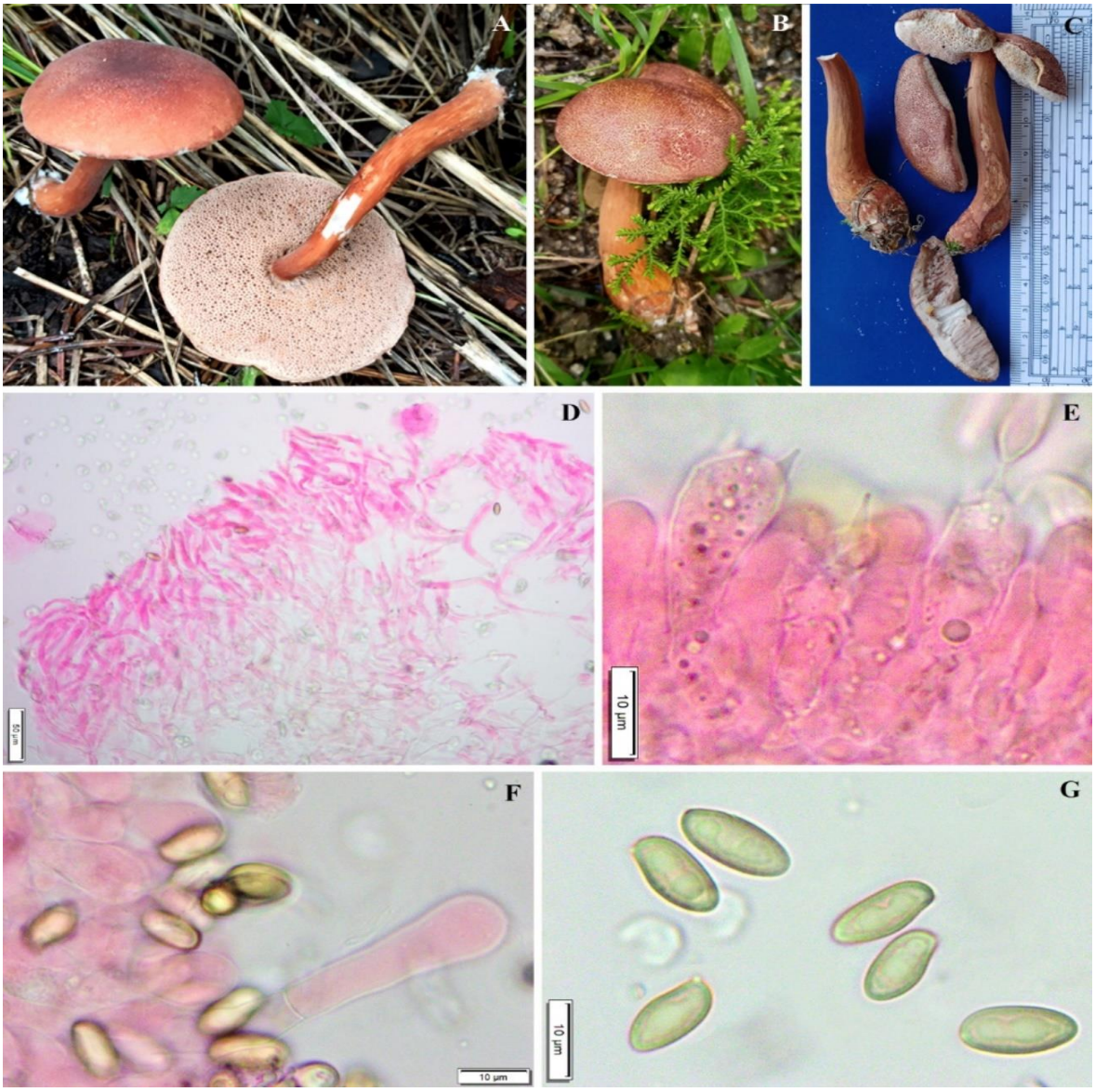

Fig. 6 (32) ***Veloporphyrellus latisporus***

A-C. Basideomata in field and in base camp; **D.** Pileipellis; **E.** Basidia; **F.** Cheilocystidia; **G.** Basidiospores. Scale bars: **D** = 50 mm; **E-G** =10 µm.

6.1.17 Family Suillaceae

33.Suillus americanus (Peck) Snell, in Slipp & Snell, Lloydia 7(1): 39 (1944). [Figure6(33)]

Specimen examined: India, Jammu and Kashmir, Kishtwar, Chatroo, Nagsena, Sarthal. Ectomycorrhizal, growing in association with *Cedrus deodara*, gregarious, scanty. Faisal Mushtaq & Ashish Vyas . Collection number FM22-088 , Accession number HBJU/M/35. July-Sep, 2022.

Basidiocarps small to medium sized. **Pileus** 46−54 mm in diam., yellowish brown(5D5), initially convex then plano-convex at maturity and black after treatment with 10% KOH, dry surface, viscid when wet with entire, uplifted and appendiculate margins . **Context** 4−20 mm wide, soft. **Tubes** up to 16 mm long, sub-decurrent, light yellow (4A5) , pores triangular to rounded , mostly angular, larger pore size towards stipe and smaller towards margin. **Stipe** 42−56 × 6−13 mm**,** amber yellow (4B6), equal. **Context** stuffed, off-white **Basidia** 22.8−29.9 × 6.6−9.8 µm, clavate , hyaline, smooth, Sterigmata 4 in number. **Basidiospores** 6.9−10.2 × 3.4−4.5 µm (a_v L = 8.55 µm, a_vW= 3.95µm, Q = 2.16), inequilateral, mono-biguttulated , elliptical to fusiform, hyaline, , thin walled, smooth. **Stipe hyphae** 3.7−9.0 µm wide, clear, smooth, hyaline, thin walled, septate, absence of clamp connections . **Pileus hyphae** 4.2−11.8 µm in width , hyaline, septate, without clamps.

Distribution: Earlier reported from Jammu and Kashmir, Himachal Pradesh and Uttarakhand as *Suillus sibiricus* (Verma and Reddy, 2016).

Edibility: not consumed in study area.

Remarks: new report from the study area.

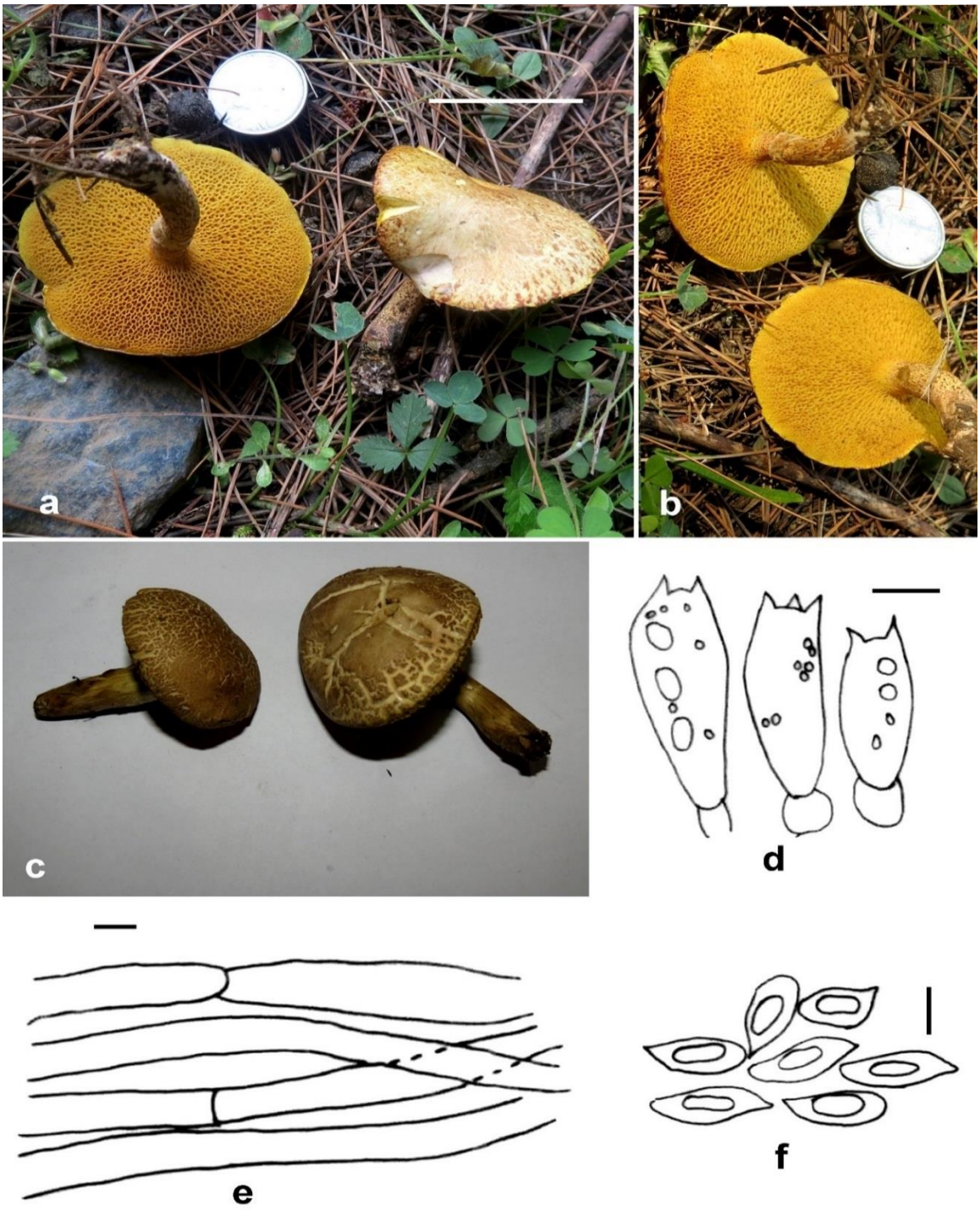

Fig. 6(33) ***Suillus americanus***

a-c. Fresh basidiomata in the forest; **d.** Basidia; **e.** hyphae; **f.** Basidiospores; Scale bars: **a-c** = 50 mm; **d-f** =10 μm.

Order Cantharellales

6.1.18 Cantharellaceae

34. *Cantharellus cibarius* Fr., *Syst. mycol*. (Lundae) 1: 318 (1821). [Figure6(34)].

Specimen examined. Jammu and Kashmir, District Kishtwar, Bindraban, Mugalmaidan, Chatroo, Chingam , humicolous , gregarious to caespitose, coniferous forest of *Pinus wallichiana* and *Cedrus deodara.* Faisal Mushtaq & Ashish Vyas.Collection number FM22-090. Accession number HBJU/M/36 .July-Sep. 2022.

Pileus 39–58 mm wide, deep yellowish (4A8), irregular in shape, depression in the centre, smooth surface with involuted margins. **Lamellae** unequal, decurrent, distant, concorolous with blunt edges, irregular hymenophoral trauma . **Stipe** 29–78 × 7–16 mm, central, somewhat glabrous, narrowing towards the base , context creamish white (1A1), thick; ; **Basidiospores:** ellipsoidal and apiculate, 5.0–9.7 × 3.9–6.2 µm(a_vL =7.35 µm, a_vW= 5.05µm, Q =1.46), presence of globular oil droplets ; **Basidia:** clavate with 3-4 sterigmata, 142–32.9 × 3.9–5.8 µm. **Pieleipellis** 2.9–8.1 µm wide, branched, hyaline, septate, presence of clamp connections . **Pileus context:** septate, upto 5.4 µm, branched, clamped.

Distribution: On soil with dead organic matter, on ground under *Pinus longifolia,* in open patches on humus and rocky soil from Solan (H.P.), Mussoorie UP., Shillong (Assam), Kashmir and West Bengal (Hennings, 1901; Bose and Bose, 1940; Ghosh *et. al.,* 1974; Abraham *et al.,* 1980).

Edibility: Edible in the study area.

Remarks: It mostly grows in clusters and is mostly found in forest.

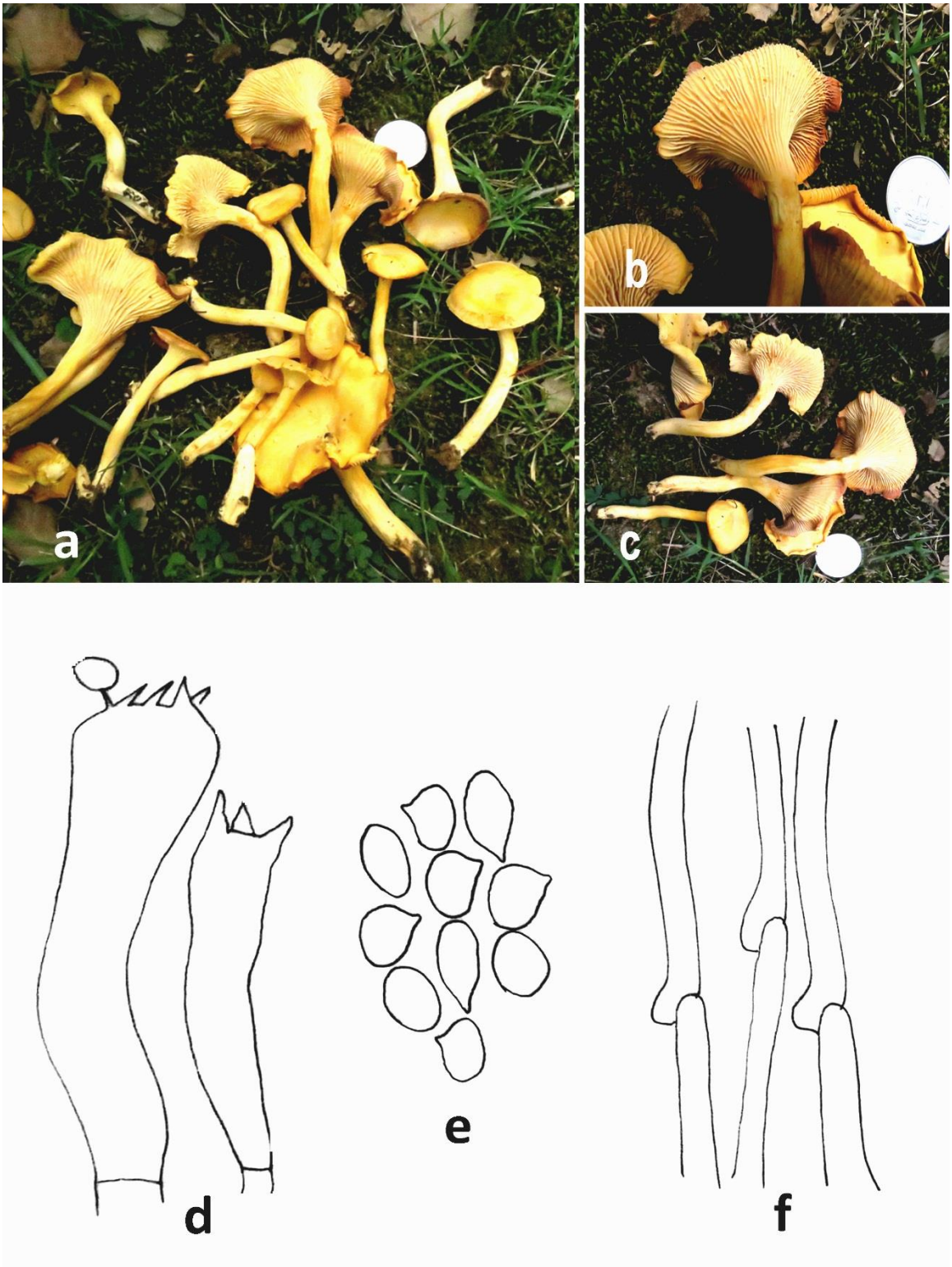

Fig. 6(34) ***Canthrellus cibarius***

a-c. Fresh basidiomata in the forest; **d.** Basidia; **e.** Basidiospores; **f.** Pilus hyphae Scale bars: **a-c** = 50 mm; **d-f** =10 μm.

Order Geastrales

6.1.19 Family Geastraceae

35. Geastrum saccatum Fr., *Syst. mycol.* (Lundae) 3(1): 16 (1829). [Figure 6(35)]

Specimen examined: Jammu and Kashmir, District Kishtwar, Chatroo, Chingam, Sarthal. Humicolous, solitary , sometimes scattered Faisal Mushtaq & Ashish Vyas .Collection number FM22-092 , Accession number HBJU/M/37 ,July-September 2022.

Gasterocarp : brown, globular to sub-globular with pointed like structure and cup like structure enclosing base of endoperidium,; **Exoperidium:** 3.2-5 x 1.4-1.8 cm broad at the base, broken beyond middle into 5-8 rays, each ray narrowly pointed ; **Mycelial layer:** thin, consisting light yellowish (3A7) , branched , hyphae 4 -6.3 µm in width ; **Fibrillose layer:** thin, leathery and composed of aseptate, unbranched hyphae upto 6.5 µm in width ; **Fleshy layer:** rust coloured, consist of texture up to 34 µm wide, spiliting and cracking with cracked edges ; **Endoperidium:** forming spore sac, globular to sub-globular, light brown, consisting of interwoven hyphae, aseptate, unbranched , 3.4-5.8 µm in width ; **Peristome:** broad with fimbriate margin ; **Gleba:** light brown coloured ; **Basidiospores:** subglobose , 3.8-5.5 µm in diameter with presence of oil drops ; **Capillitium threads:** 3.2-7.2 µm in width , light yellowish, unbranched with presence of septae..

Distribution: Earlier reported from Kashmir (Abraham1991).

Edibility: not consumed in the study area.

Remarks: new report from the study area.

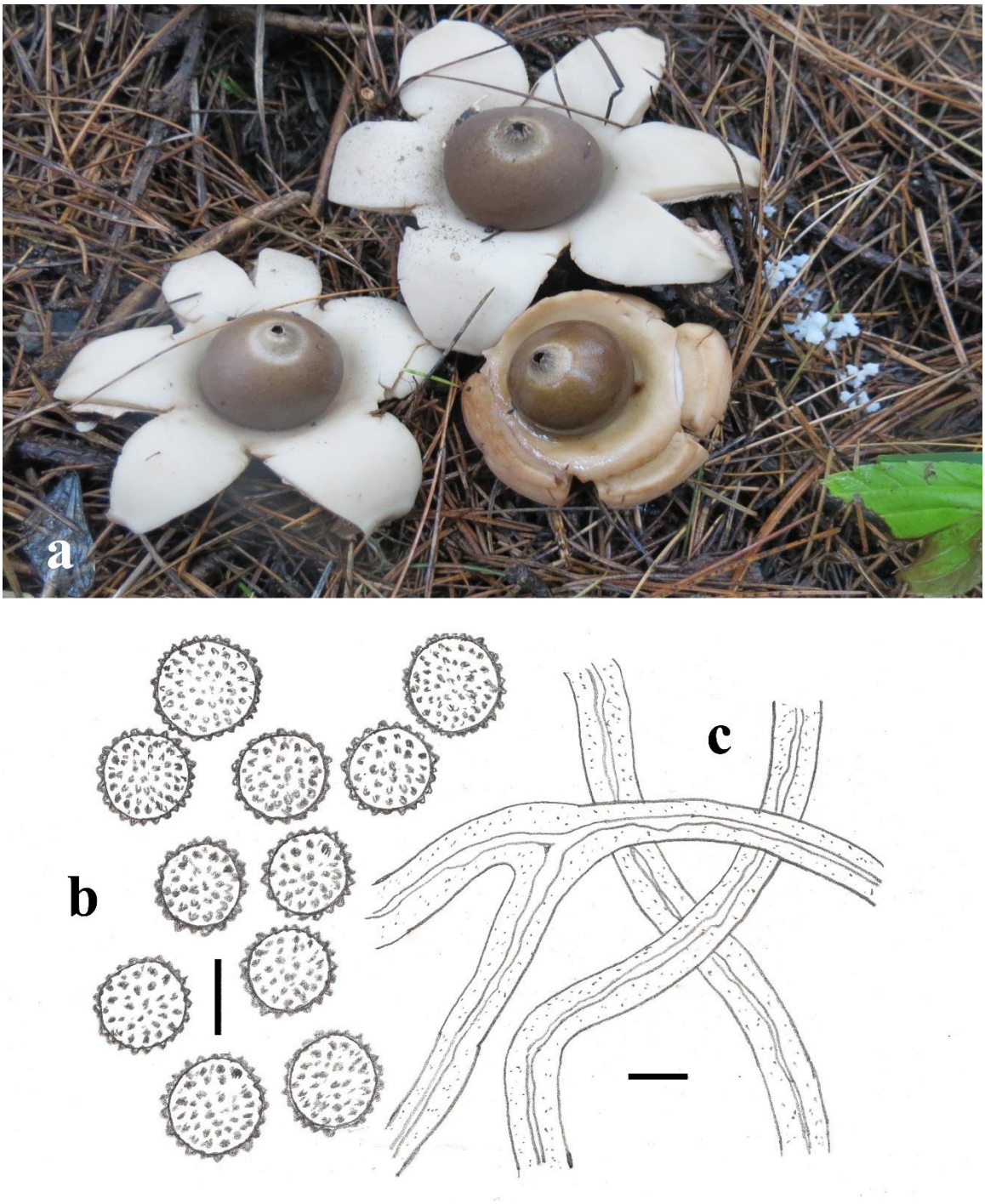

Fig. 6(35) ***Geastrum saccatum***

a. Fresh basidiomata in the forest; b**.** Basidiospores; **c.** Exoperidial hyphae Scale bars: **a** = 50 mm; **b-c** =10 µm.

Order Gomphales

6.1.20 Family Gomphaceae

36. Ramaria formosa (Pers.) Quél., Fl. Mycol. France (Paris): 466 (1888).Figure 6(36).

Collection examined: Jammu and Kashmir, Chatroo, Chingam, Ikhala, humicolous, scattered in the coniferous forests of *Pinus wallichiana* and *Cedrus deodara*. Faisal Mushtaq & Ashish Vyas .Collection number FM22-094 , Accession number HBJU/M/38 ,July-September 2022.

Fruiting body: 4.0-9.8 x 2.9-5.8 cm, erect; light yellowish (4A5) to light brownish (5D5) with prominent trunk, 1.5-3.4 cm wide, smooth, branched profusely ; Polychotmous branching below and dichotomous above; primary branches light yellowish (4A5) and measured 0.6-1.9 cm wide . **Flesh:** white ; **Basidiospores:** 7.8-13.2 x 3.9-7.2 µm (a_v L =10.5 µm, a_vW= 5.55µm, Q =1.89) smooth to slightly rough ,cylindrical to ellipsoidal with papillae, upto 1.4 µm long papilla, multi-guttulate; **Basidia:** clavate, 15.8-31.4 x 6.2-9.4 µm, 3 to 4-spored, sterigmata upto 6.0 µm long; **Hyphae:** 2.8-8.8 µm wide, branched, septate, infrequently clamped , sac like structure at the top .

Distribution: *Ramaria formosa* was earlier reported from Murree Hills (Thind, 1961) and Khasi hills, Assam, (Butler and Bisby 1960).

Edibility: consumed in the study area .

Remarks: new report from the study area.

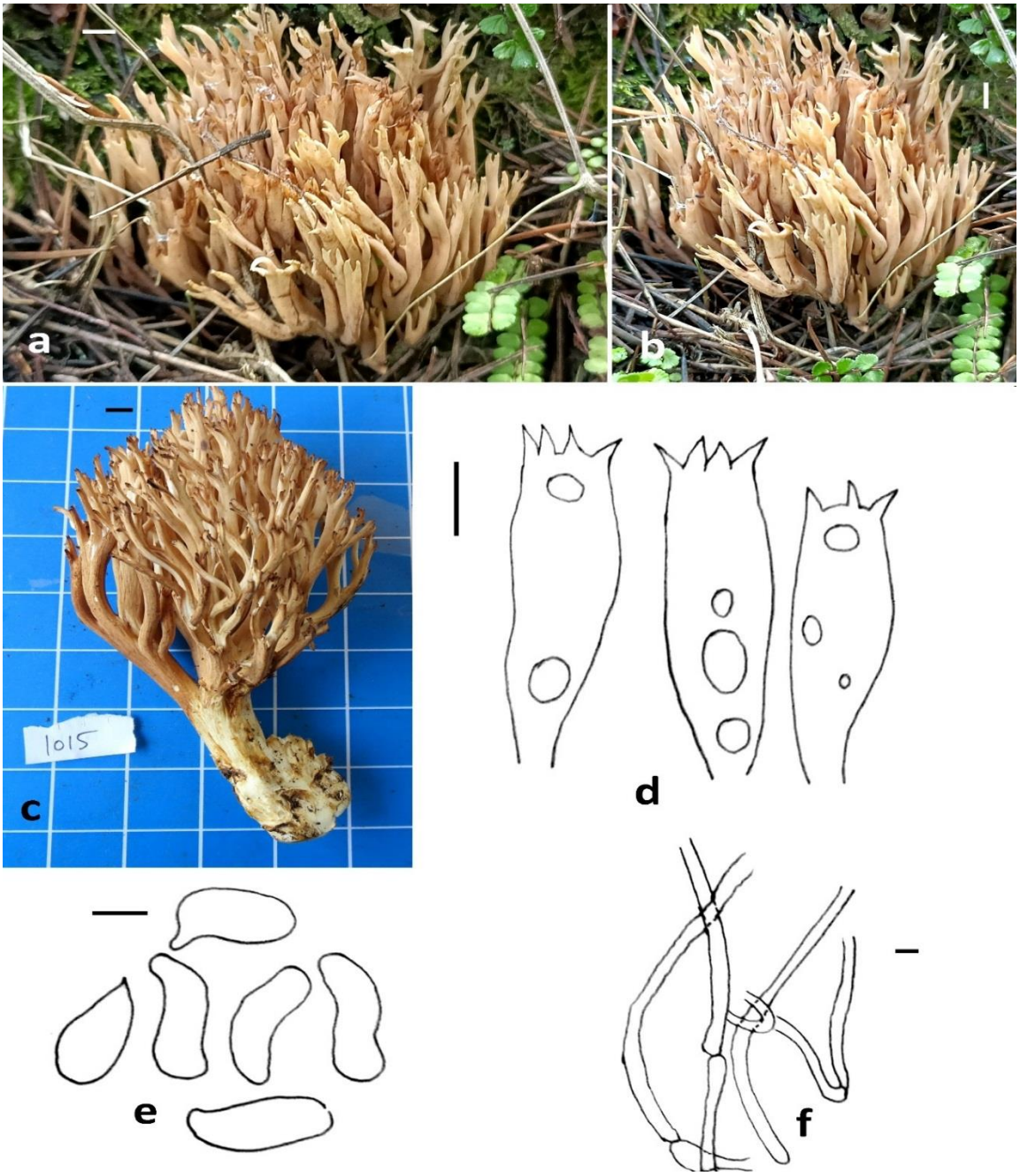

Fig. 6 (36) ***Ramaria formosa*** **a-c.** Fresh basidiomata in the forest; **d.** Basidia; **e.** basidiospores; **f.** Hyphae; Scale bars: **a-c**= 50 mm; **d-f**=10 μm.

6.1.21 Family Tricholomataceae

37. *Lepista sordida* (Schumach) Singer, Lilloa 22: 193 (1951) [1949].Figure 6(37).

Specimen examined: Jammu and Kashmir, District Kishtwar, Bindraban, Ikhala. Solitary to f gregarious, in the cultivated fields and in the coniferous forests. Faisal Mushtaq & Ashish Vyas. Collection number FM22-095 , Accession number HBJU/M/39 ,July-September 2022.

Pileus: 2.8-5.6 cm in diameter, pinkish white (12A2) to dull violet with off white central region , broadly convex, smooth with incurved margins; **Gills**: sub-decurrent, dull lilac to pinkish white , crowded with presence of lamellulae ; **Stipe**: 2.7-6.2 cm long and 0.30-1.0 cm wide, concolorous with the pileus, solid, central, smooth, longitudinally fibrillose; **Basidia**: 13-22× 5-7.5 µm, clavate, 3 to 4-spored, sterigmata up to 2.0-3.5 µm long, 3-4 in number , hyaline : **Basidiospore**s: 2.8-5.4 × 3.0 – 4.2 µm (avL= 4.1, avW= 3.6, Q= 1.13), ellipsoidal, light greenish to light brownish in Congo red, apiculate with thick wall. **Pileus context hyphae**: 2.2-3.5 µm wide, hyaline, branched, septate with absence of clamp connections ; **Stipe hyphae**: 1.5-5.4 µm wide, clear, filamentous, unbranched with presence of septae.

Distribution: Earlier recorded from Maharashtra (Senthilarasu, 2014).

Edibility: not consumed in the study area.

Remarks: new report from the study area.

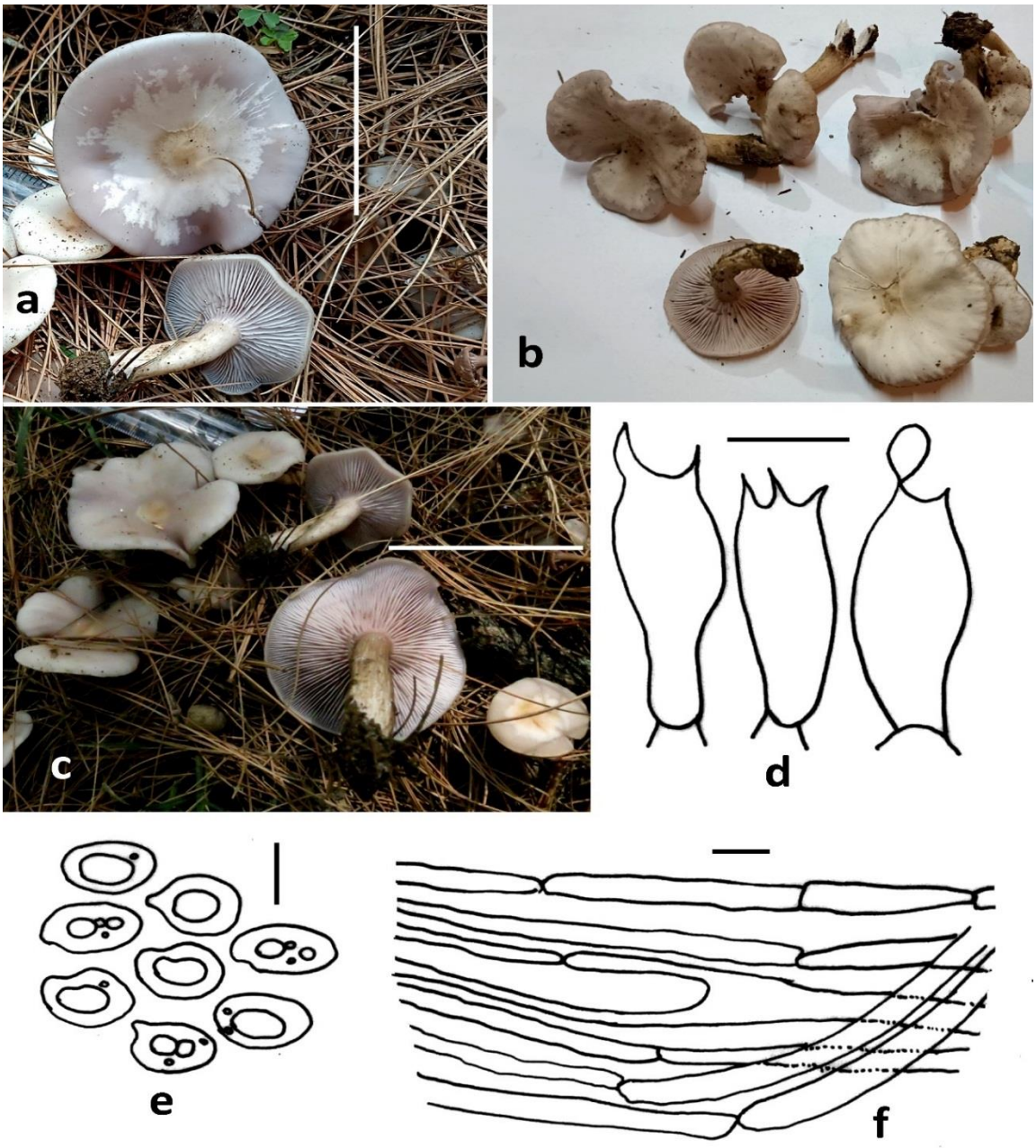

Fig. 6(37) ***Lepista scordida***

a-c. Fresh basidiomata in the forest; **d.** Basidia; **e.** Basidiospores; **f.** Hyphae ; Scale bars: **a-c** = 50 mm; **d-f** =10 μm.

Order Russullales

6.1.22 Family Hericiaceae

38. Hericium yumthangense K. Das, Stalpers & Stielow, IMA Fungus 4(2): 362 (2013).Figure 6(38).

Collection examined: India, Jammu and Kashmir, District Kishtwar, Chingam . Uncommon, solitary, lignicolous growing on trunk of *Abies pindrow*. Faisal Mushtaq & Ashish Vyas .Collection number FM22-097, Accession number HBJU/M/40 ,July-September 2022.

Fruiting Body 138 mm wide, coral like, medium to large, highly branched and branches arising from a small rooting base, light yellowish (2A5)to whitish (2A1) with orange patches . **Context** fleshy, creamish to yellowish (2A2) . Absence of stipe. Taste delicious**.** **Basidia** 26−31 × 5.4−6.2 µm, multi-guttulated, clavate with absence of clamp connection, hyaline, smooth, thin-walled **Basidiospores** 2.8−5.4 × 2.8−5.0 µm (avL= 4.1, avW= 3.9, Q= 1.05), narrowly ellipsoidal , amyloid and hyaline . Sterigmata 2.5−4 µm long, 3−4 in number. **Pileus hyphae** 3.5−11.5 µm wide, septate ,hyaline, smooth, thin-walled with conspicuous clamps.

Distribution: Reported from Sikkim (Das *et al*., 2013

Edibility: consumed in the study area.

Remarks: new report from the study area..

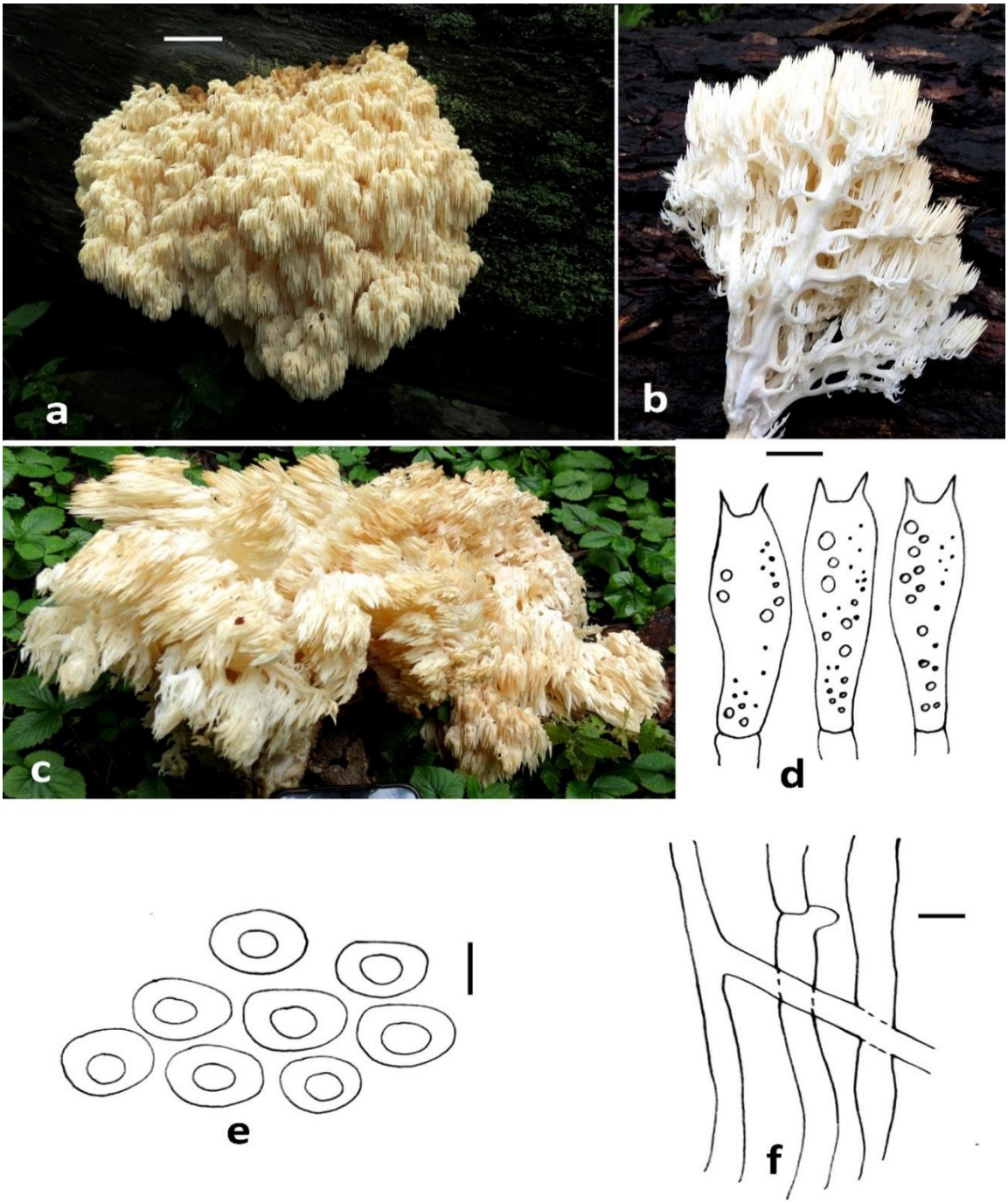

Fig. 6(38) ***Hericium yumthangense*** **a-c.** Fresh basidiomata in the forest; **d.** Basidia; **e.** Basidiospores; **f.** Clamped hyphae ; Scale bars: **a-c** = 50 mm; **d-f** =10 μm.

6.1.23 Family Russulaceae

39. ***Lactarius laeticolor*** (S. Imai) Imazeki ex Hongo, Acta Phytotax. Geobot 18: 139 (1959).Figure 6(39)

Collection examined: Jammu and Kashmir, district Kishtwar, Chatroo, Chingam, Sarthal. Scattered to gregarious , growing in forest of *Cedrus deodara* and *Pinus wallichiana*.. Faisal Mushtaq & Ashish Vyas. Collection number FM22-099 , Accession number HBJU/M/39 ,July-September 2022.

Pileus 33-92 mm , initially greyish orange (5B5) to light orange (6A4) , brownish orange (6C7) at maturity, initially convex with incurved margin then flat and depression in centre at maturity , smooth surface, . **Lamellae** crowded, orange coloured (6B7), decurrent , **Stipe** 25-42 mm, in length, hollow, concolorous with pileus, equal, orange coloured (6B7). Latex light orange colour, scarce, become light red on context, not discolouring with time.. **Basidiospores** 8.5-11 × 6.5-7.6 µm (avL= 9.75, avW= 7.05, Q= 1.38), narrowly ellipsoidal to ellipsoidal; ornamentation consist of ridges and warts, forming a complex network, **Basidia** 40-55 × 7-14 µm, subclavate, showing presence of fine granules and oil droplets, 4-spored; sterigmata 3-5.5 µm long. **Pleuromacrocystidia** sparsely present , not commonly distributed, 58-90 × 6.7-8.7 µm, with a narrow apex, thin walled, elongated and strongly emergent. Sub hymenium composed of cells which are irregularly arranged and rounded. Abundant lactifers in Hymenophoral trauma .

Edibility : consumed in the study area.

Remark : new regional record .

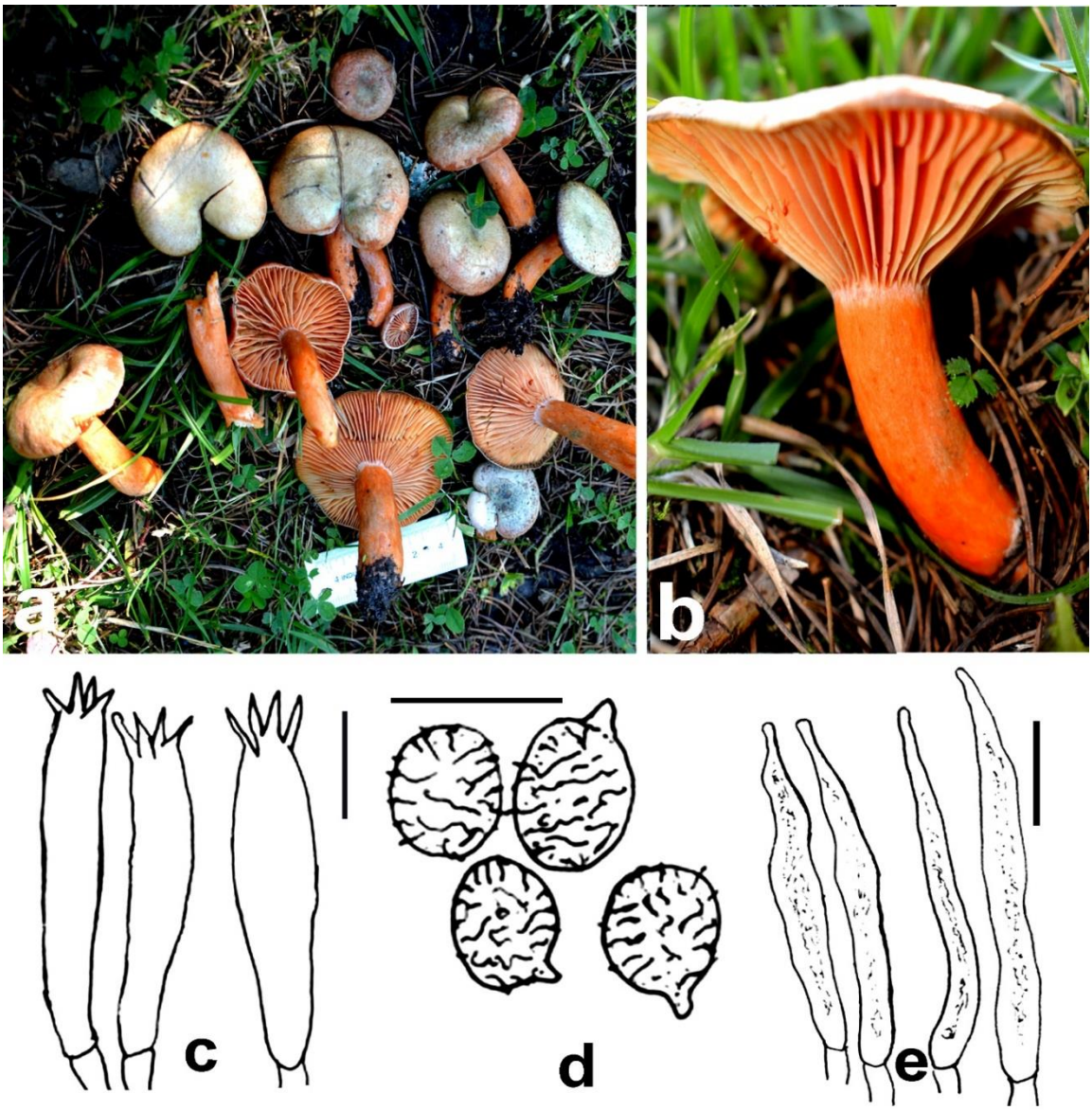

Fig.6(39)*Lactarius laeticolor*

a-b. Fresh basidiomata in the forest; **c.** Basidia; **d.** Basidiospores; **e.** Cystidia; ; Scale bars: **a-b** = 50 mm; **c-e** =10 μm.

40. ***Lactarius sanguifluus*** (Paulet) Fr., ***Epicr. syst. mycol***. (Upsaliae): 341 (1838).Figure 6(40).

Specimen examined: India, Jammu and Kashmir, District Kishtwar , Mugalmaidan, Nagseni ,Sarthal . Solitary to scattered, common, under *Pinus wallichiana* . Faisal Mushtaq & Ashish Vyas .Collection number FM22-101, Accession number HBJU/M/42 ,July-Sep, 2022.

Fruiting body medium sized; **Pileus** 36–58 mm, light pinkish , light orangish to pale orange , central part with some pale greyish to green patches**.** Initially convex with depressed centre, uplifted at maturity, margin incurved at young condition **. Lamellae** 3–5 mm wide, adnate to , crowded, 135–155mm, light pinkish to pale pinkish. Lamellulae present . **Stipe** 18–32 x 08–22 mm, equal, light pinkish at young condition and then become more greyish pink at maturity with prominance of greenish grey patches , hollow , cylindrical, tapering towards the base. **Context**: In pileus , it is 8–18 mm thick , brittle, hollow in stipe . **Latex** reddish brown to dark orange, unchanging. **Basidiospore** 8.5–9.8 × 7.0–8.5µm (avL= 9.15, avW= 7.75, Q= 1.18) broadly ellipsoidal with 0.6 µm high ornamentation and presence of ridges and isolated warts, , apiculus up to 1.5 µm . **Basidia** 42–67× 7–11.5 µm, subclavate, 4–spored, 5-8 µm long sterigmata . **Pleurocystidia** 42–65 × 6–10 µm, scarce, fusoid.

Distribution: Previously reported from Uttarakhand (Bhatt *et al*., 2000), Himachal Pradesh (Lakhanpal *et al*., 1987; Atri et al. 1994;).

Edibility: consumed in the study area.

Remarks: new regional record .

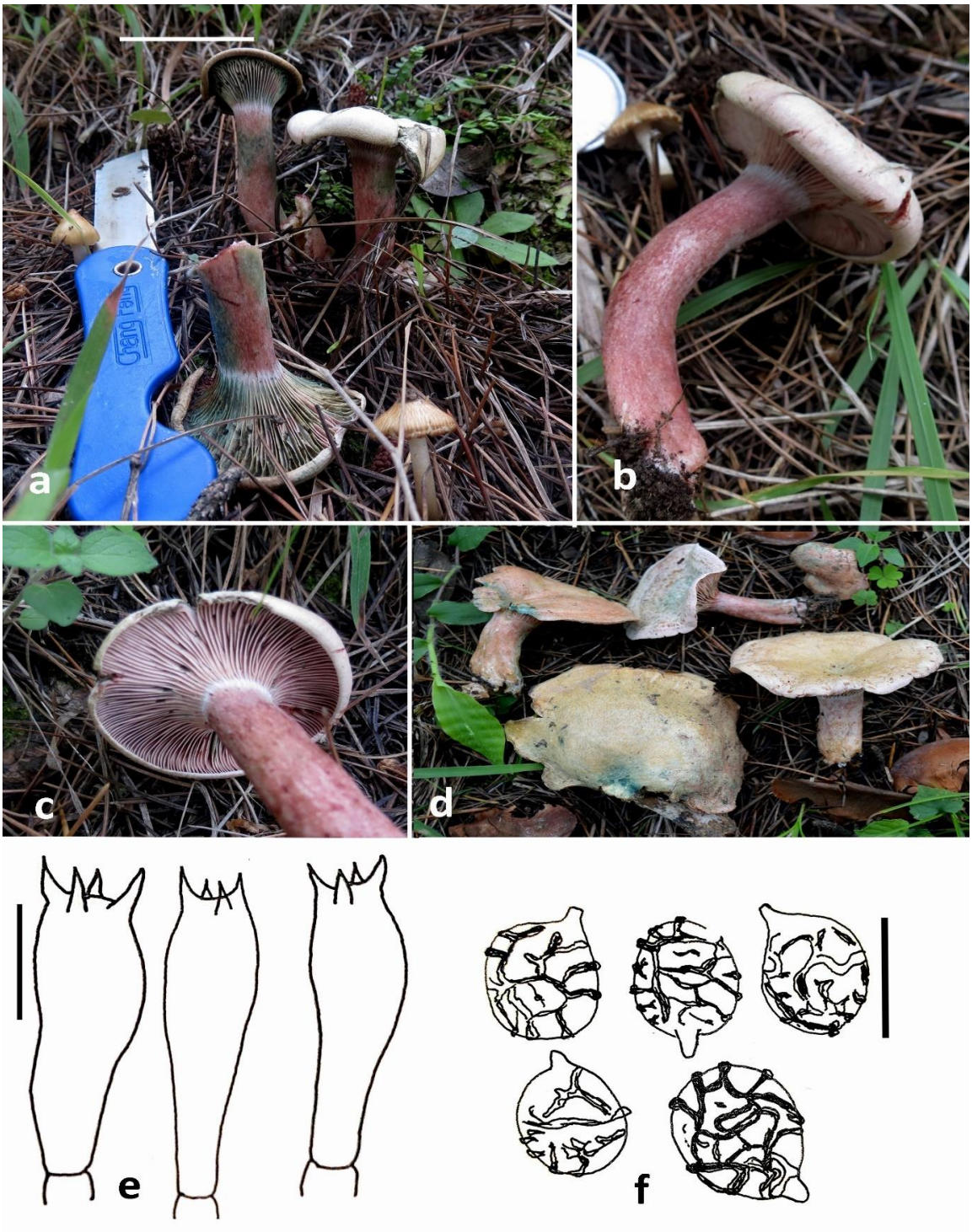

Fig.6(40) ***Lactarius sanguifluus***

a-d. Fresh basidiomata in the forest; **e.** Basidia; **f.** Basidiospores; Scale bars: **a-d** = 50 mm; **e-f** =10 μm.

41. ***Lactarius scrobiculatus*** (Scop.) Fr., Epicr. syst. mycol.(Upsaliae): 334 (1838).Figure6(41).

Specimen examined: India, Jammu and Kashmir, Kishtwar , Nagseni , Ikhala, Sarthal . Solitary to scattered, ectomycorrhizal growing in association with *Abies pindrow*. Faisal Mushtaq & Ashish Vyas . Collection number FM22-102, Accession number HBJU/M/43, Oct.-Dec., 2022.

Basidiomata mature , 45-115 mm long; **Pileus** 40-68 × 28-72 mm, dry, smooth, yellowish orange (8B7) with brownish spots, infundibuliform with prominent depression with inrolled margins , reddish on treatment with 10% KOH; **Context** 4-14 mm wide, chalky, creamish white (1A1), turning yellowish after treatment with 10% KOH; **Lamellae** 10-35mm wide, sub-decurrent, yellowish white (3A2), crowded, edges concolorous with presence of lamellulae of various lengths and absence of forkation ; **Stipe** 28-60 × 18-32 mm, creamish white with yellowish patches, bulbous at base and narrow at apex, central, smooth , become dark yellowish on treatment with 10% KOH; **Basidia** 40.5-72 × 8.0-13 µm, clavate, smooth, thin-walled; **Sterigmata** 1.1-2.5 µm long, 3-4 in number; **Basidiospores** 8.0-11.4 × 5.2-9.4 µm(a_v L = 9.7µm, a_v W = 7.3 µm, Q =1.32), broadely ellipsoidal, apiculated, amyloid withy ornamentation present in the form of ridges, warts; **Pleurocystidia** 44.0-78.0 × 4.2-8.0 µm, elongated with obtuse apex, smooth, hyaline, moniliform and thin-walled.

Distribution: Earlier reported from Jammu and Kashmir (Watling and Gregory, 1980; Atri *et al*., 1994;).

Edibility: inedible in the study area.

Remarks; new report from the study area.

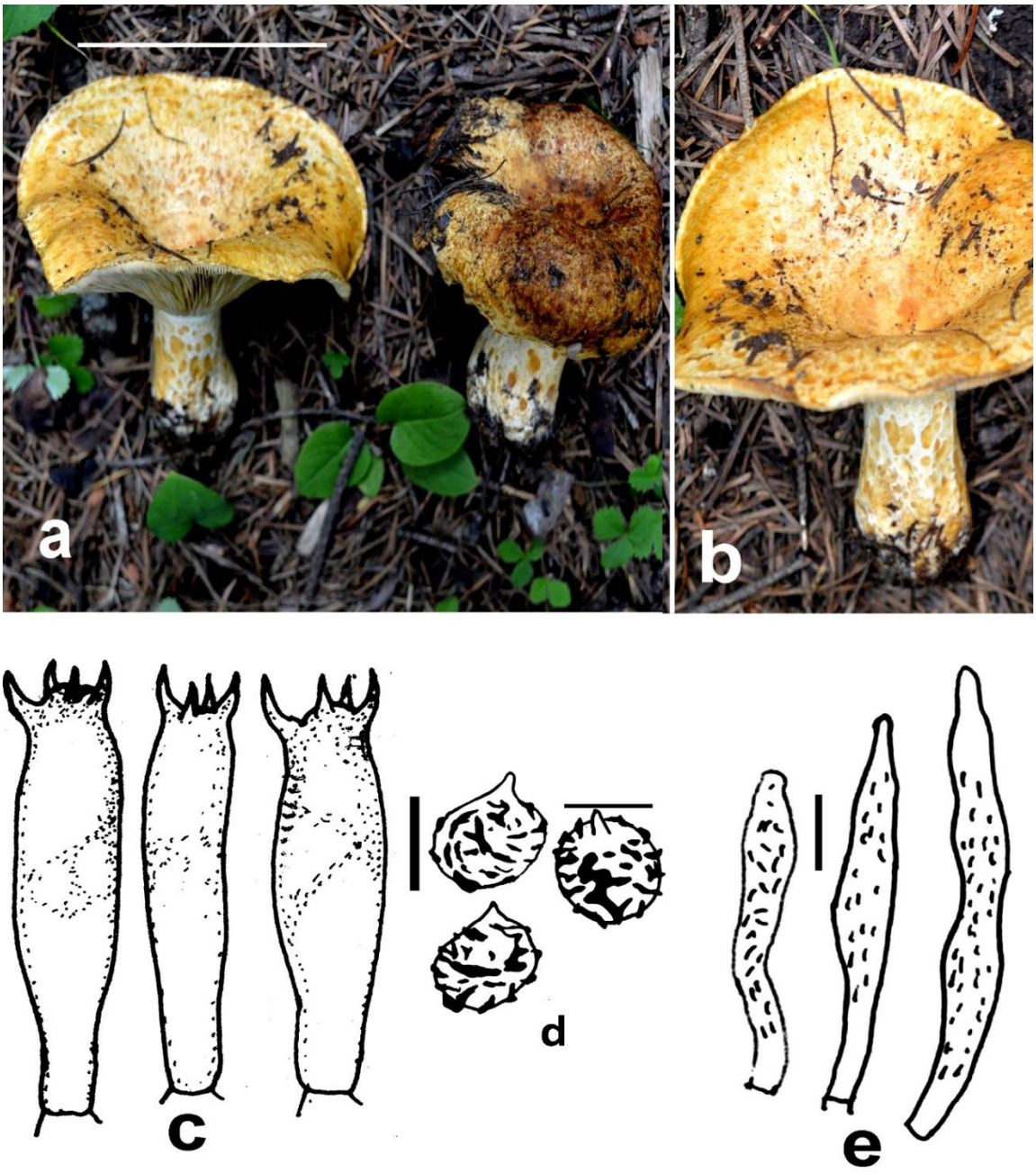

Fig.6(41) ***Lactarius scrobiculatus***

a-b. Fresh basidiomata in the forest; **c.** Basidia; **d.** Basidiospores; **e.** Cystidia; ; Scale bars: **a-b** = 50 mm; **c-e** =10 μm.

42. *Lactarius zonarius* (Bull.) Fr., Epicr. syst. mycol. (Upsaliae): 336 (1838) .Figure6(42).

Collection examined: India, Jammu and Kashmir, District Kishtwar , Chingam, Ikhala. . Solitary to scattered, ectomycorrhizal growing in association with *Abies pindrow*. Faisal Mushtaq & Ashish Vyas . Collection number FM22-103, Accession number HBJU/M/44, Oct.-Dec., 2022.

Basidiomata 38-85 mm ; **Pileus** 38-76 cm wide, smooth, infundibuliform with depression, light yellow (1A4) , light brownish (6D5) distinct zones on the surface with incurved margins ; **Lamellae** sub-decurrent, yellowish white (4A2), crowded, edges concolorous , entire with presence of lamellulae of various lengths ,presence of forkation near the stipe ; **Stipe** 2.2-5.8× 0.5-1.5 cm, creamish yellow , central, dry , cylindrical ; **Context** off white, hollow; **Latex** off white; **Basidia** 40.0-55.0 × 10.0-15.0 µm ,hyaline, mostly clavate, thin-walled, smooth ; **Sterigmata** 1.4-2.6 µm in length; **Basidiospores** 7.8-11.2× 6.3-7.2 µm(a_v L = 9.5µm, a_v W = 6.75 µm, Q =1.40), ellipsoidal to subglobose with amyloid ornamentations in the form of ridges and warts ; **Pleurocystidia** 38.0-75.0 × 5.8-7.8 µm, hyaline, moniliform , thin-walled , smooth ; **Pileipellis** upto 65.0 µm thick, composed of hyphae 2.0-4.8µm wide, smooth, thin walled and hyaline .

Edibility: not consumed in the study area.

Remarks: new regional record.

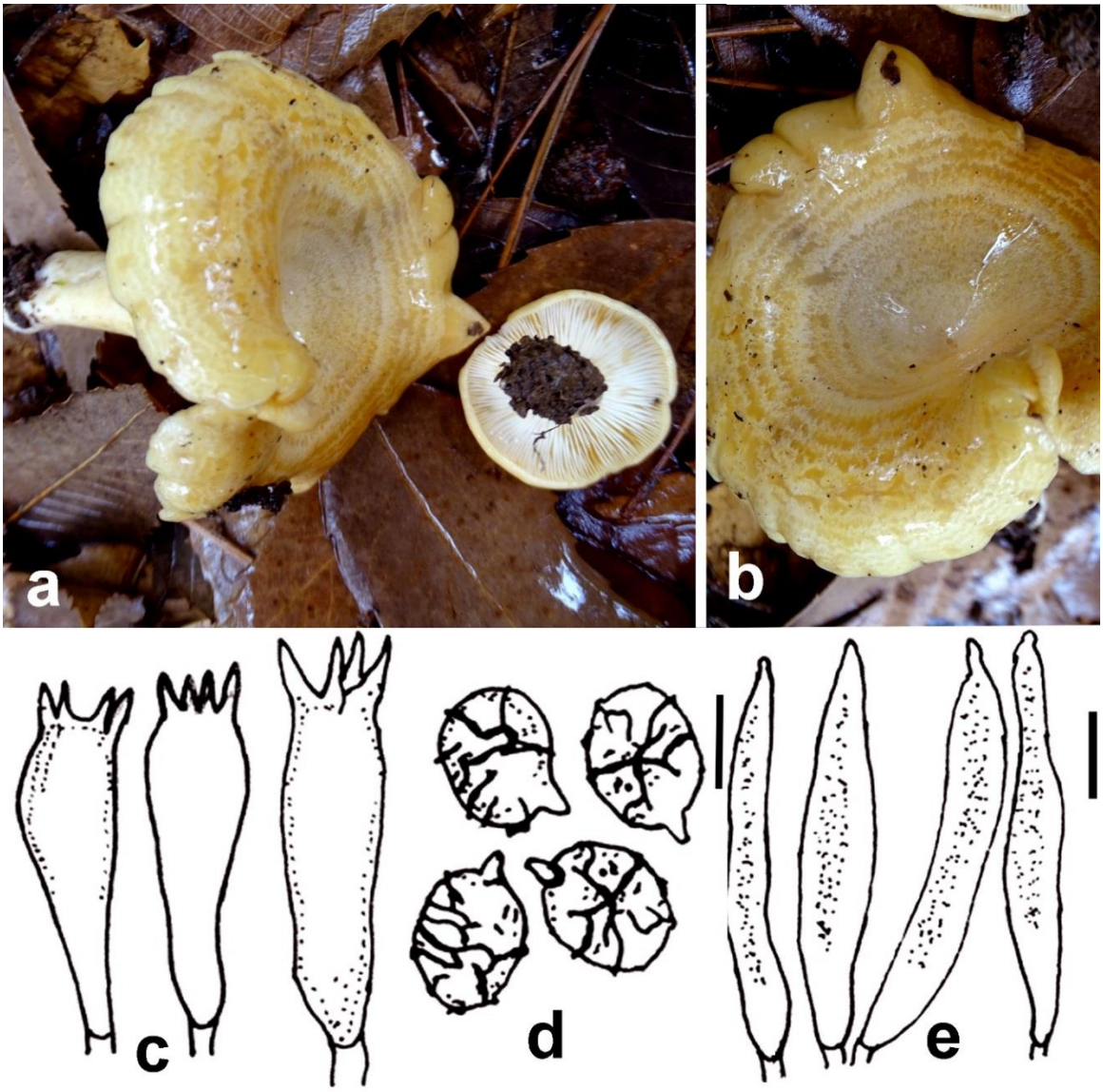

Fig.6(42) ***Lactarius zonarius***

a-b. Fresh basidiomata in the forest; **c.** Basidia; **d.** Basidiospores; **e.** Cystidia; Scale bars: **a-b** = 50 mm; **c-e** =10 μm.

43. *Lactarius abieticola* X.H. Wang 2016 Figure 6(43)

Specimen examined: India, Jammu and Kashmir, District Kishtwar , Chatroo . Scattered, ectomycorrhizal growing in association with *Abies pindrow***.** Faisal Mushtaq & Ashish Vyas. Collection number FM22-104, Accession number HBJU/M/45 , Oct.-Dec., 2022.

Basidiomata 65-88 mm long, **Pileus** 48-60 mm diam., light orange (5A5) with greenish tinge at maturity, zonate, planoconvex , depressed in the centre when young and at maturity turned infundibuliform with involuted margins; surface smooth, sticky, moist . **Lamellae** 1.3-3.5 mm broad, dark orange (5A8), smooth, decurrent, rather crowded with presence of lamellulae upto two third length . **Stipe** 55-70 × 8-14 mm, dark orange (5A8) , cylindrical , broader at the base and narrow at apex . **Context** thick at pileus, light orange (5A4), initially solid in stipe , becomes hollow at maturity. Latex scanty, orange colour. Odour pleasant. **Basidiospores** 7.2-9.0 × 5.8-7.5 µm (a_v L = 8.1µm, a_v W = 6.65 µm, Q =1.21), subglobose to broadely ellipsoidal, ornamented, amyloid, composed of irregular ridges and warts forming network like structure; **Basidia** 35-58 × 11.8- 16.5 µm, clavate, clear , thin-walled, 3-4 spored; sterigmata 4-9.5 × 0.3-1.2 µm. **Pleuromacrocystidia** abundant, 34-68 × 4.0-7.4 µm, emergent up to 30 µm, sublanceolate, dense, granular content with acuminate to sub obtuse apex; **Cheilomacrocystidia** scarce,22-54.5 × 3.8-6.8 µm, emergent up to 28 µm, dense, cylindrical with granular content.absence of clamp connections in all tissues.

Distribution: Earlier described from China and recently reported from Sikkim & Arunachal Pradesh, and is now know from Jammu and Kashmir, India.

Edibility: consumed in the study area.

Remarks; new regional record.

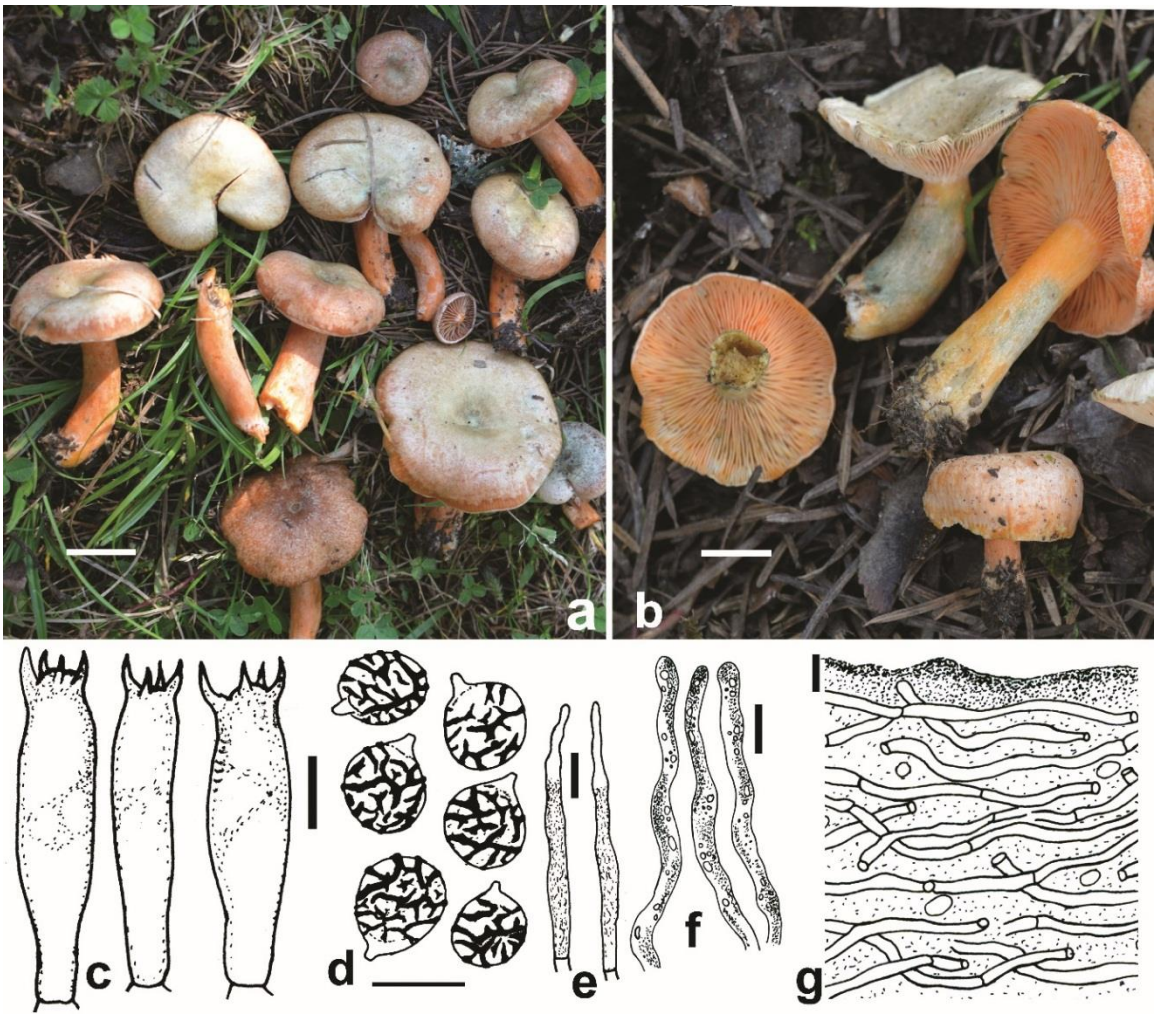

Fig. 6(43) ***Lactarius abieticola.***

a- b. Fresh Basidiomata in the field. c. Basidia; d. Basidiospores; e. Pleuromacrocystidia; f. Pseudocystidia; g. i. T.S of Pileipellis; Scale bar a-b= 2cm, c-g 10μm;

44. *Lactifluus volemus* (Fr.) Fr., Epicr. Syst. Mycol. (Upsaliae): 344 (1838).Figure 6(44).

Collection examined: India, Jammu and Kashmir, District Kishtwar , Chingam , Ikhala, Sarthal. Solitary, ectomycorrhizal growing in association with *Quercus sp.* Faisal Mushtaq & Ashish Vyas . Collection number FM22-107, Accession number HBJU/M/46 ,Oct.-Dec., 2022.

Pileus up to 6cm in diameter, ochraceous orange (XVb 15) , convex when young then flat with depression at the centre, smooth with white flesh . **Lamellae** free, creamish white (1A1) , regular . **Stipe** upto 5.0 cm long, cylindrical, concorolous with gills, solid, central. **Odour and Taste:** mild. **Latex** milky white, not changing after exposure. **Basidiospores** 5.5–10.2 × 5.8–8.4 µm (a_v L = 7.85µm, a_v W = 7.1 µm, Q =1.10), subglobose to ellipsoidal, amyloid, rough. **Basidia** clavate, 28.5–47.5 × 7.2–10.8 µm, sterigmata ranges up to 7.8 µm in length; **Cheilocystidia** 46.5–65 × 7.5 - 11.4 µm ; **Pleurocystidia** 35–65 × 12.5–11.5 µm; **Pileocystidia:** 19.5–65.5 × 5.8–10.5 µm; **Pileus hyphae** 3.8–5 µm in width , branched with septae.

Distribution: Reported from India (Garbha, 1980).

Edibility: not consumed in the study area. However, edible in other regions (Christensen, 1955; Krieger, 1967; Phillips, 1981).

Remarks: A new record from the study area.

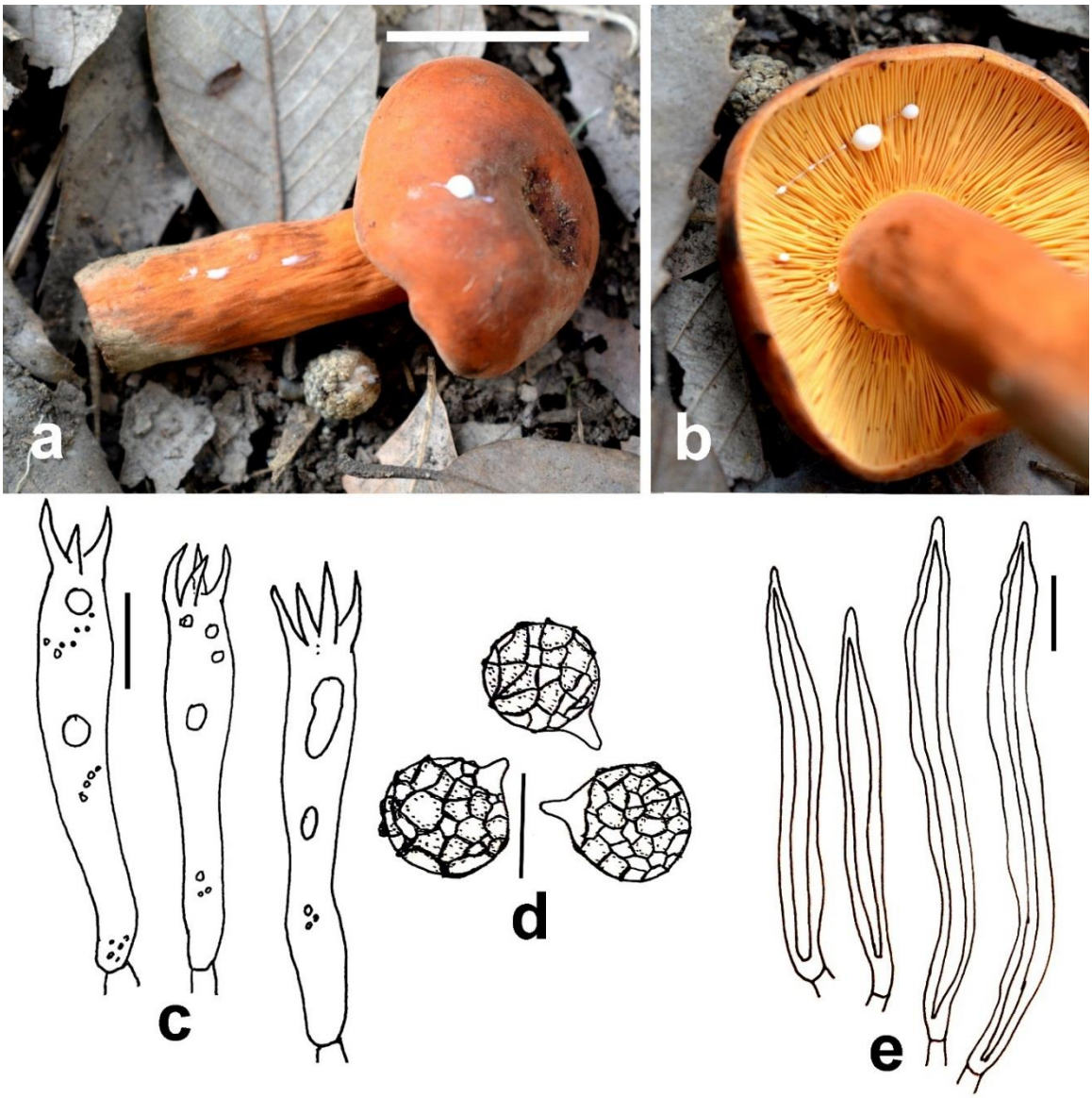

Fig.6 (44) ***Lactifluus volemus***

a-b. Fresh basidiomata in the forest; **c.** Basidia; **d.** Basidiospores; **e.** Cystidia; ; Scale bars: **a-b** = 50 mm; **c-e** =10 μm.

45. *Russula pseudoamoenicolor* A. Ghosh, Buyck, K. Das, A. Baghela & R. P. Bhatt, ***Fungal Diversity*** 80: 252 (2016).Figure 6(45)

Specimen examined: India, Jammu and Kashmir, District Kishtwar , Chingam . Solitary to scattered, occurring in close proximity with the species of *Quercus* and *Cedrus deodara* in temperate forests . Faisal Mushtaq & Ashish Vyas . Collection number FM22-108, Accession number HBJU/M/47 , Oct.-Dec., 2022.

Fruiting Body small **,** medium to large sized. **Pileus** 48–80 mm broad, velvety,purple (14F6), pastel violet (16A5), dark violet (15A6) towards the centre, convex when young becomes plano-convex at maturity , depression in centre along with incurved margin in youing condition and decurved at maturity; surface dry. **Lamellae** 3–5.5 mm wide, adnexed ,crowded , creamish white to yellowish white (1A2), forkation near the stipe, marginate edges with absence of lamellulae ; **Stipe** 45–60 × 12–18 mm, pink to pink-red (12A3–5), equal, cylindrical, central, sometimes tapered towards the base, brittle, dry, smooth. **Context** 4–7mm wide at mid pileus, off white , stuffed in stipe, unchanging when bruised. **Taste** mild. **Basidiospores** 6.0–**8.6** × 5.5–**7.5** µm (a_v L = 7.3µm, a_v W = 6.50 µm, Q =1.12), broadly ellipsoidal to subglobose, amyloid , ornamentation in the form of ridges and isolated warts , presence of apiculus . **Basidia** 28–50× 7–10 µm, cylindrical, sub-clavate , 4-spored; sterigmata 6.2 µm in length . **Pleurocystidia** 75–95 × 9–15 µm, subfusoid with circular apex, thick-walled. **Cheilocystidia** 42–75 × 7–12 µm, similar to pleurocystidia.

Distribution: Recently reported from Uttarakhand (Hyde *et al*., 2016).

Edibility: not consumed in the study area.

Remarks: new regional record

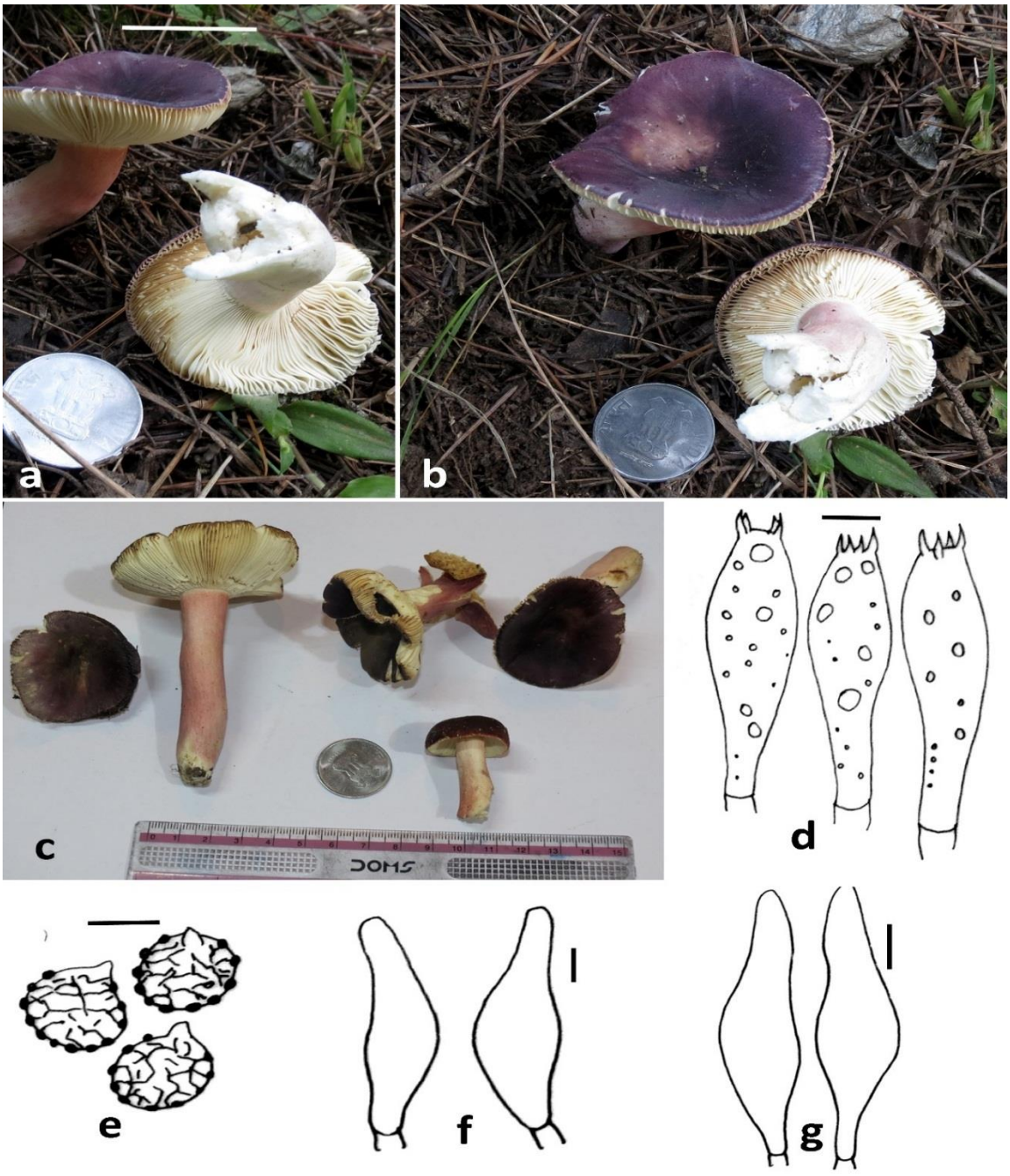

Fig.6 (45) ***Russula pseudoameonicolor***

a-c. Fresh basidiomata in the forest; **d.** Basidia; **e.** basidiospores; **f.** Cheilocystidia; **g.** Pleurocystidia; Scale bars: **a-c**= 50 mm; **d-g**=10 μm.

46. Russula lakhanpalii A. Ghosh, K. Das & R.P. Bhatt Nova Hedwigia 2020, 111 (2): 115-130. Figure 6(46).

Specimen examined: India, Jammu and Kashmir, District Kishtwar , Chatroo, Chingam . Solitary to scattered, found in close association with the species of *Quercus sp*. Faisal Mushtaq & Ashish Vyas . Collection number FM22-109, Accession number HBJU/M/46, Oct.-Dec., 2022.

Fruiting Body medium sized, **Pileus** 30-85 mm in diam., light yellow to greyish yellow (4B4-5) ; convex to planoconvex with depression in the centre, margin decurved ; shiny surface, viscid when moist and dull when dry , smooth . **Pileus context** 12-20 mm thick, off white (1A1), compact, brittle. **Lamellae** 3-5 mm broad, white, adnexed , unequal, forked irregularly , flexible and smooth, edges entire, concolorous with presence of Lamellulae . **Stipe** 40-65× 12-18 mm, cylindrical , smooth, narrow at base, central, solid, firm, creamish white with light yellow flush present up to middle, **Stipe context** solid, off white , no change after exposure or bruising ; become reddish brownish after treatment with guaiacol. **Basidiospores** 7.2-9.0 × 5.8-7.2 µm (a_vL = 8.1µm, a_vW = 6.50 µm, Q =1.24), broadly ellipsoidal to subglobose, amyloid, ornamentations present ,consisting of warts and ridges forming incomplete reticulation, apiculus present .**Basidia** 28.0-35.5 × 6-11.5 µm, 4-spored, clavate; sterigmata up to 4-7 µm long. **Pleurocystidia** 45-65× 9-11.5 µm subclavate to fusiform with capitate apex, filled with dense, crystalline content. **Cheilocystidia** 35- 45.5 × 6.0-8.5 µm, subclavate with capitate apex, partly filled with dense, heteromorphous material. **Hymenophoral trama** consist of sphaerocytes and hyphal elements. Clamp connections absent from all tissues.

Distribution: Previously reported from Uttarakhand, and now reported from Jammu & Kashmir, India.

Edibility: not consumed in the study area.

Remarks: new regional record .

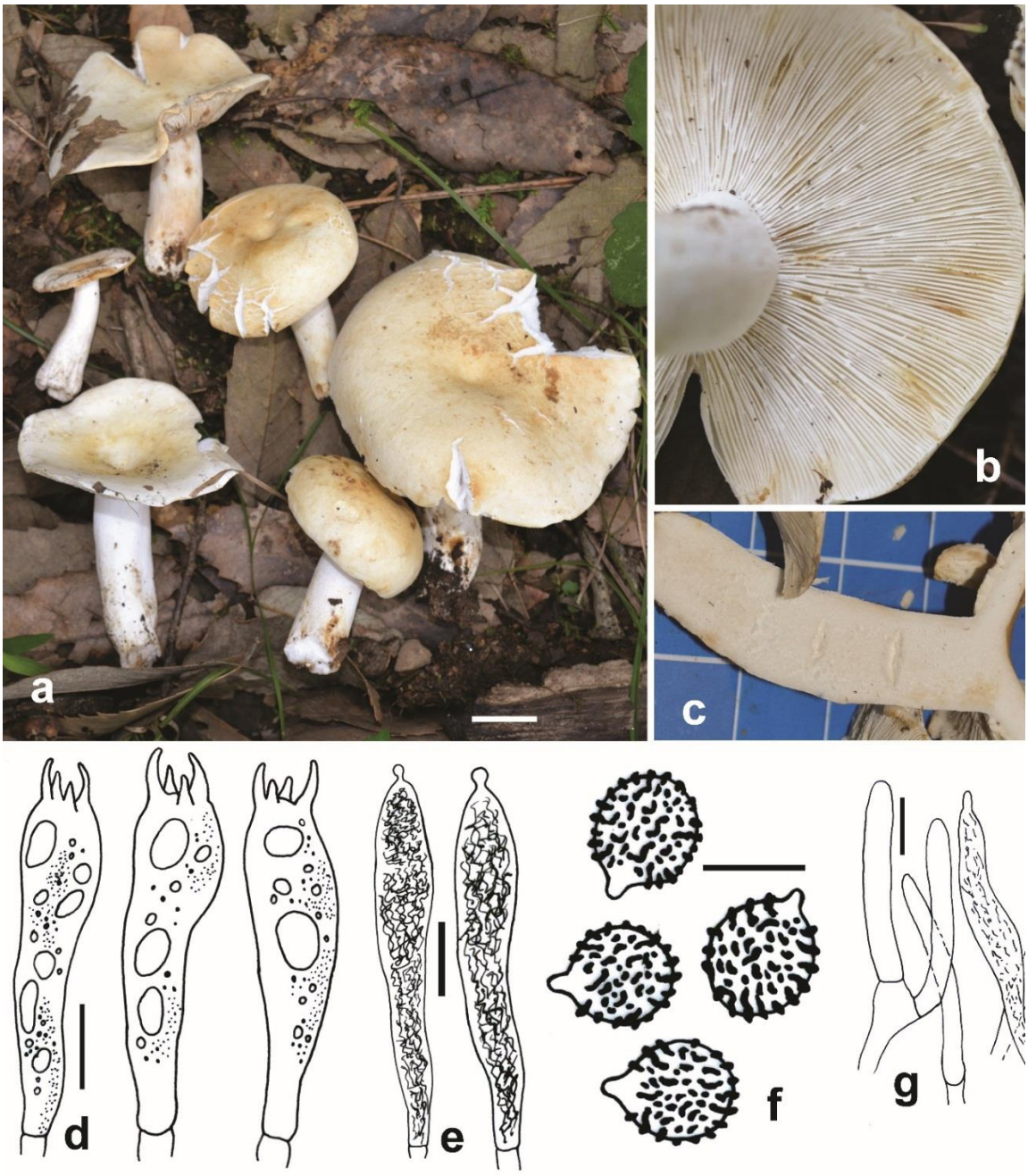

Fig.6(46) ***Russula lakhanpalii***

a-c. Fresh basidiomata in the forest; d**.** Basidia; **e.** Pleurocystidia; **f.** Basidiospores Scale bars: **a-c**= 50 mm; **d-f**=10 μm.

47. *Russula densifolia* Secr. ex Gillet, *Hyménomycètes* (Alençon): 231 (1876) [1878]. Figure 6(47).

Specimen examined: India, Jammu and Kashmir, District Kishtwar , Mugalmaidan, Chatroo, Sarthal. Solitary to scattered, gregarious, occurring in association with the species of *Pinus wallichiana* and *Cedrus deodara* . Faisal Mushtaq & Ashish Vyas . Collection number FM22-111, Accession number HBJU/M/49 , Oct.-Dec., 2022.

Fruiting body 50 – 70 mm sized. **Pileus** 25–70 mm wide, light brown (6E3) to brownish-grey (6D2) , dark brown (6F5) in the centre, light brown towards margin ,convex when young then turning planoconvex at maturity, slight depression at centre. **Lamellae** 3.0 – 6.5mm broad, creamish white to greyish yellow (3C4), adnate, crowded. **Stipe** 25–40× 6–15 mm, brownish white to dull white, dry, smooth, equal, cylindrical, solid ,after bruised or injured turn to red and then black. **Context** 4–7 mm thick at mid pileus, off white, solid at stipe, brittle , turns reddish and then black when bruised or injured , changes to reddish brown (8D7) with guaiacol. **Basidiospores** 6.0–7.8 × 5.5–6.6 µm (a_vL = 6.9µm, a_vW = 6.05 µm, Q =1.14), ellipsoidal to subglobose, amyloid , ornamentation of isolated ridges and warts forming a partial network like structure; apiculus present . **Basidia** 28–42 × 5–8 µm, subclavate ; 3-4 spored, sterigmata about 4.5-7 µm long. **Pleurocystidia** fusiform to sub-cylindrical with rounded apex with granular and dense content, thick walled. **Cheilocystidia** fusiform to sub- cylindrical with rounded apex with granular and dense content, thick walled.

Distribution: Previously reported from Jammu & Kashmir (Abraham *et al*., 1981; Atri *et al*., 1994) and from Uttarakhand (Das and Sharma 2005).

Edibility: Not edible in the study area.

Remarks: A new report from the study area.

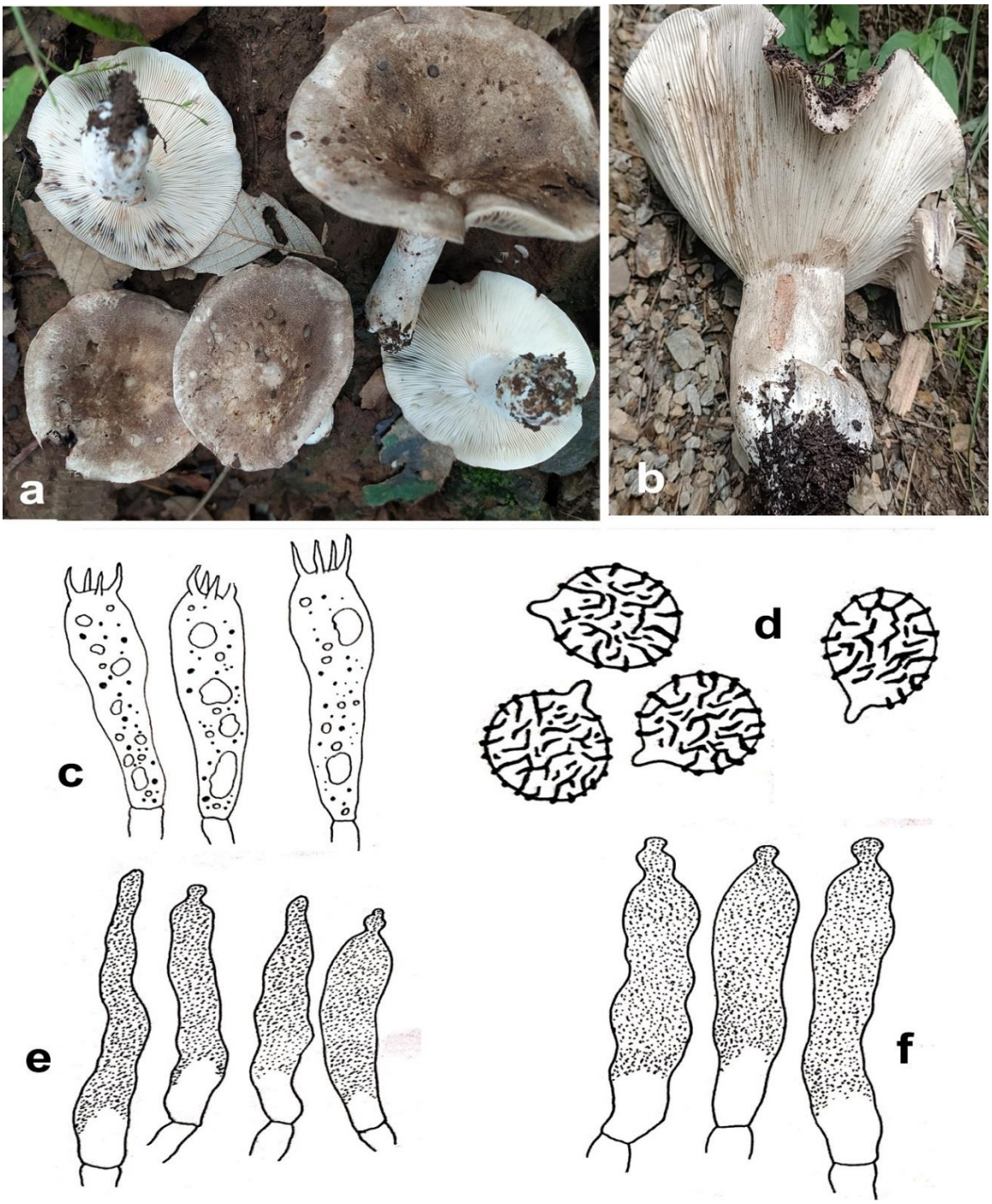

Fig.6(47) ***Russula densifolia***

a-b. Fresh basidiomata in the forest; **c.** Basidia; **d.** basidiospores; **e.** Cheilocyatidia; **f.** Pleurocystidia; Scale bars: **a-b**= 50 mm; **c-f**=10 μm.

6.2 Dominant orders and families

Out of the total macrofungal species belonging to different families and orders from the study , it has been found that order Agaricales of Basidiomycota is the most predominant as it constituted most of the families (8 Families) with family Amanitaceae (8 species) and Agaricaceae (7 species) most prevalent. Order Agaricales was followed by order Russulales in which family Russulaceae was represented by 9 species and Family Hericiaceae by 1 species. Russulales was followed by Order Pezizales comprising of four families namely Helvellaceae (2 species), Morchellaceae (1 species) ,Pyronemataceae (1 species) and Discinaceae (1 species).

6.3 New taxa proposed

In the current study , one macrofungal species with unique and distinctive morphological and microscopic characters has been proposed as new to scientific community.

Table 6(B) : Macrofungal Taxa new to Science.

S.No.	Name of species	Place of Collection	Family
1	*Amanita sp.*	Chingam	Amanitaceae

6.4 New taxa recorded from the study area

Out of total 71 collections, 47 species were identified and described out of which 25 identified species were reported first time from the study area [Table 6(C)

Table 6(C) : Macrofungal Taxa new to study area.

S.No.	Name of Species	Location	Family
1.	*Geopora arenicola*	Chatroo, Nagseni, Ikhala	Pyronemataceae
2.	*Gyromitra esculenta*	Chatroo, Chingam, Nagseni,	Discinaceae
3.	*Apioperdon pyriforme*	Kishtwar,Bindraban,Mugalmaidan Chatroo,Chingam,Sarthal,Sinthan Top.	Agaricaceae
4.	*Macrolepiota procera*	Chingam	Agaricacea
5.	*Lepiota cristata*	Nagseni, Sarthal.	Agaricaceae
6.	*Bovista plumbra*	Mugalmaidan, Nagseni, Ikhala, Sarthal.	Agaricaceae
7.	*Coprinus comatus*	Bindraban ,Sarthal	Agaricacea
8.	*Pholiota squarrosa*	Chingam	Strophariaceae
9.	*Amanita flavipes*	Bindraban , Chatroo , Nagseni,, Sarthal.	Amanitaceae
10.	*Amanita pakistanica*	Chingam,, Nagseni.	Amanitaceae
11.	*Amanita orientigemmata*	Chatroo, Chingam, Ikhala	Amanitaceae
12.	*Flammulina velutipes*	Bindraban,, Mugalmaidan , Sarthal.	Physalacriaceae
13.	*Pleurotus ostreatus*	Mugalmaidan, Ikhala.	Pleurotaceae
14.	*Pluteus cervinus*	Chatroo , Nagseni , Sarthal.	Pluteaceae
15.	*Panaeolus papilionaceus*	Kishtwar, Mugalmaidan , Chatroo, Nagseni , Sarthal.	Psathyrellaceae
16.	*Schizophyllum commune*	Kishtwar	Schizophyllaceae
17.	*Laetiporus sulphureus*	Sinthan Top	Fomitopsidaceae
18.	*Boletus edulis*	Chatroo , Chingam , Nagseni	Boletaceae
19.	*Suillus americanus*	Chatroo , Nagseni , Sarthal	Suillaceae
20.	*Geastrum saccatum*	Chatroo , Chingam , Sarthal	Geastraceae
21.	*Ramaria formosa*	Chingam,Ikhala	Gomphaceae
22.	*Lepista sordida*	Bindraban , Ikhala	Tricholomataceae
23.	*Hericium yumthangense*	Chingam	Hericiaceae
24.	*Lactifluus volemus*	Chingam,Ikhala,Sarthal	Russulacea.
25.	*Lactarius scrobiculatus*	Nagseni,Ikhala,Sarthal	Russulaceae

6.5 New taxa recorded from the Jammu and Kashmir

10 taxa belonging to 4 genera distributed over 2 families were new additions to the macrofungal flora of Jammu and Kashmir (Table and Figure). These include *Lactarius laeticolor, Lactarius sanguifluus, Lactarius scrobiculatus, Lactarius zonarius , Lactifluus volemus, Russula pseudoamoinicolor , Russula densifolia, Amanita orsonii, Amanita griseofusca, Amanita subglobosa* .

Table 6(D) : Macrofungal Taxa new to Jammu and Kashmir.

S.No.	Name of species	Place of Collection	Family
1.	*Lactarius laeticolor*	Chatroo, Chingam	Russulaceae
2.	*Lactarius sanguifluus*	Mugalmaidan, Nagseni ,Sarthal	Russulaceae
3.	*Lactarius zonarius*	Chingam,Ikhala	Russulaceae
4.	*Lactifluus volemus*	Chingam,IKhala,Sarthal	Russulaceae
5.	*Lactarius abieticola*	Chatroo	Russulaceae
6.	*Russula pseudoamoinicolor*	Chingam	Russulaceae
7.	*Russula densifolia*	Mugalmaidan,Chatroo,Sarthal	Russulaceae
8.	*Russula lakhanpalli*	Chatroo,Chingam	Russulaceae
9.	*Amanita orsonii*	Chingam	Amanitaceae
10.	*Amanita griseofusca*	Chingam	Amanitaceae
11.	*Amanita subglobosa*	Chatroo	Amanitaceae

6.6 New taxa recorded from India

Two taxa belonging to different families were reported for the first time from India. These are *Amanita griseopantherina and Veloporphyrellus latisporus.*

Table 6(E) : Macrofungal species new to India.

S.No.	Name of species	Place of Collection	Family
1	*Amanita griseopantherina*	Chatroo	Amanitaceae
2.	*Veloporphyrellus latisporus*	Bindraban	Boletaceae

Table 6(F): Molecular gene bank accession number of some macrofungal species.

S.No.	Name of Species	Family	Gene Bank Acession No.nrLSU	Gene Bank Acession no.nrITS
1	*Amanita orsoni*	Amanitaceae	OQ318213	
2	*Amanita subglobosa*	Amanitaceae	OQ318209	
3	*Amanita griseopantherina*	Amanitaceae	ON838224	
4.	*Veloporphyrellus latisporus*	Boletacea		OP910047
5.	*Amanita sp.*	Amanitaceae	MF351883	

6.7 Distributional Pattern

After thorough survey, the occurrence and distributional pattern of various wild mushrooms from various collection sites like Kishtwar city, Bindraban, Mugalmaidan, Chatroo, Chingam, Sinthan top, Nagseni, Ikhala and sarthal of district kishtwar are presented in the Table below. By comparative analyses, the large variation in the number of wild mushroom species with respect to the location of collection revealed their unequal and random distribution throughout the study area. Numerous macrofungal species, including Puff balls, Boletes, Earth stars, Chanteralles, Agarics etc. were discovered to flourish in a variety of conditions. Their sporocarps have irregular habits, appearing as solitary, gregarious, clustered, or caespitose fruiting bodies. Additionally, while few

mushrooms were found restricted in their occurrence to a specific study site, the emergence of a several mushroom species overlapped with other sites.

Of the various study sites, Chingaam was found to be the most important mycological zone of all the collection sites, with up to 25 species followed by Chatroo (21 species), Sarthal (18), Bindraban (8), Ikhala, Dachan (12), Mugalmaidan (10), Nagseni (16) and Kishtwar city (4). Sinthan Top shows the minimum occurrence of wild mushrooms with only two (2) species. The macrofungal species exclusively reported from Chingam includes *Macrolepiota procera, Amanita orsonii, A.griseofusca, A. garhwalensis, Pholiota squarrosa, Hericium yumthangense, Russula pseudoamoinicolor*. Mushroom species reported from chatroo in the current study include *Amanita subglobosa, A griseopantherina, Auricularia auricula-judae, Lactarius abeiticola, Pluteus cervinus. Schizophyllum commune* has been reported to be restricted to Kishtwar city only. The macrofungal species restricted to Bindraban include *Veloporphyrellus latisporus and Lepista sordida. Laetiporus sulphurius* has been exclusively found in sinthan top.

There are number of mushroom species which have been reported from multiple study sites. *Apioperdon pyriformi* was the most commonly found wild mushroom and was witnessed in Kishtwar city, Bindraban, ,Chatroo, Chingam, Sarthal and Sinthan top. *Agaricus campestris* was witnessed in Kishtwar city, Bindraban, Mugalmaidan, Chingam, Nagseni and Ikhala. *Coprinellus micaceus* was collected from Kishtwar city, Mugalmaidan,Chatroo,Ikhala and sarthal. *Bovista plumbra* reported from Mugalmaidan, Nagseni, Ikhala, Sarthal and *Amanita flavipes* from Bindraban, Chatroo, Nagseni and Sarthal. *Boletus edulis* from Chatroo, Chingam, Nagseni and Sinthan top. *Cantharellus cibarius* from Bindraban,Mugalmaidan,Chatroo and Chingam.

The species having narrow pattern of appearance and didn't show any specific distributional pattern include *Macrolepiota procera, Amanita orsoni,A griseofusca, A subglobosa,A. griseopantherina, Pholiota squarrosa, Laetiporus sulphurius, Auricularia auricula judae, Veloporphyrellus latisporus, Heirrecium, Schizophyllum commune, Lactarius abieticola, Russula pseudoamoenicolor Lepiota cristata, Lycoperdon, Coprenellis comatus,A pakistanica, Pleurotus ostreatus, Ramaria formossa, Lepista sordida, Lactarius zonarius* and *A lakhanpalii.*

As for as macrofungi collected from various collection sites of district Kishtwar, it has been found that *Agaricus campestris, Morchella esculenta, Cantharellus cibarius, Ramaria formosa, Suillus americanus, Amanita flavipes, A. orsoni, A. orientigemmata, A. griseopantherina, Sparassis crispa, Veloporphyrellus latiporus, Geastrun sachatum* showed their presence in dense coniferous forest dominated by *Pinus wallichiana and Cedrus deodara. Laetiporus sulphurius* was found growing on the trunk of *Betula utilis, Geopara Arenicola* was mostly restricted in *Cedrus deodara* forests in Ikhala and chatroom*, Helvella crispa, Apioperdon pyriformi, Auricularia auricula judae. Boletus udilis were* found in the vicinity of *Betula utilis* in sinthan top. *Flamullina velutipes* was found in growing on the dead wood of Cedrus deodara. *Schizophyllum commune* was mostly restricted on *Quercus. Apioperdon pyriformii* was also found in some forest patches and in open fields of Kishtwar, Bindraban, Mugalmaidan, Chatroo, Chingam, Sarthal and Sinthan top.

The main causes of variations in wild macrofungal richness include environmental conditions like humidity, temperature, vegetation, substrate type, precipitation, and soil organic composition. In the current investigation, the trend of increasing macrofungal diversity has observed up to an altitude of 3000 masl mostly in Sarthal, Chatroo and Chingam as is clear from the results, The greater coverage of deciduous trees like *Juglans regia, Alnus nitida, Quercus sp*. and coniferous vegetation like *Cedrus deodara, Abies pindrow, Picea simithiana, and Pinus wallichiana* are responsible for the luxuriant growth and abundance of mushrooms in these study sites. It has been found that the different microhabitats offered by mixed and mature forest support number of ectomycorrhizal fungi (Li *et al*., 2021b). Decaying organic matter, moisture rich environment, rich organic soil, and high humidity are all provided by the dense tree canopy of these trees. These findings support the past research of several workers, who reported that coniferous and broad-leaved woods were the most favourable habitats for different macrofungi (Kumar, 2009; Kour, 2013). The moist soil conditions encourage the growth of the macrofungal mycelium below the surface of soil. Humus rich soil layers encourage the luxuriant mushroom growth development of fruiting bodies. Increased tree canopy, soil moisture, and soil pH all significantly correlated with increased macrofungal richness (Bhandari). The distributional pattern of the wild macrofungi in the current study was consistent with past findings that

deciduous trees and conifers were the best habitats for the luxuriant growth of mushrooms,thus acting as bio-indicators of forest health (Manoharachary *et al.,* 2005; Oretega-Diaz *et al.,* 2009; Sulzbacher *et al.,* 2013; Bhandari and Jha, 2017; Meena *et al*., 2020).

Altitudinal range, ecological succession, the variety of host tree species, and soil characteristics including soil wetness, soil texture, and organic content all have an impact on the diversity and dispersion of macrofungi (Tsiaras and Domakinis, 2013; Vishwakarma et al., 2017; Meena et al., 2020). One of the factors enabling the high macrofungal diversity in Chingam, Chatroo, Sarthal , Nagseni and Ikhala could be the absence of anthropogenic activity in these places.On the other hand study sites like Kishtwar city, Bindraban and Mugalmaidan observed low macrofungal diversity as a result of the enhanced anthropogenic pressure of overharvesting, ,rapid urbanization, unchecked and uncontrolled animal grazing, overexploitation of forest produce including timber and fuelwood that may resulted in the habitat destruction of various macrofungi, unabated deforestation for various developmental activities including hydroelectric projects, overexploitation of wild edible macrofungi, etc. It has been found that the reproduction process in wild edible mushrooms is highly impaired if they are overharvested even before the dispersal of spores and it also causes reduction in fruiting bodies; as the survival, migration, and dissemination of genetic diversity depend on the spores (Dix and Webster, 1995). The high amount of disturbance in the habitat tends to obstruct fructification, which reduces the quantity of sporocarps (Rudolph et al., 2013). The characteristics of vegetation like species diversity, the structure of the forest canopy, and the biomass of plant species shows a significant change due to disturbance in forests. (Chazdon, 2003; Rydgren et al., 2004; Rousk et al., 2009). Additionally, the productivity and species richness of macrofungi (Wild Mushrooms) are decreased due to the trampling of the forest floor during macrofungal harvesting . According to Egli *et al.* (2006), trampling of the forest floor caused by the harvesting of macrofungi resulted in a reduction of macrofungi by 70%. Additionally, there may be less fallen deadwood and ectomycorrhizal partners, which could result in decreased sporocarp/ fruiting body production in wild macrofungi. Intensive farming practises by locals have a negative impact on the growth and composition of macrofungi (Dulay et al., 2020). As Kishtwar city, Bindraban and Mugalmaidan are lower elevation areas and hence

prone to the risk of uncontrolled animal grazing resulting in the decrease in macrofungal diversity. After an altitudinal range of 3000masl, a negative correlation between the richness of macrofungal species and altitude was found. Sinthan top,altitude 3900 masl ,shows very low mushroom diversity as the area is mostly treeless and hence hostless due to very high altitude and extremely unfavourable weather conditions in most part of the year especially during winters.The freezing of fungal mycelium at low temperature stops the fruiting body formation in macrofungi (Smith,2019). In addition, macrofungal species richness decreases along with increasing elevational gradient (Luo *et al* 2016). *Betula utilis,* scattered in random patches in sinthan, has been found to support *Laetiporus sulphurius* which mostly grows on the wood. *Apioperdon pyriformi* is also found to grow randomly at various sites in sinthan top.

The main ectomycorrhizal macrofungi in our study like *Lactarius laeticolor, L. sanguifuls, Lactarius scrobiculatus, Lactarius zonarius, Lactarius volemus, Russula pseudoamoinicolor, Suillus americanus, Cantharellus cibarius, Sparassis crispa, Amanita flavipes, A. pakistanica, A. orientigemmata, A. griseofusca, Morchella esculenta* have been found to show *significant* host preference for *Cedrus deodara, Pinus wallichiana, Picea smithiana, Abies pindrow,* and deciduous trees like *Quercus sp., Juglans regia, Populus alba,Alnus nitida* in chatroo, Chingam and sarthal.

Many lignicolous mushrooms in the current study shows specific host specificity and grows on the surface of wood of various conifer and deciduous trees. These mushroom species include *Flammulina velutipes(on wood of Cedrus deodara),Pleurotus ostreatus (on Quercus sps.)),Schizophyllum commune (*on *Quercus* sps.*), Ganoderma lucidum(Pinus wallichiana), Laetiporus sulphureus(*on *Betula utilis), Auricularia auricula-judae(*on *Juglans regia), Hericium yumthangense (*on *Abies pindrow).*

Table 6(G): Showing distribution of macrofungal species from different collection sites.

S.No	Species Name	Kishtwar City	Bindraban	Mugalmaidan	Chatroo	Chingam	Nagseni	Ikhala	Sarthal	Sinthan Top
1.	***Helvella crispa* (Scop.) Fr.**	-	-	-	-	+	+	-	+	-
2.	***Helvella elsatica***				+	+	+			
3.	***Morchella esculenta* (L.) Pers.**	-	-	+	-	+	+	-	-	-
4.	***Geopora arenicola* (Lév.) Kers**	-	-	-	+	-	+	+	-	-
5.	***Gyromitra esculenta* (Pers.) Fr.**	-	-	-	+	+	+	-	-	-
6.	***Agaricus campestris* (Bull.) Pers.**	+	+	+	-	+	+	+	-	-
7.	***Apioperdon pyriforme* (Schaeff.) Vizzini**	+	+	+	+	+	-	-	+	+
8.	***Lycoperdon perlatum* Pers.**	-	-	-	+	-	-	-	+	-
9.	***Lepiota crista***	-	-	-	-	-	+	-	+	-
10.	***Macrolepiota procera***	-	-	-	-	+	-	-	-	-
11.	***Bovista plumbra* Pers.**	-	_	+	-	-	+	+	+	-
12.	***Coprinus comatus***	-	-	+.				-		+
13.	***Amanita flavipes* S. Imai**	-	-	+	-	+	-	+	-	+
14.	***Amanita orsonii* Ash. Kumar & T.N. Lakh.**	-	-	-	-	-	+	-	-	-

15.	***Amanita pakistanica* Tulloss, S.H. Iqbal & Khalid**	-	-	-	-	+	+	-	-	-
16.	***Amanita griseofusca***	-	-	-	-	+	-	-	-	-
17.	***Amanita subglobosa***	-	-	-	+	-	-	-	-	-
18.	***Amanita orientigemmata***	-	-	-	+	+	-	+	-	-
19.	***Amanita griseopantherina***	-	-	-	+	-	-	-	-	-
20.	***Amanita garhwalensis***	-	-	-	-	+	-	-	-	-
21.	***Flammulina velutipes* (Curtis) Singer**	-	+	+	-	-	-	-	+	-
22.	***Pleurotus ostreatus* (Jacq. Ex. Fr.) P. Kumm**	-	-	+	-	-	-	+	-	-
23.	***Pluteus cervinus* (Schaeff.) P. Kumm.**	-	-	-	+	-	+	-	+	-
24.	***Coprinellus micaceus* Lange**	+	-	+	+	-	-	+	+	-
25.	*Panaeolus papilionaceus* (Bull.) Quél.		-		+	+	+			
26.	***Schizophyllum commune* Fr.**	+	-	-	-	-	-	-	-	-
27.	***Pholiota squarrosa* (Oeder) Kumm.**	-	-	-	-	+	-	-	-	-
28.	***Sparassis crispa***	-	-	-	-	+	-	+	+	-
29.	***Laetiporus sulphureus***	-	-	-	-	-	-	-	-	+
30.	***Auricularia auricula-judae* (Bull.) Quel**	-	-	-	+	-	-	-	-	-
31.	***Boletus edulis* Bull**	-	-	-	+	+	+	-	-	-

32.	***Veloporphyrellus latisporus.***	-	+	-	-	-	-	-	-	-
33.	***Suillus americanus* (Peck) Snell**	-	-	-	+	-	+	-	+	-
34.	***Cantharellus cibarius* Fr.**	-	+	+	+	+	-	-	-	-
35.	***Geastrum saccatum Fr.***	-	-	-	+	+	-	-	+	-
36.	***Ramaria formosa***	-	-	-	-	+	-	+	-	-
37.	***Lepista sordida***	-	+	-	-	-	-	+	-	-
38.	***Hericium yumthangense* Das, Stalpers & Stielow**	-	-	-	-	+	-	-	-	-
39.	***Lactarius laeticolor***	-	-	-	+	+	-	-	+	-
40.	***Lactarius sanguifuls***	-	-	+	-	-	+	-	+	-
41.	***Lactarius scrobiculatus* (Scop.) Fr.**	-	-	-	-	-	+	+	+	-
42.	***Lactarius zonarius* (Bull.) Fr.**	-	-	-	-	+	-	+	-	-
43.	***Lactarius abieticola***	-	-	-	+	-	-	-	-	-
44.	***Lactarius volemus* (Fr.) Fr.**	-	-	-	-	+	-	+	+	-
45.	***Russula pseudoamoinicolor***	-	-	-	-	+	-	-	-	-
46.	***Russula lakhanpalii***	-	-	-	+	+	-	-	-	-
47.	***Russula densifolia***			+	+	-			+	
	Total	**4**	**8**	**10**	**21**	**25**	**16**	**12**	**18**	**3**

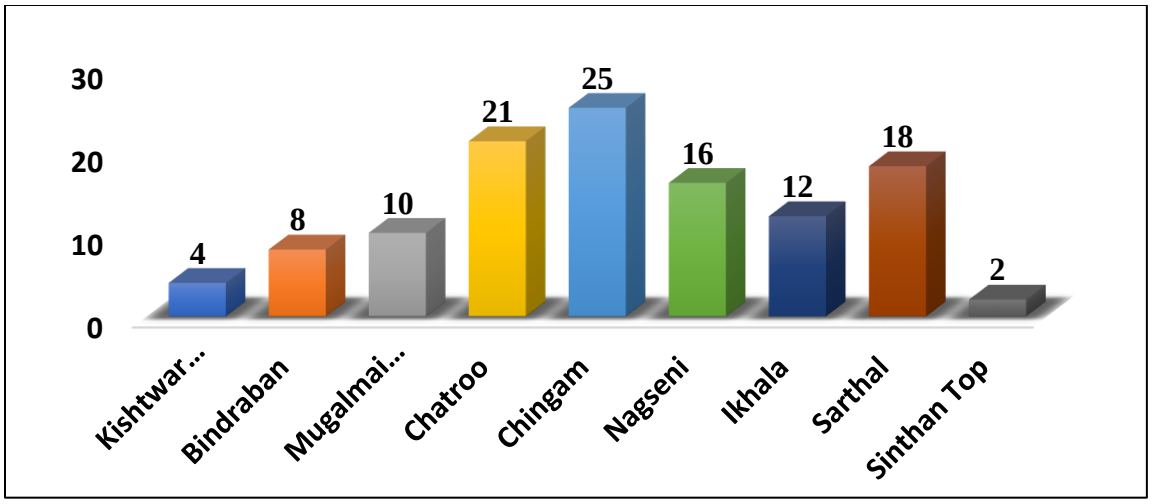

Fig 6 (48): Bar Diagram showing number of Macrofungal species in different collection Sites.

Table 6(H): Showing the number of Genera and Species of Macro-fungi (Wild Mushrooms) of different families collected from various collection sites.

Family	Genera	Species
Discinaceae	1	1
Helvellaceae	1	2
Morchellaceae	1	1
Pyronemataceae	1	1
Agaricaceae	7	7
Physalacriaceae	1	1
Psathyrellaceae	2	2
Strophariaceae	1	1
Shizophyllaceae	1	1
Amanitaceae	1	8
Pleurotaceae	1	1
Pluteaceae	1	1
Sparassidaceae	1	1
Fomitopsidaceae	1	1
Auriculariaceae	1	1
Boletaceae	2	2
Suillaceae	1	1
Cantharellaceae	1	1
Geastraceae	1	1
Gomphaceae	1	1
Tricholomataceae	1	1
Hericiaceae	1	1
Russulaceae	2	**9**

Total Genera 32, Total Species 47

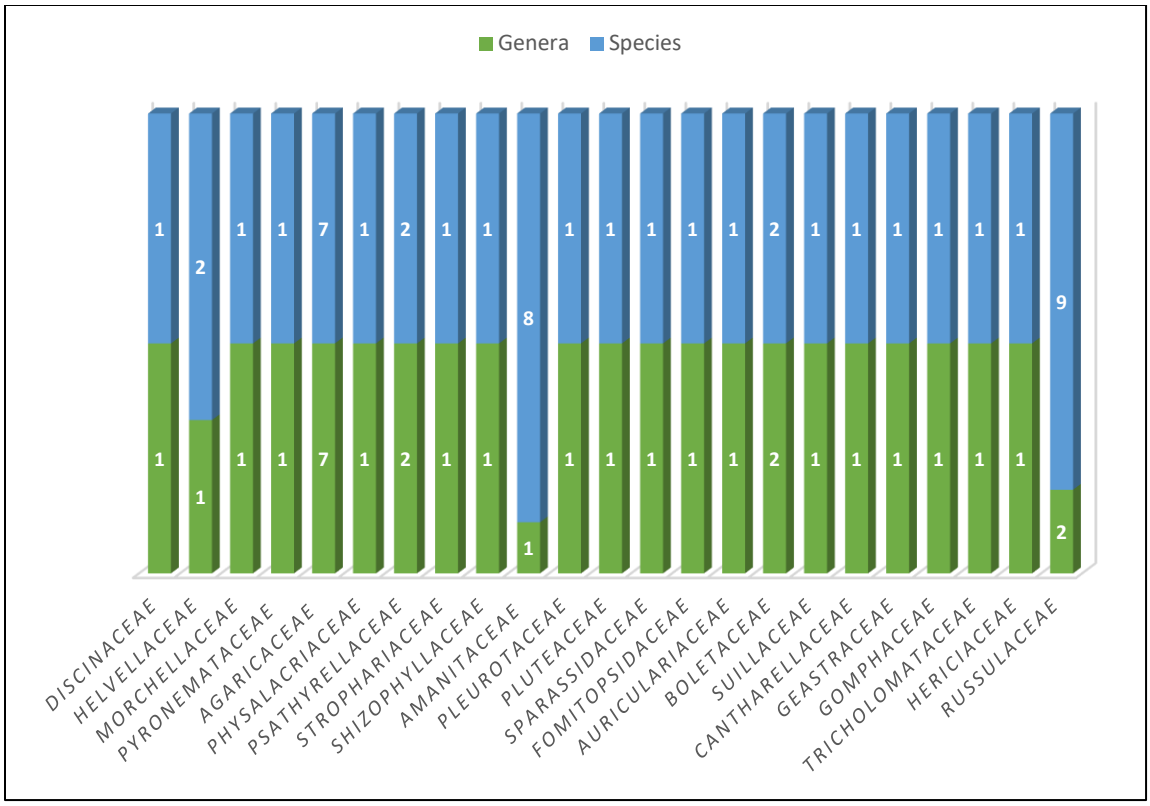

Fig 6 (49): Bar Diagram showing genera and species of wild macro fungi belonging to different families.

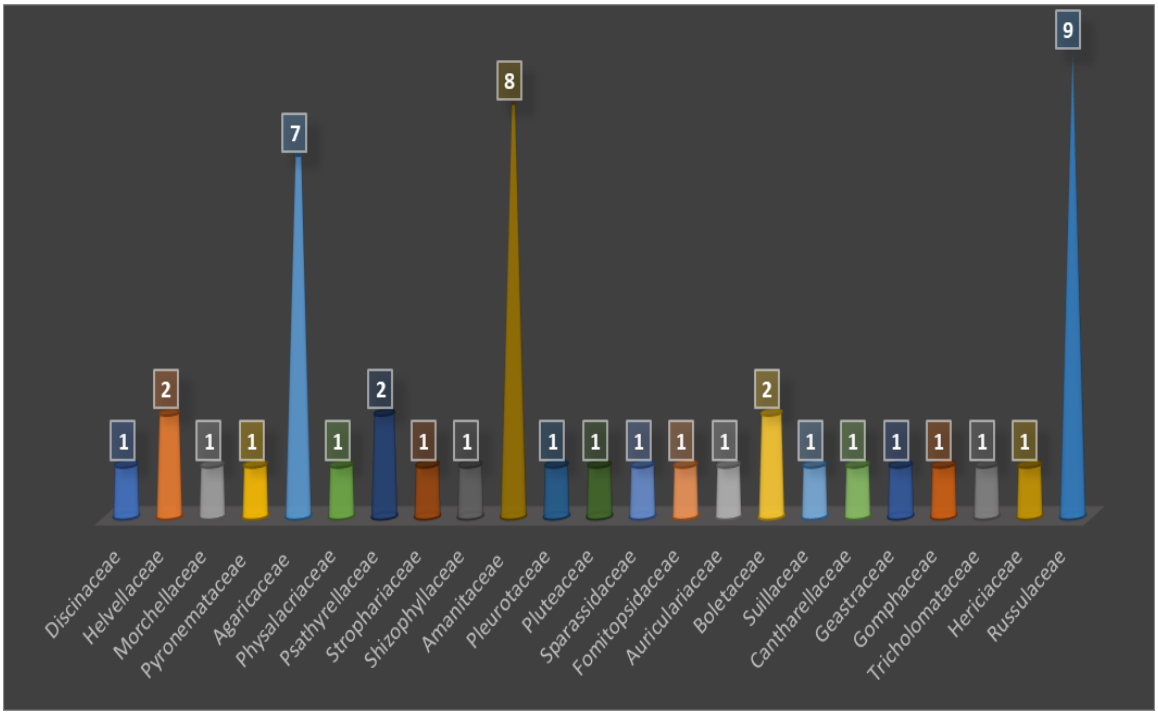

Figure 6 (50): Showing different Families of Macrofungi with number of species.

Table 6 (I) : Showing seasonal occurrence of wild mushroom.

S.No.	Species name	Jan-March (2022,2023	April-June. (2022)	July-Sep (2023)	Oct-Dec. (2021,2022)
1.	*Helvella crispa* (Scop.) Fr.				
2.	*H. elastica*				
3.	*Morchella esculenta* (L.) Pers.				
4.	*Geopora arenicola* (Lév.) Kers				
5.	*Gyromitra esculenta* (Pers.) Fr.				
6.	*Agaricus campestris* (Bull.) Pers.				
7.	*Apioperdon pyriforme* (Schaeff.) Vizzini				
8.	*Lycoperdon perlatum* Pers.				
9.	*Lepiota cristata*				
10.	*Macrolepiota procera*				
11.	*Bovista plumbra* Pers.				
12.	*Coprinus comatus*				
13.	*Amanita flavipes* S. Imai				
14.	*Amanita orsonii* Ash. Kumar & T.N. Lakh.				
15.	*Amanita pakistanica* Tulloss, S.H. Iqbal & Khalid				
16.	*Amanita griseofusca*				
17.	*Amanita subglobosa*				
18.	*Amanita orientigemmata*				
19.	*Amanita griseopantherina*				
20.	*Amanita garhwalensis*				
21.	*Flammulina velutipes* (Curtis) Singer				
22.	*Pleurotus ostreatus* (Jacq. Ex. Fr.) P. Kumm				

23.	*Pluteus cervinus* (Schaeff.) P. Kumm.				
24.	*Coprinellus micaceus* Lange				
25.	*Panaeolus papilionaceus*				
26.	*Schizophyllum commune* Fr.				
27.	*Pholiota squarrosa* (Oeder) Kumm.				
28.	*Sparassis crispa*				
29.	*Laetiporus sulphureus*				
30.	*Auricularia auricula-judae* (Bull.) Quel				
31.	*Boletus edulis* Bull				
32.	*Veloporphyrellus latisporus.*				
33.	*Suillus americanus* (Peck) Snell				
34.	*Cantharellus cibarius* Fr.				
35.	*Geastrum saccatum Fr.*				
36.	*Ramaria Formosa*				
37.	*Lepista sordida*				
38.	*Hericium yumthangense* Das, Stalpers & Stielow				
39.	*Lactarius laeticolor*				
40.	*Lactarius sanguifuls*				
41.	*Lactarius scrobiculatus* (Scop.) Fr.				
42.	*Lactarius zonarius* (Bull.) Fr.				
43.	*Lactarius abieticola*				
44.	*Lactarius volemus* (Fr.) Fr.				
45.	*Russula pseudoamoinicolor*				
46.	*Russula lakhanpalii*				
47.	*R. densifolia*				

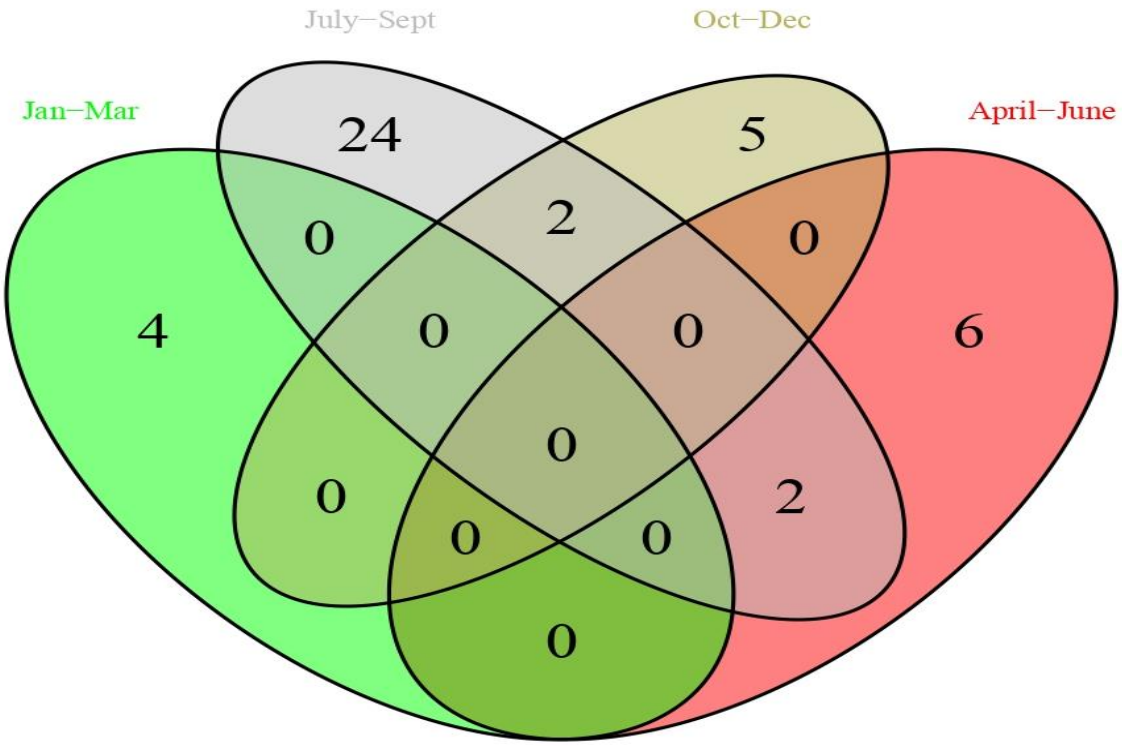

Fig. 6 (51): Venn Diagram Showing Seasonal Occurrence of macrofungi.(Oct to Dec 2021,2022), (Jan to March 2022,2023), (Apri to June 2022),(July to Sep 2022).

Table 6(J): showing different collection sites along with exclusive species.

S.No.	Name of site	Latitude	Longitude	Altitude	No of species	Species exclusive
1.	Kishtwar	33.326905°	75.772954°	1770 m	4	1
2.	Bindraban	33.351873°	75.739332°	1330 m	8	1
3.	Mugalmaidan	33.395780°	75.676582°	1300 m	10	
4.	Chatroo	33.439238°	75.628244°	2420 m	21	5
5.	Chingam	33.549517°	75.558617°	2924 m	25	7
6.	Sinthan top	33.575939	75.503198	3900m	2	1
7.	Ikhala	33.445376°	75.762253°	1780 m	12	
8.	Nagseni	33.340194	75.861745	2161m	16	
9.	Sarthal	33.575939	75.826315	2344m	18	

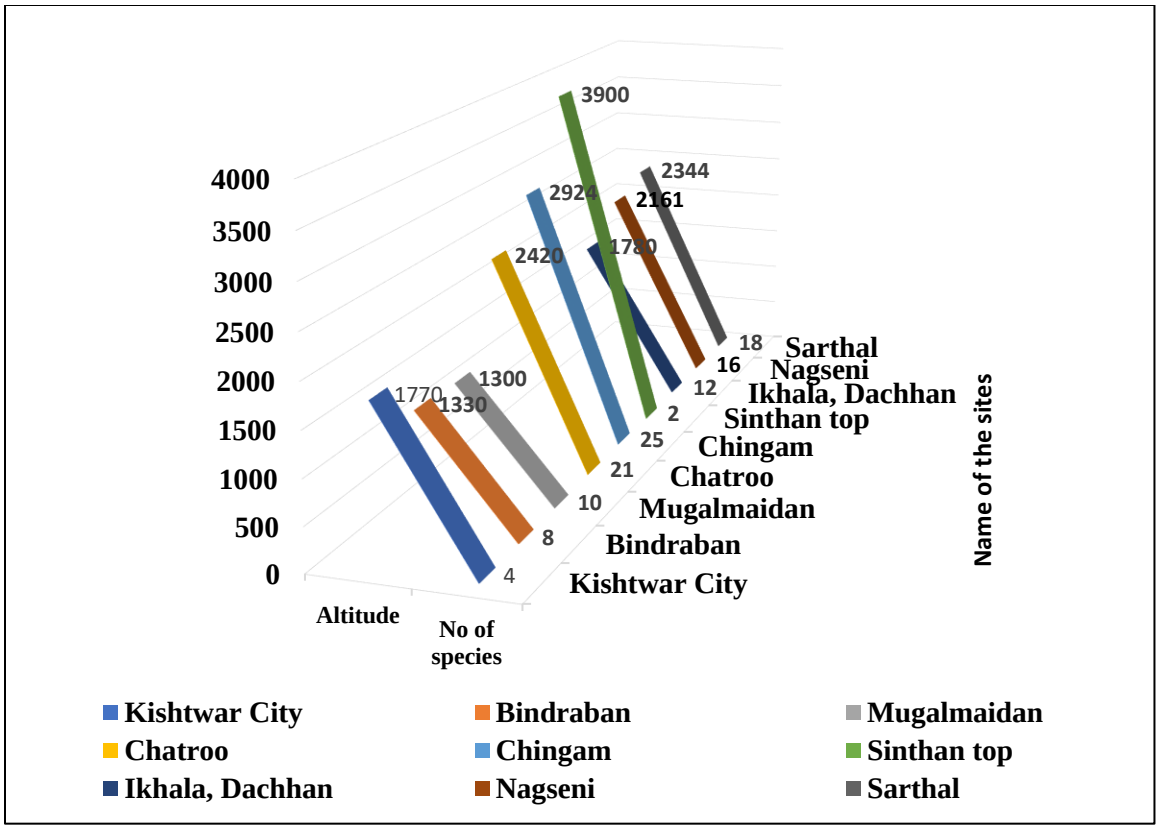

Fig 6 (52): Showing the macrofungal species distribution with altitude in different collection sites.(X axis represent the number of species and Y axis represent altitude in masl).

6.8 Substrate (Habitat) specificity of wild mushrooms.

In the current study, the substrate preferences of wild mushroom species was investigated, and the habitat diversity of these macrofungi have been categorized. Our findings, when compared, showed that macrofungal species collected from various sites differed significantly depending on the kind of habitat and substrate, indicating an unequal distribution within the study area. None of the macrofungal species collected , occupied two or more substrates, and the majority of them were substrate-specific, growing only on one kind of substrate. Out of the 47 wild macrofungal taxa that have been collected , identified and recorded from the study area, 16 species have been identified as Humicolous. These species include *Agaricus campestris*, *Coprinellus micaceus*, *Geastrum sacchatum*, , *Morchella esculenta Sparassis crispa*, *Lycoperdon perlatum*, *Apioperdon pyriforme*, *Pluteus cervinus* ,*Boletus edulis*, *Lepiota cristata*, *Macrolepiota procera*, *Bovista plumbea*, *Pholiota squarrosa*, *Gyromitra esculenta*, *Ramaria Formosa*, *Lepista*

sordida. These macrofungi are known to completely degrade plant biopolymers by inhabiting buried plant detritus and litter, thus helps in the cycling of nutrients in the ecosystem (Berg and Mc Claugherty, 2014). Because each enzyme breaks down a particular chemical in the substrate, so it is the enzyme composition which determines the ability of these macrofungi to decompose the substrate. (Martinez-Garrido et al., 2010). It has been reported & claimed that soil moisture has a significant impact on the productivity of macrofungi (Lagana et al., 2002). In particular, the macrofungal fruiting bodies that emerge from the underside of the mycelium depend on presence of ambient moisture and soil temperature (Manachere, 1980).

The forests in different study sites in the study area have been found to have higher levels of soil organic carbon (SOC), resulting mainly due to the quick decomposition of forest litter, and hence it signifies the higher biological activity in the upper layer of soil. In addition, larger tree and shrub densities, herb biomass, litter on the forest floor, and soil respiration can all be related to higher SOC accumulation (Dar and Sundarapandian, 2013). In the current study, maximum macrofungal species have been collected and identified from forests as compare to open fields. Because lignin is present in greater quantities in coniferous forests, the decomposition rate of coniferous litter is thought to be slower, which causes more litter to accumulate on the forest floor and hence the production of acidic compounds, resulting in fewer species of macrofungi in these coniferous forests (Berg, 2000). Due to the inactivity of soil organisms in these acidic soils, the amount of humus decreases, which eventually results in greater litter on the forest floor (Thuille and Schulze, 2006).

Forests in different study sites have been found to have acidic soil with low ph. (Dar et al., 2016). High forest density and moisture content are connected because soil moisture is influenced by forest and litter cover. The dense forest canopy and overlaying litter on the forest floor create shaded conditions on the forest floor that impedes the process of transpiration and evaporation, thus preventing the moisture loss (Palviainen et al., 2004).

Out of 47 taxa reported , 23 species of wild macrofungi , divided into 10 genera and 7 families have been reported to form ectomycorrhizal association with the roots of

higher plants in different study sites.(Table). These species included *Helvella crispa, H.elastica , Amanita. flavipes, A. orsonii, Geopora arenicola A. pakistanica, Amanita griseofusca, Amanita subglobosa , Amanita orientigemmata , Amanita griseopantherina, Amanita garhwalensis, , Veloporphyrellus latisporus, Suillus americanus, Lactarius sanguifuls, Lactarius abieticola , Lactarius volemus, Russula pseudoamoinicolor, Russula lakhanpalii , R. densifolia Cantharellus cibarius, L. laeticolor, L. scrobiculatus, L. zonarius,* . Several macrofungal species were reported during the current study to grow in close proximity of trees and were ectomycorrhizal in nature. These macrofungi have been found to have ectomycorrhizal associations with roots of conifers and broad leaved trees. In the current investigation, similar to the prior study (Mehmood et al., 2021), *Amanita pakistanica* was discovered to be growing in association with *Abies pindrow*. Collections of *Amanita flavipes and A. orsonii* were made in coniferous forests where *Abies pindrow* predominated (Mehmood et al., 2018, 2019*).A orientigemmata* has been found to be closely associated with *Pinus wallichiana and Cedrus deodara . A. subglobosa* grows under *Quercus* species. A new species of *Amanita* was found under the *Quercus tree.* A new record from india , *Veloporphyrellus latisporus* has been found to grow in close proximity of *Pinus wallichiana and Cedrus deodara. Cantharellus cibarius* was reported to be growing in conjunction with *Pinus wallichiana* and *Cedrus deodara* but earlier it was found to have ectomycorrhizal relationship with *Quercus incana* (Deepika et al., 2013). In addition to its recognised associations with *Cedrus deodara* and *Cupressus torulosa* (Joshi et al., 2013) , *Lactarius scrobiculatus, L. laeticolor, L . volemus, L. sanguifulus* were reported near *Pinus wallichiana* and *Cedrus deodara . Lactarius abieticola grows near Abies pindrow and Lactarius zonarius* was found near *Quercus* sp. *Russula psuedoamenicolor* grows near *Cedrus deodara* and *Quercus sp*. Similarly *R. lakhanpalii* was reported to grow near *Quercus sp*.

A total of 6 macrofungal species exhibiting lignicolous habit (growing on fallen dead wood logs and wood stumps). were identified during the current study. *Auricularia auricula-judae, Flammulina velutipes, Hericium yumthangense,, Pleurotus ostreatus, Laetiporus sulphureus and Schizophyllum commune* are some of the lignicolous saprotrophic taxa in this group. *Hericium yumthangense* was seen growing on the fallen tree trunk of *Abies pindrow.Earlier it was reported to grow* on *Abies densa* (Das *et al*.,

2013a). *Flammulina velutipes* was seen proliferating on the dead wood of *Cedrus deodara* .Similarly *Auricularia auricula-judae* was reported to be growing on the wood of *Juglans regia*. *Schizophyllum commune* was found to be growing on the trunk of *Quercus sp.* Justo et al. (2014) reported *Pluteus cervinus* on decaying wood of deciduous trees (*Alnus, Quercus, Populus),* similar to the findings of the current study). *Laetiporus sulphureus* was found growing on the trunk of *Betula utilis.* The existence of macrofungi on wood may be explained by the abundance of hydrolytic and oxidative extracellular enzymes found in certain mushroom species, which aid in the mobilisation of nutrients by breaking down lignin and cellulose substrates (Elisashvili et al., 2006).

The wood products and materials can be degraded by macrofungal members from the Ascomycota and Basidiomycota (Pournou, 2020). The majority of the lignicolous macrofungi species that have been found in the present study are white rots ,with the exception of *Schizophyllum commune* which was reported to be a grey rot(Krah *et al*., 2018) , that cause the breakdown of cell wall components and hence making availability of nutrients and open habitats for other organisms that feed and grow on dead wood like insects, bacteria etc (Kalmis *et al.,* 2008; Zhou *et al.,* 2014; Wu *et al.,* 2018).

In the current investigation, only two macrofungal taxa have been reported to be coprophilous . These include *Coprinus comatus and Panaeolus papilinaceus*.

In light of these findings, it can be said that the characteristics of the substrate, the type of vegetation, and the mix of tree species are the most crucial variables affecting the variety of macrofungi in the study area.

Table 6 (K): Showing the substrate preference and putative host of wild mushroom from the study area.

S. No.	Macrofungal species	Putative Host	Substrate Preference
Phylum	Ascomycota		
Order	Pezizales		
Family	Helvellaceae		
1.	*Helvella crispa*	*Cedrus deodara, Picea smithiana*	Ectomycorrhizal

2.	*H. elastica*	*Cedrus deodara , Pinus wallichiana*	Ectomycorrhizal
Family	Morchellaceae		
3.	*Morchella esculenta*		Humicolous
Family	Pyronemataceae		
4.	*Geopora arenicola*	*Cedrus deodara , Abies pindrow*	Ectomycorrhizal
Family	Discinaceae		
5.	*Gyromitra esculenta*		Humicolous
Phylum	Basidiomycota		
Order	Agaricales		
Family	Agaricaceae		
6.	*Agaricus campestris*		Humicolous
7.	*Apioperdon pyriforme*		Humicolous
8.	*Lycoperdon perlatum*		Humicolous
9.	*Lepiota cristata*		Humicolous
10.	*Macrolepiota procera*		Humicolous
11.	*Bovista plumbea*		Humicolous
12.	*Coprinus comatus*		Coprophilous
Family	Amanitaceae		
13.	*Amanita flavipes*	*Abies pindrow*	Ectomycorrhizal
14.	*Amanita orsonii*	*Abies pindrow*	Ectomycorrhizal
15.	*Amanita pakistanica*	*Abies pindrow*	Ectomycorrhizal
16.	*Amanita griseofusca*	*Quercus sp.*	Ectomycorrhizal
17.	*Amanita subglobosa*	*Quercus sp.*	Ectomycorrhizal
18.	*Amanita orientigemmata*	*Pinus wallichiana and Cedrus deodara*	Ectomycorrhizal
19.	*Amanita griseopantherina*	*Quercus & Pinus sp.*	Ectomycorrhizal
20.	*Amanita sp.*	*Quercus sp.*	Ectomycorrhizal
Family	Physalacriaceae		
21.	*Flammulina velutipes*	*Cedrus deodara*	Lignicolous
Family	Pleurotaceae		
22.	*Pleurotus ostreatus*	*Quercus sps.*	Lignicolous
Family	Pluteaceae		
23.	*Pluteus cervinus*		Humicolous
Family	Psathyrellaceae		

24.	*Coprinellus micaceus*		Humicolous
25.	*Panaeolus papilionaceus*		Coprophilous
Family	*Schizophyllaceae*		
26.	*Schizophyllum commune*	*Quercus sps.*	Lignicolous
Family	*Strophariaceae*		
27.	*Pholiota squarrosa*		Humicolous
Order	*Polyporales*		
Family	*Sparassidaceae*		
28.	*Sparassis crispa*		Humicolous
Family	*Fomitopsidaceae*		
29.	*Laetiporus sulphureus*	*Betula utilis*	Lignicolous
Order	*Auriculariales*		
Family	*Auriculariaceae*		
30.	*Auricularia auricula-judae*	*Juglans regia*	Lignicolous
Order	*Boletales*		
Family	*Boletaceae*		
31.	*Boletus edulis*	*Cedrus deodara*	Humicolous
32.	*Veloporphyrellus latisporus.*	*Pinus wallichiana , Cedrus deodara*	Ectomycorrhizal
Family	*Suillaceae*		
33.	*Suillus americanus*	*Cedrus deodara*	Ectomycorrhizal
Order	*Cantharallales*		
Family	*Cantharellaceae*		
34.	*Cantharellus cibarius*	*Pinus wallichiana , Cedrus deodara*	Ectomycorrhizal
Order	*Geastrales*		
Family	*Geastraceae*		
35.	*Geastrum saccatum*		Humicolous
Order	*Gomphales*		
Family	*Gomphaceae*		
36.	*Ramaria formosa*		Humicolous
Family	*Tricholomataceae*		
37.	*Lepista sordida*		Humicolous
Order	*Russullales*		

Family	*Hericiaceae*		
38.	*Hericium yumthangense*	*Abies pindrow*	Lignicolous
Family	*Russulaceae*		
39.	*Lactarius laeticolor*	*Pinus wallichiana , Cedrus deodara*	Ectomycorrhizal
40.	*Lactarius sanguifuls*	*Pinus wallichiana , Cedrus deodara*	Ectomycorrhizal
41.	*Lactarius scrobiculatus*	*Pinus wallichiana , Cedrus deodara*	Ectomycorrhizal
42.	*Lactarius zonarius*	*Quercus sp.*	Ectomycorrhizal
43.	*Lactarius abieticola*	*Abies pindrow*	Ectomycorrhizal
44.	*Lactarius volemus*	*Quercus sp.*	Ectomycorrhizal
45.	*Russula pseudoamoinicolor*	*Quercues sp. , Cedrus deodara*	Ectomycorrhizal
46.	*Russula lakhanpalii*	*Quercus sp.*	Ectomycorrhizal
47.	*Russula densifolia*	*Pinus wallichiana , Cedrus deodara*	Ectomycorrhizal

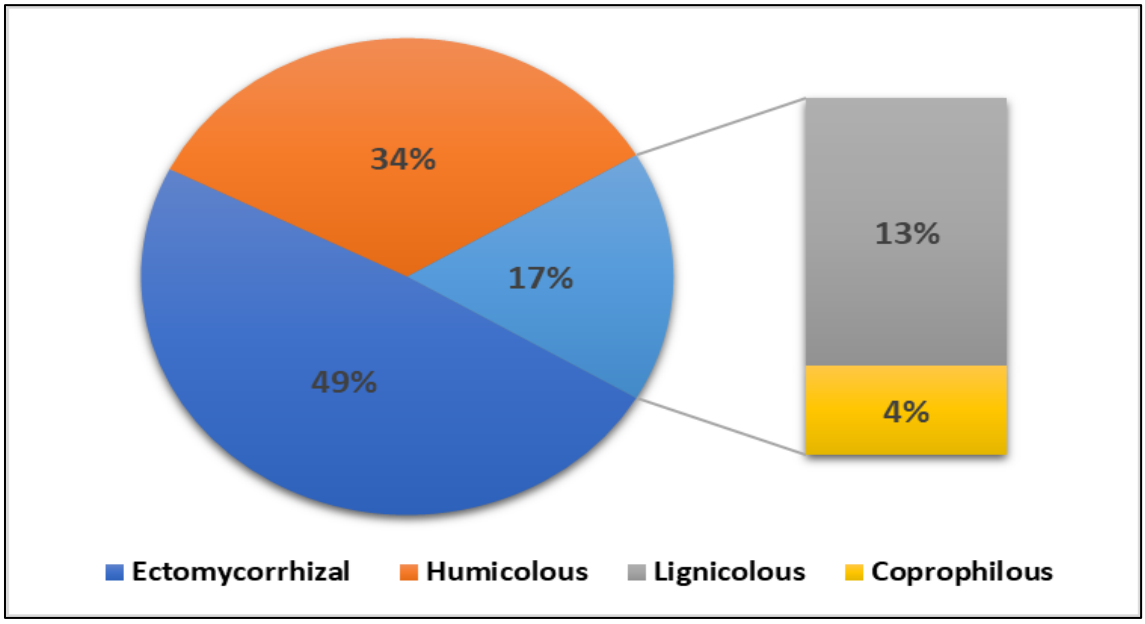

Fig 6(53): Habitat preference of wild macro fungi in terms of percentage

Out of total 47 species reported,23 are Ectomycorrhizal ,16 are Humicolous,6 are Lignicolous & 2 are Coprophilous.

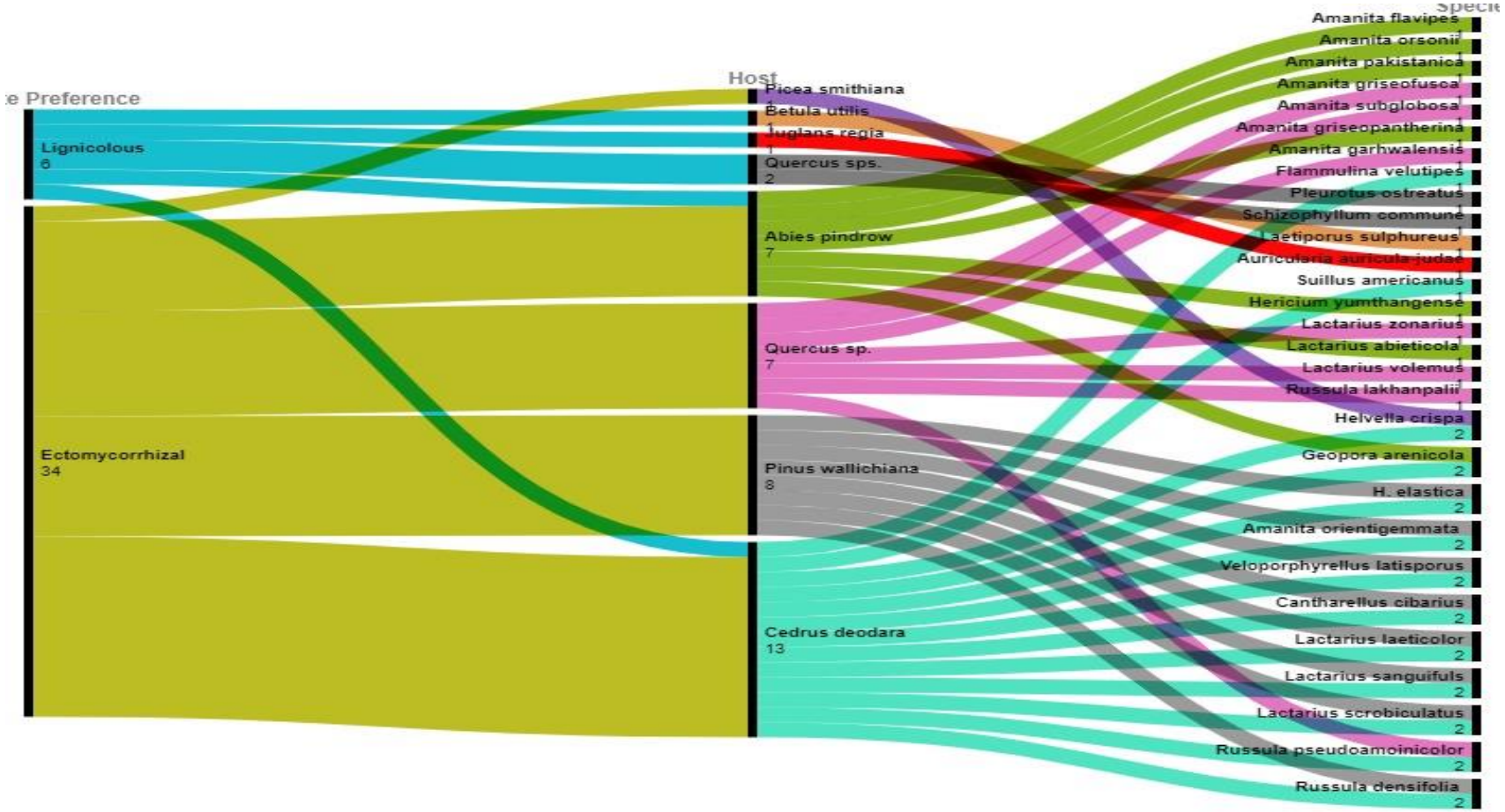

Fig:6 (54): Sankeys Plot showing Substrate Preference and Host Specificity of wild macro fungi

6.9 Ethnomycological Studies

In the recent times, mycologists have started to investigate the local folk uses of mushrooms around the world because traditional knowledge of mushrooms could provide an insight of new findings within the scientific community. In many regions of the world, the practise of searching wild mushrooms predates the development of ethnomycology as a field of study. It is the practise of gathering wild edible macrofungi from the surrounding forest and in the wild for food and other purposes. Besides exploration of traditional knowledge, ethnomycology is the study of the cultural and environmental consequences of macrofungal relationship with humans over time and location (Reyes-Lopez et al., 2020). In order to gather useful data regarding consumption and usage of fleshy macrofungi by the inhabitants of various settlements, surveys , relating to the collecting of wild mushrooms , were carried out in a number of localities in the district of Kishtwar between the years of 2021and 2023. Elderly people of the study area, important informants, and the head of the village were all questioned using specially self-designed questionnaires . Information has been gathered in various sites of the study area through semi-structured interviews, conversations, and first hand observations with tribal members, hakeems, nomads, elderly people, local informants, as well as by distributing questionnaires to the general public. They were questioned in their native Kashmiri, Kishtwari language to get their opinions on the historical context of wild mushrooms, their indigenous usage, edibility status, health benefits, folk taxonomy, preservation techniques and commercial significance etc. More information has been gathered by displaying the authentic samples and printed photos. The findings of ethnomycological studies showed that 24 macrofungal species were employed both as food and for ethnomedical purposes.

6.9.1 Collection of wild edible mushrooms

During the course ethnomycological survey, spring (April-June) and summer months (July-September) were preferred by the local community for collection of the wild mushrooms. Many researchers have recommended and supported this period of the year for maximal appearance of fleshy macrofungi due to favourable climatic conditions like temperature and adequate moisture (Dutta and Acharya, 2014; Semwal *et al*., 2014; Tatengo and Ragragio, 2018).

6.9.2Drying and preservation of wild edible mushrooms

Wild mushrooms have short life in nature and therefore, decay very rapidly. Specimens were preserved by dry preservation method. For preservation of wild mushrooms, people also adopted sun drying method. The various other methods of mushroom drying including smoke drying, sun drying on roof tops, freezing, salting followed by blending with crude turmeric sticks (rhizomes) have been previously documented (Kumar and Sharma, 2011a; Lalotra *et al*., 2016a). The macrofungal species destined for marketing were sundried in open and afterwards stored in jars or intertwined as garlands. These indigenous preservation techniques were not gender specific, and males and females both were associated with processing and preservation practice.

6.9.3 Edibility status and culinary potential of wild edible macrofungi (mushrooms)

Edibility status of wild macrofungi (mushrooms) by ethnomycological studies revealed that wild edible mushrooms are an essential part of diet for people including tribal communities especially those living in hilly areas of the study area. Wild edible mushrooms were also found to be used by locals for therapeutical purposes. Respondents gave different reasons for utilization of these edible mushrooms such as their appealing flavour and taste, mutton like consistency, abundance and availability, substitution for meat, nutritional and therapeutic values, and provisions of better income. It was further found during the survey that through perception of colour, odour, edibility information, and thorough experience, locals including tribals could differentiate between the edibles and non-edible macrofungi. Information wss also obtained about the culinary preparations of wild edible mushrooms.

Mushrooms were usually fried when consumed fresh or cooked with vegetables or meat or other mushrooms. Many wild edible mushrooms are dried and preserved for consumption during winters when there is scarcity of vegetables. Information regarding the methods of preparations and consumption of wild edible mushrooms was extracted from people especially women folk of the study area. During the survey, preparation methods of the cuisines have been documented, some of which are discussed below:

Recipe 1. Mushroom Pulaw (Kuch palav) (*Morchella* species, *Pleurotus ostreatus*)

Ingredients.

Mushrooms 400-700g

Rice 200 gms

Soyabean oil 250 ml

Finely chopped green chillies and onions

Mint and coriander leaves

Cumin powder

Red chilli powder

Coriander powder

Turmeric powder

Salt (as per taste)

One bowl of rice was kept in water for 30 minutes. 2-3 table spoons of oil were heated in a deep pan and afterward spices (cloves, fennel, green cardamom, cumin, cinnamon) were added and heated till fragrant. After that, chopped onions and green chillies were added till translucent. Now, tomatoes, mint and coriander leaves were added. The entire blend was stirred till tomatoes turned mellow. Further turmeric, coriander, and red chilli powder were added and stirred until spices get equally blended with the rest of mixture. Further, mushrooms were added and kept on medium flame for 10 minutes. Water was added and mixture was brought to simmer, then rice along with rest of mint and coriander leaves were added. Finally, salt was added and pan was covered with lid. The whole mixture was kept at low flame till rice grains were cooked.

Recipe 2. Mushroom Vegetables (*Laetiporus sulphureus , Hericium yumthangense*)

Ingredient.

Fruiting Body 500kg

Oil 50ml

Red Chilli Powder 1 medium table spoon

Turmeric Powder 1 medium table spoon

Cumin half table spoon

Table salt half table spoon

Coriander leaves

Tomatoes 4

Preparations. To prepare the dish , oil was put in a pan ,heated and then mushroom fruiting bodies fried for 20 minutes , followed by adding of tomatoes, red chilli powder, turmeric powder, cumin powder ,table salt and coriander leaves in the end and cooked for 10 minutes.

Table 6(L): Respondents gender wise and age wise for ethnomycological information.

S.No.	**Gender**	**No Of Respondents**
1	Male	33
2	Female	46
	Total	**79**
S.No.	**Category (Male & Female Age wise)**	**No of Respondents**
1	0-20	5
2	21-40	41
3	41-60	22
4	60 Above	11
		79
	Female	
S.No.	**Category (Age wise)**	**No Of Respondents**
1	0-20	2
2	21-40	22
3	41-60	15
4	60 Above	7
		46
	Male	
S. No	**Category (Age wise)**	**No. Of Respondents**
1	0-20	3
2	21-40	19
3	41-60	7
4	60 Above	4
		33

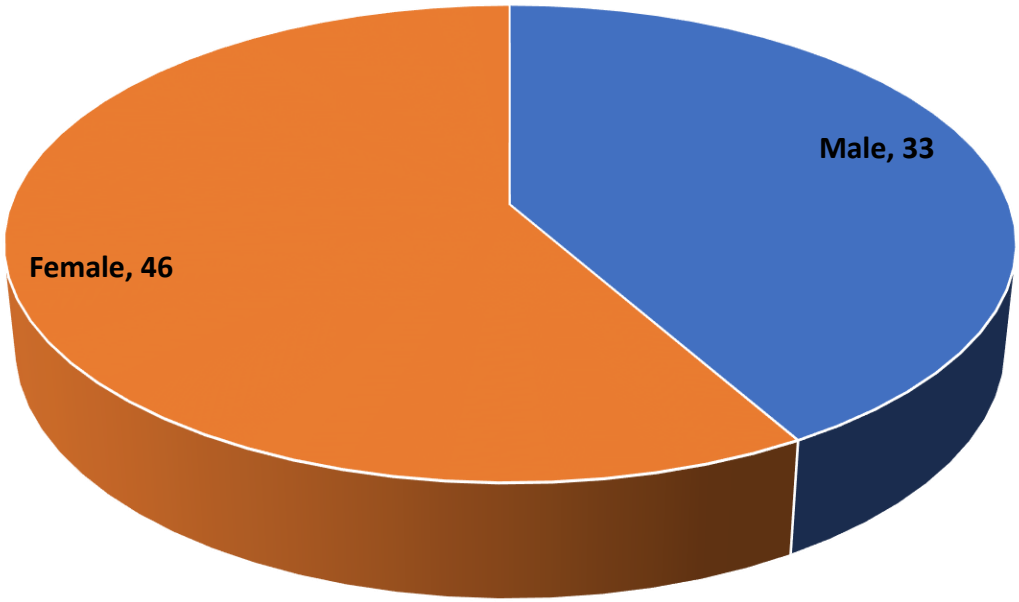

Fig 6 (55): Total number of male and female respodents during ethnomycological studies.

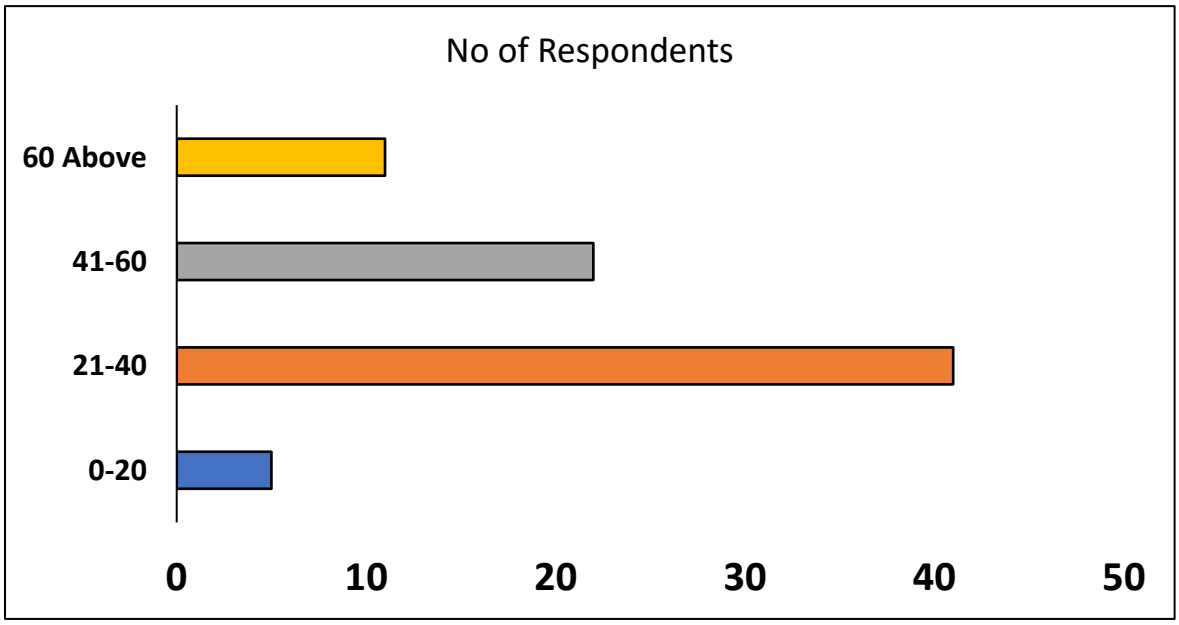

Fig 6 (56): Respondents in different age groups(X axis represent the different age groups, Y axis represent the number of respondents)

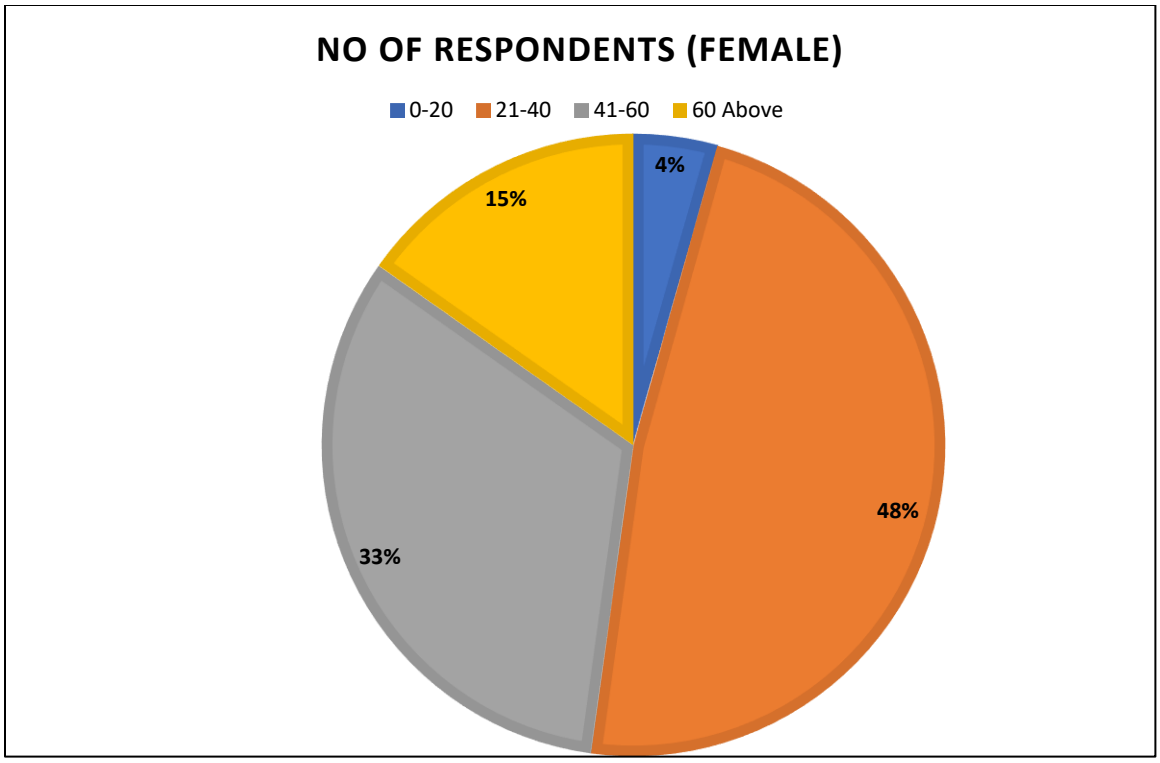

Fig 6(57): Female respondents in different age groups.

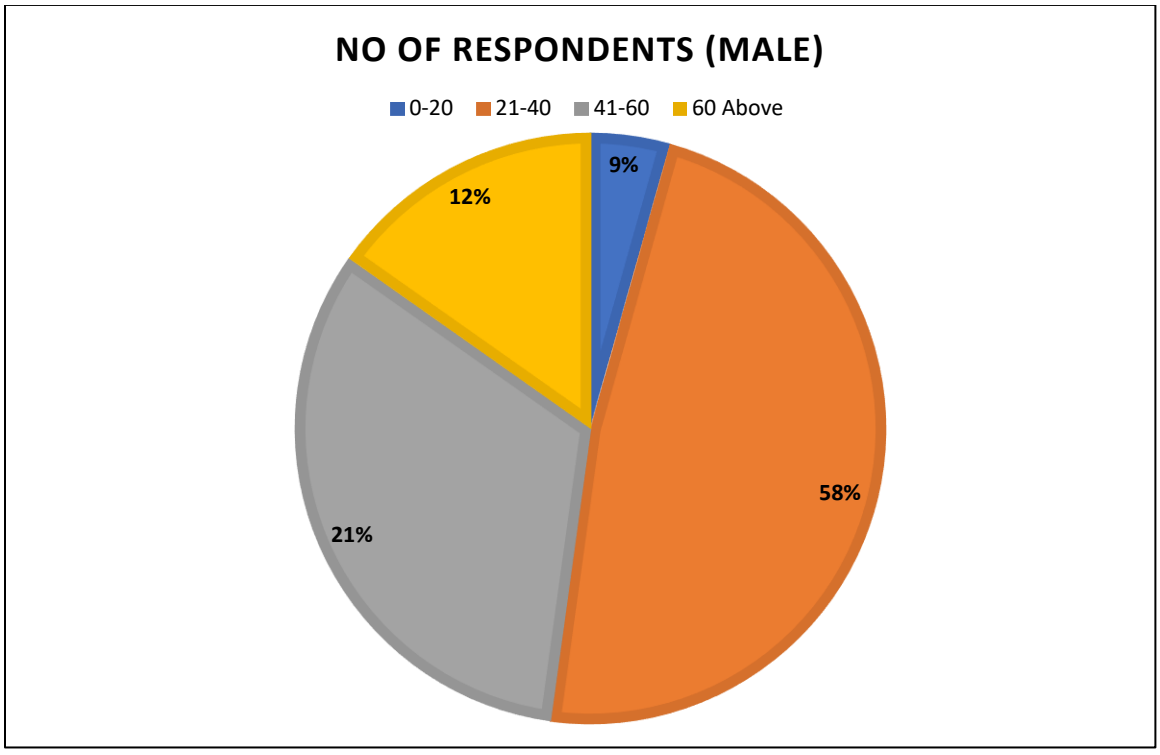

Fig 6 (58): Showing male respondents in different age groups

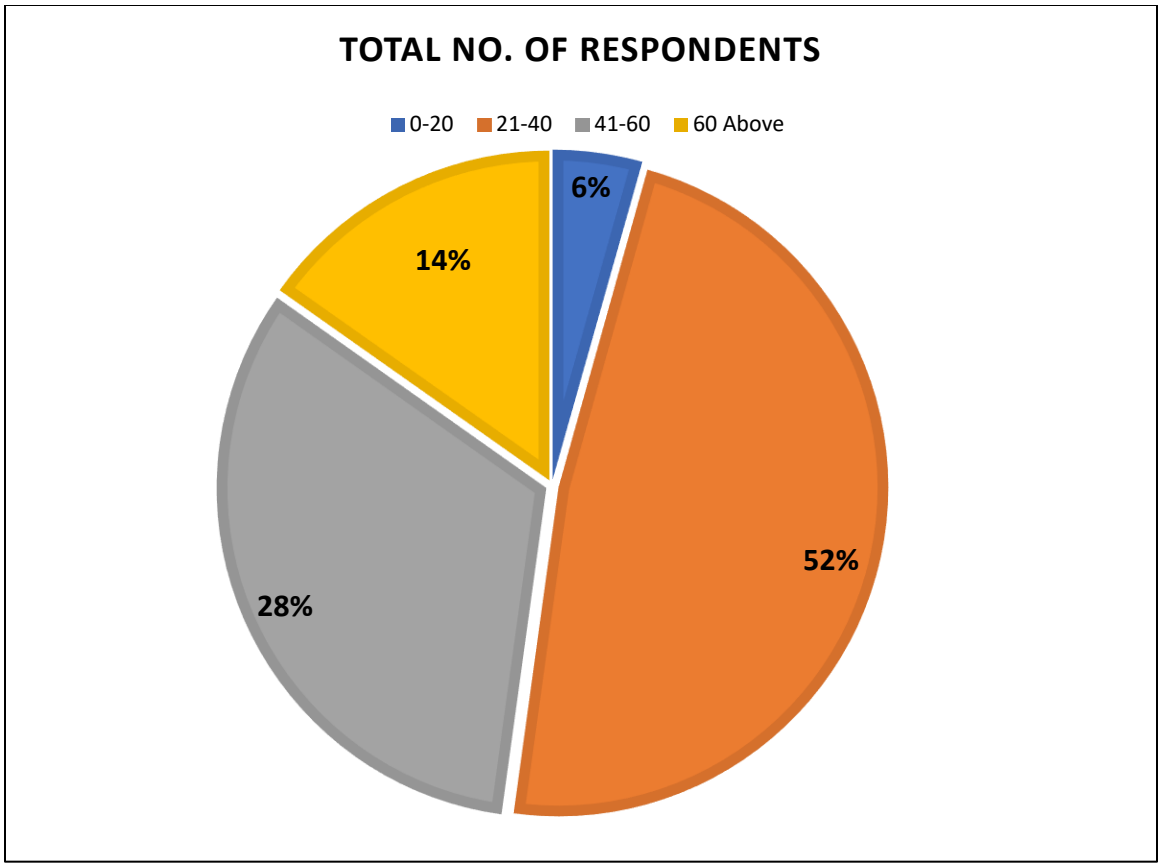

Fig 6(59) : Showing Total number of respondents .

6.9.4 Folk Taxonomy

The way locals interpret and connect to their natural surroundings affects the traditional knowledge in that area. Through numerous frequent meetings and interviews, the accurate taxonomic classification of folk taxonomy was empowered. Folk perceptions on macrofungal species were also depicted in addition to relating folk taxa to scientific nomenclature. The entire mushroom group has been categorized into two broad categories; one category includes edible and medicinal mushrooms, about which people have extensive ethnomycological knowledge. The other group of mushrooms was avoided as it was morphologically difficult to identify and potentially toxic species about which which people had no detailed knowledge. This group had been mostly disregarded. India, Ethiopia, Mexico, and the Philippines all reported having the same idea about these unidentified mushrooms (Kumar and Sharma, 2011; Garibay-orijel et al., 2006; De Leon et al., 2013; Sitotaw et al., 2020).

Mushrooms are generally referred to as "haeder," whereas the exact names of the mushrooms were proposed based on the substrate. For instance, *Panaeolus papilionaceus* is also known as "guh-haeder," which refers to a fungus (haeder) growing on dung which is called as 'guh' in kashmiri. Similarly , *Hericium yumthangense* was locally known as as "rael-gab," which implies that it grows on *Abies pindrow*, also known as "rael" in the native tongue. Sometimes the names are being given on the bases of shape of fruiting body.For instance , *Geastrum sacchatum* is known as "gul-e-aftab," or "appearing like the sun," and *Geopora arenicola* is known as "kondal," which means "shape of the kangri pot. *Auricularia villosula* and *Helvella crispa* are commonly known as "kankich," meaning "ear-shaped mushrooms,". Likewise folk names are being given on the bases of texture. For example the folk name of *Suillus americanus* was ‘lihn haeder’ meaning slippery texture of pileus. *Apioperdon pyriforme* was called ‘famb-duong’ which means like ‘cotton ball’. Some species are named based on their habitats, like the name 'hoon kich; for *Coprinellus micaceus* which means growing in damp habitat and the folk name 'wan haeder' meaning growing in forest for *Cantharellus cibarius* (forest in kashmiri language is called 'wan'. Taste is also one of the crucial factor for mushroom identification, with locals using prefixes like'maazkhel' for Agaricus campestris and'maaz-haeder' for Pluteus cervinus .'Maaz' in kasmiri language means ‘ meat like taste’. The ethnotaxa observed were Generally monotypic ethnotaxa (with one folk name only) were observed but some were polytypic (one term used for more than one species) . For example *Helvella crispa , Helvella elastica , Auricularia auricula judae* were together called as *‘kan kich’***.** Similarly, *Amanita flavipes , A. orsonii , A pakistanica, A sub globoisa* as Zahar-haedar.

The odour and colour of mushrooms are also typical characteristics that have been used to distinguish the ethnotaxa in addition to shape, substrate, texture, and taste. Locals in tribal district of Kinnaur in Himachal Pradesh have used colour as a significant feature in mushroom identification Sagar et al. (2005) . Additionally, Dutta and Acharya (2014) noted that locals have adapted the form and colour of mushrooms as a useful trait for mushroom identification. Robles-Garcia et al. (2018) listed comparative characteristics for distinguishing native mushrooms. In several parts of Jammu and Kashmir, documentation on the availability and use of wild edible mushrooms have been carried out (Kumar and Sharma, 2011a; Lalotra et al., 2016a; Malik et al., 2017), but in district

Kishtwar, no such ethnomycological information regarding wild mushrooms has been documented. In the current study, we found that the study area is rich in macrofungal diversity and there is great potential about the ethnomycological usage of wild edible mushrooms

The folk taxonomy (traditional names) for wild mushrooms collected from the study region has also been tabulated [Table 6(M)]. Additionally shown in other table 6(N) are their folk genus and english terminology.

Table 6 (M): Ethno-mycotaxonomical details of wild mushrooms collected from the study area.

S.No	Name Of Species	Vernacular Name	Meaning
1.	***Helvella crispa***	Kan kitchh, Thuntoo	Ear shaped , Come out after thundering.
2.	***H. elastica***	Kan kitchh Thunthoo	Ear shaped mushroom, Come out after thundering.
3.	***Morchella esculenta***	Bata Kitchh	Mushrooms eaten with rice.
4.	***Geopora arenicola***	Pyali Haider, Koundal	Bowl shaped. Shape of kangri pot
5.	***Gyromitra esculenta***	Wozul Kitchh	Red Colour Morel
6.	***Agaricus campestris***	Haidar, Maazkhel	After cooking, Meat like taste.
7.	***Apioperdon pyriforme***	Ophands, Goal Haider	Come out after rains Ball like.
8.	***Lycoperdon perlatum***	Famb dong , Ophands	Cotton ball like, Emerge out just after rains.
9.	***Macrolepiota procera***	Chaitir haider	Umbrella shaped mushroom
10.	***Bovista plumbea***	Ophanda	Emerge out just after rains.
11.	***Coprinus comatus***	Safaid Haidar Bam Haider	White mushroom Mushroom growing on dung.
12.	***Amanita flavipes***	Laidur haider	Yellow colour mushroom
13.	***Amanita orsonii***	Nachan Sirer	Seems to be poisonous
14.	***Amanita griseofusca***	Zahr haider	Umbrella shaped
15.	***Amanita subglobosa***	Chaitir haider	Umbrella shaped

16.	***Amanita orientigemmata***	Zahr haider	Umbrella shaped
17.	***Flammulina velutipes***	Laidur Chaitir	Yellow colour mushroom
18.	***Pleurotus ostreatus***	Haider,Sirer	Umbrella shaped
19.	***Pluteus cervinus***	Maaz haider,Sirer	Meat like taste,Umbrella shaped
20.	***Coprinellus micaceus***	Hooun kich Aab haiuder	Growing in damp habitats,Watery mushroom
21.	***Panaeolus papilionaceus***	Bam haider	Mushroom growing on dung.
22.	***Schizophyllum commune***	Lokit Gaub	Small mushroom growing on wood logs
23.	***Sparassis crispa***	Rao Gaub Posh haider	Associated with Abies pindrow Flower like mushroom
24.	***Laetiporus sulphureus***	Gaub	Growing on wood logs
25.	***Auricularia auricula-judae***	Kan kitchh	Ear like shape.
26.	***Boletus edulis***	Lihn haider Dailoo	Slippery texture Easily divisible into two pieces
27.	***Suillus americanus***	Lihn haider	Texture slippery.
28.	***Cantharellus cibarius***	Wan haider	Mushroom growing forest.
29.	***Geastrum saccatum***	Gull-e- aftaab	Star shaped mushroom
30.	***Ramaria formosa***	Khen haider	Edible mushroom
31.	***Hericium yumthangense***	Raai gub Jhat haider	Mushroom growing on *Abies.* Fur like mushroom.
32.	***Lactarius laeticolor***	Chaitar haider	Umbrella shaped mushroom
33.	***Lactarius sanguifluus***	Chaitir haider	Umbrella shaped mushroom
34.	***Lactarius scrobiculatus***	Chaitar haider	Umbrella shaped mushroom
35.	***Lactarius abieticola***	Chaitir haider	Umbrella shaped mushroom
36.	***Russula lakhanpalli***	Chaitir haider	Umbrella shaped mushroom
37.	***Lactarius zonarius***	Nachan Sirer	Seems to be poisonous

Table 6(N): Folk taxonomy (Ethno-mycotaxonomical knowledge) of wild mushrooms collected from different collection sites of district Kishtwar.

S.No.	Name of the wild mushroom	English terminology	Folk genus	Meaning
1.	***Helvella elastica , H. crispa***	Saddle fungi	Kankich	Developing saddle shaped ascocarps
2.	***Amanita. flavipes, Amanita orsonii, Amanita pakistanica , Amanita griseofusca , Amanita subglobosa Amanita orientigemmata , Agaricus campestris, Macrolepiota procera, Coprinus comatus, Flammulina velutipes ,Lactarius laeticolor. Lactarius sanguifluus, Lactarius scrobiculatus , Lactarius abieticola , Russula lakhanpalli, Panaeolus papilionaceus , Pluteus cervinus, Schizophyllum commune,Cantharellus cibarius, Coprinellus micaceus, Pleurotus ostreatus,Pluteus cervinus ,***	Agarics	Haedar, Maazkhel, Hooun-kich	Species are characterized by the presence of gills on the underside of pileus
3.	***Boletus edulis ,Suillus americanus***	Boletes/ poroid macrofungi	Katij-haeder, Lihn-haeder	Which develop tubes ending in pores on the underside of pileus
4	***Auricularia auricula- judae***	Jelly macrofungi	Kankich	Jelly like consistency
5.	***Geastrum saccatum***	Earthstar	Gull-e-aftaab	Species developing spherical spore sac surrounded by star shaped structure.
6.	***Morchella esculenta***	Morels	Kich	Species developing conical cap with a highly pitted and ridged surface

7.	***Geopora arenicola***	Cup fungi	Pyali haider Kondal	Species producing cup or disc shaped fruiting bodies bearing spores on its inner surface.
8.	***Apioperdon pyriforme , Lycoperdon perlatum , Bovista plumbea***	Puffballs	Famb-dong, Moagj	The macrofungi developing spherical or pear-shaped fruiting bodies which on maturity release cloud of spores or puff, hence called puffballs.

Ethno-medicinal use of wild mushrooms in the study area

In the present study, locals including tribals, elderly people, hakeems etc. were interviewed about the medicinal importance of wild edible mushrooms found in the study area. The details collected from the local populace regarding the usage form and medicinal importance of wild mushrooms are shown in the form of a table.

Table 6 (O): Showing usage form and medicinal use of wild mushrooms documented from the study area.

S.No.	Species Name	Usage form	Medicinal Use
1.	***Helvella crispa***	Fruiting Body (Ascocrap)	Sartan(Cancer), Cough(chaas)
2.	***Morchella esculenta***	Fruiting Body (Ascocarp) used as vegetable.	Aphrodiasic, Dod badawan(lactating mothers), Kamzoori(weakness).
3.	***Geopora arenicola***	Fruiting Body (Ascocarp) used as vegetable.	Neendri khatri (Sleep inducing) ,Weakness(kamzoori),Nazla zukam(cold).
4.	***Agaricus campestris***	Fruiting Body (Basidiocarp) used as vegetable.	Dehydration , in burn injuries , ,Fatigue(Thakawat)
5.	***Lycoperdon perlatum***	Fruiting Body (Basidiocarp)	Dast (Loose Motion) and Vomiting
6.	***Macrolepiota procera***	Fruiting Body	Nutritional Disorders
7.	***Coprinus comatus***	Fruiting Body	Kamzori (weakness)

8.	***Flammulina velutipes***	Fruiting Body (Basidiocarp) used as vegetable.	Weakness (kamzoori)
9.	***Pleurotus ostreatus***	Fruiting Body (Basidiocarp) used as vegetable. Dried form used as powder.	Dama (asthama), Jigruk dod (liver disease)
10.	***Pluteus cervinus***	Fruiting Body (Basidiocarp) used as vegetable	Kamzoori khatri(Weakness)
11.	***Coprinellus micaceus***	Fruiting Body	Headache ,Fatigue(Thakawat)
12.	***Schizophyllum commune***	Whole Fruiting Body	Sartan(cancer), strengthen immune system
13.	***Sparassis crispa***	Fruiting Body (Basidiocarp) used as vegetable.	Sartaan(Anticancerous), Sugaras(Diabetes). Diarrhoea.
14.	***Laetiporus sulphureus***	Fruiting Body (Basidiocarp) used as vegetable.	Kamzoori(Weakness)
15.	***Auricularia auricula-judae***	Whole Fruiting Body	Sugar(Diabetes),General weakness(Kamzoori)
16.	***Cantharellus cibarius***	Fruiting Body (Basidiocarp) used as vegetable	Wound healing(zakhamas ang),General weakness(Kamzoori)
17.	***Ramaria Formosa***	Fruiting Body (Basidiocarp) used as vegetable.	Blood pressure, Sugaras (diabetes),General weakness(Kamzoori).
18.	***Hericium yumthangense***	Fruiting Body	Sugaras(diabetes), Heart problem and in reducing high blood pressure .
19.	***Lactarius laeticolor***	Fruiting Body	Soojan(Anti-inflammetry),
20.	***Lactarius sanguifluus***	Fruiting Body	Soojan(Anti-inflammetry),
21.	***Lactarius scrobiculatus***	Fruiting Body	Kamzoori(weakness) ,Thakawat(Fatigue)
22.	***Lactarius abieticola***	Fruiting Body	Kamzoori(weakness) ,Thakawat(Fatigue)
23.	***Lactarius volemus***	Fruiting Body	Kamzoori(weakness) ,Thakawat(Fatigue)
24.	***Russula lakhanpalii***	Fruiting Body	Aech dod(eye problems), cheati dod(chest infection)

6.9.5 Beliefs and Practices regarding usage of wild mushrooms in the study area.

1. People used to think that snow melting and thunderstorms with rain and other precipitation were the main causes for the growth and proliferation of wild mushrooms.

2. There is a belief that keeping dry morels in home will increase the wealth .

3. Wild mushrooms are believed to grow in shady and moistened places and it is also also supported by scientific bases.

4. People consider harder and colourful mushrooms as inedible.

5. People commonly think that as wooden stumps start to rot, mushrooms start to grow wildly on them.

6. Some locals believe that consuming certain mushrooms types causes madness.

7. Some wild mushrooms like puff balls are believed to be used to ward off evil spirits.

8. After the burning of forests , many locals believe that wild mushrooms grow luxuriantly.

6.9.6 Use Value of wild mushrooms

Use Value is the quantitative measure for the relative importance of mushroom species in the study area. Use value (UV) has been calculated by the formula:

$$UV=\sum U/n$$

where U is the number of use reports cited by each informant for a given species and n refers to the total number of informants.

Mushroom species with high UV value were designated as culturally important speciesand were well know among the local population , mosty for their medicinal properties.

Table 6(P): Use Values of different Edible mushrooms.

S.No.	Species Name	No. of Respondent	C	M	Citations	Use Value
1	***Helvella crispa***	79	59	28	87	1.10
2	***Morchella esculenta***	79	65	63	128	1.62
3	***Geopora arenicola***	79	71	69	140	1.77
4	***Agaricus campestris***	79	61	59	120	1.52
5	***Lycoperdon perlatum***	79	14	1	15	0.19
6	***Macrolepiota procera***	79	22	2	24	0.30
7	***Coprinus comatus***	79	20	8	28	0.35
8	***Flammulina velutipes***	79	29	2	31	0.39
9	***Pleurotus ostreatus***	79	40	3	43	0.54
10	***Pluteus cervinus***	79	54	41	95	1.20
11	***Coprinellus micaceus***	79	42	17	59	0.75
12	***Schizophyllum commune***	79	16	3	19	0.24
13	***Sparassis crispa***	79	20	14	34	0.43
14	***Laetiporus sulphureus***	79	15	11	26	0.33
15	***Auricularia auricula-judae***	79	21	17	38	0.48
16	***Cantharellus cibarius***	79	62	2	64	0.81
17	***Ramaria Formosa***	79	40	3	43	0.54
18	***Hericium yumthangense***	79	20	57	77	0.97
19	***Lactarius laeticolor***	79	22	6	28	0.35
20	***Lactarius sanguifuls***	79	18	5	23	0.29
21	***Lactarius scrobiculatus***	79	17	2	19	0.24
22	***Lactarius abieticola***	79	28	3	31	0.39
23	***Lactifluus volemus***	79	10	7	17	0.22
24	***Russula lakhanpalii***	79	41	10	51	0.65

- **C (Culinary Value)**
- **M (Medicinal Value)**

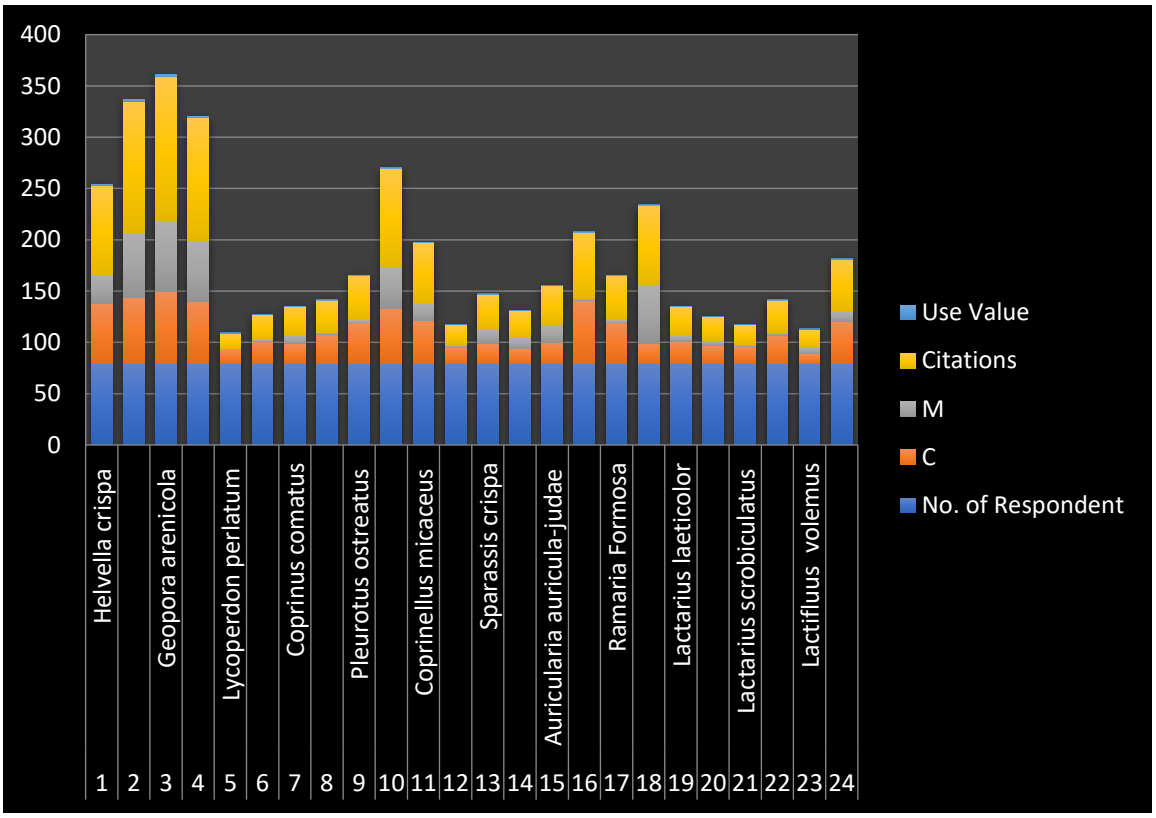

Fig 6 (60): Culinary value, Medicinal Value and Citations of Wild Edible Macro fungi.

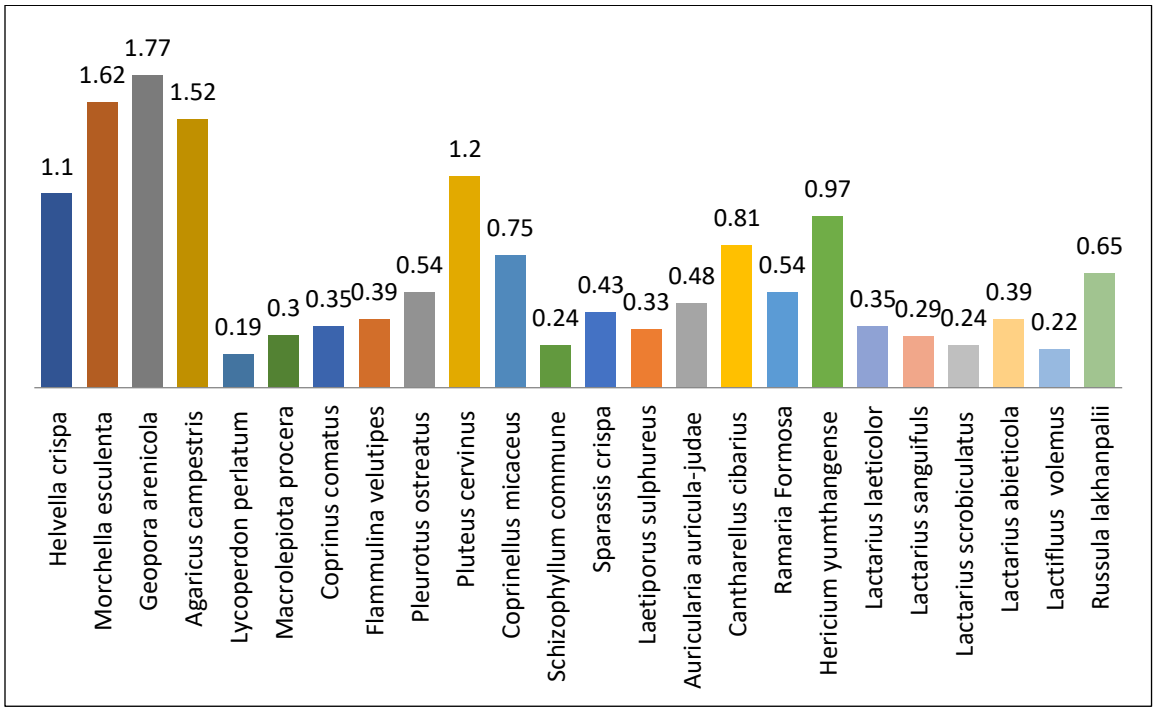

Fig 6 (61) : Bar diagram showing Use Value of wild macrofungi from the study area.

From the above table it is clear that mushroom species with highest use value (1.77) is *Geopora arenicola* .It is followed by *Morchella esculenta* (1.62), *Agaricus campestris* (1.52), *Pluteus cervinus* (1.20) , *Helvella crispa* (1.10) , *Hericium yumthangense* (0.97) , *Cantharellus cibarius* (0.81) , *Coprinellus micaceus* (0.75) , *Russula lakhanpalii* (0.65) , *Ramaria formosa, Pleurotus ostreatus* (0.54) , *Auricularia auricula-judae* (0.48), *Sparassis crispa* (0.43) , *Flammulina velutipes* (0.39) , *Coprinus comatus (0.35)* . Lower use value reading indicated the restricted and limited knowledge possessed by local population including tribals regarding that mushroom species where as high use value report signifies that local inhabitants have deep understanding about the culinary and medicinal properties of that particular mushroom . *Geopora Arenicola* and *Morchella esculenta* has a long tradition of being used as culinary and in folk medicine. In the treatment of diabetes, heart problems, and reducing blood pressure , *Hericium yumthangense was* considered ethnomedicinally important. *Hericium erinaceus* has been found to have anti-fatigue properties and hence recommended as sports nutrition (Liu *et al.,* 2015). The extracts of this mushroom have been found to treat number of ailments as it has high free radical scavenging activity (Lew *et al.,* 2020). Similarly *Sparassis crispa* , besides having culinary potential , was traditionally used in the treatment of diarrhoea, diabetes and as an anti-cancerous agent. Ohno *et al.,* in 2000 supported this ethnomedicinal use of *S. crisspa* by reporting polysaccharides having antitumour properties from this mushroom. In the treatment of dehydration and burns , the local inhabitants have been found to use *Agaricus campestris*. Literature also support the fact that *Agaricus campestris* has anti-microbial, anti-inflammatory, antibacterial and neuroprotective properties due to the presence of various organic acids like fumaric acid, malic acid, oxalic acid. (Altmeyer et al., 1994 ; Baati et al., 2011;Kwak et al ., 2016).

Table 6 (Q): Wild edible mushrooms consumed in the study area.

S.No.	Name of mushroom species	Consumed
1.	***Helvella crispa***	Fresh/dried
2.	***Morchella esculenta***	Fresh /dried
3.	***Geopora arenicola***	Fresh/dried
4.	***Agaricus campestris***	Fresh/dried
5.	***Lycoperdon perlatum***	Fresh
6.	***Macrolepiota procera***	Fresh
7.	***Coprinus comatus***	Fresh
8.	***Flammulina velutipes***	Fresh
9.	***Pleurotus ostreatus***	Fresh/dried
10.	***Pluteus cervinus***	Fresh
11.	***Coprinellus micaceus***	Fresh
12.	***Schizophyllum commune***	Fresh/dried
13.	***Sparassis crispa***	Fresh
14.	***Laetiporus sulphureus***	Fresh/dried
15.	***Auricularia auricula-judae***	Fresh
16.	***Cantharellus cibarius***	Fresh/dried
17.	***Ramaria Formosa***	Fresh/dried
18.	***Hericium yumthangense***	Fresh/dried
19.	***Lactarius laeticolor***	Fresh/dried
20.	***Lactarius sanguifuls***	Fresh
21.	***Lactarius scrobiculatus***	Fresh
22.	***Lactarius abieticola***	Fresh
23.	***Lactarius volemus***	Fresh
24.	***Russula lakhanpalii***	Fresh

6.9.7 Cultural significance of wild Edible Mushrooms

In the current study, cultural significance of 24 wild edible Macro fungi has been calculated based on seven (7) cultural variables or sub-cultural indices .These indices are

Perceived abundance Index **(PAI)**

Frequency of use index **(FUI)**

Taste Score Appreciation Food Index (**TSAI)**

Multifunctional food index (**MFFI)**

Knowledge Transmission Index (**KTI)**

Economic index (**EI)**

Health index (**HI).**

Edible Mushroom Cultural Significance Index (EMCSI) has been calculated from the sum of all these sub- cultural indices multiplied by mention index.

Table6(R): Mushroom Cultural Significance Index along with other associated indices of wild edible macrofungi collected from the study area.

S.No	Species Name	M	MI	PAI	TASFI	HI	KTI	MFFI	EI	FUI	EMCSI
1	***Helvella crispa***	66	8.35	6.962	7.477	6.104	4.474	6.739	6.042	2.602	337.34
2	***Morchella esculenta***	78	9.87	8.987	9.385	8.010	8.904	8.987	9.477	9.500	624.278
3	***Geopora arenicola***	77	9.74	7.310	8.687	7.480	8.506	7.310	8.510	8.838	551.684
4	***Agaricus campestris***	76	9.62	8.038	7.963	7.131	7.849	8.038	8.009	7.674	526.234
5	***Lycoperdon perlatum***	65	8.22	4.019	3.108	2.442	3.215	1.853	3.330	4.500	184.679
6	***Macrolepiota procera***	64	8.10	4.019	3.185	2.664	3.240	1.853	3.207	7.500	207.910
7	***Coprinus comatus***	55	6.96	4.209	4.666	3.422	4.116	2.112	4.320	3.333	182.199
8	***Flammulina velutipes***	54	6.83	4.968	2.840	2.498	2.983	4.968	2.924	6.349	188.029
9	***Pleurotus ostreatus***	65	8.22	7.943	3.406	2.938	3.388	7.943	3.458	8.060	305.258
10	***Pluteus cervinus***	66	8.35	7.627	5.643	4.631	5.233	7.627	5.882	8.269	375.016
11	***Coprinellus micaceus***	53	6.70	6.269	4.502	3.383	4.249	6.269	4.242	7.321	242.775
12	***Schizophyllum commune***	42	5.31	6.930	2.131	1.998	2.562	6.930	2.379	5.946	153.332
13	***Sparassis crispa***	70	8.86	7.373	5.668	4.000	4.705	7.373	5.120	7.500	369.808
14	***Laetiporus sulphureus***	55	6.96	6.607	3.769	2.982	3.603	4.722	4.075	6.250	222.776
15	***Auricularia auricula-judae***	65	8.22	6.009	6.670	4.376	5.334	3.851	6.546	7.143	328.216
16	***Cantharellus cibarius***	70	8.86	6.884	3.226	3.131	3.226	5.612	3.226	6.381	280.738
17	***Ramaria Formosa***	44	5.56	5.728	3.171	3.053	3.171	4.280	3.126	4.342	149.403
18	***Hericium yumthangense***	52	6.58	6.867	7.184	6.513	7.085	6.867	7.180	5.313	309.320
19	***Lactarius laeticolor***	56	7.09	7.057	4.241	3.748	4.241	6.530	4.320	7.500	266.846
20	***Lactarius sanguifuls***	53	6.70	5.095	4.258	3.634	3.852	3.542	4.782	5.441	205.047
21	***Lactarius scrobiculatus***	61	7.72	5.095	2.979	2.871	3.128	3.542	3.053	5.833	204.588
22	***Lactarius abieticola***	33	4.18	5.918	2.454	2.498	2.498	4.625	1.915	6.724	111.322
23	***Lactarius volemus***	42	5.31	5.570	5.668	4.166	4.304	4.167	5.557	4.527	180.323
24	***Russula lakhanpalii***	39	4.93	4.937	4.145	3.899	4.041	4.937	4.443	3.750	148.649

M: Number of mentions in free listing, **MI:** Mention index, **PAI:** Perceived abundance index, **TASFI:** Taste score appreciation index, **HI:** Health index, **KTI:** Knowledge transmission index, **MFFI:** Multifunctional food index, **EI:** economic index, **FUI:** Frequency of use index, **EMCSI:** Cultural significance of wild edible mushrooms.

Table 6(P), clearly depicts that the cultural significance values of wild edible mushrooms varied from 111.322 for *Lactarius abieticola* to 624.278 for *Morchella esculenta* . Mushrooms with highest cultural significance values (EMCSI greater than or equal to 300) included *Morchella esculenta ,Agaricus campestris, Geopora Arenicola , Pluteus cervinus , Sparassis crispa , Auricularia auricula-judae , Helvella crispa , pleurotus ostreatus , Hericium yumthangense* . Mushrooms with low cultural significance values (EMCSI lower than or equal to 100) included *Lactarius abieticola,Russula lakhanpalli,Ramaria Formosa , Schizophyllum commune , Lactarius volemus ,Coprinus comatus, Flammulina velutipes ,Lycoperdon perlatum.* Since the relative importance of mentions determines EMCSI, species with more mentions have higher EMCSI values than those with fewer mentions. The most significant mushrooms were *Morchella esculenta ,Agaricus campestris, Geopora Arenicola , Pluteus cervinus , Sparassis crispa , Auricularia auricula-judae , Helvella crispa , pleurotus ostreatus , Hericium yumthangense* due to their flavour, health benefits, cooking easiness and economic worth. The sub-indices like PAI, TSAI, KTI, EI, FUI, MFFI, and HI made a substantial contribution to their cultural relevance.

According to Garibay-Orijel et al. (2007), *Ramaria spp., Cantharellus cibarius, and Amanita caesarea* were found to have highest EMCSI values. Alonso-Aguilar et al. (2014) recognised *Agaricus campestris, Amanita basii,* and *Ramaria spp.* to be culturally significant due to their delectable flavours and beneficial nutritional qualities. Due to their abundance and widespread consumption by the population, *Lactarius indigo* and *Amanita basii* were the most culturally significant macrofungal species (Robles-Garcia et al., 2018). *Pleurotus tuber-regium*, *Schizohyllum commune, Lentinus squarrulosus, Auricularia delicata,* and *A. cornea* were listed by Kamalebo et al. (2018) as the top five culturally significant mushrooms with *Pleurotus tuber-regium* the most culturally important mushroom and it was utilized for medicine, food and in relation to myth. The potential of some edible mushrooms has been worked out by Lopez-Hortas *et al* ., (2022).

Table 6(S): Shannon diversity Index and Evenness of wild macrofungi from various study sites.

Indices	Kishtwar City	Bindraban	Mugalmaidan	Chatroo	Chingam	Nagseni	Ikhala	Sarthal	Sinthan Top
Taxa_S	4	8	10	21	25	16	12	18	2
Menhinick	0.85	1.11	1.54	2.13	2.67	2.56	1.95	2.43	1.00
Margalef	0.97	1.77	2.41	4.37	5.36	4.09	3.02	4.24	0.72
Dominance_D	0.32	0.24	0.13	0.07	0.05	0.07	0.12	0.08	0.63
Shannon_H	1.26	1.67	2.14	2.85	3.08	2.71	2.27	2.71	0.56
Evenness_ e^H/S	0.91	0.81	0.93	0.94	0.96	0.98	0.91	0.94	0.81

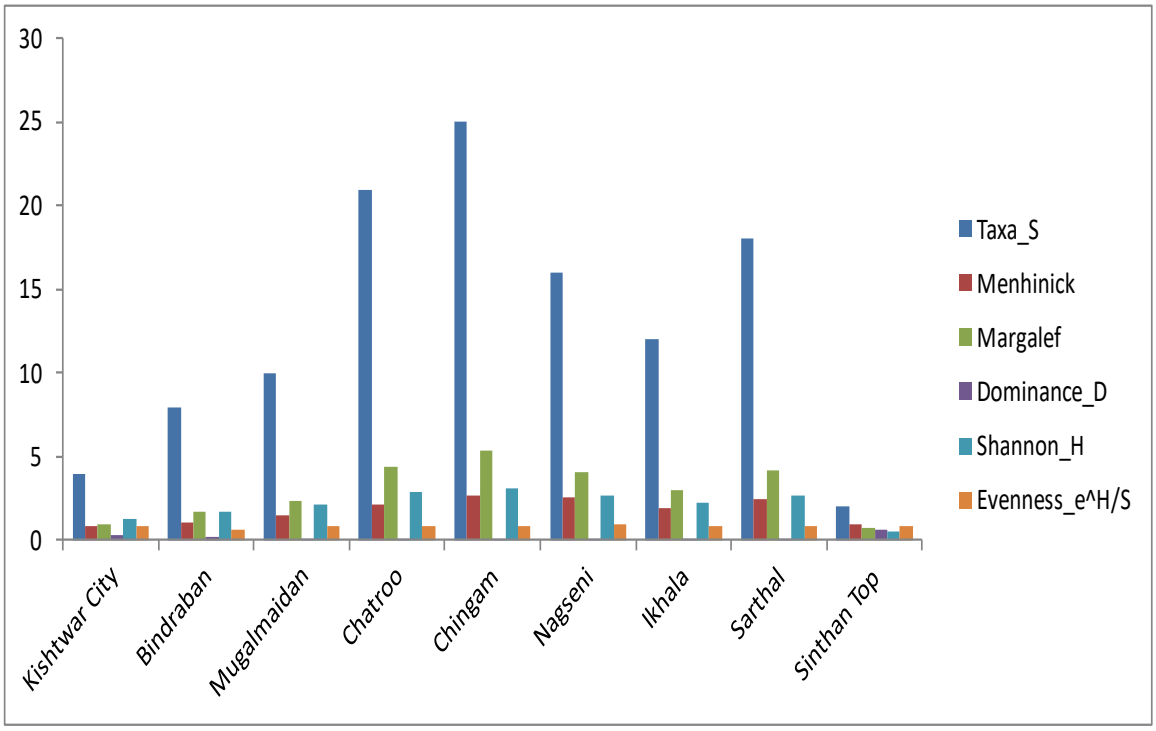

Fig 6(62): Showing different value of indices (richness and diversity indices) in various sites of the study area.

CHAPTER SEVEN

SUMMARY AND CONCLUSION

Wild Mushrooms constitute a wide range of heterotrophic macrofungi , producing either epigeous or hypogeous fruiting bodies and can be seen by naked eyes .They are made up of a vast network of microscopic filaments that resemble threads (hyphae), which when exposed to favourable temperatures and sufficient moisture, give rise to one or more fruit bodies . Besides cosmopolitan in distribution , mushrooms vary specifically with respect to their nutritional and ecological preferences. During monsoon season, favourable season, they occupying diverse niches in forest ecosystem. The mycelial filaments of wild mushrooms are invisibly underground, but the fruiting bodies are diverse and either upper or lower. Mushrooms have been categorised as bracket fungi, agarics, cup fungi, boletes, stinkhorns, jelly fungi, truffles, puffballs, bird's nest fungi, etc. Four major groups of Macrofungi/Mushrooms include edible, medicinal, poisonous and miscellaneous, where the properties are less well defined. Out of these, wild edible macro fungi offer number of applications in the form of food and medicines besides their key ecological roles.

The estimated number of fungal species is around 2.2-3.8 million with only a little over 150,000 species having been discovered, recognised and described so far . 97% of all fungal species are contributed by Ascomycota and Basidiomycota phyla in the kingdom fungi. Ascomycota is the largest phylum in the kingdom fungi with over 80,000 species belonging to around 6540 genera while the number of species in Basidiomycota is 30,000 belonging to 1589 genera . More than 27,000 different species of mushrooms are said to exist in the world out of which edible mushrooms belong to 2700 species and mushrooms of therapeutic value belongs to 700 species. In the kingdom Fungi, the phylum Ascomycota and Basidiomycota cover approximately 97% of all fungal species. The largest phylum in the fungal kingdom, Ascomycota, is highly diverse, containing 6540 genera with an estimated of over 80,000 species occupying various niches.

Some macro fungi are complex and diverse, hence necessitating the use of molecular technologies to distinguish and identify them in their habitat. The internal transcribed spacer (ITS) region of nuclear ribosomal DNA is the most often utilised

molecular marker for this purpose . The identification of a wide range of macrofungal species through various sequence-based investigations has significantly increased the diversity of known macrofungi. By incorporating the molecular analyses for complex macrofungi,the conflicting morphological characterization, discrepancies, and problems of discrimination between macrofungal species often associated with traditional taxonomic strategies can be mitigated .

The study of indigenous knowledge, folklore and traditional usage pattern of mushrooms as food, medicine and recreational objects as well as an aid to seasonal household economies is known as Ethnomycology which has become another research area to study the interrelationship between human social structures and macrofungi . People have used wild mushrooms for medicine, food and cosmetics, as well as other economic and cultural uses, since decades. Collecting fungi from the wild exist since ages.

According to the literature, the Union Territory of Jammu and Kashmir has been recognised as one of the hotspots for biodiversity, including mushrooms and taxonomy of mushrooms have been studied by several mycologist in recent times in the past. In Jammu and Kashmir , many researchers including the researchers from Mushroom Research Lab, Department of Botany, University of Jammu have made their marked contribution with respect to diversity and ethnomycology of macrofungal .This lab is now surveying the state's macrofungal diversity and has so far been successful in revealing the occurrence of numerous wild mushroom species that were earlier unknown in the area The investigations shows that Jammu and Kashmir, with its high biodiversity, served as the nursery for these species, indicating the likelihood of many more of these macrofungal species in the region. Such studies are found wanting in Kishtwar district of Jammu and Kashmir . Kishtwar , the newly created district of Jammu province, was chosen for the current study because the diversity of mushrooms has never been studied or discovered so far. Furthermore, considering the vegetation and climatic characteristics of the area, it was predicted that this area would be home to a number of unique and interesting .

In the current study , a total of 71 different mushroom collections were made from the nine sites of the study area. Out of these, 47 macrofungal species belonging to 32 genera, 23 families, 9 orders and 2 phyla were morpho taxonomically characterized and

identified. Some macrofungal species were also molecularly characterized wherever species delineation was required. The identified species belonged to genera *viz*., *Helvella* (2 species) ,*Morchella* (1 species), *Geopora* (1 species), *Gyromitra* (1 species) , *Agaricus (1 species)* , *Apioperdon* (1 species) ,*Lycoperdon* (1 species) , *Lepiota* (1 species), *Macrolepiota* (1 species), *Bovista* (1 species) ,*Coprinus* (1 species), *Amanita (8 species), Flammulina (1 species) ,Pleurotus (1 species) , Pluteus (1 species), Coprinellus (1 species), Panaeolus (1 species), Schizophyllum (1 species)* , *Pholiota (1 species)* , *Sparassis (1 species),Laetiporus (1 species) , Auricularia (1 species) ,Boletus (1 species), Veloporphyrellus (1 species), Suillus (1 species),Cantharellus (1 species), Geastrum (1 species), Ramaria (1 species), Lepista (1 species), Hericium (1 species) ,Lactarius (5 species), Lactifluus (1 species) , Russula (3 species).*

Out of the total macrofungal species belonging to different families and orders from the study, it has been found that order Agaricales of Basidiomycota is the most predominant as it constituted most of the families(8 Families) with family Amanitaceae (8 species) and Agaricaceae (7 species) most prevalent. (8 families) with eight (8) families . Order Agaricales was followed by order Russulales in which family Russulaceae was represented by 9 species and Family Hericiaceae by 1 species. Russulales was followed by Order Pezizales comprising of four families namely Helvellaceae (2 species), Morchellaceae (1 species), Pyronemataceae (1 species) and Discinaceae (1 species).

One macrofungal species i.e *Amanita sp*. having unique microscopic and morphological characteristic features has been proposed as new to science.

Out of total 71 collections, 47 species were identified and described out of which 22 identified Species were recorded for the first time from the study area. 16 taxa belonging to 6 genera distributed over 5 families were new additions to the macrofungal flora of Jammu and Kashmir (Table and Figure). These include *Lactarius laeticolor, Lactarius sanguifluus, Lactarius scrobiculatus, Lactarius zonarius, Lactarius abieticola, Lactifluus volemus, Russula pseudoamoinicolor, Russula lakhanpalii, Russula densifolia, Amanita orsonii, Amanita pakistanica, Amanita griseofusca, Amanita subglobosa, Lepista sordida, Amanita orientigemmata, Laetiporus sulphureus.* Two taxa belonging to different families

have been reported for the first time from India . These include *Amanita griseopantherina and Veloporphyrellus latiporus.*

Significant differences in the number of macrofungal species with respect to the location of collection site were revealed by a comparative analysis of the distribution of several macrofungal groups, demonstrating the unequal distribution of these organisms in the study area. With up to 25 species, Chingam emerged as the most diverse mycological zone of all the collection sites, followed by Chatroo with 21 species , Sarthal with 18 species , Nagseni with 16 species , Ikhala with 12 species and Mugalmaidan with 10 species. The least amount of mushroom species were discovered in Sinthan top (2 species), Bindraban (4 species) and Kishtwar city (8 species). The macrofungal species exclusively reported from Chingam includes *Macrolepiota procera, Amanita orsonii, A.griseofusca, A. garhwalensis, Pholiota squarrosa, Hericium yumthangense, Russula pseudoamoinicolor*. Chatroo specific mushroom species reported in the current study include *Amanita subglobosa, A griseopantherina, Auricularia auricula-judae,Lactarius abeiticola, Pluteus cervinus.* Schizophyllum commune has been reported to be restricted to Kishtwar city only. The macrofungal species restricted to Bindraban include *Veloporphyrellus latisporus and Lepista sordida. Laetiporus sulphurius* has been exclusively found in sinthan top.

In the current investigation, four intervals of annual phenological observations were made i.e January to March, April to June, July to September, October to December in order to explore the seasonal differences in macrofungal phenology. The phenological events of these macrofungal species were compared, and the results showed that 4 species proliferated from Jan to March, 8 species were found from Aril to June. However, during the wet summer months (July – Sep.), 30 macrofungal species were gathered . Only nine macrofungal species were gathered during the autumn season (Oct. – Dec.) indicating a decrease in the prevalence of these species. Low incidence of macrofungal species during winter months (Jan -March) may be related to climate signals like snow cover, freezing temperatures, frost, etc. that limit fungal mycelium's ability to grow and function, which in turn prevents the formation of fruiting bodies. The fact that macrofungal fruiting body production is highest from july to sep. , when monsoons are at their peak in the

region, suggests that moisture plays a significant role in fruiting of these macrofungi. The abundance of mushrooms during rainy season has been reported by number of researchers (Abraham et al ., 1981; Vishwakarma et al ., 2012; Sharma et al.,2020).

In the current study the substrate preferences of mushrooms was also investigated and it has been found none of the mushroom species occupied two or more substrates and the majority of them were substrate-specific, growing only on one kind of substrate. Out of the 47 wild macrofungal taxa that have been collected , identified and recorded from the study area, 16 species have been identified as Humicolous and these included *Agaricus campestris, Coprinellus micaceus, Geastrum sacchatum, , Morchella esculenta Sparassis crispa, Lycoperdon perlatum, Apioperdon pyriforme, Pluteus cervinus ,Boletus edulis, Lepiota cristata, Macrolepiota procera, Bovista plumbea, Pholiota squarrosa, Gyromitra esculenta, Ramaria Formosa, Lepista sordida.* . 23 species of wild macrofungi , divided into 10 genera and 7 families have been reported to form ectomycorrhizal association with the roots of higher plants in different study sites. These species included *Helvella crispa, H.elastica , Amanita. flavipes, A. orsonii, Geopora arenicola A. pakistanica, Amanita griseofusca, Amanita subglobosa , Amanita orientigemmata , Amanita griseopantherina, Amanita garhwalensis, , Veloporphyrellus latisporus, Suillus americanus, Lactarius sanguifuls, Lactarius abieticola , Lactarius volemus, Russula pseudoamoinicolor, Russula lakhanpalii , R. densifolia Cantharellus cibarius, L. laeticolor, L. scrobiculatus, L. zonarius,* A total of 6 macrofungal species exhibiting lignicolous habit(growing on fallen dead wood logs and wood stumps). were identified during the current study and these include *Auricularia auricula-judae, Flammulina velutipes, Hericium yumthangense,, Pleurotus ostreatus, Laetiporus sulphureus and Schizophyllum commune.* Only two macrofungal taxa i.e *Coprinus comatus and Panaeolus papilinaceus* have been reported to be coprophilous in the current study.

In the study area , the ethnomycological survey made it possible to record folk taxonomy of wild macrofungal taxa. Vernacular names of collected wild mushrooms were gathered from the locals , adding to the folk taxonomy that mycologists can use when looking for such fungi in far-off forest regions. The locals were found to prefer collecting the mushrooms in the spring and summer seasons. In order to gather useful data regarding

the consumption and usage of fleshy macro-fungi by the inhabitants of various settlements, surveys relating to the collecting of wild mushrooms were carried out in a number of localities in the district Kishtwar between the years of 2020 and 2022. Elderly people of the study region, important informants, and the head of the village were all questioned using specially self-designed questionnaires in their native tongue. Information has been gathered in various sites of the study area through semi-structured interviews, conversations, and first hand observations with tribal members, hakeems, nomads, elderly people, local informants, as well as by distributing questionnaires to the general public.

The ethnomycological findings showed that 24 wild mushroom species were consumed and utilised medicinally. These include *Helvella crispa , Morchella esculenta, Geopora Arenicola, Agaricus campestris ,Lycoperdon perlatum ,Macrolepiota procera,Coprinus comatus,Flammulina velutipes,Pleurotus ostreatus ,Pluteus cervinus, Coprinellus micaceus, Schizophyllum commune ,Sparassis crispa,Laetiporus sulphureus,Auricularia auricula-judae, Cantharellus cibarius ,Ramaria Formosa,Hericium yumthangense, Lactarius laeticolor,Lactarius sanguifuls,Lactarius scrobiculatus ,Lactarius abieticola,Lactifluus volemus, Russula lakhanpalii.* These mushrooms have socio-economic, traditional, and cultural significance in the study area as revealed by ethnomycological survey. The cultural significance of these 24 wild edible mushrooms was also determined on the bases of some important sub-cultural indices *viz.*, Mention Index, Frequency of use index, Taste score appreciation food index, Perceived abundance index , Knowledge transmission index, Multifunctional food index , Health index and Economic index. The study of cultural significance of wild edible mushrooms is the first quantitative analysis of ethnomycological knowledge conducted in India. Mushrooms with the highest cultural significance values included *Morchella esculenta ,Geopora Arenicola* and with lowest cultural significance values included *Lactarius abieticola, Russula lakhanpalli, Ramaria Formosa.*

Also, the indigenous knowledge extracted through ethnomycological survey can be integrated as an input in mycomedicinal studies and food security. The study also recommends the domestication and cultivation of indigenous culturable mushrooms to diversify their cultivation. The clinical investigation of their medicinal uses *in vivo* to

validate the indigenous practices of local populace are also called for and finally there is a need to devise strategies to conserve these mushroom genetic resources for sustainable ecosystem services.

In the conclusion, this is the first thorough study on wild mushrooms ever conducted in district Kishtwar of Jammu and Kashmir. Due to the different topography, climatic conditions and dense forest cover in the study area, wild mushrooms were discovered to be abundant and diversified, creating an ideal setting for their luxuriant growth and distribution . From the above results , it is clear that out of total 47 macrofungal species identified , twenty four species were found to be edible on the basis of ethnomycological information. Twenty three species were found to form ectomycorrhizal association , sixteen species as humicolous , six as lignicolous and only two species were found to be coprophilous. The number of macrofungal species reported for the first time from the study area are twenty five. Similarly macrofungal species reported for the first time from J&K are eleven. From India two species were reported for the first including one new generic record and one species was proposed new to science. The maximum number of macrofungal species identified from the single collection site is twenty five and the minimum species identified from any collection site is two.There is still a great probability that the area has many more intriguing wild mushroom species. Therefore, more research and explorations must be done to gather mushrooms in the nearby locations, which may result in the discovery of some new and valuable mushroom species.

Additionally, the indigenous knowledge from an ethnomycological survey can be used as a source of information for mycomedicinal studies and food security. The study also recommends more explorations needs to be done to characterize and identify the edible and medicinally important mushroom species and their possible cultivation on a large scale to uplift the rural economy and ensure food security. Finally, it is necessary to come up with plans to preserve these mushroom genetic resources for long-term ecological uses in sustainable manner.

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