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WILD EDIBLE MUSHROOMS OF THE WESTERN HIMALAYAS: DISTRIBUTION, ETHNOMYCOLOGY AND MORPHOTAXONOMIC CHARACTERIZATION

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ABSTRACT

Wild edible fungi (WEF) represent an important component of Himalayan biodiversity and constitute valuable nutritional and ethnomycological resources for indigenous communities. The present study aimed to document the diversity, traditional utilization and morphotaxonomic characteristics of WEF from the Western Himalayan region. Ten species, namely *Laccaria* sp., *Ganoderma lucidum*, *Agaricus* sp., *Volvariella bombycina*, *Sparassis crispa*, *Lepista nuda*, *Coprinus comatus*, *Morchella esculenta*, *Geopora arenicola* and *Rhizopogon* sp., were collected and identified through detailed macro-morphological characterization. Collection forays were predominantly recorded during March–April and July–August, coinciding with favourable environmental conditions for sporocarp emergence. Taxonomic analysis revealed that eight species belonged to Basidiomycota and two to Ascomycota, representing four orders and ten families. Ethnomycological investigations indicated that most of the documented species were traditionally consumed as fresh food by local populations. Additionally, powdered preparations of *Ganoderma lucidum* and *Sparassis crispa* were reported to be used in traditional healthcare practices for the management of common cold and immune related ailments. Morphotaxonomic characterization based on diagnostic features, including pileus, stipe, ring, volva and veil morphology, facilitated species delineation and identification. The present investigation provides baseline information on the diversity, traditional knowledge and morphotaxonomy of WEF from the Western Himalayas, including documentation of some taxa reported for the first time from the study area. The findings highlight the ecological, nutritional and socio economic significance of these fungal resources and emphasize the need for sustainable conservation and cultivation strategies for their future utilization.

Keywords: Collection, Biodiversity, Ethnomycology, Morphotaxonomy, Wild mushrooms.

Introduction

Wild edible mushrooms are important components of forest biodiversity and have long been valued for their nutritional, medicinal, economic and cultural significance. Since ancient times, human societies have relied on naturally occurring biological resources for sustenance, and mushrooms have traditionally formed an integral part of indigenous food systems. These macrofungi, often referred to as "delicacies from the mountains," are collected from diverse natural habitats and are increasingly recognized for their therapeutic and nutraceutical potential. Globally, nearly 150,000 mushroom species are estimated to exist, although only about 10% have been scientifically described. Among these, approximately 2,000 species are considered edible, while only a limited number are commercially cultivated worldwide (Hoa *et al*., 2017; Kumari, 2011). In India, cultivation

is largely confined to *Agaricus bisporus*, *Pleurotus* spp., *Volvariella volvacea*, *Calocybe indica* and *Lentinula edodes*.

In recent decades, mushroom consumption and cultivation have increased substantially owing to growing awareness regarding their nutritional attributes and health promoting bioactive compounds (Elnaiem *et al*., 2017). Mushrooms are now widely regarded as functional foods and sources of nutraceuticals with potential applications in disease prevention and management (Vieira *et al*., 2016). However, not all naturally occurring mushrooms are edible, and several species may be toxic or even lethal. Indigenous communities have traditionally distinguished edible species through accumulated ethnomycological knowledge passed across generations (Fui *et al*., 2018).

Wild edible mushrooms are commonly encountered during the rainy season in forests, grasslands, agricultural fields and decaying organic substrates. Understanding their ecology, diversity and traditional uses is essential for sustainable utilization, conservation and domestication of economically important taxa (Rizal *et al*., 2016; Kalaw *et al*., 2016). Owing to its diverse agro climatic conditions, the Jammu region of the Western Himalayas harbours rich fungal diversity. Therefore, the present study was undertaken to document the diversity, ethnomycological significance and morphotaxonomic characteristics of wild edible mushrooms from this region, with the objective of preserving traditional knowledge and exploring their potential for nutritional security and rural livelihoods.

Materials and Methods

Study area and ethnomycological survey

Field investigations were conducted during 2018–2021 in different forested locations of the Jammu region of the Western Himalayas, including Bhaderwah (Doda district), Bani and Sarthal (Kathua district), and Nathatop (Udhampur district). These regions were selected because of their diverse agro-climatic conditions and rich macrofungal diversity. Several collection sites and adjoining forest areas were surveyed for the occurrence of wild edible fungi (WEF) (Fig. 1). Periodic field explorations were mainly conducted during March–April and July–August, corresponding to peak sporocarp emergence periods. Ethnomycological information regarding traditional uses, edibility and medicinal applications of WEF was collected through semi-structured interviews and personal interactions with local inhabitants, elderly residents, livestock rearers and nomadic tribes including Gujjars and Bakkarwals.

Collection and preservation of specimens

Fresh and healthy sporocarps (n = 10–15 per species) were carefully collected from their natural habitats using a sterile digging knife to avoid damage to underground structures. Field photographs and ecological observations were recorded at the collection sites. Macromorphological characteristics, including pileus and stipe morphology, colour, size and habitat features, were documented immediately after collection. Colour terminology was standardized according to Ridgway (1912). Each specimen was assigned a unique accession code and transported in sterile brown paper bags to prevent contamination and sample mixing. Samples were dried in a hot air oven at 60°C and subsequently stored at 4°C for further taxonomic investigations (Yesil and Yıldız, 2004).

Isolation and maintenance of pure cultures

Pure cultures were established under aseptic conditions. Fruiting bodies were washed with sterile distilled water and blotted dry on sterilized filter paper. Small tissue bits (1–2 mm) excised from the pileus region were surface sterilized in 0.5% sodium hypochlorite solution for 1 min, rinsed and inoculated onto potato dextrose agar (PDA) plates. The inoculated plates were incubated at 25 ± 1°C for 7–10 days. Emerging mycelia were sub-cultured to obtain pure cultures, which were maintained on PDA slants at 4°C for subsequent studies and spawn preparation.

Morphological characterization

Microscopic characterization was carried out by reviving dried specimens in 5% ethanol followed by treatment with 3% KOH for 10–15 min. Thin hand-cut sections were stained with Congo red and crystal violet and examined under an Olympus CX43 biological microscope at magnifications up to 1000×. Photomicrographs were recorded, and identification was performed using standard microscopic and anatomical characteristics (Overholt, 1953).

Macromorphological characterization of collected WEF was performed following the descriptors proposed by Atri *et al*. (2005). Important diagnostic features, including habit, pileus morphology, hymenial configuration, lamellae arrangement, stipe characteristics, context, annulus and volva, along with taste, odour and latex secretion, were recorded at the time of collection (Table 1).

Deposition of specimens

Pure mycelial cultures and dried specimens were deposited in the culture repositories of the Indian Institute of Integrative Medicine (IIIM), Jammu, and

the Directorate of Mushroom Research (DMR), Solan, Himachal Pradesh, India.

Results and Discussion

A total of ten wild edible fungi (WEF) were collected from different forested locations of the Jammu region of the Western Himalayas and identified through detailed morphotaxonomic characterization as *Laccaria* sp., *Ganoderma lucidum*, *Agaricus* sp., *Volvariella bombycina*, *Sparassis crispa*, *Lepista nuda*, *Coprinus comatus*, *Morchella esculenta*, *Geopora arenicola* and *Rhizopogon* sp. Morphological diversity and field characteristics of the collected taxa are presented in Plate 1. Taxonomic classification, family placement and accession numbers of the identified WEF deposited in different culture repositories are presented in Table 2. Among the identified taxa, eight species belonged to Basidiomycota, whereas two species belonged to Ascomycota. These fungi represented four orders, namely Agaricales, Polyporales, Pezizales and Boletales, and ten families including Hydnangiaceae, Polyporaceae, Agaricaceae, Pluteaceae, Sparassidaceae, Tricholomataceae, Coprinaceae, Morchellaceae, Pyronemataceae and Rhizopogonaceae. Pure mycelial cultures and dried voucher specimens were successfully deposited in the culture banks of the Directorate of Mushroom Research (DMR), Solan and Indian Institute of Integrative Medicine (IIIM), Jammu (Plate 2). The accession numbers assigned to the deposited cultures are also listed in Table 2.

Ethnomycological investigations revealed that local inhabitants possessed substantial traditional knowledge regarding the identification, utilization and medicinal significance of WEF (Table 3). Most of the collected species, including *Laccaria* sp., *Agaricus* sp., *Volvariella bombycina*, *Lepista nuda*, *Coprinus comatus*, *Morchella esculenta*, *Geopora arenicola* and *Rhizopogon* sp., were consumed as fresh food. However, powdered preparations of *Ganoderma lucidum* and *Sparassis crispa* were traditionally utilized for the treatment of common cold and immune related disorders. Similar ethnomycological utilization patterns of edible and medicinal mushrooms from Jammu and Kashmir were reported by Sharma *et al*. (2022) and Ullah *et al*. (2022), indicating the strong association of indigenous communities with naturally occurring fungal resources.

Collection records, including locality, altitude, GPS coordinates and habitat characteristics of the collected WEF, are presented in Table 4. Among the surveyed regions, Kathua district exhibited comparatively greater fungal diversity, accounting for seven species, while three species were recorded from Doda district. Most taxa were collected from coniferous forest ecosystems characterized by high organic matter accumulation, moderate temperature and humid microclimatic conditions favourable for sporocarp emergence. Fruiting bodies were predominantly encountered during March–April and July–August, corresponding to periods of increased rainfall and soil moisture. Similar seasonal occurrence and habitat preferences of wild mushrooms from Jammu and Kashmir were also documented by Lalotra *et al*. (2018). Species exhibited diverse ecological associations, including saprophytic, humicolous, lignicolous and hypogenous growth habits. *Ganoderma lucidum* was frequently associated with decaying wood and tree stumps, whereas *Rhizopogon* sp. occurred as underground fruiting bodies in conifer-dominated habitats. *Sparassis crispa* was observed growing singly or in clusters near the base of oak and pine trees, indicating its saprobic/parasitic association with woody substrates.

Pure cultures of all collected WEF were successfully established on potato dextrose agar (PDA) medium and maintained at 4°C for further studies and spawn preparation. Microscopic observations of revived specimens revealed distinct taxonomic features such as basidiospores, ascospores, basidia and cheilocystidia, which aided in accurate species identification (Plate 3 and Plate 4). The microscopic characters observed were consistent with standard taxonomic descriptions reported for these genera.

Macromorphological characterization of fresh sporocarps revealed substantial variability in pileus morphology, stipe structure, hymenial configuration and reproductive characters among the identified WEF (Table 5). Variations were observed in pileus shape, colour, texture, margin characteristics and surface ornamentation, which served as important diagnostic features for species delimitation. The pileus colour ranged from light brown in *Laccaria* sp. to reddish-brown in *Ganoderma lucidum*, creamy white in *Volvariella bombycina*, dark brown in *Morchella esculenta* and light yellow in *Rhizopogon* sp. Lamellar arrangement also varied considerably, with free, crowded and sub distant lamellae observed in agaricoid taxa, whereas *Ganoderma lucidum* possessed a poroid hymenial surface. Presence of annulus was observed only in *Agaricus* sp., while a well-developed saccate volva was characteristic of *Volvariella bombycina*. Veil structures were absent in all other taxa. Distinctive branching morphology in *Sparassis crispa* and honeycomb like ascocarp structure in *Morchella esculenta* further facilitated species differentiation.

Similar emphasis on macro and micro morphological characterization for fungal identification has been reported by Joty *et al*. (2020), Rahaman *et al.* (2016), Semwal *et al*. (2014) and Kumar *et al*. (2013). Comparable diversity of edible macrofungi from Jammu and Kashmir has also been documented by Dar *et al*. (2022) and Kumar and Sharma (2011), including genera such as *Agaricus*, *Coprinus*, *Geopora*, *Morchella*, *Rhizopogon* and *Sparassis*.

Conclusion

The present investigation provides comprehensive baseline information on the diversity, ethnomycology and morphotaxonomy of wild edible fungi (WEF) from the Western Himalayan region of Jammu. Ten edible macrofungal species belonging to Basidiomycota and Ascomycota were documented and characterized using detailed macro and micro morphological traits. The study revealed substantial indigenous knowledge regarding the nutritional and medicinal utilization of WEF among local communities. Seasonal abundance during March–April and July–August highlighted the ecological suitability of conifer dominated habitats for sporocarp development. Morphotaxonomic characterization, coupled with preservation of pure cultures and voucher specimens in recognized culture repositories, provides valuable reference material for future taxonomic, ecological and domestication studies. The findings underscore the ecological, nutritional and socio-economic importance of naturally occurring mushroom resources and emphasize the need for sustainable conservation, scientific validation and development of cultivation technologies for promising WEF species to enhance rural livelihoods and nutritional security in the Himalayan region.

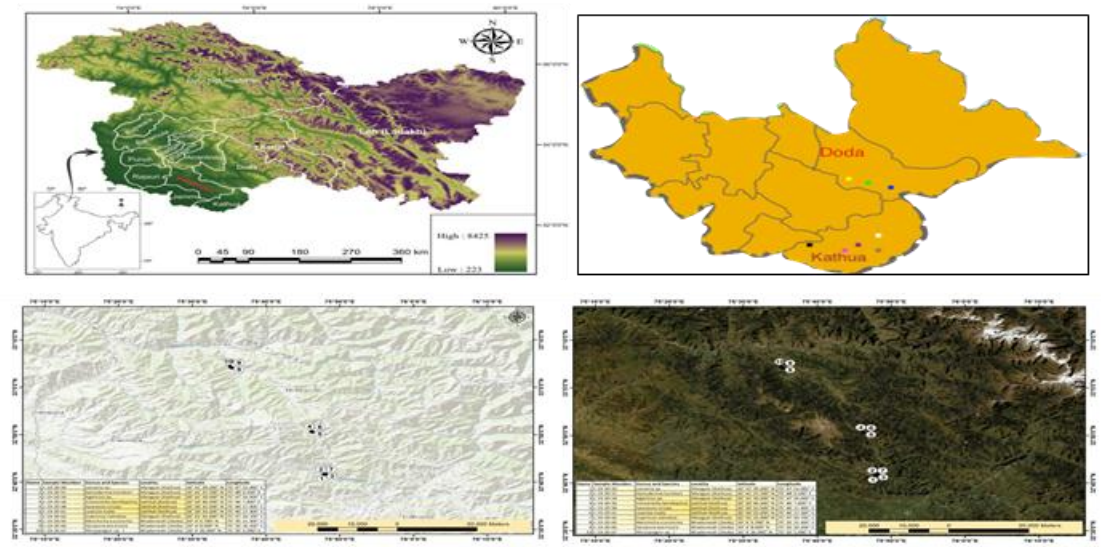

Fig. I : Study area map of wild edible fungi of Jammu region

Table 1: Performa for identification of wild edible fungi

○	Specimen No.	
○	Date of collection	
○	Locality	
○	GPS Data	
	Longitude	
	Latitude	
	Altitude	
○	Single, in groups or connate (United)	
○	Habitat (Humus, wooden stumps or trees, dung, sand, or any other)	
○	Smell (Y/N)	
○	Cap	
	Colour	
	Diameter	
	Shape	
	Scales / smooth/any other	
○	Stipe	

	Central, lateral or excentric	
	Colour	
	Stipe size and length	
	Stipe base	
o	Ring present or absent	
o	Volva present or absent	
o	Veil present or absent	
o	Gill colour	
o	Photographs of natural specimen showing habitat and after taking out from the soil showing cap, stem, ring, gills, volva and stem base	

Table 2: Taxonomic position and accession numbers of wild edible fungi

Sample No.	Genus and species	Order	Family	Accession Number	Culture bank
J-19-20-50	*Laccaria* sp.	Agaricales	Hydnangiaceae	DMRX-1812	DMR, Solan
J-19-20-51	*Ganoderma lucidum*	Polyporales	Polyporaceae	MRCJ-1063	IIIM, Jammu
J-19-20-54	*Agaricus* sp.	Agaricales	Agaricaceae	DMRX-1816	DMR, Solan
J-19-20-56	*Volvariella bombycina*	Agaricales	Pluteaceae	DMRX-1811	DMR, Solan
J-19-20-58	*Sparassis crispa*	Polyporales	Sparassidaceae	DMRX-1813	DMR, Solan
J-19-20-61	*Lepista nuda*	Agaricales	Tricholomataceae	MRCJ-1061	IIIM, Jammu
J-19-20-62	*Coprinus comatus*	Agaricales	Coprinaceae	DMRX-1817	DMR, Solan
J-19-20-65	*Morchella esculenta*	Pezizales	Morchellaceae	MRCJ-1066	IIIM, Jammu
J-19-20-66	*Geopora arenicola*	Pezizales	Pyronemataceae	MRCJ-1064	IIIM, Jammu
J-19-20-67	*Rhizopogon* sp.	Boletales	Rhizopogonaceae	MRCJ-1065	IIIM, Jammu

Table 3: Ethnomycology and folk taxonomy of wild edible fungi of Jammu region

Sample No.	Genus and species	Local name	Time of appearance	Traditional use
J-19-20-50	*Laccaria* sp.	Chaitar	July-August	Used as dietary source and general tonic
J-19-20-51	*Ganoderma lucidum*	Heand, Reishi	July-August	Decoction is advised to people with compromised immune systems. It is used by local herbalists to treat coughs and colds combined with honey and kaloongi.
J-19-20-54	*Agaricus* sp.	Chatri, Chaitar	July-August	Widely used as dietary source and general tonic
J-19-20-56	*Volvariella bombycina*	Sirer	July-August	Mainly used fresh for food
J-19-20-58	*Sparassis crispa*	Bedth Shairee, Kawa khour	July-August	Blood purifier, anti-cold, and general tonic are the main uses.
J-19-20-61	*Lepista nuda*	Chatri, Khumb	July-August	Mainly used fresh for food
J-19-20-62	*Coprinus comatus*	Setherwat	July-August	Mainly used fresh for food
J-19-20-65	*Morchella esculenta*	Kann guch, Guuch, Guchhii, , Batta Guchi	March-April	Widely used as dietary source, fresh as well as in dried form
J-19-20-66	*Geopora arenicola*	Kundii, Shage Kan	March-April	Used as dietary source and cooked with milk.
J-19-20-67	*Rhizopogon* sp.	Dudh Katt, Moraii Dudh Katt	March-April	Utilized as a general tonic when raw, dried, or as a vegetable

Table 4: Collection and distribution of wild edible fungi from Jammu region

Sample No.	Genus and species	Date of collection	Locality	GPS Data			Single/ groups	Habitat
				Longitude	Latitude	Altitude		
J-19-20-50	*Laccaria* sp.	23.08.2019	Mangyar (Kathua)	75°47'52.6"E	32°41'39.2"N	2000 m	Single	Scattered in grasses
J-19-20-51	*Ganoderma lucidum*	23.08.2019	Mangyar (Kathua)	75°48'09.5"E	32°41'37.7"N	2000 m	Single and in groups	Wooden stumps
J-19-20-54	*Agaricus* sp.	23.08.2019	Mangyar (Kathua)	75°47'56.6"E	32°41'39.3“N	2000 m	Single	Humicolous soil
J-19-20-56	*Volvariella bombycina*	24.08.2019	Sarthal (Kathua)	75°46'07.8"E	32°50'40.2"N	2150 m	Single	On tree
J-19-20-58	*Sparassis crispa*	24.08.2019	Sarthal (Kathua)	75°46'17.4"E	32°50'32.5"N	2150 m	Single	On tree stumps
J-19-20-61	*Lepista nuda*	24.08.2019	Sarthal (Kathua)	75°46'17.3"E	32°50'33.2"N	2150 m	Groups	Open grasslands
J-19-20-62	*Coprinus comatus*	23.08.2019	Mangyar (Kathua)	75°47'50.7"E	32°41'35.4"N	2000 m	Growing gregariously or in groups	Humicolous soil
J-19-20-65	*Morchella esculenta*	02.04.2020	Bhaderwah (Doda)	75°35'21.3"E	33°04'05.7"N	1700 m	Single or in Groups	Humicolous soil
J-19-20-66	*Geopora arenicola*	02.04.2020	Bhaderwah (Doda)	75°35'20.2"E	33°04'08"N	1700 m	Groups	Humicolous soil
J-19-20-67	*Rhizopogon* sp.	02.04.2020	Bhaderwah (Doda)	75°35'05.9"E	33°04'26"N	1700 m	Single	Under Ground

Table 5: Morphological characters of wild edible fungi collected from Jammu region

Sample No.	Genus and species	Pileus				Stipe			Ring Present/ absent	Volva present/ absent	Veil present/ Absent
		Colour	Diameter (cm)	Shape	Scales	Central/ lateral	Colour	Diameter and length (cm)			
J-19-20-50	*Laccaria* sp.	Light brown	3-4	Depressed with a umbo	No	Central	Light brown	0.4 and 3.5-5	Absent	Absent	Absent
J-19-20-51	*Ganoderma lucidum*	Brown to reddish brown	4.5-6	Reniform	No	Lateral	Brown to reddish brown	0.5-1and 9-12	Absent	Absent	Absent
J-19-20-54	*Agaricus* sp.	Yellowish white	5	Convex	Light brown more dense towards the center	Central	White	0.4 and 8	Present	Absent	Absent
J-19-20-56	*Volvariella bombycina*	Creamish white	8.5	Conical	Cover entire pileus surface	Central	White	0.6 and 7-9	Absent	Present	Absent
J-19-20-58	*Sparassis crispa*	White	20	-	-	-	-	-	Absent	Absent	Absent
J-19-20-61	*Lepista nuda*	White to Light brown	2-3	Convex	Smooth	Central	White	0.2-0.3 and 1.5- 2.5	Absent	Absent	Absent
J-19-20-62	*Coprinus comatus*	White	1-2	Conical	Smooth	Central	White	0.2-0.3 and 2.5- 4	Absent	Absent	Absent
J-19-20-65	*Morchella esculenta*	Brown to Dark Brown	0.5-1	Conical	No	Central	White to cream	0.2-0.3 and 1.5- 2.5	Absent	Absent	Absent
J-19-20-66	*Geopora arenicola*	Cream to white	0.5-1	Cup	No	-	-	-	Absent	Absent	Absent
J-19-20-67	*Rhizopogon* sp.	Cream to light yellow	1-2	Round	No	-	-	-	Absent	Absent	Absent

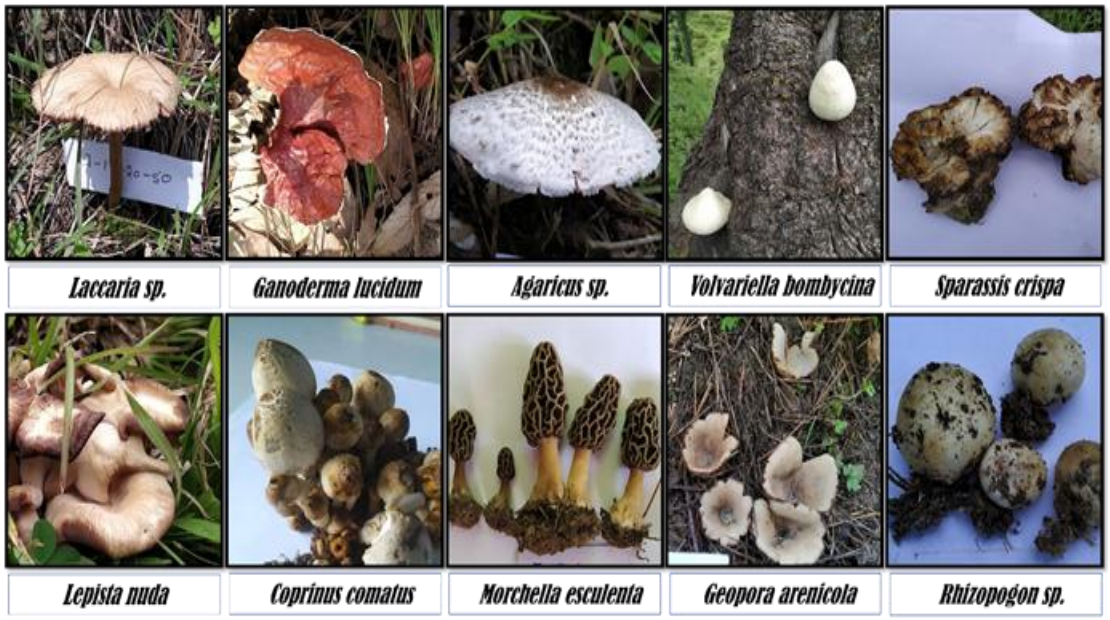

Plate 1: Field photographs of wild edible fungi

Plate 2: Wild edible fungi: - (A) Pure mycelial cultures; (B) Dried specimens

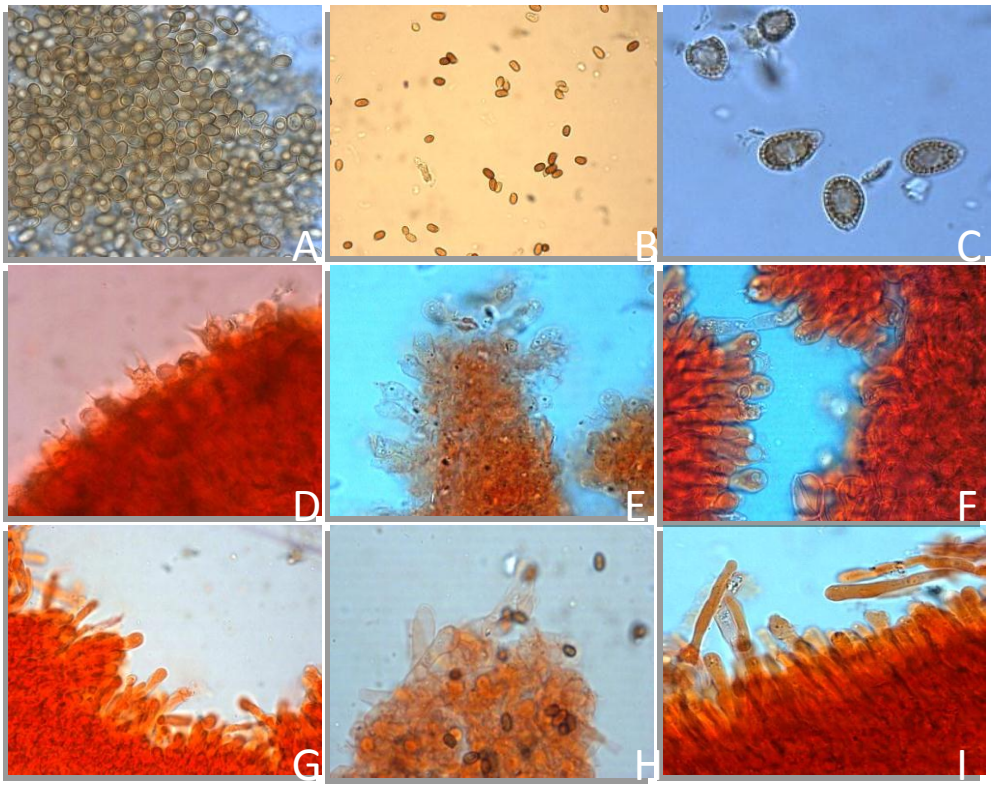

Plate 3: Microscopic details of wild edible fungi at 1000X
A, B and C: Basidiospores; D, E and F: Basidia; G, H and I: Cheilocystidia

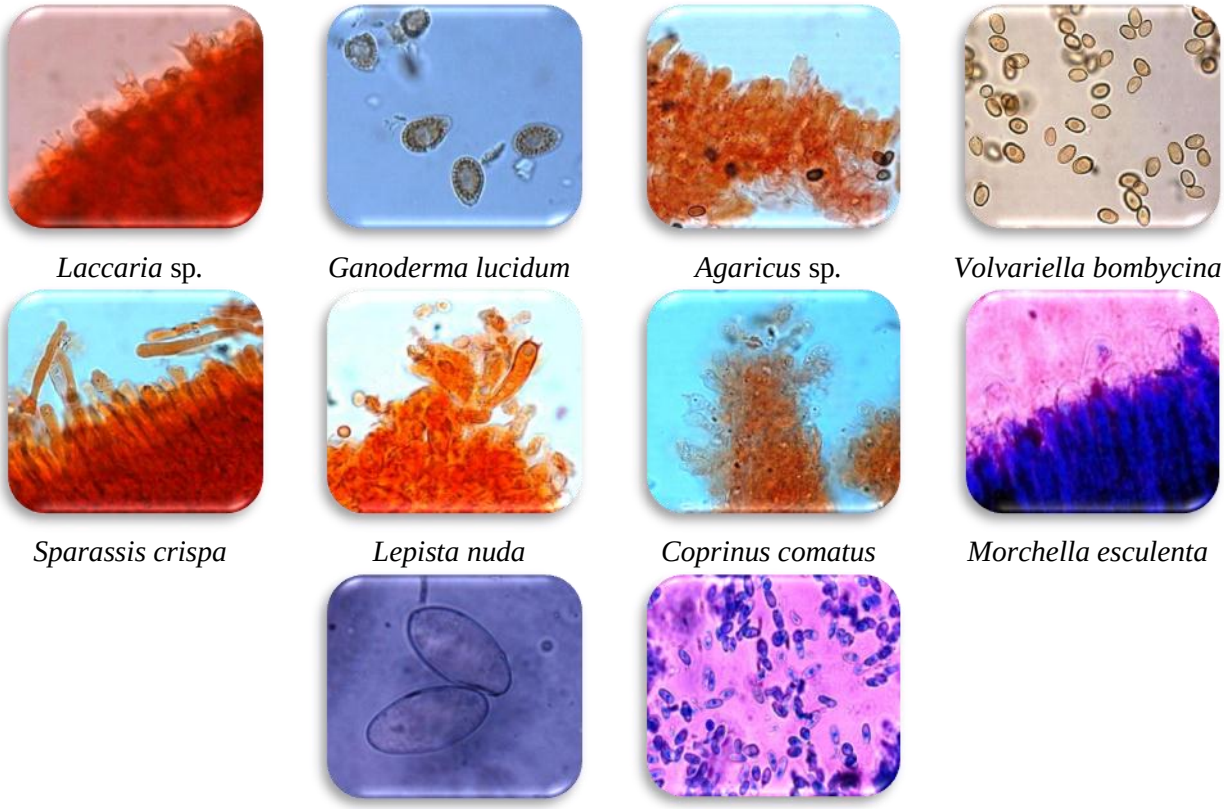

Plate 4: Microscopic photographs of wild edible fungi at 1000X

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