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Edible mushrooms from forests of Sikkim Himalaya

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Until now numerous species of wild edible mushrooms (WEM) have been identified and are found to be superior to other foods with respect to their proximate and nutraceutical properties. Sikkim Himalaya is a treasure house of variety of WEM which have been consumed by the local/ethnic people as well as it is considered as income generator for the tribal people of this region. The present paper throws light on the common species of WEM based on extensive field survey conducted during 2018-2021 in the forest areas of Sikkim Himalaya. A total of 26 WEM were collected from this region and documented with their morphological and anatomical descriptions.

Key words: Morpho-antatomy, proximate composition, wild edible mushrooms, Sikkim Himalaya

INTRODUCTION

Mountain provides different Ecosystem amenities to the rural native communities living in the Himalayan region. The hills of Darjeeling (3149 sq km.) and Sikkim (7096 sq km.) constitute the Sikkim Himalayan ensemble. Its complex topography, wide range of microclimatic conditions, altitudinal variation along with diverse group of habitats including a number of mycorrhizal trees, huge amount of leaf-litter have made it hotspot for luxuriant growth of wild mushrooms (Das, 2010). Wild edible mushrooms (WEM) have been a part of our daily life since time immemorial and have profound biological and economic impact. These are consumed by human being with delicacy probably, for their texture and attractive flavour (Das, 2010).

The consumption of WEM is increasing, even in the developed world, due to a good content of proteins, dietary fibers as well as a higher content of trace minerals (Dasgupta *et al*. 2013; Toshinungla *et al.* 2016; Khatua *et al.* 2021).

Traditional mycological knowledge of most Indian ethnic groups have proven to be wide and profound, consuming nearly 283 species of wild edible mushrooms out of the 2,000 species over the globe (Verma *et al.* 2014). In recent times many Indian mycologists have reported several new edible mushrooms from different areas (Das *et al.,* 2016; Khatua *et al.* 2015). The WEM are greatly valued throughout the Sikkim-Himalayan region and served as a vital source of food of many rural and ethnic communities. They also provide a source of income and are in high demand among the local consumers. The oldest record of the naturally occurring macrofungi of Sikkim Himalayas comes from the study of Berkley, who provided a list of 131 species from this region. During field survey in 2018-2021 at various remote places of Sikkim Himalaya, several noteworthy wild edible mushrooms were collected and identified. Morpho-anatomical descriptions of some of the most encountered species are presented in this paper.

MATERIAL AND METHODS

Study area

To carry out this study, the field trips were conducted at regular intervals during the monsoon seasons from 2018-2021 at different forests of Sikkim Himalaya. This region is surrounded by huge areas of Tibetan plateau in North, Kingdom of Bhutan and Chumbi valley in the east and Nepal in the west (Fig.1). Vertical range is from 100 m amsl consisting foothills, through 4000 m amsl composed of timberline and up to 8500 m amsl constituting the Kanchenjunga peak. During the rainy season the region has very high humidity ranging up to 85-97%. Generally three seasons

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have been identified in the region, among which rain and high humidity are recurring and predominant (Rai and Sharma, 1994). Within this small area sharp climatic variation have been recorded which led to the formation of different ecological zones and establishing of a rich biological diversity including large number of edible macrofungi (Acharya *et al.* 2010).

Collection and morpho-anatomical desc-ription of WEM

The study materials were collected during filed trips in 2018-2021. Careful field notes were made for habitats, hosts, soil, and forest type and photographs were taken for studying the wild fresh materials. Macroscopic characters are recorded in the natural habitat viz. color, size, shape, taste, order etc. Microscopic properties were determined by Olympus research microscope. Identification of the specimens were done using relevant keys, monographs and books (Ramsbottom, 1965; Bessey, 1978; Singer, 1986).

Many ethnic groups of Sikkim-Himalayan region were found to be mushroom lovers and have wide range of mycological knowledge. Different remote areas of Sikkim Himalayas were surveyed to record the indigenous use of various wild mushrooms by the local ethnic people. Mushroom hunters, old and experienced persons from ethnic communities were consulted using questionnaire and recording interviews to reveal the necessary information regarding, the local names, occurrence, edibility, and are taken as guides to collect different wild edible mushroom.

RESULTS

The present study documented the 26 species of wild edible macrofungi belonging to 25 genera and 20 families. The collected edible macrofungal species from the wide range of habitats with their scientific name, local and common name, family, habitat, site of collection, season of occurrence are listed in Table 1.

Aleuria aurantia (Pers.) Fuckel

Carpophores gregarious, growing on the ground, gravelly or sandy soil. Fruitbodies orange, saucer or cup shaped, often becoming wide and flattened reaching the widths of 10 cm with age, it looks even more like orange peel, sometimes split along the margin, under surface usually whitish but often small orange cup like, smooth, sessile or laterally stipitate (Fig. 2a). Flesh thin and brittle turns green by iodine. Asci with 8 spores, elliptical, surface coarsely reticulate with presence of oil droplets. Sometimes with thorn-like projections at each end of the spore. Spore print white.

***Armillaria mellea* (Vahl) P. Kumm.**

Carpophores usually growing solitary, gregarious or in tufts at the base of the dead or old tree stumps. Fruitbodies with cap, gills and stipe (Fig. 2b). Cap 12- 15cm, initially convex later expanded to subumbonate form, honey coloured to dull reddish brown, surface glabrous, sometimes scaly or absent. Gills distinct, adnate to decurrent, whitish when young, coloured with age. Stipe central, cylindrical, uniform in thickness, yellowish to brownish, smooth, elastic, stuffed or hollow, annulate, well developed thick, white and prominent ring. Flesh white, thick becoming thinner towards the margin. Basidiospores white, round or elliptical. Spore print cream.

***Auricularia auricula-judae* (Bull.) Quél.**

Carpophores growing solitary or in dense tufts on dead wood, logs and bamboos. Fruitbodies 6-15cm or more wide, shallow cup shaped or flattened or shaped like an ear, wavy and irregular, jelly like or gelatinous with leathery consistency, usually sessile to substipitate, surface yellow brown to reddish brown, veined, smooth, moist, the upper surface velvety, sometimes hairy and concentrically zonate, soft and flexible but hard and brittle on drying (Fig. 2c). Spores white, sausage-shaped and transversely septate. Spore print white.

***Cantharellus cibarius* Fr.**

Carpophores growing scattered on the forest floor covered with leaf litters (Fig. 2d). Fruitbodies with cap, gills and stipe. Cap 10–13 cm wide and 5-10 cm tall, colour varies from light yellow to dark, convex when young then flattened and finally funnel shaped, fleshy, smooth surface with involute margin, expanded and wavy. Red spots seen on the damaged cap. Gills decurrent, forked, loosely arranged, narrow, thick with blunt edge. Stipe usually thick and short, 3-5 cm, yellow, firm, solid, glabrous and generally tapering at the base. Flesh

thick, fibrous and white. Basidiospores yellowish, elliptical, wrinkled with furrows and folds. Spore print ochraceous.

***Coprinus comatus* (O.F. Müll.) Pers.**

Carpophores singly or in clumps, growing on grassy land, lawns, gardens, fields and on refuse dumps (Fig. 2e). Fruitbodies with cap, gills and stalk. Cap 7–10 cm, long oval to round when young, oblong, campanulate with age, fleshy, fragile, white, covered with woolly, shaggy scales, the center smooth and yellowish-brown, whitish between the scales, the margin becomes pinkish then black as autodigestion proceeds as ages. Gills distinct, crowded, free, initially white then pink and finally black, deliquescing into an inky fluid. Stipe central, tapering at the top, smooth, hollow, 12.5- 17.5 cm. long, 10-12 mm thick, white thin and loose annulus around the stipe, volva absent. Basidiospore smooth and elliptical.Spores print black.

***Crepidotus mollis* (Schaeff.) Staude**

Carpophores growing on overlapping piles of hardwood, fallen wood or dead branches or on old stumps (Fig. 2f). Fruitbodies with cap, gills and stipe. Cap 5- 7 cm in diameter, fleshy, soft, glabrous, kidney shaped, white when young and turns ochre when older, flesh white and flabby, smooth surface upper layer is elastic, stretched at the margin. Gills soft, crowded, decurrent and pale brown. The stalk is rudimentary or lacking or laterally stipitate. Spores elliptical and smooth. Spore print brown.

***Entoloma lividoalbum* (Kühner & Romagn.) Kubièka**

Carpophore grows at the floor of coniferous forest, scattered, gregarious. Fruitbodies with cap, gills and stipe. Cap 6-9 cm broadly-convex to bell shaped, nearly plane, greasy when fresh, bald or yellow brown, fading with age, frequently with a broad to low umbo, margin incurved in youth at maturity decurved, translucent-striate, often wavy, surface moist and soft. (Fig. 2g). Gills adnate to notched, narrowly attached to the stalk, at first white becoming pinkish or pinkish-grey with age. Stipe 5.0-10.0 cm long, 1 - 2.5 cm thick, more or less equal, apex surface minutely scaly, fibrillose-striate, white but discoloring dingy-tan with handling. Flesh white, solid, fleshy-fibrous, partial veil absent. Spores pinkish, angular in face-view, mostly five to six-sided, thin-walled, with a conspicuous peg-like hilar appendage. Spore print pink.

***Fistulina hepatica* (Schaeff.) With.**

Carpophores solitary or rarely in groups grows in shelving fashion at the trunks of living trees or sometimes in the dead tree trunk. Fruit-bodies upto 20-30 cm, often fan shaped or tongue like, stipitate very soft, juicy, dark red to liver colour, finely bumpy, velvety, margin lobed (Fig. 2h). Hymenium poroid, surface pale pinkish, becoming reddish brown in age, distinctly separated tubes, sticky and moist when young. Flesh whitish, streaked with reddish areas, thick, soft, watery, exuding reddish juice when squeezed. Stipe absent or rudimentary, thick, lateral, red, firm and solid. Basidiospores yellowish and elliptical. Spore print pinkish to pinkish brown.

***Flammulina velutipes* (Curtis) Singer**

Carpophores growing in clusters on dead or old stumps of hardwood either erect or prostrate. Fruit-bodies with cap, gills and stipe. Cap 4-7 cm broad, convex to flattened, sometime obtuse, moist, shiny and sticky when fresh, bald, colour fairly variable orange brown to yellowish brown, often fading with maturity, surface glabrous, viscid, flesh thin whitish to yellowish, KOH reddish on cap surface (Fig. 3a). Gills attached to the stalk, adnexed, distinctly formed, whitish to pale yellow, crowded. Stipe central, 3-11 cm long 3-10 mm thick, equal, larger towards the base, pale yellow when immature, firm, cartilaginous, stuffed or hollow, dense growth of reddish brown hairs giving a velvety appearance, without volva or ring. Flesh yellowish white, soft, delicate and thin. Basidiospores white, narrow and elliptic. Spore print white.

***Grifola frondosa* (Dicks.) Gray**

Carpophores growing as weak parasitic to saprobic on decaying wood. Fruitbodies 10-25 cm occurring in a cluster consisting of multiple grayish-brown caps which are often curled, or spoon-shaped or fan shaped, with wavy margins and 3-4 cm thickness (Fig. 3b). Smooth surface, pleasant smell, undersurface minute pore tubes. Stipe, short tough, milky-white, branchy structure, wavy caps, organised in large clusters of rosettes arising from a single branched stem. Spore print white.

Table 1: Habitat and locality of some WEM of Sikkim Himalaya

Name of the macrofungi and family	Common name/ vernacular name	Habitat	Season of occurrence	Locality
Aleuria aurantia (Pers.) Fuckel (Pyronemataceae)	Orange peel fungus	On the soil among the grasses	July -September	Mall Road, Darjeeling; Khichiperi, Sikkim
Armillaria mellea (Vahl) P. Kumm (Physalacriaceae)	Honey mushroom / Todke cheu	Cluster at the base or stump of living trees;	May- July	Sinchel, Darjeeling; Samdong, East Sikkim.
Auricularia auricula-judae (Bull.) Quél (Auriculariaceae)	Jelly ear / Kaney cheu	On dead stumps and branches of sub-tropical and temperate trees especially *Alnus* species.	End May-November	Mungpoo, Lebong, Darjeeling
Cantharellus cibarius Fr. (Cantharellaceae)	Girolle/ Sulpe cheu	On the forest floor covered with leaf litters	June-September	Near Chitray, Lebong, Darjeeling
*Coprinus comatus (*Mul.*)*Pers. (Agaricaceae)	Shaggy Mane / Gobre cheu	On moist floor or on green lawns.	May-August	Samdong, Sikkim, Darjeeling
Crepedotus mollis (Schaeff. Ex.Fr.) Kumm. (Inocybaceae)	Soft Slipper toad stool	Grows in overlapping tiers on the living woods.	June-August	Sonada, Chitray, Darjeeling.
Entoloma lividoalbum (Kühner & Romagn.) Kubička (Entolomataceae)	Salle Cheu	Grows at the forest floor of Coniferous forest.	June- August	Sinchel Jungle, Darjeeling. Khichipari, Sikkim
Fistulina hepatica (Schaeff.) With. (Fistulinaceae)	Beefsteak fungus/ Jibray Chau	Trunk of *Castanopsis hystrix*	April-June	Lebong and Rajbhawan area, Darjeeling
Flammulina velutipes (Curtis)Singer (Physalacriaceae)	Enoki / Jhuppey Cheu	Wounded stump of living *Leucoseptrum cannum*	May- August	Near Rajbhawan, Darjeeling
Grifola frondosa (Dicks.)Gray (Meripilaceae)	'Maitake, hen-of-the-woods/ Kande cheu, Nangrey cheu	Base of dead tree stump of hardwood tree	May-June	Sinchel, Darjeeling; Bhusuk-East Sikkim.
Hygrocybe miniata (Fr.) Kumm. (Hygrophoraceae)	Vermillion waxcap	On rotten woods or sometimes on old tree stumps.	June-August	Happy valley tea Garden, Darjeeling; Soreng, South Sikkim
Lactarius volemus (Fr.) Fr. (Russulaceae)	Orange brown fungus/ Dudhey cheu	On the ground in forest or in open place.	June-August	Sinchel Lake area, Darjeeling
Laetiporus sulphureus (Bull.) Murrill (Fomitopsidaceae)	Crab-of-the-wood / Katusey Cheu	Saprotropically upon dead bamboo stumps or on standing living trees.	July-September	Ravangla, South Sikkim
Lentinula edodes (Berk.) Pegler (Omphalotaceae)	Shiitake/ Sanai chau	On trunks of Oak trees	June-July	Lebong, Darjeeling.
Lycoperdon pyreforme.Wild. (Lycopordaceae)	Puffball/ Phusphuse cheu	On forest walls and floor	July-October	Chatakpur, Darjeeling; Samdong East Sikkim
Meripilus giganteus (Pers.) P. Karst. (Meripilaceae)	Giant polypore/ Giddey cheu	On or near the base of hardwood trees.	June-September	Tigerhill, Lebong, Darjeeling
Oudemansiella mucida (Schrad.) Hohn. (Physalacriaceae)	Porcelain fungus	Grows in cluster on the stump of wood, common wood rot fungus	June-August	Lava, Lolaygao, Lebong, Chatakpur, Darjeeling
Pholiota aurivella (Batsch) P.Kumm. (Strophariaceae)	Golden Pholiota	Grows in clusters in live or dead trees.	May -July	Sonada, Mungpoo, Darjeeling
Pleurotus flabellatus Sacc. (Pleurotaceae)	Oyester/ Junglee kanney chau	Grows in a large clusters on the trunk of dead wood.	June-August	Lebong, Maneybhanjang, Darjeeling
Ramaria aurea (Schaeff.) Quél. (Gomphaceae)	Coral Mushroom/ Thakre cheu	Coniferous and broad leaf forest floor,	June-August	Sinchel, Darjeeling, Tadong, West Sikkim
Russula cyanoxantha (Schaeff.) Fr. (Russulaceae)	Charcoal burner	Ectomycorrhizal association with *Quarcus* and *Lithocarpus* temperate mixed forest.	July- August	Sinchel Lake, Darjeeling; West Sikkim
Schizophyllum commune Fr (Schizophyllaceae)	Split Gill fungus	On dead bamboo plant, dead trunk.	June-August	Gangtok-East Sikkim.
Sparassis crispa (Wulfen) Fr. (Sparassidaceae)	Wood cauliflower	On dead log, branch and on base of coniferous trees	Nov-Dec	Samdong East Sikkim
Termitomyces eurrhizus (Berk.) R. Heim (Lyophyllaceae)	Termite fungus / Kalunge cheu	Soil, on or near to termitaria	June-July, September	Darjeeling, East Sikkim
Termitomyces medius R. Heim & Grassé (Lyophyllaceae)	Termite fungus/ Jhari cheu	On the soil near Termite nest.	June-July	Mungpoo, Darjeeling
Xerula radicata (Relhan) Dörfelt (Physalacriaceae)	Kgkhutte cheu	grows on soil among grasses	May-July	Pandam tea garden, Sonada, Maneybhanjang, Jalapahar, Darjeeling

Table 2: Proximate profile (gm /100 gm dry weight) of some selected mushrooms

Species	Protein	Carbohydrate	Lipids/fats	Ash	Fiber	References
Armillaria mellea	24.47	60.08	„	-	15.8	Rai *et al.,* 2007a
Auricularia auricula-judae	36.30	33.23	-	7.07	2.81	Kumar *et al.,* 2013
Cantharellus cibarius	21.1	-	1.6	13.2	12.8	Agrahar-murugkar and Subbulakshmi,2005
Cantharellus cibarius	34.17	47.00	-	7.78	1.40	Kumar *et al.,* 2013
Coprinus comatus	23.7	40.42	2.04	13.24	21.13	Stilinović *et al.,* 2020.
Flammulina velutipes	17.60	73.10	1.90	7.40	3.70	Manikandan, 2011
Fistulina hepatica	21.5	48.0	2.0	-	15.2	Rai *et al.,* 2007b
Grifola frondosa	31.47	40.77	1.49	5.13	7.0	Johnsy *et al*., 2011
Lentinus edodes	32.93	47.60	3.73	5.20	28.80	Manikandan, 2011
Lentinus edodes	22.8	64.4	2.1	6.0	-	Longvah and Deosthale, 1998
Meripilus giganteus	21.2	53.7	2.2	-	23.46	Acharya and Rai, 2012
Oudesmansiella mucida	24.6	46.9	3.6	-	9.2	Rai *et al.,* 2007c
Ramaria aurea	19.3	47.1	2.3	-	20.3	Rai and Acharya, 2012
Russula cyanoxantha	49.20	9.56	7.87	2.56	30.81	Srikram and Supapvanich, 2016.
Russula delica	26.25	34.88	5.38	17.92	15.42	Pushpa and Purushothama, 2010
Sparassis crispa	21.53	37.58	3.9	-	27.18	Acharya *et al.,* 2004
Schizophyllum commune	15.9	68.0	2.0	8.0	-	Longvah and Deosthale, 1998
Schizophyllum commune	22.50	32.43	-	10.10	6.50	Kumar *et al.,* 2013
Termitomyces medius	46.2	33.3	2.0	5.0	7.5	Atri *et al.,* 2016

***Hygrocybe miniata* (Fr.) P. Kumm.**

Carpophores growing solitary or clustered on rotten fallen wood, old stumps or on open field. Fruitbodies with cap, gills and stipe. Cap upto 4 cm in diameter, red-to-yellow, often fading to orange, convex initially, later flattens and depressed with a wavy and cracked edges, surface glabrous with small scales (Fig. 3c). Gills adnate, orange with red tinged, blunt, waxy, thick, remote. Flesh orange, and is devoid of any odour. Stipe central, cylinder, often long, glabrous, solid when young, hollow when old and tapering towards the base, slightly paler, with a white base, ring or volva absent. Spores cylindrical, elongate, and smooth. Spore print white.

***Lactarius volemus* (Fr.) Fr.**

Carpophores scattered, or gregariously growing on the ground or in open places of conifers with mycorrhizal associations. Fruitbodies with cap, gills and stipe. Cap 11-15 cm in diameter, at first convex then flattened with an inrolled even margin, often depressed at the centre, sometimes umbonate, shallow vase- shaped, smooth or sometimes wrinkled, finely velvety to touch, golden brown to brownish orange, often darker towards the centre, KOH olive on cap surface (Fig. 3d). Gills crowded, adnate, creamy white or light brown, discoloring brown where injured, often forking near the margin. Flesh white to yellowish, brittle, latex brown, staining white paper brown. Stipe 5-10 cm long, central, equal or tapering to base, smooth, sometimes ribbed longitudinally and solid. Spore white, globose, occasionally elliptical, ornamented, turns blue to black with iodine. Spore print white.

***Laetiporus sulphureus* (Bull.) Murrill**

Carpophores growing as annual, solitary or saprophytic upon dead bamboo stumps. Fruitbodies 19-25 cm width, 5-14 cm length with small stalk, tough when fresh, rigid on drying, overlapping, woody, pleasant smell. Cap wavy edged thicker at base than margin,orange yellow, smooth surface with margin, pore very minute, pores circular, 3-5 mm, pore tubes long underside creamy white to yellowish (Fig. 3e). Stipe laterally stipitate, upto 2.0 cm. long, upper surface smooth, glabrous, usually with fine radial striations, ochraceous to straw brown, context corky and straw

coloured. Hymenial surface biscuit coloured to brownish. Basidiospores hyaline, thin-walled, smooth, ellipsoid cylindric, Spore print white.

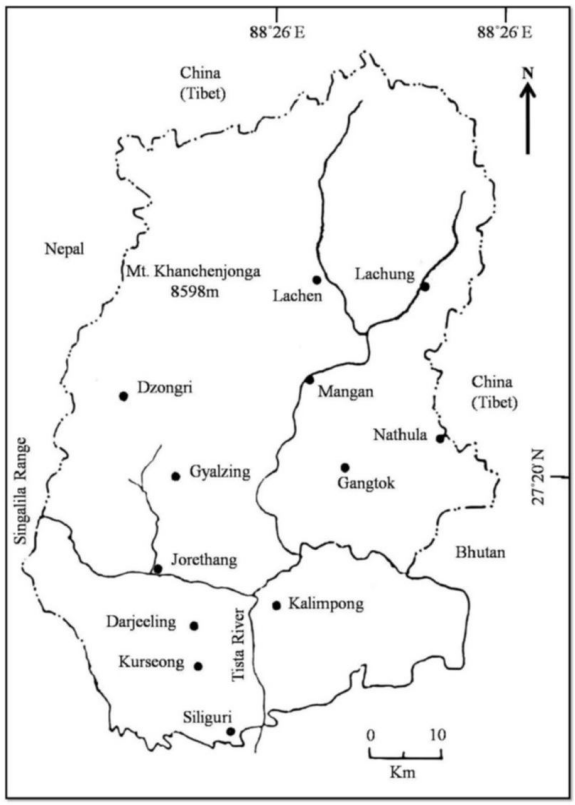

Fig. 1 : Map of Sikkim Himalaya

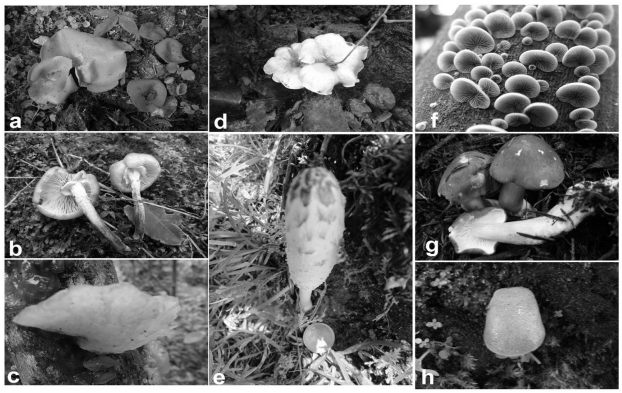

Fig. 2: a.*Aleuria aurantia;* b. *Armillaria mellea;* c. *Auricularia auricula-judae*; d. *Cantharellus cibarius;* e. *Coprinus comatus;* f. *Crepedotus mollis*; g. *Entoloma lividoalbum*; h. *Fistulina hepatica.*

Lentinula edodes (Berk.) Pegler.

Carpophores growing on the dead deciduous trees. Fruit-bodies with cap, gills and stipe. Cap upto 12 cm in diameter, brown, convex at first, then depressed, sometimes umbonate when old, scale darker in the centre, lighter towards the margin (Fig. 3f). Gills crowded, edge denticulate, adnate,

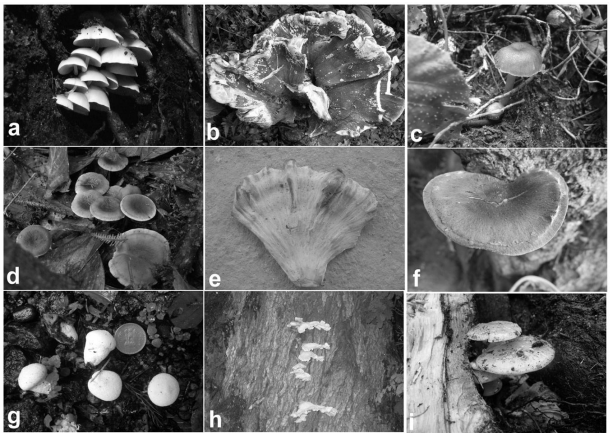

Fig. 3: a. *Flammulina velutipes;* b. *Grifola frondosa;* c. *Hygrocybe miniata;* d. *Lactarius volemus;* e. *Laetiporus sulphureus;* f. *Lentinula edodes;* g. *Lycoperdon pyreforme;* h. *Meripilus giganteus;* i. *Oudemansiella mucida.*

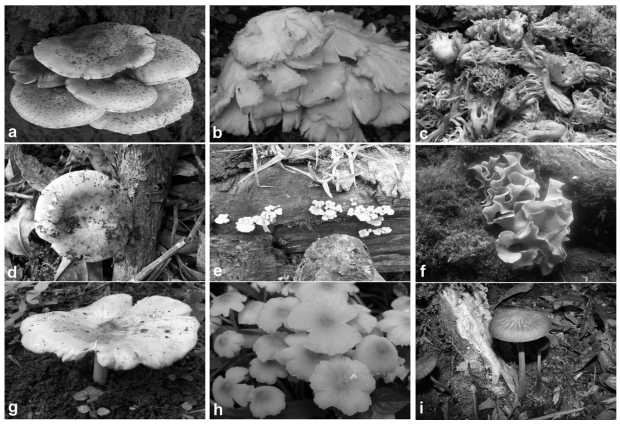

Fig. 4. a. *Pholiota aurivella;* b. *Pleurotus flabellatus;* c. *Ramaria aurea;* d. *Russula cyanoxantha;* e. *Schizophyllum commune*; f. *Sparassis crispa;* g. *Termitomyces eurrhizus;* h. *Termitomyces medius ;* i. *Xerula radicata*

adnexed or sinuate, free, whitish later becomes brownish or greyish.Flesh white, brownish, soft, fleshy when tender, tough when old. Stipe central, pale to reddish brown, solid, broad at the middle, rarely bulbous at the base, cortina present. Basidiospores white, cylindrical to elliptical, smooth, thin walled, inamyloid. Spore print white.

Lycoperdon pyriforme Wild.

Carpophores growing on leaf litter admixed soil or on the stump of decaying or rotten wood in the forest. Fruitbodies pear-shaped to nearly round, 1.3–5.2 cm high. Peridium whitish to pale brown when young, yellowish to dark rusty-brown with age, at first smooth or with a few small scattered spines on top, later cracked to form small patches or minute granular particles, giving rough to touch, the layer ultimately fall away to expose the smooth

inner layer in which an apical pore or tear is very slow to form (Fig. 3g). Sterile base small or well developed, spongy when fresh, occupying the stem like base, chambers very small, conspicuous white mycelia threads, radiating from the base and connected to others in the surrounding wood or humus. Basidiospores round and smooth. Spore mass powdery, white, then yellow to olive, finally deep olive-brown.

***Meripilus giganteus* (Pers.) P. Karst.**

Carpophores solitary growing in a rosette generally at the base of dead stump. Fruitbodies massive fan-shaped, stacked, laterally stipitate, tough when fresh, rigid on drying, tan or light brown,11 to 28cm wide and 1 to 3cm thick, occasionally more than a meter across (Fig. 3h). Surface off white. Hymenium poroid, tubes 4.5 to 7 mm deep, terminate in tiny round white pores, when bruised, the pores turn dark brown or black. Basidiospores ovoid or ellipsoidal, smooth, hyaline and inamyloid. Spore print white.

***Oudemansiella mucida* (Schrad.) Hohn.**

Carpophores growing in cluster on the stump of wood, it is a common wood rot fungus. Fruitbodies with cap, gills and stipe. Cap 6–8 cm wide, rounded and remain broadly domed rather than completely flat at maturity, pale greyish when young, becoming white with age, covered with a semi-translucent and slimy layer, often with an ochraceous surface at the centre (Fig. 3i). Gills adnate, broad and distant, initially translucent white then ochre tint with age. Flesh thin with striate margin. Stipe slender, central, 30–100 mm tall and 3–10 mm wide, with a substantial stem ring, slightly scaly and greyish below. Spores globose to subglobose, smooth and very thick-walled. Spore print white.

***Pholiota aurivella* (Batsch) P. Kumm.**

Carpophores growing in clusters on the stump of dead trees. Fruitbodies with cap, gills and stipe. Cap 9- 12 cm in diameter, bright golden yellow to rusty brown and with a slimy or greasy surface covered in darker-brown scale, campanulate then convex finally gibbous when expanded, centre ferruginous, margin floccose, involute (Fig. 4a). Gills crowded, adnate, broad, cream when young, turning reddish-brown at maturity. Flesh thin, white, light yellow. Stipe dry, central, equal, curved, pale, and scaly closer to the bottom, rusty brown turning to yellow at the top, fibrillose scales present below the annulus, annulus not persistent. Spores brownish to smoky brown, oblong and smooth, **Spore print** brownish**.**

***Pleurotus flabellatus* Sacc.**

Carpophores growing in a large clusters on the trunk of dead wood. Fruit-body with cap, gills and reduced stipe. Cap 5–7 cm wide, cucullate, spathulate to flabelliform, more rarely infundibuliform, convex towards the base, surface initially with pinkish tints, cream colour, or with ochraceous brown to grayish tints with age, finely tomentose towards the base, smooth with a silky sheen, finely striate, margin at first involute (Fig. 4b). Gills deeply decurrent, white or creamy tints, narrow, moderately crowded and edge entire. Flesh thin, translucent when moist. Stipe absent or reduced and then lateral or eccentric, solid, surface white and tomentose. Spores thin walled, cylindric and hyaline. Spore print white.

***Ramaria aurea* (Schaeff.) Quél.**

Carpophores usually erect, much branched, medium sized, gregarious on forest floor. Fruitbodies 9 to 12 cm high and 5 to 10 cm wide, stipitate, thick, whitish stem into numerous branches that are forked or clipped at the end, branched, flesh brittle, smooth, bright salmon-orange or salmon-colored, tips rich corn yellow, coral like, crowded, cylindrical, dichotomous branches, two to four centimeters high and more or less tapers towards the base (Fig. 4c). Flesh firm, white. Basidia four spored, club shaped, basidiospores light brown with dark wall. Spore print yellowish.

***Russula cyanoxantha* (Schaeff.) Fr.**

Carpophores growing in mycorrhizal association with the roots of conifers. Fruitbodies with cap, gills and stipe. Cap 13–18 cm, wide, convex at first and later flattened, greenish to bright brown, vary considerably in color, flesh, firm, viscid when wet (Fig. 4d). Gills adnexed, whitish or creamish, flexible, oily to touch. Flesh white and pink just below the cuticle, solid and granular. Stipe long and thick, central, usually whitish in colour, firm, initially solid, then spongy and hollow with age,

green when rubbed with ferrous sulphate. Spores white, broadly ellipsoidal and warted. Spore print white.

***Schizophyllum commune* Fr.**

Carpophores grows scattered or in groups on branches or trunks of trees, on old wood. Fruitbodies with cap, gills and rarely with stalk. Cap upto 4 cm long, 2 cm wide, circular or semi-circular or fan shaped with narrow base, covered with dense small hairs, dry, tough, coriaceous, white to greyish in colour, lower surface composed of gills with folds that are split down the middle, margins incurved, attached laterally to the substratum (Fig. 4e). Gills distinctly formed, whitish or greyish white, radiating from the point of attachments, with revolute and split edges. Flesh grey to brown, leathery, thin, pliable when fresh but brittle when dry. Stipe rudimentary if present or often absent. Spore print white.

***Sparassis crispa* (Wulfen) Fr.**

Carpophores grows usually at the base of coniferous or on the cut stump of hardwood. Fruitbodies 20-55 cm across, subglobose, creamy to pale buff, much branched and forming a dense mass, cauliflower like shape with neumerous flattened lobes on short thick rooting stalk, branches compact, fleshy, brittle, wavy or curled, the edges tinted brownish with age (Fig. 4f). Stipe short, whitish at first, turning black when old. Spores pale ochraceous, egg shaped. Odour pleasant. Spore print off white.

***Termitomyces eurrhizus* (Berk.) R. Heim**

Carpophores large usually growing solitary on the soil or near termitaria. Fruitbodies with cap, gills and stipe. Cap 15–18 cm wide at first convex later expanded with a broadly umbonate, surface, white but olivaceous near the umbonal region, smooth and glabrous, slimy when wet, surface scaly, margin regular not incurved (Fig. 4g). Gills creamish to whitish, crowded, free to subadnate, pliable and entire. Flesh white, non-amyloid hyphae. Stipe central, long, broad, above ground level, equal or attenuated towards the apex, cylindric, firm, solid, surface white. Elongated pseudorrhiza usually black in colour tapering at the base. Persistent membranous cortinoid annulus present, volva absent. Spores ovoid to ellipsoid, inamyloid, thin-walled, hyaline. Spore print pink.

***Termitomyces medius* R. Heim & Grassé**

Carpophores growing usually in groups or sometimes solitary on the soil in association with termite nests. Fruitbodies with cap, gills and stipe. Cap 5-7 cm wide, silky, grayish brown, first conical, then expanded with a dark grayish coloured sharply pointed umbo (Fig.4h). Gills free, crowded, creamy white and pink with maturity. Stipe upto 8 cm long, central, white to dirty brown, fleshy, fibrous and hollow. Basidiospores obovoid to broadly ellipsoidal, smooth and thin walled. Spore print pink.

***Xerula radicata* (Relhan) Dörfelt**

Carpophores growing on soil among grasses or on open lawns. Fruitbodies differentiated into cap, gills and stipe. Cap 8–10 cm. wide, convex when young, flattened to concave with a central umbo with age, radially wrinkled, slimy when moist, olive brown to reddish brown or greyish (Fig. 4i). Gills adnexed, distant, white, thick. Stem 10–20 long, cylindrical, central, fibrous, sometimes twisted with a long rooting base, white at apex gradually becoming concolorous with the pileus. Spores broadly ellipsoid to ellipsoid, smooth and yellowish white. Spore print white.

DISCUSSION

Mushroom collection for food with the onset of monsoon have found to be a routine work amongst the different ethnic communities in Sikkim Himalayan region. These mushrooms are also used as ethnomedicines by the local people for treatment of several ailments. Reports of new mushrooms from untapped regions and their eth o medicinal uses have been provided by several authors (Verma *et al.* 2014; Khatua *et al.* 2017, 2021) This study lists 26 taxa of the wild edible mushrooms from different forests of Sikkim Himalaya with morpho-anatomical details, habitat, locality and fruiting season of each species. Most of these mushrooms are consumed by the local people and forest dwellers but in different village markets it has been observed that mushroom gatherers sell some of the highly demanding edible species such as *Auricularia auricula-judae, Pleurotus flabellatus, Grifola frondosa, Meripilus giganteus, Lentinula edodes, Ramaria aurea, Entoloma lividoalbum, Laetiporus sulphurous* and *Termitomyces eurrhizus* locally known as kane, junglee kanney, nangrey, giddey, sanai, thakray,

salley, katusay and kalunge cheu respectively. The documented mushrooms are also explored for their proximate compositions and it has been found that different scientists have reported nutritional profiles of these mushrooms and results showed that these mushrooms are rich in protein, dietary fibers and contain low fat as well as they are considered as low calorific diet (Table 2). Many mushrooms are still remain unexplored and their nutritional benefits are unknown to us. Inadequate knowledge along with difficulty in correct identification are the fundamental factor that limits its consumption. Moreover, these essential natural resources are likely to be lost if these are not documented. Therefore, the diversity of these wild resources should be preserved for the benefit of the future of mankind. It has also been observed that during monsoon mushroom gatherers collect huge amount of some important species like *Pleurotus flabellatus, Entoloma lividoalbum, Armillaria mellea* and *Ramaria aurea* as a result sometime the fruitbodies may get wasted. If these mushrooms are preserved in proper manner and utmost care like canning, production of mushroom pickles and other culinary products that may help the local peoples to become an entrepreneur. Last but not the list there are ample of scope for mushroom industries to flourish here successfully and can become a lucrative business for the unemployed rural youth and may ultimately boost up the economy of this area.

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