

***Pleurotus himalayaensis* Dhancholia Sp.nov. A Highly
Delicious Edible Mushroom from Dry Temperate Cold Desert
Zone of Lahoul Valley in Himachal Pradesh (India)**

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Abstract: A new species of *Pleurotus himalayaensis* sp. nov. was collected growing in association with a threatened perennial herbaceous host plant *Ferula jaeschkeana* Vatke, from the dry temperate and cold deserts region of Lahoul and Spiti (India). The mushroom appears in the surrounding of five villages viz., Kwaring (3400 mts), Meh (4000), Shakoli (2900 mts) Sumnam (3100 mts) and Tandi (2900 mts) which covers approximately 50 - 60 square kilometres of area in the whole valley. Similarly, the distribution of host plant is also restricted within this area. People in Lahoul valley find the mushroom to be highly delicious. They collect the mushroom from the wild and consume either fresh or cut into small pieces and dry to preserve for consumption during the winters. Mushroom specimens collected from the Lahoul valley have been deposited in the Herbarium of Department of Botany, Punjabi University, Patiala (Punjab), India for future references. All the macroscopic as well as microscopic characters of this new species are taxonomically described and illustrated for the first time in this paper.

Key words: *Pleurotus himalayaensis* • *Ferula jashchkeana* • New species • Lahoul Spiti

INTRODUCTION

Genus *Pleurotus* which includes several edible species belongs to the family Pleurotaceae as reported by Kirk *et al.*, [1]. Species of this genus are widespread in plains as well as in hills. The valley of Lahoul from which the collection has been made is situated to the South of Ladakh which falls between 32°38' 0" North, 77°10' 0" East, having cold deserts and sparse population and vegetation. The harsh conditions of Lahoul permit only scattered tufts of hardy grasses and shrubs to grow, even below 4,000 metres. Glacier lines are usually found above 5,000 metres. The valley lies in the dry temperate zone of the state and due to heavy snowfall in the winters it remains cut off from the rest of the world for nearly six months due to closure of Rohtang Pass (13,000 ft) the gateway to access the valley. *Pleurotus himalayaensis* Dhancholia sp. nov. is frequently found associated with *Ferula jaeschkeana* Vatke at altitudes between 2900-4000 mts a.m.s.l. in Lahoul valley of Himachal Pradesh. The mushroom appears in the surrounding of five villages

viz., Kwaring (3400 mts), Meh (4000), Shakoli (2900 mts) Sumnam (3100 mts) and Tandi (2900 mts) which covers approximately 50 - 60 square kilometres of area in the whole valley. Similarly, the distribution of host plant is also restricted within this area. The local inhabitants believe that definitely there is some correlation with the appearance of mushroom fruit bodies and the host plant but sometimes it has been noticed that although *F. jaeschkeana* Vatke exists but fructification of mushroom do not appear nearby.

The mushroom generally fruits after the snow melt. Snowfall in the valley starts towards the mid of December to late December and continues up to the end of January or first week of February and thereafter it starts melting slowly in the first fortnight of April. Soon after the snow melts and the temperature still varies between 6 - 12°C, the basidiocarps start appearing among the growing grass. Fructification of mushroom starts towards the last week of April and continues up to first week of August with more frequency in the months of May-June.

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The first fruit body appears when the *Ferula* plants bear 5 - 7 leaves and the surrounding soil has saturated moisture while the land is lush green with the growth of other fodder grasses.

The village Sumnam is 3000 - 3100 mts a.m.s.l in Lahoul valley is the centre of attraction for this mushroom. The village a special location named "Mokshthalza" (Moksha means Mushroom and Thalza means place) or the 'mushroom place', in the grassland about 2.5 km from the main village. This place has a large population of *F. jaeschkeana* Vatke with maximum production of *P. himalayaensis*. In this village the mushroom appears within the radius of 3-4 km and that too in patches. Total production of mushroom in this area is approximately 8-10 quintals during the season. The inhabitants of the village Sumnam believe that when the snow is less the population of the host plant increases manifold but for appearance of the mushroom rainfall should be more otherwise the fruit body population is meagre/ reduces although the host plant population has increased.

The increase in population of *F. jaeschkeana* Vatke gradually reduces the appearance of other fodder grasses nearby. The cattle's do not feed on *F. jaeschkeana* Vatke and as such the plant is of no use to the locals except to host the mushroom and with some medicinal properties. It is also believed that the number of mushroom fruit bodies develop more in quantity when the plant is under foliar growth. Once the inflorescence develop the quantity of mushroom appearance decline. Mushroom fruit bodies were noticed in the first week of August when the leaves of the host plant dries and only the spike with umbels remains as the distinguishing part of the plant.

The village Kwaring (3400 mts a.m.s.l.) is inhabited with 17 families. The host plant in this area is locally named as "Mokshswachi" which literally mean "mushroom plant" (Moksha means mushroom and swachi means plant). The villagers collect nearly 80-90 kg of this mushroom during the growing season. People in Lahoul valley find the mushroom to be highly delicious. They collect the mushroom from the wild and consume either fresh or cut into small pieces and dry to preserve for consumption during the winters. The dried fruit bodies are soaked for some time in warm before cooking as a vegetable. The mushroom is also gifted to friends and relatives on special occasions. Dish of the mushroom is also prepared during the visit of special guests. Information regarding the mushroom and host plant from Meh, Shakoli and Tandi villages is almost identical to those provided by residents of Sumnam and Kwaring.

MATERIALS AND METHODS

Standard techniques for collection, preservation and description of agarics have been followed given by Atri *et al.* [2]. Morphological features, habit and habitat data were noted from fresh specimens and in the field itself. Microscopic characters were studied by free hand sections mounted in Lactophenol and stained with 2% Cotton blue. Colours in description are based on Methuen Handbook of Colours by Kornerup and Wanscher [3]. The specimens have been deposited in the Herbarium of Botany Department, Punjabi University Patiala under PUN 4300.

RESULTS

Taxonomy

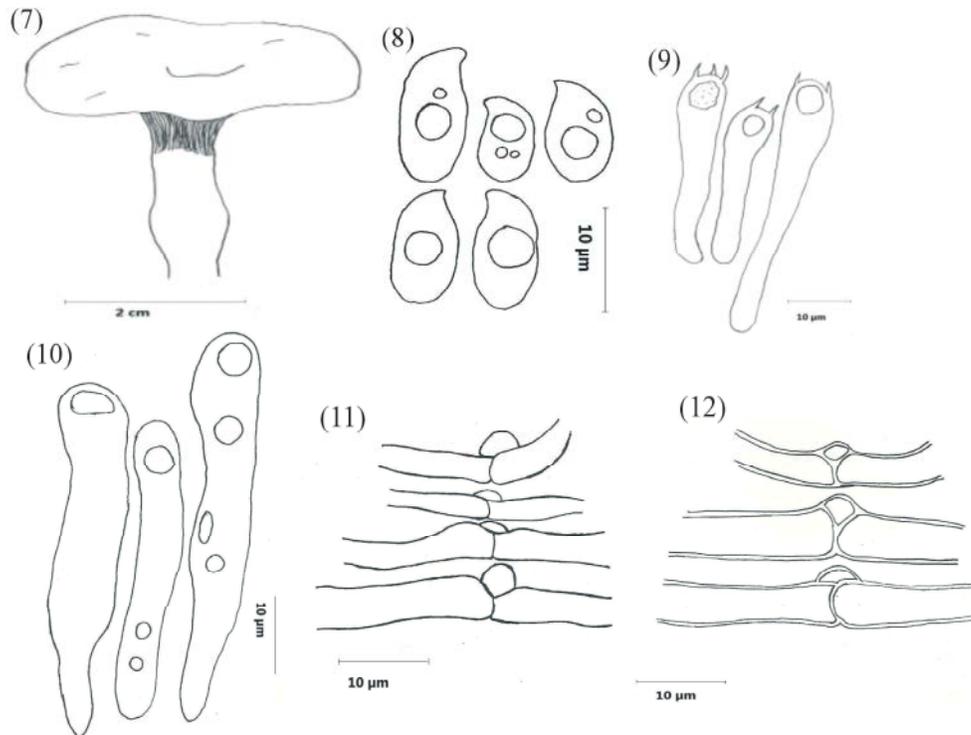
Pleurotus himalayaensis: *Dhancholia sp. nov.* Figs. 7-12.

Description-Pileus 2.5 - 23 cm across, the shape varies widely from convex to plano-convex, sometimes broadly depressed in the centre to appanate, milky white to off white to cream with age, pale brownish on drying but never yellow, surface glabrous, smooth but cracking in some fruit bodies to expose the white flesh beneath, margin incurved to strongly incurved with age, flesh white, cream with age, 0.5 to 4.5 cm thick in the centre, stuffed and spongy but shrinks on drying. Lamellae decurrent to strongly decurrent, white to cream in colour, 0.4-1.1 cm wide, moderately thick, firm, do not get detached easily from the pileus, edge smooth. Lamellulae of seven types. Stipe 1.2-9 cm long and up to 3.4 cm thick, more frequently eccentric and lateral sometimes centric, surface white to concolorous with pileus, smooth to striate above due to extension of the decurrent lamellae, caespitose, wide above and slightly tapering towards base, base attached with or enclosed in the fibrous roots of the host plant, sometimes on soil in the vicinity of the host plant.

Basidiospores (8) 9-14 (14.6) X 4-5.84 μ m, elongated, cylindrical, broad from centre, thin walled, hyaline, with large gullets and small oil droplets. Basidia elongated, tetra sterigmatic ranging from 35.04-51.1 X 4.38-5.84 μ m, Sterigmata 2.92 μ m. Pleurocystidia absent. Gill edge sterile with numerous chielocystidia. Chielocystidia, hyaline elongated, elongated cylindrical, filled with oil contents measuring 43.8-54.02 X 4.3-7.0 μ m (Fig. 1). Pileipellis thickness ranges 595-680 μ m. Pileus trama made up of interwoven, clamped hyphae having 2.92-5.84 μ m breadth, monomitic thin walled, interwoven. Gill trama made up of interwoven hyphae having breadth 2.93-4 μ m.



Figs. 1-6: 1. *Ferula jaeschkeana* Vatke, the host plant of *P. himalayaensis*. 2. Perennial host plant showing fibrous roots. 3. Associated *P. himalayaensis* with fibrous roots of host plant. 4. Plant association with mushroom. 5. Cracks on pileus surface exposing white surface underneath. 6. Variation in the shape of basidiocarps.



Figs. 7-12: *Pleurotus himalayaensis* Dhancholia sp. nov. 7. Basidiocarp (bar 4cm = 2 cm). 8. Basidiospores (bar = 10 µm) 9. Basidia (bar = 10 µm) 10. Chilelocystidia (bar = 10 µm) 11. Pileus hyphae (bar = 10 µm) 12. Stipe hyphae (bar = 10 µm).

Stipe surface is composed of parallel arranged thick walled skeletal hyphae having 4.38-7.3 µm breadth, unbranched, prominently clamped.

Etymology: The host plant in this area is locally named as “Mokshswachi” which literally mean “mushroom plant” (Moksha means mushroom and swachi means plant)

Host Plant: *Ferula jaeschkeana* Vatke has been reported to occur at an altitude of 3400 - 4000 mts. The average density (individuals/m²) varied from 0.6 to 3.0 at various places in Spiti valley of Himachal Pradesh. It is reported to be one of the 24 threatened plants of Himachal Pradesh as reported by Kala [4] and Pullaiah [5]. Data on density of this plant in Lahoul valley is yet to be recorded. It has been observed that in Lahoul valley the distribution of this plant is restricted in occurrence. The plant is locally popular as “Kaldaish” and also as “Hingupatri”.

Distribution: Since the mushroom grows in association with *Ferula jaeschkeana* and the population of this plant is restricted, it is presumed that the mushroom occurrence may become threatened. Also keeping in view the pressure on collection and consumption of this mushroom it may one day become an endangered species similar to that of the *P. nebrodensis*. Hence immediate measures are required to conserve both the plant as well as the mushroom. This may become easier as the distribution of both is restricted to a particular area in Lahoul valley.

Material Examined: *Pleurotus himalayaensis* S. Dhancholia : INDIA, Lahoul Spiti (3100 mts), near village Sumnam in association with fibrous roots of *F. Jaeschkeana* Vatke, 31 Aug 2010, DL 280 PUN 4300.

DISCUSSION

Pegler [6] revised descriptions of the *Pleurotus* species known from the Indian subcontinent along with a key to their identification. Watling and Gregory [7] while studying the larger fungi of Kashmir accounted for existence of eleven *Pleurotus* species in India. Manjula [8] revised the list of the agaricoid and boletoid basidiomycetes from India and Nepal and provided a key of twelve *Pleurotus* species known to be reported from India.

The present species bears similarity in many respects with *P. Eryngii* and *P. nebrodensis* (Table 1 - 2) such as the geographic location, time of occurrence, fruit body morphology etc. The pileus size in *P. nebrodensis* is 3 - 14.5 cm which appanate to ovoid in shape, surface light ivory to cream, cracking (from centre) glabre, changing sulphur yellow when dry. The lamellae are ivory coloured. The stipe is 1.4 - 3 cm wide and 2.1 - 7.5 cm long, equal to bulbous or slightly tapered at base in longitudinal view, eccentric or lateral and inserted in the root residue of *Cachrys ferulacea* Caest. The pileus size of the present species varies from 2.5 to 23 cm across, the shape varies widely from convex to plano-convex,

Table 1: Comparative account of Morphological details of new species with closely related species

Species	Size of basidiocarp		Shape of basidiocarp	Surface of pileus	Colour	Spore print colour	Associated host (s)
	Pileus	Stipe					
<i>Pleurotus himalayaensis</i>	2.5-22 cm	1.2 - 9 X 2- 3.4 cm	Convex to broadly depressed	Cracks on mature basidiocarp. No squamules	white (4A1)	White (4A1)	Only associated with roots of <i>Ferula jashchkeana</i>
<i>Pleurotus nebrodensis</i>	3.0-14.5 cm	2.1-7.5 X 1.4-3.0 cm	Convex with involuted margins, flat at maturity	Cracks mostly in center	Light ivory to Cream	Light ivory to Cream	<i>Cachrys ferulacea</i>
<i>Pleurotus eryngii</i>	4-12.5 cm	1.5-3.5 X 0.5-2.5 cm	Convex to mussel shaped	Spots on mature basidiocarp. Squamules present	Warm grey to beige buff or light beige	Cream yellow to Light brown	<i>Eryngium</i> species, <i>Ferula communis</i> , <i>Ferulago galbanifera</i> , <i>Cachrys ferulacea</i> , <i>Laserpitium</i> species.

Table 2: Comparative account of microscopical features of new species with closely related species

Species	Basidiospore size	Basidia size	Pileipellis	Chielocystidia	Pileus hyphae	Stipe hyphae
<i>Pleurotus himalayaensis</i>	(8) 9-14 (14.6) X 4-5.84 µm (Q = 2.05)	35.04-51.1 X 4.38-5.84 µm	595-680 µm	Abundant 43. 8-54.02 µm	2.92-5.84 µm	4.38-7.3 µm
<i>Pleurotus nebrodensis</i>	12.5-15.1 (-18) X 5.2-6.1 µm	40-50 X 10-11.5 (14)	-	50-60 X 6.2-7.5 (-9)	5-10 µm	-
<i>Pleurotus eryngii</i>	8.0-13.0 X 3.5-6.0 µm	30-52.1 X 7.1-8.8 µm	260-420 µm	Rare	4.1-5.5 µm	4.6-8.5 µm

Table 3: Analysis of soil associated with host plant and mushroom

Parameters	Test Value	Medium range/Thresh hold value	Remarks
Carbon	23	5 - 10/kg soil	High
pH	6.3	6.5-7.5	Slightly acidic
Nitrogen	317	280-560 kg/ha	Medium
Phosphorus	64	10-25 kg/ha	High
Potassium	250	118-280 kg/ha	Medium
Sulphur	25.6	22.5 kg/ha	Sufficient
Calcium	11.0	1.5 meq./100	Sufficient
Magnesium	1.8	1.0 meq./100	Sufficient
Iron	55.4	4.5 mg/kg	Sufficient
Manganese	47.6	1.0 mg/kg	Sufficient
Copper	2.8	0.2 mg/kg	Sufficient
Zinc	-	0.6 mg/kg	-
EC (μ s)	90	4 dS/m	Safe
Boron	0.1	0.5 mg/kg	Deficient

sometimes broadly depressed in the centre to appanate, milky white to off white to cream with age, pale brownish on drying but never sulphur yellow, surface glabrous, smooth but cracking in some fruit bodies to expose the white flesh beneath, margin incurved to strongly incurved with age, flesh white, cream with age, 0.5 to 4.5 cm thick in the centre, stuffed and spongy but shrinks on drying. Lamellae : decurrent to strongly decurrent, white to cream in colour, 0.4 - 1.1 cm wide, moderately thick, firm, do not get detached easily from the pileus, edge smooth, lamellulae of seven types. The stipe is 1.2 - 9.0 cm long and up to 3.4 cm thick, more frequently eccentric and lateral sometimes centric, surface white to concolorous with pileus, smooth to striate above due to extension of the decurrent lamellae, caespitose, wide above and slightly tapering towards base, base attached with or enclosed in the fibrous roots of *F. jaeschkeana* Calest, sometimes on soil in the vicinity of the host plant. This plant is the first new record as a host to this mushroom in the world.

Microscopically the basidiospores of *P. nebrodensis* are 12.5 - 15.1 (-18) X 5.2 - 6.1 μ m, cream in colour whereas those of the present species are hyaline, measuring (8) 9-14 (14.6) X 4-5.84 μ m with one large guttule and few small oil droplets. The cheilocystidia in *P. nebrodensis* are 50 - 60 X 6.2 - 7.5 (-9) μ m whereas those of the present species are 43. 8-54.02 μ m (Table 1 - 2). The h y p h a e in *P. nebrodensis* are monomitic and thin walled with clamp connections whereas those of the present species are thin walled, monomitic, with clamp connections in pileus and flesh but thick walled monomitic with clamp connections in the stipe region. From *P. eryngii* it differs in not having the cream yellow to gray yellow pileus and growing under a perennial herb (*F. jaeschkeana* Vatke) rather than under

a tree (*F. communis* L.). Moreover, *P. nebrodensis* grows with a wide variety of host belonging to Apiaceae and Compositae, whereas *P. himalayaensis* grows only in association with *F. jaeschkeana* Vatke.

Soil samples from the mushroom growing areas and around the host plants were analysed. (Table 3) shows the test report revealing the presence of high amounts of Phosphorous and Boron deficient soil. The pH of the soil is slightly acidic (6.3) having high organic carbon i.e. 23 g/kg soil. Nitrogen and potassium content in the soil were found to be medium i.e., 317 and 250 kg/ha, respectively. The other elements like sulphur, calcium, magnesium, iron, manganese and copper were found to present in sufficient amounts. Venturella [9] reported that *P. nebrodensis* grows only on limestone in northern Sicily in association with *Cachrys ferulacea* Calest. In the Indian Himalayas the species of *Pleurotus* being reported prefers a slightly acidic soil with pH of 6.3, although high amounts of phosphorous are present in the soil.

The present species thus, differs considerably in macro and microscopic characters, habit and habitat as well as the host plant. Hence it is proposed that *P. himalayaensis* Dhancholia sp. nov. is a new species occurring only in the Himalayan region of India.

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