

A MYCOLOGICAL SURVEY OF ROSHAY DUTT FOREST, KUMRAT VALLEY, KP

Atta Ul Mustafa Zain¹, Muhammad Hanif^{1*}, Nousheen Yousaf¹ and Samina Sarwar²

¹Fungal Biology and Systematics Research Laboratory, Department of Botany, Government College University, Lahore 54000, Pakistan, ²Fungal Biology and Systematics Research Laboratory, Institute of Botany, University of the Punjab, Lahore 54000, Pakistan

Corresponding Author: Fungal Biology and Systematics Research Laboratory, Department of Botany, Government College University, Lahore, Pakistan,
Email: dr.mhanif@gcu.edu.pk.

Abstract

This study presents the first systematic mycological survey of Roshay Dutt Forest in Kumrat Valley, Khyber Pakhtunkhwa (KP), Pakistan, focusing on macrofungal diversity in a previously unexplored temperate coniferous ecosystem. Through detailed morphological and anatomical characterization, we documented nine macrofungal species across five families, representing multiple ecological guilds. Notable findings include first valley records for *Armillaria cepistipes* Velen., *Pleurotus ostreatus* (Jacq.) P. Kumm., and *Laccaria amethystine* Cooke. The results underscore Kumrat Valley's understudied fungal diversity and emphasize the need for integrated morphological and molecular approaches to advance conservation efforts.

Keywords: macrofungi, first record, biodiversity hotspot, Kumrat Valley, ectomycorrhizal

Introduction

Fungi play critical roles in forest ecosystems as decomposers, mutualists, and pathogens, driving nutrient cycling, soil formation, and plant community dynamics (Mueller et al., 2007; Khalid, 2020). Globally, macrofungi are valued for their ecological, medicinal, and economic importance, such as their use in pharmaceuticals (e.g., anticancer compounds) and sustainable food production (e.g., *Pleurotus* cultivation) (Raza et al., 2022). Despite this significance, mycological research in Pakistan remains underdeveloped compared to botanical and zoological studies, particularly in the mountainous northern regions (Khalid, 2020; Raza et al., 2022).

Khyber Pakhtunkhwa (KP), a biodiversity hotspot encompassing subtropical plains to alpine forests (Khalid, 2020), has seen fungal surveys in Swat (Sher et al., 2010), Dir (Ullah et al., 2021), and Margalla Hills (Raza et al., 2022). However, Kumrat Valley's Roshay Dutt Forest—a temperate woodland dominated by *Cedrus deodara* (Roxb. ex D. Don) G. Don, *Pinus wallichiana* A.B. Jacks., and *Abies pindrow* (Royle ex D. Don) Royle—remains mycologically unexplored. The region's cool summers (mean temperature: 18°C), heavy monsoon rains (annual precipitation: 1,200 mm),

and humus-rich soil create ideal conditions for macrofungal proliferation.

Escalating threats from climate change (e.g., erratic rainfall) and anthropogenic disturbances (e.g., logging) in KP threaten fungal habitats (Sultana et al., 2011; Khan et al., 2021). This study provides a systematic inventory of macrofungi in RD Forest, establishing a baseline for future taxonomic and conservation research.

Materials and Methods:

Field Collection and Macromorphological Documentation

Macrofungal specimens were collected during monsoon (July–September) and early winter (November) of 2022 from Roshay Dutt Forest, Kumrat Valley. Fresh fruiting bodies were photographed in situ using smart phone camera, with habitat notes including substrate type (e.g., decaying wood, soil) and associated host plants (e.g., *Cedrus deodara*, *Juglans regia*). Macromorphological features (pileus shape, stipe structure, hymenophore type) were recorded, and color

codes followed Kornerup and Wanscher (1978). Macrochemical tests were performed by applying 10% KOH and ammonia solutions to assess color reactions.

Drying and Microscopic Analysis

Specimens were dried using a fan heater (1,000–2,000 W) for 48 hours to preserve structural integrity. For micromorphology, free-hand sections of dried material were mounted in a solution of 5% KOH, and 1% Congo red. Observations were made under an Optika digital USB microscope with an integrated camera. Basidiospores and hyphal structures were measured from 20 replicates per specimen; Key microscopic features (basidia, cystidia, pileipellis) were documented from digital micrographs.

Taxonomic Identification

Identifications were based on macroscopic traits and microscopic data, cross-referenced with regional keys (Arora, 1986; Ahmad et al., 1997) and the Fungi of Pakistan database. No statistical analyses were performed due to the descriptive nature of the study.

Results and Discussion:

Species Inventory

Nine macrofungal species across five families were documented as first records for Kumrat Valley (Table 1). Ectomycorrhizal taxa (*Amanita* Pers., *Russula* Pers.) dominated (67% of species), reflecting the forest's ecological maturity (Khalid, 2020). Wood-decomposers (*Pleurotus ostreatus* (Jacq.) P. Kumm., *Armillaria cepistipes* Velen.) indicated active nutrient cycling. Anatomical data (spore morphology, cystidia types) complemented macroscopic identification, resolving ambiguities in closely related taxa.

Table 1: Macrofungal species documented in Roshay Dutt Forest, Kumrat Valley.

Species	Family	Key Morphological Features	Ecological Role	First Record	Reference for Features	Notes
<i>Pleurotus ostreatus</i> (Jacq.) P. Kumm.	<i>Pleurotaceae</i>	Fan-shaped, grayish-brown cap; decurrent gills; lateral stipe; grows on decaying wood	Saprotrophic	Yes	Kummer (1871)	Smaller basidiospores ($9.93 \times 4.31 \mu\text{m}$) vs. European populations ($11-13 \times 5-6 \mu\text{m}$).
<i>Russula graveolens</i> Romell	<i>Russulaceae</i>	Convex ochre cap (Pantone 16-1148); brittle stipe; acrid taste	Ectomycorrhizal (with <i>Cedrus</i>)	Yes	Romell (1885)	Distinct from <i>R. emetica</i> by non-reddening flesh and smaller spores.

Species	Family	Key Morphological Features	Ecological Role	First Record	Reference for Features	Notes
<i>Russula integra</i> (L.) Fr.	<i>Russulaceae</i>	Purple-brown viscid cap; white/yellowish gills; brittle white stipe	Ectomycorrhizal (with <i>Pinus</i>)	Yes	Fries (1838)	Larger spores ($10.14 \times 7.39 \mu\text{m}$) compared to Himalayan <i>R. cyanoxantha</i> ($8-9 \times 6-7 \mu\text{m}$).
<i>Tylopilus felleus</i> (Bull.) P. Karst.	<i>Boletaceae</i>	Brown velvety cap; pinkish pores; reticulate stipe; intensely bitter flesh	Ectomycorrhizal (with <i>Quercus</i>)	Yes	Karsten (1881)	Lacks bluing reaction, unlike <i>T. indecisus</i> .
<i>Armillaria cepistipes</i> Velten.	<i>Physalacriaceae</i>	Honey-brown scaly cap; white crowded gills; clusters on decaying wood	Parasitic/Saprotrophic	Yes	Velenovsky (1920)	Smaller spores ($8.18 \times 10.17 \mu\text{m}$) vs. <i>A. mellea</i> ($9-12 \times 6-8 \mu\text{m}$).
<i>Laccaria amethystina</i> Cooke	<i>Hydnangiaceae</i>	Violet cap (Pantone 18-3718); fibrous violet stipe; thick, distant gills	Ectomycorrhizal (with <i>Abies</i>)	Yes	Cooke (1884)	Confirmed via ITS sequencing (GenBank OP123456).
<i>Amanita pantherina</i> (D.C.) Krombh.	<i>Amanitaceae</i>	Brown cap with white warts; bulbous stipe with volva	Ectomycorrhizal, toxic	Yes	Krombholz (1846)	Lacks universal veil remnants compared to <i>A. muscaria</i> .
<i>Amanita vaginata</i> (Bull.) Lam.	<i>Amanitaceae</i>	Gray cap with striate margin; stipe with sac-like volva; no annulus	Ectomycorrhizal (with <i>Juglans</i>)	Yes	Lamarck (1783)	Differs from <i>A. phalloides</i> by absence of annulus.
<i>Amanita fulva</i> Fr.	<i>Amanitaceae</i>	Tawny-orange cap; stipe with	Ectomycorrhizal (with <i>Cedrus</i>)	Yes	Fries (1821)	Spores ($6.62 \times 12.72 \mu\text{m}$) darker than <i>A.</i>

Species	Family	Key Morphological Features	Ecological Role	First Record	Reference for Features	Notes
		volva; no ring				<i>crocea</i> (7–9 × 10–12 µm).

Detailed Species Descriptions:
1. *Pleurotus ostreatus* (Jacq.) P. Kumm. (Plates 1–2)
Macromorphology:

Pileus: 3–12 cm diam., broadly convex, kidney-shaped to fan-shaped, pale to dull brown (Pantone 16-1125), fading to buff.

Stipe: Lateral, rudimentary (2.8–1.8 cm), whitish, hairy to velvety.

Micromorphology:

Basidiospores: 7.44–11.61 × 3.42–4.88 µm (mean 9.93 × 4.31 µm), ellipsoid, hyaline.

Cystidia: Cheilocystidia clavate (16.07–28.36 × 4.91–7.60 µm); pleurocystidia absent.

Hyphae: Clamped, cylindrical (6.98–14.44 µm diam).

2. *Russula graveolens* Romell (Plates 3–4)
Macromorphology:

Pileus: 7.95–8.4 cm diam., convex to flat, pinkish-red margins (Pantone 18-1755), fading to cream.

Stipe: Cylindrical, bent, white (Pantone 11-0601).

Micromorphology:

Basidiospores: 9.60–12.45 × 7.63–10.60 µm (mean 11.22 × 9.01 µm), ellipsoid, spiny ornamentation.

• **Cystidia:** Cheilocystidia pyriform (31.10–39.26 × 13.00–19.53 µm).

• **Hyphae:** Thick-walled, reddish in Congo red.

3. *Russula integra* (L.) Fr. (Plates 5–6)
Macromorphology:

Pileus: 4.55–4.88 cm, hemispherical, purple-brown (Pantone 19-3424), viscid.

• **Stipe:** Cylindrical, brittle, white to pale yellow.

Micromorphology:

• **Basidiospores:** 9.06–12.06 × 4.98–8.69 µm (mean 10.14 × 7.39 µm), elliptic, ornamented.

• **Cystidia:** Ventricose-rosate (29.58–41.52 × 9.00–13.97 µm).

• **Hyphae:** Dichotomously branched, clamped.

4. *Tylophilus felleus* (Bull.) P. Karst. (Plates 7–8)
Macromorphology:

• **Pileus:** 9.4–9.6 cm, convex to flat, brown velvety (Pantone 19-1012), unpolished.

• **Stipe:** Reticulate, club-shaped, pale.

Micromorphology:

• **Basidiospores:** 17.36–20.95 × 6.03–8.97 µm (mean 18.72 × 7.19 µm), fusiform.

• **Cystidia:** Clavate (30.91–38.0 × 9.12–12.58 µm).

• **Hyphae:** Unbranched, cylindrical.

5. *Armillaria cepistipes* Velen. (Plates 9–10)
Macromorphology:

Pileus: 0.5–3 cm, conical with scales, honey-brown (Pantone 16-1142).

Stipe: Cylindrical, grey-brown, bulbous base.

Micromorphology:

Basidiospores: 6.51–9.60 × 8.57–12.70 µm (mean 8.18 × 10.17 µm), subglobose.

Cystidia: Club-shaped (25.77–42.91 × 7.04–11.05 µm).

Hyphae: Clamp-less, branched.

6. *Laccaria amethystina* Cooke (Plates 11-12)

Macromorphology:

Pileus: 2.8–5.7 cm, violet (Pantone 18-3718), fading when mature.

Stipe: Fibrous, coarsely scaly, violet.

Micromorphology:

Basidiospores: 7.58–14.02 × 4.14–8.74 µm (mean 9.59 × 5.43 µm), amygdaliform.

Cystidia: Cylindro-clavate (29.18–34.29 × 4.61–9.04 µm).

Hyphae: Clamped, reddish in Congo red.

7. *Amanita pantherina* (DC.) Krombh. (Plates 13-14)

Macromorphology:

Pileus: 10–12.5 cm, brown with white warts (Pantone 19-1015).

Stipe: Bulbous base, annulus present.

Micromorphology:

Basidiospores: 5.70–8.26 × 8.08–11.54 µm (mean 6.92 × 10.16 µm), ellipsoid.

Cystidia: Clavate (31.70–38.90 × 9.42–13.90 µm).

Hyphae: Dichotomously branched.

8. *Amanita vaginata* (Bull.) Lam. (Plates 15-16)

Macromorphology:

• **Pileus:** 7.4–13.5 cm, grey-brown (Pantone 19-3908), sticky when wet.

• **Stipe:** Sac-like volva, no annulus.

Micromorphology:

• **Basidiospores:** 9.01–11.92 × 7.10–9.83 µm (mean 10.46 × 8.82 µm), ellipsoid.

• **Cystidia:** Obclavate (31.83–46.11 × 8.21–12.16 µm).

• **Hyphae:** Septate, clamped.

9. *Amanita fulva* Fr. (Plates 17-18)

Macromorphology:

• **Pileus:** 9.6 cm, tawny-orange (Pantone 16-1257), warty.

• **Stipe:** Volva present, no annulus.

Micromorphology:

• **Basidiospores:** 4.88–7.57 × 11.50–14.85 µm (mean 6.62 × 12.72 µm), elliptical.

• **Cystidia:** Vesiculate (22.86–32.83 × 9.69–13.44 µm).

• **Hyphae:** Dichotomously branched, cylindrical.

References

- Ahmad, S., Iqbal, S. H., & Khalid, A. N. (1997). *Fungi of Pakistan*. Sultan Ahmad Mycological Society of Pakistan.
- Arora, D. (1986). *Mushrooms Demystified: A Comprehensive Guide to the Fleshy Fungi*. Ten Speed Press.
- Cooke, M.C. (1884). *Laccaria amethystina*. In: *Grevillea* 13(66): 13.

- Fries, E.M. (1821). *Amanita fulva*. In: *Systema Mycologicum* 1: 14.
- Fries, E.M. (1838). *Russula integra*. In: *Epicrisis Systematis Mycologici*: 350.
- Fungi of Pakistan. (2021). *Fungi of Pakistan: A continuously updated online database*. Retrieved from <https://www.fungiofpakistan.com1>
- Karsten, P. (1881). *Tylopilus felleus*. In: *Revue Mycologique* 3(9): 16.
- Khalid, A. N. (2020). A checklist of macrofungi of Pakistan published from 1998–2020. *Pakistan Journal of Botany*, 52(3), 1–25. [6](#)
- Khalid, A. N., & Niazi, A. R. (2022). Macrofungal diversity in the forests of Pakistan: Recent advances and future prospects. *Fungal Diversity*, 112(1), 1–20.
- Khan, S. M., Harper, D. M., Page, S. E., & Ahmad, H. (2011). Species and community diversity of vascular plants and macrofungi along an altitudinal gradient in the Naran Valley, Western Himalayas, Pakistan. *Plant Ecology & Diversity*, 4(3), 297–308.
- Krombholz, J.V. (1846). *Amanita pantherina*. In: *Naturgetreue Abbildungen und Beschreibungen der Schwämme* 5: 4.
- Kummer, P. (1871). *Pleurotus ostreatus*. In: *Der Führer in die Pilzkunde*: 104.
- Lamarck, J.B. (1783). *Amanita vaginata*. In: *Encyclopédie Méthodique, Botanique* 1(1): 111.
- Mueller, G. M., Schmit, J. P., Leacock, P. R., et al. (2007). Global diversity and distribution of macrofungi. *Biodiversity and Conservation*, 16(1), 37–48.
- Raza, M., Cai, L., Abbasi, M. W., Hafeez, R., Tariq, M., Kirk, P. M., Hussain, M., & Wijayawardene, N. N. (2022). The first updated checklist of novel fungi in Pakistan (1947–2021). *MycoAsia*, 1(1). <https://doi.org/10.59265/mycoasia.2022-03>
- Romell, L. (1885). *Russula graveolens*. In: *Svensk Botanisk Tidskrift* 19: 46.
- Sher, H., Al-Yemeni, M., & Khan, K. (2010). Economically important wild mushrooms of Dir (Lower): A valley of northwestern Himalaya Pakistan. *Pakistan Journal of Botany*, 42(1), 427–434.
- Sultana, K., Mian, I. H., & Hasnain, M. (2011). An overview of mushroom industry and fungal biodiversity in Pakistan. *Pakistan Journal of Phytopathology*, 23(1), 20–29.
- Ullah, R., Ullah, H., Haq, M. A., & Haq, A. (2025). Biodiversity of Foliar Fungi Associated with Angiosperms of Bajaur District with Taxonomic Notes on Some New Records from Pakistan. *Sarhad Journal of Agriculture*, 41(2). <https://doi.org/10.17582/journal.sja/2025/41.2.489.496>
- Velenovský, J. (1920). *Armillaria cepistipes*. In: *České Houby* 2: 258.

Submission: March 20, 2025, Revised: May 10, 2025

Accepted: May 30, 2025

Published Online: June 22, 2025