Diversity of Wild Mushrooms in Chaukot, Panauti

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ABSTRACT

Exploration on mushroom is relatively limited compared to other organism. This study aim to explore and documentation of diversity of wild mushrooms in chaukot community forest. A field survey was conducted in between 1500 and 1700 m a.s.l., to assess wild mushroom diversity. Mushrooms were sampled using quadrats along transects, identified through morphological and microscopic characteristics, and their diversity was evaluated using Shannon – wiener index and Simpson diversity index. A total of 68 mushroom were identified belonging Basidiomycota, Ascomycota and Mycetozoa. Among mushroom species, most of the mushroom were belongs to Russulaceae family and Agaricales order, Russula genera Laccaria laccata species in terms of number of species The highest species of mushroom were found in soil. More than half percentage of the mushroom were saprobe which favored by high canopy cover. Out of 68 species found in study area 34 mushroom species were edible, 19 inedible, 10 poisonous and 5 having unknown edibility. The current study showed Laccaria laccata had highest density and abundance. The Shannon diversity index was 3.78 and Simpson diversity index was 0.97 underscoring significant diversity. These findings emphasize the role of soil, and forest type in shaping mushroom diversity and their potential for ecological and local community applications.

Keywords: Diversity index, *Laccaria laccata*, Mushroom, *Scleroderma cepa*

Introduction

Fungi play a critical role in maintaining ecological balance, with mushroom being one of the most viable representatives of this kingdom. Nepal has divers of several types of habitats and an immense variety of species in such a small area (Aryal and Budhathoki, 2012). Mushrooms are crucial decomposers, facilitating nutrient recycling in ecosystems, and they exhibit remarkable diversity across different ecological regions of the world (Chang and Miles, 2004). Even though Mushroom are incredibly beneficial, there has been relatively little research done on wild mushrooms compared to other types of plants (Muller *et al*., 2007).

According to database of GBIF 2024, the total number of 173660 fungal species have been documented and cataloged in the GBIF database. Total of 3971 specimens of mushrooms from Nepal is digitized and published in GBIF portal (GBIF, 2021). Wild mushrooms of Nepal belong to 108 families, 357 genera, and 1291 species with 34 endemic species (Devkota and Aryal, 2020). Among them 159 species of mushrooms are edible in nature (Devkota and Aryal, 2020). Central Nepal has comparatively more investigations and studies regarding mycology as compared to eastern and western region (Adhikari, 1999; Adhikari, 2000; Adhakari and Bhattarai, 2014). Due to varieties of weather condition the distribution of macrofungal species is high in spring and autumn but low during the hot dry season (Sibounnavong *et al*., 2008). Hibbett, (2007) has described mushrooms have simpler forms of fruiting bodies consisting of pileus, stipe, gills, annulus, volva and mycelium. According to mushroom include a variety of ecology, including mycorrhizae (*Russula*, *Boletus*, *Amanita*, and *Lactarius*), saprophytic (*Coprinus*, *Agaricus*, etc.), hyperparasite (like *Asterophora* on *Russula*, etc.), and parasitic (like *Polyporous*, *Fomes*, etc.).

Although Nepal is known for its rich biodiversity, including a wide variety of macrofungi, comprehensive studies focusing on mushroom diversity in the Kathmandu Valley remain scarce and fragmented. Most existing research in Nepal has either concentrated on ethnomycological uses (Adhikari, 2000; Budha et al., 2009) or provided only localized checklists without broader ecological analysis (Thapa & Rai, 2012). There is a notable lack of systematic surveys that enumerate mushroom species across multiple habitats within the valley and assess how environmental variables—such as altitude, forest type, canopy cover, temperature, and humidity—influence species richness and distribution. This gap limits our ecological understanding and constrains conservation and sustainable utilization efforts. Addressing this void by documenting the macrofungal diversity and analyzing distribution patterns along environmental gradients is crucial to support future biodiversity monitoring, conservation strategies, and local livelihoods.

The chaukot community forest offers diverse range of habitat due to its varied altitude, climate and vegetation which supports a wide variety of mushroom. As a less studied area compared to other region, this study will help in the confirmation of current understanding and providing new information to the public about diversity of mushroom.

The objectives of this study were to enumerate mushrooms species found within study area and to assess the pattern of species diversity and distribution along environmental variables.

Materials and methods

Study site

The site for this study is situated around 30 km east of Kathmandu valley in the Panauti Municipality of Kavrepalanchok district, Bagmati Province, Nepal (Figure 1). Geographically, it is located between 27°37′N and 85°33′E. Chaukot Community Forest was selected for the mushroom survey. The forest is dominated by *Schima wallichii* and *Castonopsis* sp. with associated species like *Pinus roxburghii*, *Myrica esculenta*, and *Rhododendron arboretum*. Elevation range of the site was 1500 to 1700 meters above sea level, along the northern slopes of the hills.

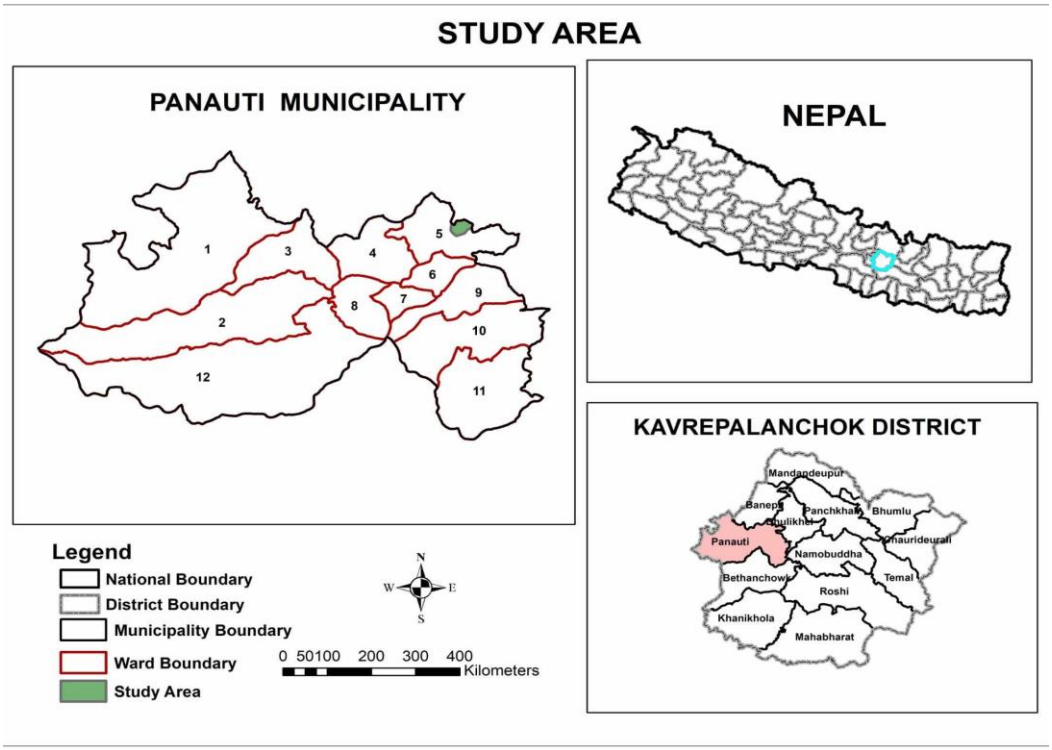

Fig. 1: Location map of Chaukot community forest located in Panauti Municipality of Kavrepalanchok district, Nepal

According to data obtained from the Department of Hydrology and Meteorology across eleven years (2013–2023), the maximum average precipitation occurs in July with average of 364 mm. January had the lowest recorded temperature of 4 ºC with low precipitation (2mm). Based on the data, the maximum relative

humidity was determined to be in August and the minimum to be in April, with values of 91% and 62%, respectively.

Survey of mushroom

A total of 18 quadrats of size 10 x 10 m were sampled along three transects spaced 100 meters apart for survey of mushrooms. The mushrooms present in each plot were reported. They were properly dug up and the wood-rooting mushrooms were extracted from the host adhered to. Photographs were taken and morphological characteristics such as fruiting bodies, pileus color, pileus edge, scale, gill color, gill spacing, stipe length, width, color, veil, annulus, and volva were noted in the field (Srivastava and Bano, 2010).

The samples were collected for each species reported, labeled, preserved. Hard mushrooms were dried out and fleshy were preserved in liquid (25: 5: 70) ml of ethyl alcohol, formalin, and distilled water.

Microscopic study

For microscopic study, the spore prints were observed and observed under Olympus CX22 high power microscope with magnifications of 40x and 100x. Length and width of spores of each mushroom species were measured.

Identification of mushrooms

The mushrooms were identified based on morphological and microscopic characteristics such as spore size and shape, fruiting bodies, Pileus color, Pileus edge, scale, gill color, gill spacing, stipe length, width, color, type of veil, annuls, and volva.using following standard literatures (Watling, 1973; Philips, 1981; Adhikari, 2000). Edibility was assessed through literature review (Budha et al., 2009; Adhikari, 2000) and consultation with local foragers. Identifications were verified with taxonomic experts and herbarium specimens at TUCH.

Diversity Index, frequency and density

The Shannon-Wiener diversity index (H) and Simpson diversity index (D) were calculated following Magurran (2004) using the formula as given below

$H = -\Sigma Pi \ln Pi$
Where, H = Shannon-Wiener diversity index
Pi = ratio of individual of species i divided by all individuals
n = number of species

$$\text{Simpson diversity index (D)} = \frac{\Sigma n\,(n-1)}{N\,(N-1)}$$

Where, D = Simpson diversity index
N = Total number of individuals of all species
n = Total number of organisms of particular species

Frequency and density of the mushrooms also calculated using following formulae (Daubenmire, 1959).

$$\text{Frequency \%} = \frac{number\ of\ quadrates\ in\ which\ species\ present}{Total\ number\ of\ quadrates\ sampled} \times 100\%$$

$$\text{Density} = \frac{\text{Total number of individual of a species in all quadrates}}{\text{Total number of quatrates}}$$

Important Value Index = Relative density+ Relative Frequency+ Relative Abundance

Soil sampling and analysis

Soil samples were also taken from the quadrats sampled from depth of 15 cm. The samples were thoroughly mixed before being placed in a Zipper bag for analyzing in the lab. soil pH and moisture were determined following Zobel *et al*., (1987).

$$\text{Moisture content \%} = \frac{\text{Weight of fresh soil} - \text{weight of oven dried soil}}{\text{Weight of oven dried soil}} \times 100\%$$

Canopy cover was determined following Lemmon, 1956.

$$\text{Canopy cover (\%)} = \frac{\text{Total filled squares}}{96} \times 100\%$$

Statistical analysis

A regression analysis was performed to determine the link between environmental variables and the richness of mushroom species. Excel was utilized to assess the mean value of nutrients among species and conduct an independent sample T-test. Significance was recognized at the 5% significance level. To ensure that the results are accurate, the analysis was done three times.

Results and Discussion

Mushroom diversity

The study revealed 68 different species of mushroom resembled to the three phylum, twenty eight families, and fourteen orders.

Table 1: List of mushroom with their ecology, habitat, order, family, edibility, frequency, density, abundance and IVI

S.N	Scientific Name	Ecology	Habitat	Order	Family	Edibility	Frequency (%)	Density	Abundance	IVI
1	*Amanita farinose*	Mycorrhizal	soil	Agaricales	Amanitaceae	Poisonous	16.67	0.28	1.67	1.5
2	*A. fulva*	Mycorrhizal	Soil	Agaricales	Amanitaceae	edible	27.78	2.06	7.40	5
3	*A, caesarea*	Mycorrhizal	Soil	Agaricales	Amanitaceae	edible	33.33	1.78	5.33	4.5
4	*A, veginata*	Mycorrhizal	Soil	Agaricales	Amanitaceae	edible	33.33	2.28	6.83	5.3
5	*A. phalloides*	Mycorrhizal	Soil	Agaricales	Amanitaceae	Poisonous	27.78	1.83	6.60	4.6
6	*A. rubrovolvata*	Mycorrhizal	Soil	Agaricales	Amanitaceae	Poisonous	44.44	3.78	8.50	7.4
7	*A. sinensis var. sinensis*	Mycorrhizal	Soil	Agaricales	Amanitaceae	Poisonous	16.67	0.39	2.33	2
8	*A. strobiliformis*	Mycorrhizal	Soil	Agaricales	Amanitaceae	Unknown	16.67	0.17	1	1.2
9	*Armillaria tabescens*	Saprobe	Soil	Agaricales	Physalaciaceae	edible	33.33	3.89	11.67	5.3
10	*Arcyria denudate*	Saprobe	Leaf litter	Trichiida	Trichiidae	Inedible	5.56	0.06	1	0.6
11	*Aureoboletus flaviporus*	Mycorrhizal	Soil	Boletales	Boletaceae	edible	27.78	1.5	5.4	4
12	*Bjerkandera adusta*	Saprobic	Deadwood	Polyporales	Hapalopilaceae	Inedible	55.56	5.94	10.70	10.2
13	*Boletus edulis*	Mycorrhizal	Soil	Boletales	Boletaceae	Edible	33.33	0.89	2.67	3.1
14	*Boletellus emodensis*	Mycorrhizal	Soil	Boletales	Boletaceae	Inedible	11.11	0.22	2	1.3
15	*Collybia confluence*	Saprobe	leaf litter	Agaricales	Omphalotaceae	Inedible	33.33	2.56	7.67	5.7
16	*Clitocybe gibba*	Saprobe	Leaf litter	Agaricales	Tricholomataceae	edible	38.89	2.33	6	5.3
17	*C. odora*	Saprobe	Leaf litter	Agaricales	Tricholomataceae	edible	33.33	1.28	3.83	3.7
18	*Coltricia cinnamomea*	Mycorrhizal	Soil	Hymenochaetales	Hymenochaetaceae	Inedible	33.33	5.44	16.33	7.7
19	*Craterellus cornucopioides*	Mycorrhizal	Soil	Cantharellales	Cantharellaceae	edible	33.33	1.89	5.67	4.6
20	*Cuphophyllus virgineus*	Saprobe	Deadwood	Agaricales	Hygrophoraceae	unknown	22.22	0.89	4	2.9
21	*Dacrymyces spathularia*	Saprobe	dead wood	Dacrymycetales	Dacrymycetaceae	edible	33.33	1.28	3.83	3.7
22	*Ganoderma lucidum*	Saprobe	Tree stump	Polyporales	Ganodermataceae	edible	33.33	1.78	5.33	4.5
23	*Gyroporous castaneus*	Mycorrhizal	Soil	Boletales	Gyroporaceae	edible	11.11	0.11	1	0.9

24	*Heterobasidion annosum*	Saprobe	Tree stump	Russulales	Bondarzewiaceae	Inedible	22.22	6.22	28	10.3
25	*Hygrocybe cantharellus*	Mycorrhizal	Soil	Agaricales	Hygrophoraceae	edible	22.22	3.39	15.25	7.9
26	*Hygrocybe miniata*	Mycorrhizal	Soil	Agaricales	Hygrophoraceae	edible	38.89	3.44	8.86	7
27	*Hymenochaete rubiginosa*	Saprobe	Firewood	Hymenochaetales	Hymenochaetaceae	Inedible	22.22	6.78	30.5	6.6
28	*Hypholoma fasciculare*	Saprobe	Leaf litter	Agaricales	Strophariaceae	Inedible	33.33	6.11	18.33	8.1
29	*Isaria sinclairii*	Parasitic	Soil	Hypocreales	Cordycipitaceae	Unknown	33.33	6.06	18.17	11.3
30	*Laccaria laccata*	Mycorrhizal	Soil	Agaricales	Hydnangiaceae	edible	50	10.83	21.67	13.8
31	*Lactarius corrugis*	Mycorrhizal	Soil	Russulales	Russulaceae	edible	5.56	0.06	1	0.6
32	*L. lilacinus*	Mycorrhizal	Soil	Russulales	Russulaceae	Inedible	27.78	1.28	4.6	3.6
33	*L. piperatus*	Mycorrhizal	Leaf litter	Russulales	Russulaceae	edible	38.89	1.11	2.86	3.5
34	*Leccinum crocipodium*	Mycorrhizal	Soil	Boletales	Boletaceae	edible	5.56	0.06	1	0.6
35	*Leotia lubrica*	Saprobe	Leaf litter	Leotiales	Leotiaceae	Inedible	50	5.50	11	9.
36	*Lepiota cristata*	Mycorrhizal	Soil	Agaricales	Agaricaceae	poisonous	16.67	0.44	2.67	1.9
37	*Leucocoprinus birnbaumii*	Saprobe	Animal dong	Agaricales	Agaricaceae	Inedible	27.78	1.94	7	4.8
38	*L. fragilissimus*	Saprobe	Leaf litter	Agaricales	Agaricaceae	Inedible	44.44	5.56	12.5	8.3
39	*Lycoperdon pyriforme*	Saprobe	Leaf litter	Agaricales	Agaricaceae	edible	55.56	3.44	6.2	6.6
40	*Megacollybia platyphylla*	Saprobe	Leaf litter	Agaricales	Tricholomataceae	poisonous	33.33	1.39	4.17	3.8
41	*Microporus xanthopus*	Saprobe	Wood	Polyporales	Polyporaceae	Inedible	61.11	6.89	11.27	10.7
42	*Nigroporus vinosus*	Saprobe	Tree stump	Polyporales	Polyporaceae	Unknown	33.33	1.89	5.67	4.6
43	*Oudemansiella radicata*	Saprobe	Soil	Agaricales	Physalacriaceae	edible	16.67	0.17	1	1.2
44	*Panus conchatus*	Saprobe	Wood	Polyporales	Polyporales	Inedible	38.89	1.39	3.57	4
45	*Paxillus involutus*	Saprobe	Fallen tree	Boletales	Paxillaceae	poisonous	5.56	0.06	1	0.6
46	*P. cuprinus*	Mycorrhizal	Soil	Boletales	Paxillaceae	poisonous	5.56	0.06	1	0.6
47	*Polyporus arcularius*	Saprobe	Wood	Polyporales	Polyporaceae	Inedible	44.44	1.72	3.88	4.6
48	*Psathyrella candolleana*	Saprobe	Wood	Agaricales	Coprinaceae	edible	50	6.33	12.67	10.4
49	*Rhodocollybia butyracea*	Saprobe	Leaf litter	Agaricales	Omphalotaceae	edible	27.78	0.61	2.2	2.4

50	*Russula aeruginea*	Mycorrhizal	Soil	Russulales	Russulaceae	edible	16.67	0.22	1.33	1.4
51	*R. mairei*	Mycorrhizal	Soil	Russulales	Russulaceae	Inedible	27.78	0.89	3.2	2.9
52	*R. ochroleuca*	Mycorrhizal	Soil	Russulales	Russulaceae	edible	11.11	0.22	2	1.3
53	*R. foetens*	Mycorrhizal	Soil	Russulales	Russulaceae	Poisonous	5.56	0.06	1	0.6
54	*R. fragilis*	Mycorrhizal	Soil	Russulales	Russulaceae	Inedible	16.67	0.22	1.33	1.3
55	*R. mariae*	Mycorrhizal	Soil	Russulales	Russulaceae	edible	33.33	0.78	2.33	2.9
56	*R. nigricans*	Mycorrhizal	Soil	Russulales	Russulaceae	edible	33.33	1.06	3.17	3.3
57	*R. nitida*	Mycorrhizal	Soil	Russulales	Russulaceae	edible	27.78	0.89	3.20	2.9
58	*R.rose*	Mycorrhizal	Soil	Russulales	Russulaceae	Inedible	44.44	3.94	8.88	6.8
59	*Scleroderma cepa*	Mycorrhizal	Soil	Boletales	Sclerodermataceae	edible	50	8.28	16.56	9.9
60	*Strobilomyces strobilaceus*	Mycorrhizal	Soil	Boletales	Boletaceae	edible	38.89	1.61	4.14	4.3
61	*Tapinella panuoides*	Saprobe	Stump	Agaricales	Tapinellaceae	Poisonous	22.22	0.67	3	2.4
62	*Trametes hirsuta*	Saprobe	Wood	polyporales	polyporaceae	Inedible	44.44	2.33	5.25	5.4
63	*Tremella fuciformis*	Saprobe	Wood	Tremellales	Tremellaceae	edible	22.22	0.22	1	1.5
64	*T. mesenterica*	Mycorrhizal	Tree stump	Tremellales	Tremellaceae	edible	27.78	0.72	2.60	2.6
65	*Tremellodendropsis tuberosa*	Saprobe	Debris of wood	Tremellodendropsidales	Tremellodendrops idaceae	edible	22.22	0.83	3.75	2.8
66	*Xylaria polymorpha*	Saprobe	Dead tree stump	Xylariales	Xylariaceae	Inedible	11.11	0.5	4.50	2.2
67	*X.hypoxylon*	Saprobe	Decaying leaves	Xylariales	Xylariaceae	Inedible	44.44	1.89	4.25	4.8
68	*X. oxyacanthae*	Saprobe	Decaying leaves	Xylariales	Xylariaceae	Unknown	16.67	1.06	6.33	3.4

Families Russulaceae and Agaricaceae were rich in terms of number of species (Table 1). This may be due to the various environmental factors such as soil moisture, pH favoring the growth which aligns with the findings of Ganguly *et al*., (2021), rich organic layers Wang et al., (2015), high rainfall Shrestha *et al*., (2021) and diverse host plants provide favorable conditions for these mushroom diversity. Ullah *et al*., (2022) states that plantation or degraded forests often show a decline in the dominance of these families due to reduced ectomycorrizal hosts and altered soil conditions; however, such a decline cannot be attributed to human

disturbance, as there has been no recent human activity in the chaukot community forest.

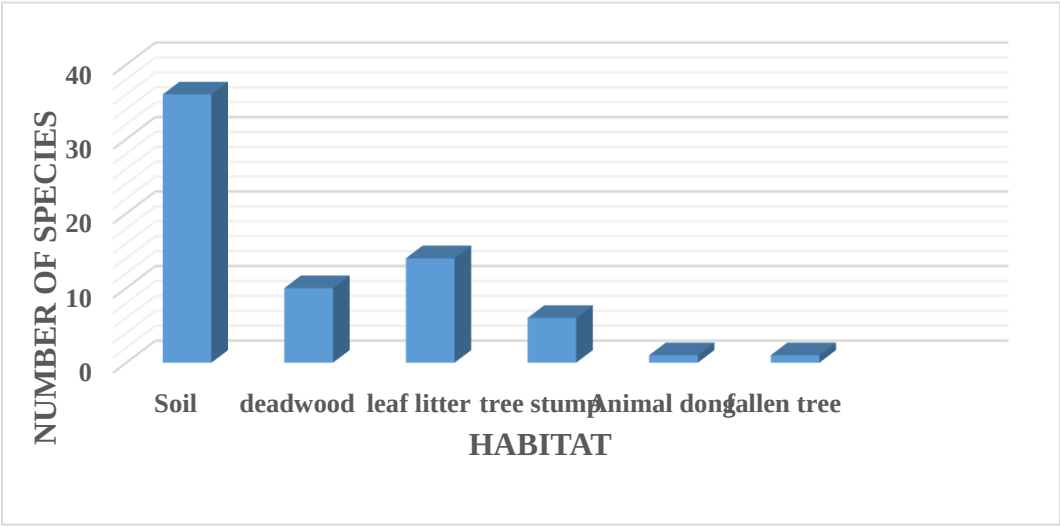

Fig. 2: Habitat wise mushroom distribution

The primary habitat for the growth of mushrooms was determined to be soil, followed by leaf litter (fig. 2). This result is consistent with previous research conducted by Bhandari and Jha (2017). The observed variations in the habitat of mushroom species are because of mode of nutrition (Parveen *et al*., 2017) and the associations of mushroom with distinct plant and tree species (Hawkworth, 2001). According to Yamanaka (2003), saprotrophic species can grow best at pH range 7 or 8. The Shannon diversity index and Simpson index were 3.78 and 0.97. These values indicate that the study area had high diversity of mushroom species. The great diversity of mushroom identified in the research area may have been influenced by the favorable ecological conditions for mushroom growth and development (Rudolf *et al*., 2013).

Relationship between mushroom species richness and environmental variables

The relationship between species richness and three environmental variables was assessed by simple linear regression analyses using soil pH, soil moisture content, and tree canopy cover as independent variables. This analysis was conducted to determine the extent to which each environmental factor predicts variation in mushroom species richness across different sampling sites. The line graph (Figure 4, 5, 6) shows that species richness is correlated with soil pH, moisture content, and tree canopy cover. There is a range of 14.9–66.7% soil moisture, 18–61% tree

canopy cover, and 5.1-6.1 soil pH values. Increased soil moisture and greater tree canopy cover were both positively associated with higher mushroom species richness, as indicated by significant regression results ($P < 0.05$). In contrast, variation in soil pH did not significantly influence species richness, as its regression was not statistically significant ($P > 0.05$). In comparison to soil pH and soil moisture, tree canopy cover had the strongest correlation with species richness among the three variables. The independent variable tree canopy cover accounts for around 62% of the variance in the dependent variable, species richness, whereas soil moisture and pH account for approximately 41% and only 5% of the variance in species richness, respectively.

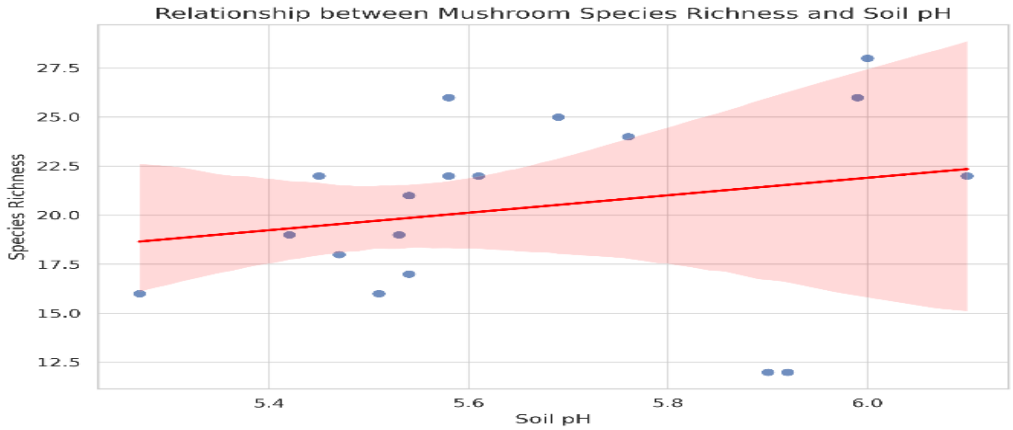

Fig. 4: Relationship between mushroom species richness with soil pH

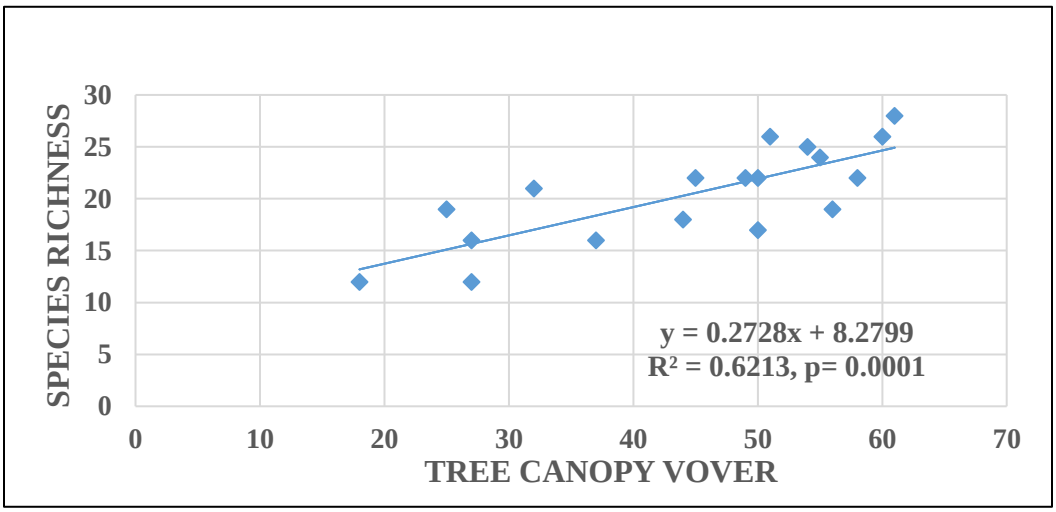

Fig. 5: Relationship between mushroom species richness with Tree canopy cover

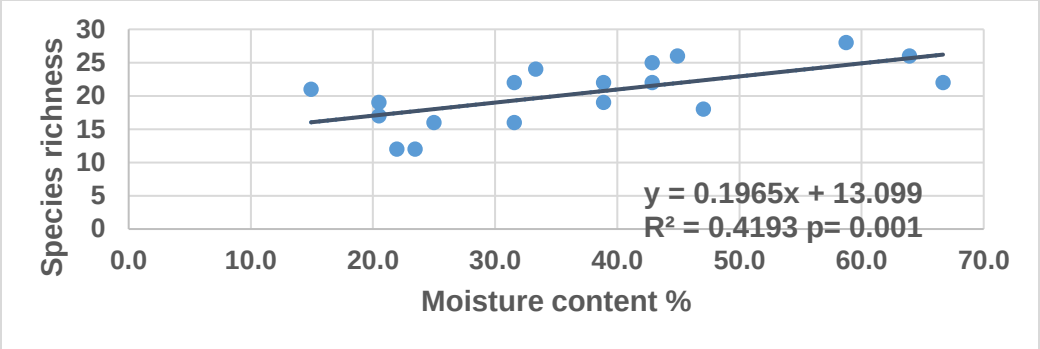

Fig. 6: Relationship between mushroom species richness with soil moisture

Fungal development is mostly determined by abiotic variables such as soil pH, light, canopy cover, soil nutrition, leaf litter, and soil moisture content (Thapa *et al*., 2022). Soil pH values that are either slightly basic, slightly acidic, or nearly neutral are ideal for the growth and survival of most mushrooms (Khan *et al*., 2013; Kalaw *et al*., 2016; Ge *et al*., 2017). According to our study, higher moisture was associated with higher species richness supporting growth of ectomycorrhizal fungi supported by the findings of Priyamvada *et al*., (2017). Research in the tropical dry evergreen biome found that mushroom diversity peaks during monsoons, though excessive soil moisture can hinder fungal activity, with soil type, vegetation, and microhabitat playing key roles in diversity (Shah *et al*., 2020; Paredes *et al*., 2021). Our results indicate that there is no significant correlation between species richness and soil pH. The regression analysis showed a very weak relationship (R^2 = 0.05, P = 0.33), suggesting that within the observed pH range (5.1–6.1), changes in pH did not strongly influence mushroom species richness. This outcome may be attributed to the relatively narrow pH range across study sites, which was not extreme enough to affect fungal community composition substantially. Similar findings have been reported by other studies that suggest fungi can tolerate slightly acidic soils, and pH alone is not always a limiting factor for diversity.

Soil moisture showed a statistically significant relationship with species richness ($P < 0.05$), indicating that as soil moisture increased, so did the number of mushroom species. Sites with higher moisture levels (up to ~66%) supported a richer fungal community. This may be due moist environments are more favorable for spore germination and decomposition processes, aligning with the observations of previous studies such as those by Trudell & Edmonds (2004).

Tree canopy cover showed the strongest positive correlation with species richness among the three environmental factors studied. The regression model indicated

that canopy cover alone explained approximately 62% of the variation in species richness. Denser canopy areas likely provide a more stable microclimate, retain higher soil moisture levels, and accumulate greater litter input—all of which create suitable conditions for various fungal groups. This finding is consistent with Han et al. (2023) and Zhu et al. (2023). Santos-Silva et al. (2011) and Nakamura et al. (2017) emphasize that canopy density directly shapes habitat complexity and moisture retention, influencing fungal productivity and diversity.

Conclusion

A total of 68 specimens were collected from chaukot community forest, Panauti, Nepal. These species are belongs to the three phylum, twenty eight families, and fourteen orders. Agricales order is predominant. *Laccaria laccata* was found most dominant species. The pH of the soil was somewhat acidic which facilitates growth of ectomycorrhizal mushroom species but did not significantly influence species richness. Higher soil moisture and tree canopy cover of study site were both positively associated with higher mushroom species richness.

The diversity index values of studied area shows high species richness.

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References

Adhakari M. K. 2000. Mushrooms of Nepal. Kathmandu: P.U. Printers, Kathmandu Nepal.

Adhikari, M. K. (1999). Status of wild potential mushrooms in Nepal. *In Proceedings of the Third National Conference on Science and Technology* (pp. 1339–1350). Royal Nepal Academy of Science and Technology.

Adhikari, M. K. (2000). Mushrooms of Nepal. Kathmandu: P.U. Printers, Kathmandu Nepal.

Adhikari, M. K. & Bhattarai, K. R. (2014). Catalog of fungi preserved in National Herbarium and Plant Laboratories (KATH), Mycology section, Godavari. Lalitpur, Nepal: Department of Plant Resources.

Aryal, H. P. &Budathoki, U. (2012). Macro-fungi of Karhiya community forest, western Terai, Nepal. *Nepalese Journal of Biosciences, 2*,93-97.

Baral, S., Thapa-magar, K.B., Karki, G., Devkota, S., & Shrestha, B.B. (2015). Macrofungal diversity in community – managed Sal (Shorea robusta) forest in Central Nepal. *Mycology, 6***(**3-4**),** 151-157.

Budha, P. B., Hyde, K. D., & Durrieu, G. (2009). Biodiversity of mushrooms in Nepal: A review., *34*, 1–34.Chang, S.T, & Miles, P.G. (2004). Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact. CRC press.

Devkota, S. & Aryal, H. P. (2020). Wild mushrooms of Nepal. In M. Siwakoti, P.K. Jha, S. Rajbhandary & S.K. Rai (Eds.), *Plant diversity in Nepal* (pp. 41-54). Botanical Society of Nepal.

Gabel, A. C. & Gabel, M. L. (2007). Comparison of diversity of Mushroom and vascular plants at seven sites in the Black Hills of South Dakota. *The American midland naturalist, 157*(2), 258-296.

Ganguly, A., Nad, S., Singha, K., Pathak, R., Hazra, P., Singha, P., Dhua, P., Mohapatra, P. K. D., & Mandel, A. (2021). Diversity and distribution of wild mushrooms in different forest areas of Bankura district, WB, India. *Acta Biologica Szegediensis*, *65*(2), 185–198. https://doi.org/10.14232/abs.2021.2.185-198GBIF (2021). Digitization of Mushrooms and Lichens collections from Nepal: Bringing Underrepresented Taxonomic Groups into the Global Biodiversity Database.

Ge, Z.W., Brenneman, T., Bonito, G. & Smith, M.E. (2017). Soil pH and mineral nutrients strongly influence truffles and other ectomycorrhizal fungi associated with commercial pecans (*Carya illinoinensis*). *Plant Soil*, 418, 493–505. https://doi.org/10.1007/s11104-017-3312-z.

Hawksworth, D. L. (2001). The magnitude of fungal diversity: the 1.5 million species estimate revisited. *Mycological Research 105*(12), 1422–1432. DOI: 10.1017/s0953756201004725

Hawksworth, D.L., Kirk, P.M., Sutton, D.C., &Pegler, D.M. (1995). Ainsworth and Bisby's dictionary of the fungi. 8th edition. CAB International Wallingford.

Hibbett, D. S. (2007). After the gold rush, or before the flood? Evolutionary morphology of mushroom-forming fungi (Agaricomycetes) in the early 21st century. *Mycological Research, 111*(9), 1001–1018. doi:10.1016/j.mycres.2007.01.012.

Joshi, K., Adhikari, H.R., Aryal, H.P., & Shrestha, L.J. (2022). Macrofungal diversity in different vegetation compositions in teghari community forest, Kailali, west Nepal. *Biotropia, 29*(3), 272-282. DOI: 10.11598/btb.2022.29.3.1792.

Kalaw, S.P., Alfonso, D.O., Dulay, R.M.R., De Leon, A.M., Undan, S.Q., Undan, J.R., &Reyes, R.G. (2016). Optimization of culture conditions for secondary mycelial growth of wild edible mushrooms from selected area in central Luzon, Philippines. *Current Research in Environmental and Applied Mycology, 6*(4), 277-287. Doi:10.5943/cream/6/4/5.

Khan, N. A., Ajmal, M., Nicklin, J., Aslam, S. & Asif Ali, M. (2013). Nutritional value of Pleurotus (Flabellatus) Djamor (R-22) cultivated on sawdusts of different woods. *Pakistan Journal of Botany*, *45*(3), 1105-1108.

Lemmon, P.E. (1956). A spherical densitometer for estimating forest overstory density. *Forest Science.* 2(4), 314-320.

Lin, W.R., Wang, P.H., Chen, M.C., Kuo, Y.-L., Chiang, P.N., & Wang, M.K. (2015). The impacts of thinning on the fruiting of saprophytic fungi in Cryptomeria japonica plantations in central Taiwan. *Forest Ecology and Management* 336, 183–193. doi:10.1016/j.foreco.2014.10.022

Magurran, A.E. (2004). Measuring biological diversity. Blackwell Science, Oxford.

Mueller, G.M., Bills, G.F., & Foster, M.S. (2007). Biodiversity of Fungi: Inventory and Monitoring Methods. Elsevier Academic Press.

Nakamura, A., Kitching, R. L., Cao, M., Creedy, T. J., Fayle, T. M., Freiberg, M., Hewitt, C. N., Itioka, T., Koh, L. P., Ma, K., Malhi, Y., Mitchell, A., Novotny, V., Ozanne, C. M. P., Song, L., Wang, H. & Ashton, L. A.

(2017). Forests and their canopies: achievements and horizons in canopy science. *Trends in Ecology and Evolution 32*(6), 438-451.

Paredes, C.C., Tajmel, D., & Rousk, J. (2021). Can moisture affect temperature dependences of microbial growth and respiration? *Soil Biology and Biochemistry, 156*, 108223. https://doi.org/10.1016/j.soilbio.2021.108223.

Parveen, A., Khataniar, L., Goswami, G., Hazarika, D. J., Das, P., Gautom, T. & Boro, R. C. (2017). A study on the diversity and habitat specificity of Mushroom of Assam, India. *International Journal of Current Microbiology Applied Sciences, 6*(12), 275-297.

Phillips, R. (1981). Mushroom and other fungi of Grrat Britain and Europe. Pan Books Ltd., London. 288.

Priyamvada H, Akila M, Singh RK, Ravikrishna R, Verma RS, Philip L, et al. (2017). Terrestrial macrofungal diversity from the tropical dry evergreen biome of Southern India and its potential role in aerobiology. *PLoS ONE 12*(1), e0169333. doi:10.1371/journal.pone.0169333.

Rudolf, K., Morschhauser, T., Pal-Fam, F., & Botta-Dukat, Z. (2013). Exploring the relationship between Mushroom diversity, abundance, and vascular plant diversity in semi-natural and managed forests in north-east Hungary. *Ecological Research, 28*(4), 543–552. Doi:10.1007/s11284-013-1044-y

Santos-Silva, C., Goncalves, A. & Louro, R. (2011). Canopy cover influence on macrofungal richness and sporocarp production in montado ecosyStipes. *Agroforestry SyStipes, 82*(2), 149-159.

Shah, P., Aryal, H. P. & Darji, T. B. (2020). Species Richness of Mushroom and Ethnomycological Studies in Chitlang, Makwanpur, central Nepal. *Kavaka, 55*, 101-107.

Shrestha, S., Gautam, T. P., Mandal, T. N. & Aryal, H. P. (2021). Ecology and Diversity of Ectomycorrhiza in moist Tropical Forest of Sunsari District, Eastern Nepal. *Journal of Institute of Science and Technology 26*(1), 35-42.

Sibounnavong, P., Cynthia, C. D., Kalaw, S. P., Reyes, R. G. & Soytong, K. (2008). Some species of Mushroom at Puncan, Carranglan, Nueva Ecija in the Philippines. *Journal of Agricultural Technology, 4*(2), 105-115.

Sribastava, H.C., & Bano, J. (2010). Studies on the cultivation of Pleurotus species on paddy straw. *Food Science,* 11, 36-38.

Thapa, R., & Rai, S. K. (2012). Checklist of wild mushrooms from Shivapuri Nagarjun National Park, Kathmandu. *Nepal Journal of Science and Technology*, *13*(1), 135–142.

Thapa, S., Shrestha, S. & Jha, S.K. (2022). Macrofungal diversity of Brahakshetra community forest, Ghorahi, Dang, Nepal. *Journal of Institute of Science and Technology, 27*(2), 91-107. https://doi.org/10.3126/jist.v27i2.51359.

Ullah, T.S., Firdous, S.S., Shier, W.T., Hussain, J., Shaheen, H., Usman, M., Akram, M. & Khalid, A.N. (2022). Diversity and ethnomycological importance of mushrooms from Western Himalayas, Kashmir. *Journal of Ethnobiology Ethnomedicine, 18,* 32. https://doi.org/10.1186/s13002-022-00527-7

Wang, J.T., Zheng, Y.M., Hu, H.W., Zhang, L.M., Li. J&He, J.Z. (2015). Soil pH determines the alpha diversity but not beta diversity of soil fungal community along altitude in a typical Tibetan forest ecosyStipe. *Journal of Soils Sediments, 15,* 1224 –1232. https://doi.org/10.1007/s11368-015-1070-1.

Watling, R. (1973). Identification of the larger fungi. Hulton educational publicatns ltd., Raans Road Amersham, Bucks.

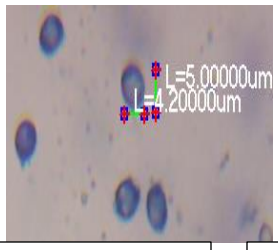
Yamanaka, T. (2003). The effect of pH on the growth of saprotrophic and ectomycorrhizal ammonia fungi in vitro. *Mycologia, 95*(4), 584-589.

Zhu, Z., Liu, X., Hsiang, T., Ji, R. & Liu, S. (2023). Forest type and climate outweigh soil bank in shaping dynamic changes in macrofungal diversity in the ancient tree park of Northeast China. *Journal of Fungi, 9,* 856. https://doi.org/10.3390/jof9080856.

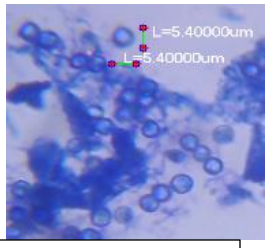
Zobel, D.B., Behan, M.J., Jha, P.K., &Yadav, P.K.R. (1987). A practical manual for habitat. Kathmandu, Nepal: Ratna Book Distributors.

Annex

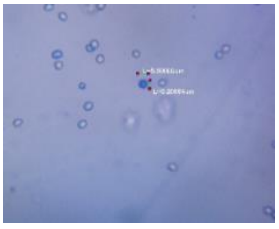
Photo plates

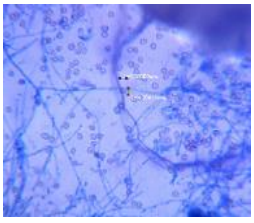
Amanita phalloides with its spore

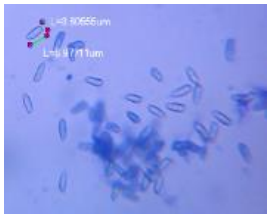
Amanita rubrovolvata with its spore

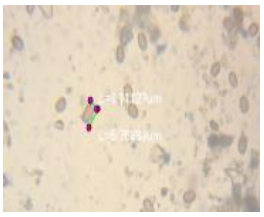
Armillaria tabescens with its spore

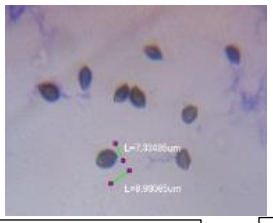
Bjerkandera adusta with its spore

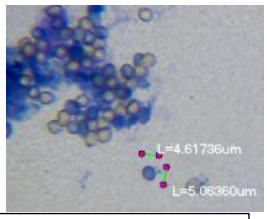
Boletellus emodensis with its spore

Coltricia cinnamomea with its spore

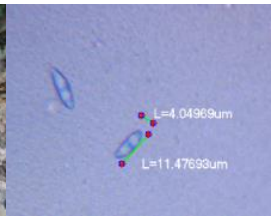



Boletus edulis with its spore

Hygrocybe cantharellus with its spore

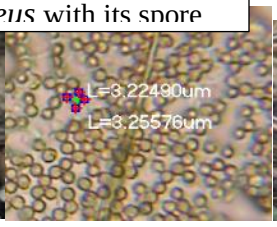


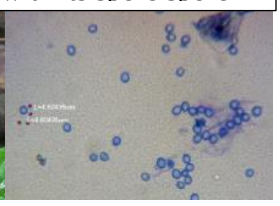


Leotialubrica

Gyroporus castaneus with its spore

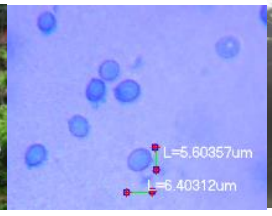
Leotia lubrica with its spore spore

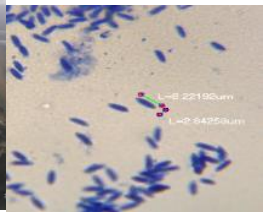



Lycoperdon pyriforme with its spore

Russula maeriae with its spore

Russula nitida with its spore

Xylaria hypoxylon with its spore