

DISTRIBUTION AND STATUS OF HIGHLAND MUSHROOMS: A STUDY FROM DOLPA, NEPAL

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This study comprises report on mycological exploration in 2006 at the most remote and highland district, Dolpa of Western Nepal. The study area was virgin for mushrooms study. Forty four species were collected, out of which 40 are new to the area. The collected species are parasitic, saprophytic and mycorrhizal associates' in habitat. Locally 22 and five species were used for culinary and medicinal values respectively. *Cordyceps sinensis*, *Morchella conica*, *M. esculenta*, *Laetiporus sulphureus*, *Agaricus bisporus*, *Termitomyces clypeatus* and *Cantharellus cibarius* are most popular and potential resources from the study sites.

Key words: Caterpillar fungus, Dolpa, macrofungi, morels mushrooms, Nepal

Introduction

Wild mushrooms or macrofungi have been collected and consumed by people for thousands of years. Out of 69,000 species of fungi described throughout the world, 10,000 species are fleshy macrofungi which are commonly known as mushrooms (Hawksworth, 1991). Wild mushrooms are important Non-Timber Forest Products (NTFPs) from the forests and are being used as food since time immemorial. Collection of wild mushrooms is very common in Nepal and is important for livelihoods in rural areas (Adhikari 2000, Christensen & Larsen, 2005, Devkota, 2006).

The collection and survey on mycoflora from Nepalese Himalayan belt was at first done by Hooker (1848-54) from Eastern Nepal. The result of his gatherings was published by Berkeley (1854 a, b, c, d). He reported 44 higher fungi in "Indian Fungi" in Hooker's Journal of Botany. Balfour- Browne (1968) published the fungal species collected from eastern and central Nepal. The major studied on wild mushrooms in temperate to alpine regions of Nepal were carried out by Imazeki *et al.*, (1966), Pandey (1976), Singh & Nisha (1976), Pegler (1977), Waraitch & Thind (1977), Sacherer (1979), Bhandary (1980), Otani (1982), Thind & Sharma (1983), Hijortstam & Ryvarden (1984), Cotter & Bhandary (1985), Cotter (1987), Adhikari (1988, 1990, 1999, 2000), Bills & Cotter (1989), Adhikari & Manandhar (1996), Devkota *et al.*, (2005), Pandey *et al.*, (2006), Rana & Giri (2006), Devkota, (2006), and Adhikari & Devkota (2007).

Previously occurrence of *Cordyceps sinensis* (Sharma, 1974), *Lycoperdon perlatum* (Lama *et al.*, 2001), *Morchella conica* and *M. esculenta* (Ghimire, *et al.*, 2001) were recorded from Dolpa district.

Materials and Methods

Site description

This paper highlights the mushroom diversity in Raha and Majhphal areas of Dolpo district of Nepal. Dolpa covers a total area of 7,932.3 sq km, which is 5.38% of the total country area. It is in 1225 to 7625 m in altitude. Maximum temperature recorded is 22^o C in summer season and -1^o C in winter. Average recorded rainfall is 245 mm/year (SNV/WWF, 2001). Shey-Phoksundo National Park (SPNP), the largest national park of Nepal (core park area of 3555 km²) covers a large part of the district. Dolpa has one of the largest stores of high altitude Himalayan medicinal and aromatic plants in Nepal and also a vast body of knowledge related to the management and use of medicinal plants (Ghimire, 2005). Dolpa district has been a famous ground of *Cordyceps sinensis* and *Morchella* spp in the country since long time (Subedi, 2001, Devkota, 2006).

On the basis of bioclimatic ground Ghimire (2005) grouped Dolpo region into arid, semi arid humid zone. Main vegetation in study sites are *Quercus incana* *Q. semecarpifolia*, *Pinus wallichiana*, *Picea smithiana*, *Abies spectabilis*, *Betula utilis*, *Sorbus cuspidata*, *Juniperus indica*, *J. recurva* and *J. squamata*, *Rhododendron anthopogon*, *R. lepidotum*, *R. nivale*, *Caragana brevispina* and *Lonicera spinosa*.

Methods

The mushrooms were photographed in their natural habitat before they were collected. The broken, rotten and insect eaten species were discarded. I made an attempt to collect all the developmental stages of the basidiocarps to have idea of all morphological characters. Field observation formats were prepared to record informations about all the morphological and chemical characters including surrounding ecology of specimens.

The specimens were collected during the year 2006. The specimens were identified examining the microscopic structures and consulting the literatures. The specimens preserved as herbarium were identified with the help of standard literatures (Adhikari, 2000; Bakshi, 1971; Corner, 1950; Fries, 1938; Imazeki, et al., 1988; Pacioni, 1985; Philips, 1981; Purukayastha & Chandra, 1985; Rinaldi & Tyndalo, 1972; Svreck, 1975). They were also compared with the specimens at National Herbarium (KATH) and Tribhuvan University Central herbarium (TUCH). The voucher specimens are deposited in Tribhuvan University Central Herbarium (TUCH), Central Department of Botany, Tribhuvan University, Nepal.

Results and Discussion

Distribution

A total of 44 macrofungi belonging to 25 families and 37 genera were collected from Raha and Majhphal VDCs of Dolpa district. Among the collected species 22 have found with their culinary values and 5 with medicinal values (Table 1).

Table 1: List of collected mushrooms

S.N	Col. Date	Locality	Altitude (m)	Scientific Name	Local Name	Family	Uses
1	26.05.2006	Raha Gaun	2845	<i>Coprinus disseminatus</i> (Pers. : Fr.) Gray	<i>Gobryauu</i>	Coprinaceae	
2	26.05.2006	Raha Gaun	2850	<i>Coprinus comatus</i> (Müll: Fr.) Pers.	<i>Gobryauu</i>	Coprinaceae	
3	26.05.2006	Raha Gaun	2954	<i>Daldinia concentrica</i> (Bull. : Fr.) Ces.& De Not.	<i>Katheuu</i>	Xylariaceae	
4	26.05.2006	Raha Gaun	2954	<i>Fomitopsis pinicola</i> (Swartz. :Fr.) Karst.	<i>Katheuu</i>	Fomitopsidaceae	
5	26.05.2006	Raha Gaun	2954	<i>Schizophyllum commune</i> Fr. : Fr.		Schizophyllaceae	
6	26.05.2006	Raha Gaun	2954	<i>Xylaria polymorpha</i> (Pers. : Fr.) Grev.		Xylariaceae	
7	26.05.2006	Raha Gaun	3450	<i>Coltricia cinnamomea</i> (Jacq. :Fr.) Murr.		Hymenochaetaceae	
8	26.05.2006	Raha Gaun	3145	<i>Guepinea spathularia</i> (Schw.) Fr.		Tremellaceae	
9	26.05.2006	Raha Gaun	3365	<i>Trametes versicolor</i> (L. : Fr.) Lloyd		Polyporaceae	
10	26.05.2006	Raha Gaun	3305	<i>Coriolus hirsutus</i> (Fr.) Quel.		Coriolaceae	
11	27.05.2006	Raha Gaun	3055	<i>Morchella conica</i> Pers.	<i>Mathheura</i>	Pezizaceae	E, M
12	27.05.2006	Raha Gaun	3045	<i>Morchella esculenta</i> L. :Fr.	<i>Mathheura</i>	Pezizaceae	E, M
13	27.05.2006	Raha Gaun	3345	<i>Pycnoporus cinnabarinus</i> (Jacq. : Fr.) Karst.		Polyporaceae	
14	27.05.2006	Raha Gaun	3035	<i>Ramaria botrytis</i> (Pers. :Fr.) Ricken	<i>Nangreuauu</i>	Ramariaceae	E
15	03.06.2006	Tirtha, Raha	5050	<i>Cordyceps sinensis</i> (Berk.) Sacc.	<i>Yarsagumba</i>	Clavicipitaceae	E, M
16	05.06.2006	Raha ko Dill, Raha	4750	<i>Lycoperdon pyriforme</i> Schaeff. : Pers	<i>Phusseauu</i>	Lycoperdaceae	M
17	09.06.2006	Ghatta, Majphal	2845	<i>Mycena spp.</i>		Marasmiaceae	
18	09.06.2006	Ghatta, Majphal	3075	<i>Lactarius volemus</i> (Fr.) Fr.	<i>Sunphureuu</i>	Russulaceae	E
19	09.06.2006	Ghatta, Majphal	3085	<i>Laccaria proxima</i> (Boud.) Pat.	<i>Thunreuu</i>	Tricholomataceae	E
20	09.06.2006	Ghatta, Majphal	3154	<i>Hypholoma capnoides</i> Fr.	<i>Nalleuauu</i>	Strophariaceae	E
21	09.06.2006	Ghatta, Majphal	3154	<i>Lentinus edodes</i> (Berk.) Pegler		Pleurotaceae	E
22	09.06.2006	Ghatta, Majphal	3155	<i>Armillaria mellea</i> (Vahl. : Fr.) Kummer.		Tricholomataceae	E
23	09.06.2006	Ghatta, Majphal	3155	<i>Heterobasidion annosum</i> (Fr.) Bref.		Polyporaceae	
24	10.06.2006	Lahara, Majphal	2954	<i>Termitomyces clypeatus</i> (Berk.) Heim.	<i>Nundhukuli</i>	Tricholomataceae	E
25	10.06.2006	Lahara, Majphal	3085	<i>Pleurotus ostreatus</i> (Jacq. : Fr.) Kummer	<i>Kanney</i>	Pleurotaceae	E
26	10.06.2006	Lahara, Majphal	3100	<i>Clavaria rosea</i> Fr.		Clavariaceae	
27	10.06.2006	Lahara, Majphal	3105	<i>Clavaria acuta</i> Sch. : Fr.		Clavariaceae	
28	10.06.2006	Lahara, Majphal	3105	<i>Scleroderma citrinum</i> Pers. :Pers.		Sclerodermataceae	E
29	10.06.2006	Lahara, Majphal	3115	<i>Clavaria vermicularis</i> Swartz: Fr.		Clavariaceae	
30	10.06.2006	Lahara, Majphal	3115	<i>Clavulinopsis fusiformis</i> (Sow. : Fr.) Corner.		Clavariaceae	
31	10.06.2006	Lahara, Majphal	3115	<i>Gleophyllum sepiarium</i> (Schw.) Fr.		Fomitopsidaceae	
32	10.06.2006	Lahara, Majphal	3145	<i>Russula aurora</i> Krombh.	<i>Rakteauu</i>	Russulaceae	E
33	10.06.2006	Lahara, Majphal	3155	<i>Phellinus pini</i> (Fr.) Pilat		Phellinaceae	
34	10.06.2006	Lahara, Majphal	3157	<i>Helvella crispa</i> (Scop. :Fr.) Fr.	<i>Kaanpureuu</i>	Pezizaceae	E
35	10.06.2006	Lahara, Majphal	3165	<i>Phellinus igniarius</i> (L. :Fr.) Quel.		Phellinaceae	
36	10.06.2006	Lahara, Majphal	3190	<i>Russula chloroides</i> (Krombh.) Bres.		Russulaceae	E
37	10.06.2006	Lahara, Majphal	3208	<i>Cantharellus cibarius</i> (Fr. : Fr.) Fr.	<i>Sulpeuu</i>	Cantharellaceae	E
38	10.06.2006	Lahara, Majphal	3208	<i>Laetiporus sulphureus</i> (Fr.) Murr.	<i>Rakteauu</i>	Grifolaceae	E
39	10.06.2006	Lahara, Majphal	3305	<i>Auricularia auricula - judae</i> (Bull. : Fr.) Wettst.		Auriculariaceae	E
40	10.06.2006	Lahara, Majphal	3405	<i>Suillus granulatus</i> (L. :Fr.) Rous.	<i>Laddeauu</i>	Bolytaceae	E
41	10.06.2006	Lahara, Majphal	3450	<i>Grifola frondosa</i> (Dicks. :Fr.) S.F. Gray	<i>Nangreuauu</i>	Grifolaceae	E
42	10.06.2006	Lahara, Majphal	3550	<i>Microporus xanthopus</i> (Fr.) Kuntze		Polyporaceae	
43	10.06.2006	Saiquarry, Majphal	3645	<i>Agaricus bisporus</i> (Lange) Imbach.	<i>Gobryauu</i>	Agaricaceae	E
44	18.06.2006	Sangtaa, Raha	3050	<i>Morcella elata</i> Fr.	<i>Mathheuraa</i>	Pezizaceae	E, M

E = Edible, M = Medicinal

History and uses practices

The exact figure about existing numbers of mushrooms in Dolpa is still not well known, but it is found that *Morchella* spp (morels) and *Cordyceps sinensis* (caterpillar fungus) are most demand oriented mushrooms from long years back. Collectors in Raha and Majphal VDCs hunt mushrooms in forested areas and in highland pastures. Preferable mushrooms after caterpillar fungus and morels are *Laetiporus sulphureus*, *Agaricus bisporus*, *Termitomyces clypeatus* and *Cantharellus cibarius*.

The history of using *Morchella* spp locally called Mattheuraa or Guchhi chyou is not yet known and elder people are using it since long back from their childhood. According to the respondents the main *Morchella* occurring locations are Kalika, Rimi, Sharmi, Liku, Tripurakot, Phoksundo, Majphal and Raha. During this research three species of *Morchella* namely *Morchella conica*, *M. esculenta* and *M. elata* were collected. Locally, *Morchella esculenta* and *M. conica* are collected in large amount for trading purpose, as they are of high abundance than *M. elata*.

Sharma, (1974) reported the local belief upon *Cordyceps sinensis* for its tonic value in Dolpa. But the local people became aware about its market value only after the year 1987 (Devkota, 2006). Indigenous peoples are utilizing this Himalayan treasure for the treatment of different diseases like diarrhea, headache, cough, rheumatism, liver disease, and also as an aphrodisiac and tonic. Internationally it is regarded as Himalayan Viagra (Devkota, 2006, 2007a).

The use of less numbers of fungi for medicinal purposes could be due to the higher availability of medicinal plants in Dolpa. Local people believed that as the price of caterpillar fungus and morel is getting higher and higher, the knowledge about the appreciation of other wild mushrooms is rapidly lost.

High altitude; low poisoning rate

In present study very few number of instances were recorded where family members were adversely affected due to mushrooms poisoning. However, in the year 2001, a collector (40 years old) from Rimi VDC died after consumption of poisonous mushrooms. In 1992, four family members of Mr. Manchandra Buda, from Tripurakot VDC, neighboring VDC of Majphal suffered from mushroom poisoning, but no any death incidents occurred.

Locally poisonous mushrooms are called Bhoot chyou and Bhatkhoriyau chyou. Local people of Raha and Majphal used Satuwa (*Parish poryphylla*) and Timur (*Xanthoxylum armatum*), to minimize possible poisoning along with vinegar. Addition of vinegar is a worldwide method to minimize and cure mushroom poisoning (Chaube, 1995; Adhikari, 2000; Adhikari *et al.*, 2005; Pandey *et al.*, 2006 and Devkota, 2007b).

Collection and marketing

In Dolpa, the collection of mushrooms starts from May to August. Males and females and children were actively participating for the collection of *Morchella* spp. *Agaricus bisporus*, *Termitomyces clypeatus* and *Cantharellus cibarius*. However, to avoid risks of mushroom poisoning, elder people only were found collecting some mushrooms. In study sites morels

are distributed from the altitude of 3045m-3305m in wet and shady coniferous forests, especially on north facing slopes. The main plant associates of morels are *Tsuga dumosa*, *Cupressus torulosa*, *Pinus wallichina*, *Picea smithiana*, *Quercus semicarpifolia*, and *Abies spectabilis*. Ghimire (2005) reported the occurrence of *Morchella esculenta* in the altitude of 2900 to 3500 in Dolpa. According to the local respondents morels starts to grow in March to May, and occasionally up to August. Morels are collected in wild and are dried by hanging morel garlands in well ventilated part of their houses and sometimes near by hearth. They are not dried in sun as the morel loses its flavor and color.

With the arrival of spring, people from all ethnic and religious background from Dolpa and neighboring districts participate for the collection of *Cordyceps sinensis* in more than 25 pastures of Dolpa. Normally collection season is from May - July (Devkota, 2008). Both male and female of 7-76 years participate in collection. The common practices of collection are uprooting, picking, gathering, cleaning and drying in shade or in cotton bags. This was done carefully, since breaking off the larva reduces the value.

Morchella spp and *Cordyceps sinensis* have high demand both in national and international markets. Except these two, mushrooms are used only for immediate consumption. Whereas, *Laetiporus sulphureus* is sometimes used as a gift item. There is no exact figure available for the collection and export of morels from Nepal. However, Subedi (2001) estimated about 6,000 kg of dried morels harvested from Jumla, Humla, Mugu and Dolpa districts of Nepal. Study revealed that *Morchella conica* and *Morchella esculenta* are common in trade from Dolpa. For the year 2006, the prices for a kg of dried morels and *Cordyceps sinensis* in Dolpa were NRs 6000-8000 / Kg and NRs 250,000 - 420,000 / Kg respectively [US \$ 1 = NRs. 64]. The quality is the main issue for high value of morels and *Cordyceps sinensis*.

Macrofungi and Sustainability issues

The practice of intentional fire for the good proliferation of morels and caterpillar fungus is a serious problem in the study area. Though the practice is getting low, but still there are people with strong belief that burning enhance production rate. Mer (1992) reported practice of forest fire in the Indian Himalaya forest to harvest a rich *Morchella* in the ensuing year. Forest fires in many cases enhance the growth and yield of *Morchella* for some years (Pilz *et al.*, 2004), but fire in the high altitude *Pinus wallichina* forests cannot be recommended because it hampers the regeneration pattern (Chirstensen & Larsen, 2005). The major threats are due to excessive grazing of animals, haphazard collection, over trampling effects, high use of fuel woods and intentional fires (Devkota, 2006, 2008). Fungi represent a major portion of the prevailing biodiversity in forest ecosystems but are overlooked in the management of the forests, despite their evident ecological importance as decomposers, recyclers, mycorrhizal symbionts, and pathogens.

Information on availability of other edible wild mushrooms in the Dolpa is essential. Real and potential collecting areas must be mapped, as well as recording and monitoring the production is necessary. Adhikari (1999) emphasized on the proper collection and use of mushrooms from their surroundings or nature rather than exclusion as these are perishable items. So, domestication of the edible, medicinal and other species is utmost necessary for sustainable socio-economic growth.

Conclusion

Dolpa, situated in the west is far from mycological research Nepal and hard to reach due to different topographical settings. This is the first effort to shed light on distribution and status of macrofungi in highlands of Dolpa. As more parts of the Dolpa are still waiting exploration, this knowledge will be helpful for further research and extensions. Commercial harvesting of *Cordyceps sinensis* and *Morchella species* in Dolpa is unsustainable unless appropriate and locally sound measures are taken to limit the degradation of suitable habitats. The potential mushroom such as *Laetiporus sulphureus* could be dried for long term storage. As the area is in remote and scarcity of foods prevails for long term, this kind of procedure may be helpful to overcome malnutrition. So, sustainable management of this species is utmost necessary by conserving old trees of *Quercus* spp or by the establishment of intensive managed sites.

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