Traditional Ecological Knowledge Related to Himalayan Medicinal Plants: *Paris polyphylla* Smith and *Neopicrorhiza scrophulariiflora* (Pennell) D.Y. Hong in Annapurna Conservation Area, Central Nepal

A dissertation submitted to the Central Department of Botany, Tribhuvan University for the partial fulfillment of the requirement for M. Sc. in Biodiversity and Environmental Management (BEM)

Submitted by

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T.U. Regd. No.: 5-2-0048-1445-2013

Exam Symbol No.: BEM 302/075

Batch: 2075

Submitted to

Central Department of Botany

Institute of Science and Technology

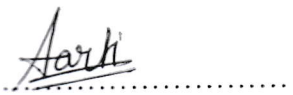
Tribhuvan University

Kirtipur, Kathmandu, Nepal

July, 2024

DECLARATION OF ORIGINALITY

I hereby declare that this dissertation entitled "**Traditional Ecological Knowledge Related to Himalayan Medicinal Plants: *Paris polyphylla* Smith. And *Neopicrorhiza scrophulariiflora* (Pennell) D.Y. Hong in Annapurna Conservation Area, Central Nepal**" is my original work, and has not been submitted elsewhere for an award of any degree. All sources of the information used have been specifically acknowledged by references to author (s) or institution (s)



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LETTER OF RECOMMENDATION

This is to recommend that **Ms. Arati Gurung** has carried out research entitled "**Traditional Ecological Knowledge Related to Himalayan Medicinal Plants: *Paris polyphylla* Smith. and *Neopicrorhiza scrophulariiflora* (Pennell) D.Y. Hong in Annapurna Conservation Area, Central Nepal**" for the award of Master's degree of Science in **Biodiversity and Environmental Management (BEM)** under my supervision. The entire work is primarily based on the result of her research work and has not been submitted for any other degree.

She has fulfilled all the requirements laid down by the Central Department of Botany, Institute of Science and Technology (IoST), Tribhuvan University, Kirtipur for the submission of the dissertation for the award of Master's degree.

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LETTER OF APPROVAL

The MSc. dissertation entitled "**Traditional Ecological Knowledge Related to Himalayan Medicinal Plants: *Paris polyphylla* Smith. and *Neopicrorhiza scrophulariiflora* (Pennell) D.Y. Hong in Annapurna Conservation Area, Central Nepal**" submitted by **Ms. Arati Gurung** to the Central Department of Botany, Tribhuvan University has been accepted for the partial fulfillment of the requirement for the MSc. degree in Biodiversity and Environmental Management (BEM).

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ACKNOWLEDGMENTS

It is my pleasure to express my sincere gratitude to my supervisor, Prof. Dr. Suresh Kumar Ghimire for his untiring guidance, support, patience, inspiring advice, and critique throughout the course of this research work.

I am equally grateful to Prof. Dr. Sangeeta Rajbhandary, Head of the Department, for her essential administrative support. I extend my heartfelt thanks to all the professors, associate professors, and staff of the Central Department of Botany for their encouragement, support, and for fostering an enriching academic environment.

This work would not have been accomplished without the generous assistance from the staff of the Annapurna Conservation Area (ACA) and the local communities of Bhujung and Chhomrong village, who graciously shared their valuable knowledge and information during the fieldwork. Their contributions and hospitality were crucial to the success of this research, and their support is deeply appreciated.

I would like to express my profound respects to my father, my beloved mother, and my sister, whose constant support, love, and faith have been a source of strength and motivation. The help and forbearance of all my family members have been fundamental to my achievements.

I am also deeply grateful to my friends Tika Maya Shrestha (Tina), Nirmala Bohara, Mandira Maharjan, Anuj Dangol, Nita Kumari Somai and Shanti Ranabhat for their help during my fieldwork, study periods and during thesis writing process. Additionally, I wish to extend my gratitude to all my batch mates, seniors and juniors who have provided insightful feedback and encouragement along the way. Their moral support has been instrumental in refining this research.

Finally, I am thankful to everyone who directly or indirectly contributed to the successful completion of this study. Your support and encouragement have been vital in this journey, and I am eternally grateful.

Arati Gurung

ABSTRACT

Indigenous mountain communities are rich in traditional ecological knowledge (TEK) as they are highly dependent on the plant sources to meet their basic needs as well as for primary healthcare. *Paris polyphylla* and *Neopicrorhiza scrophulariiflora* are two important medicinal plants that hold significant cultural and medicinal value in the Himalayan region. These plants have been used for generation to treat various ailments. Investigating about the traditional uses and the associated ecological knowledge provides invaluable insights into the traditional heritage of these communities. Thus, this study focuses on documenting traditional knowledge on most commonly used medicinal plant species, assess the variation in traditional uses in terms of specific ailments treated and preparation methods and to investigate TEK related to life-history, habitat diversity, localities growing and identify the major issues and conservation recommendations based on local perception. Altogether, 47 informants were interviewed using semi-structured questionnaire during May, June and September month of 2022. The study was conducted in two Gurung villages Bhujung and Chhomrong situated in Annapurna Conservation Area (ACA). The result showed 23 medicinal plants are most preferred by local people to cure some of the common diseases like digestive system disorder and fever. *P. polyphylla* followed by *Aconitum heterophyllum* and *N. scrophulariiflora* were frequently cited medicinal plants in the study area. Both the communities were aware about the use-practice of the study species. However, self-use of *P. polyphylla* was reported more along with the trade only in Bhujung. Both the species are obtained through self-harvest and occasionally gifted by herders and porters. Additionally, the habitats and localities of growth of *P. polyphylla* were widely recognized compared to *N. scrophulariiflora.* The main habitat of *N. scrophulariiflora* was found to be lekh (high-altitude) whereas for *P. polyphylla* was reported to be shady places and forest as per the result of the study. Despite the extensive traditional ecological knowledge, the study also found the significant conservation issues causing in decline in the population of the study species, overharvesting and unsustainable practices being one of main serious causes. The study concludes with the set of recommendations provided by the local informants themselves that aims at promoting sustainable harvesting practices and aware local communities about the status of these important medicinal plants.

Keywords: Traditional Ecological knowledge, indigenous people, medicinal plants

शोध सार

आदिवासी पहाडी समुदायहरू परम्परागत पारिस्थितिक ज्ञान (TEK) मा धनी छन् किनभने तिनीहरू आफ्नो आधारभूत आवश्यकताहरू पूरा गर्न र प्राथमिक स्वास्थ्य सेवाको लागि बिरुवा स्रोतहरूमा अत्यधिक निर्भर छन्। सतुवा र कुट्की हिमालय क्षेत्रमा महत्वपूर्ण सांस्कृतिक र औषधीजन्य मूल्य राख्ने दुई महत्वपूर्ण औषधीजन्य वनस्पति हुन्। तसर्थ, यो अध्ययनले प्रायः प्रयोग हुने औषधीजन्य वनस्पति प्रजातिहरूमा परम्परागत ज्ञानको अभिलेख गर्न, विशिष्ट रोगहरूको उपचार र तयारी विधिहरूको सन्दर्भमा परम्परागत प्रयोगहरूमा हुने भिन्नताको मूल्याङ्कन गर्न र जीवन-इतिहास, बासस्थानको विविधता, बढ्दो ठाउँहरू र पहिचानसँग सम्बन्धित TEK अनुसन्धान गर्न केन्द्रित छ। 2022 को मे, जुन र सेप्टेम्बर महिनामा semi-structured प्रश्नावली प्रयोग गरी 47 जना को रुपमा स्थानिय जानकार अगुवाहरूसँग अन्तर्वार्ता लिइयो। अध्ययन अन्नपूर्ण संरक्षण क्षेत्र (ACA) मा अवस्थित दुई गुरुङ गाउँ भुजुङ र छोमरोङमा गरिएको थियो। नतिजाले पाचन प्रणालीको विकार र ज्वरो जस्ता सामान्य रोगहरू निको पार्न स्थानीय मानिसहरूले स्थानिय जडिबुटिलाई बढी रुचाउने गरेको देखियो। सतुवा पछि निर्मसी र सतुवा लाई अध्ययन क्षेत्रमा बारम्बार जडिबुटीको रुपमा प्रयोग गरिएको थियो। दुवै समुदाय अध्ययन प्रजातिहरूको प्रयोग बारे सचेत थिए। तर, भुजुङमा मात्रै व्यापारसँगै सतुवाको स्व-प्रयोग बढी रिपोर्ट गरिएको थियो। दुबै प्रजातिहरू self-harvest गरिन्छ र कहिलेकाहीं गोठालाहरू र भरियाहरू द्वारा उपहार दिइन्छ। थप रूपमा, कुट्कीको तुलनामा सतुवाको विकासको बासस्थान र स्थानहरू व्यापक रूपमा पहिचान गरिएको थियो। अध्ययनको नतिजा अनुसार कुट्कीको मुख्य बासस्थान लेख (उच्च उचाइ) रहेको पाइयो भने सतुवाको लागि छायादार ठाउँ र जंगल रहेको पाइएको थियो। व्यापक पारम्परिक पारिस्थितिक ज्ञानको बावजुद, अध्ययनले यी प्रजातिहरूको जनसंख्यामा गिरावट, अत्यधिक फसल काट्ने र दिगो अभ्यासहरू मुख्य गम्भीर कारणहरू मध्ये एक भएको महत्वपूर्ण संरक्षण मुद्दाहरू पनि फेला पारेको छ। स्थानीय सूचनाकारहरूले आफैंले उपलब्ध गराएको सिफारिसहरूको साथ अध्ययनले दिगो फसल काट्ने अभ्यासलाई प्रवर्द्धन गर्ने र स्थानीय समुदायहरूलाई यी महत्त्वपूर्ण औषधीय बिरुवाहरूको स्थितिबारे सचेत गराउने उद्देश्य राखेको छ।

शब्दकुंजी: परम्परागत पारिस्थितिक ज्ञान, आदिवासी जनजाति, जडिबुटी

ABBREVIATION AND ACRONYMS

ACAP	:	Annapurna Conservation Area Project
°C	:	Degree Celsius
CAMP	:	Conservation Assessment and Management Plan
CBD	:	Convention on Biological Diversity
CITES	:	Convention on International Trade in Endangered Species of Wild Flora and Fauna
cm	:	Centimeter
DNPWC	:	Department of National Park and Wildlife Conservation
DPR	:	Department of Plant Resources
°E	:	Degree East
GoN	:	Government of Nepal
IUCN	:	International Union for Conservation of Nature
m	:	Meter
MAPs	:	Medicinal and Aromatic Plants
masl	:	Meter above sea level
mm	:	Millimeter
MoFE	:	Ministry of Forests and Environment
MoFSC	:	Ministry of Forests and Soil Conservation
MPs	:	Medicinal Plants
°N	:	Degree North
NTFPs	:	Non-Timber Forest Products
NTNC	:	National Trust for Nature Conservation
PIC	:	Prior Informant Consent
TEK	:	Traditional Ecological Knowledge
TK	:	Traditional Knowledge

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CHAPTER I

INTRODUCTION

1.1 Background

1.1.1 Traditional Ecological Knowledge (TEK)

Humans have relied on nature to supply all of their fundamental requirements from the beginning of time. They have always been drawn to the surrounding plant diversity out of curiosity. The early need for food, shelter, and medicine sparked interest in plants. Indigenous knowledge still determines the plants that a particular set of local people in a certain location consume (Martin, 1995). For the preservation of species and the wise use of resources, indigenous knowledge must be documented (Gemedo-Dalle *et al.*, 2005). According to Rajbhandary and Winkler (2015), every ethnic group in the nation has created its own indigenous knowledge systems that cover the use of plants for food, clothing, housing, medicine, and spiritual rituals. Nepal is inhabited by 142 castes/ethnicities groups (Population census, 2021). In Nepal TEK is deeply embedded in the cultural heritage and it shapes the lives and livelihood of these diverse communities (Chaudhary *et al.*, 2017). TEK plays a key role in resource management, particularly in the context of medicinal plants (Nepal, 2023). Communities have long relied on TEK to identify, harvest and utilize medicinal plants sustainably, ensuring their availability for future generation (Harisha *et al.*, 2016). As a result, the preservation of biodiversity, the management of natural resources, and socioeconomic growth all depend on traditional ecological knowledge.

Indigenous people have a unique understanding of resource dynamics, use, and management due to their long-term interactions with the environment for their livelihoods (Folke, 2004). People who live in isolated mountainous areas are deeply in touch with nature and possess a strong grasp of how to connect with their surroundings in a sustainable way. They have acquired the information, skills, and behaviors necessary to preserve a healthy environment by drawing their collective experiences and generational knowledge (Beltran, 2000; Bhandari, 2021).

The Convention on Biological Diversity (CBD), which was established at the Rio de Janeiro Earth Summit in 1992, acknowledged the vital role that indigenous knowledge

plays in the protection of biodiversity, particularly in relation to Article 8(j). The significance of indigenous knowledge in modern environmental management is shown by this recognition (Cormier-Salem and Roussel, 2002). Traditional knowledge is valuable in areas other than everyday life; for instance, it is helpful in contemporary industries such as agriculture and business. Traditional knowledge is the source of many commonly used items, including cosmetics, health products, and plant-based medications (Balick and Cox, 1996). Furthermore, handicrafts and clothing produced of natural fibers—as well as agricultural and non-timber forest products—benefit from this understanding. The necessity to systematically record indigenous knowledge about plant applications is highlighted by the fact that traditional therapies are frequently more accessible, inexpensive, and long-lasting than modern drugs (Dilshat *et al.*, 2010; Aziz *et al.*, 2018).

Traditional knowledge may provide innovative, comprehensive frameworks of sustainable development that are economically achievable, ecologically beneficial, and socially acceptable when combined with a new scientific discovery (Shinwari and Gilani, 2003). Traditional knowledge must thus be recorded and preserved since it is essential to the local and scientific communities. Huntington (2000) highlighted that while traditional knowledge is difficult to acquire and biological data collection requires scientific methodologies, using them more generally in scientific research remains challenging.

Beyond their role as managers of natural resources, indigenous and local communities make important contributions to the preservation of biodiversity and sustainable resource use. Their abilities and methods give the world community valuable knowledge as well as practical models for biodiversity policy. Furthermore, indigenous and local populations are actively involved in conservation and sustainable practices since they are on-site communities with in-depth knowledge of the surrounding ecosystems. The importance of traditional knowledge on species ecology is becoming more widely acknowledged in resource management across the world since it may lead to novel paths in scientific research and conservation (Huntington, 2000).

However, the loss of biological resources along with associated traditional knowledge is taking place globally due to socioeconomic changes, changes in land use, overexploitation of natural resources, and climate change (Slingenberg *et al.*, 2009; Smith, 2018). The preservation of indigenous knowledge is also threatened by younger

generations' disinterest in traditional knowledge, especially in herbal remedies, and their preference for modern pharmaceuticals (Hussin *et al.,* 2018).

1.1.2 Status of Medicinal and Aromatic Plants (MAPs) in Nepal

Medicinal plants are an essential part of both traditional and modern medicine because of their medicinal potential and documented benefits to health (Mckenna, 2018). Aromatic plants are also valuable due to their volatile substances such as essential oils. Medicinal and aromatic plants (MAPs) together offer essential means of nutrition and income generation for rural communities (Shackleton & Shackleton, 2004). According to Barnes and Prasain (2005), these plants are attractive suppliers of raw ingredients for the cosmeceutical, nutraceutical, and pharmaceutical industries.

Medicinal plants are integral to the pharmacopeia of allopathic treatments, with approximately 28,187 species identified in herbal medicine (Willis, 2017). Currently, about 25% of allopathic drugs are composed of plant-derived substances and compounds (Rao *et al.,* 2004). Despite this, only 15% of plant species have undergone phytochemical research, and a mere 6% have been tested for their pharmacological efficacy (Seidel, 2020). This indicates a vast potential for the discovery of new medicinal compounds from plants (Thomford *et al.,* 2018).

Nepal ranks 25th globally and 11th in Asia in terms of biodiversity richness (Ministry of Forests and Environment, 2018). The country's unique topography and diverse climates contribute to its rich flora, which includes 11,971 species, representing 3.2% of the world's total (MoFSC, 2014). According to the Medicinal and Aromatic Plants Database of Nepal (MAPDON), there are about 1,624 medicinal plant species in Nepal, with around 100 species traded annually (SAWTEE, 2015). The Department of Plant Resources (DPR) reports that the number of recognized medicinal plant species has increased from 701 in 2007 to 819 in 2016 (DPR, 2007; DPR, 2016). Nepal is home to 285 endemic plant species from 43 families, which hold global biological significance (Rajbhandari and Dhungana, 2011). MAPs are predominantly found in the forests and grasslands of Nepal's hilly and mountainous regions above 2,000 meters (EPI, 2017).

In Nepal, especially in the Far-West and Mid-West areas, almost 85% of MAPs are collected from the wild (GIZ, 2017). About one-third of Nepal's entire MAP trade volume comes from the Far-West alone, with the Jajarkot district providing US$13,209.4 to the country's economy through MAP trading (Kunwar *et al.,* 2015). For economic reasons,

some 143–161 species of non-timber forest products (NTFPs), including MAPs, are gathered (Subedi, 2006). However, according to Bhattarai et al. (2002), 60 MAP species are considered endangered. An estimated 50–60% of MAP harvests are thought to be unreported since they are either sold in local markets or used in households without official documentation (KC, 2014). Only 20 species, representing 80% of the overall trade volume and value, are traded out of the approximately 100 Nepalese NWFPs. (KC, 2014). Studies on herbs, herbal products, and spices that were presented at a 2005 conference indicate that the forestry industry accounts for around 15% of Nepal's GDP, of which NTFPs make up roughly 5% (CECI, 2006). The market for MAPs is still growing because of the rising demand for organic and natural products globally (Acharya, 2014).

1.1.3 Threats to MAPs: Unsustainable Harvesting Practices

In earlier times, locals and traditional healers gathered small quantities of aromatic and medicinal herbs for household and medical use (Rai *et al.*, 2000). They stored considerable medicinal plants for everyday use or medical treatments, and they possessed an extensive understanding of MAPs and traditional harvesting techniques. Faith beliefs frequently served as the basis for these collecting methods (Adams, 1988). These traditional methods have been significantly changed by the commercialization of herbal goods, though, which has resulted in early harvesting, an increase in collectors, and a decline in MAP populations in nature.

In the past, MAP harvesting was aligned with the phenological phases of the desired species. Today, collectors frequently disregard these traditional guidelines, starting the harvest too early, which negatively impacts plant growth and productivity (Sharma, 2017; Sharma, 2018). Collectors once had extensive knowledge of plant taxonomy and the specific parts needed for various uses (Kala, 2006), but interest in traditional medicinal practices has declined among younger generations (Kala, 2005). The rising demand for MAPs in regional and international markets has drawn many untrained collectors into the field (Sharma and Kala, 2016). Furthermore, many traders rely on unskilled laborers to collect wild medicinal plants, often resulting in the extraction of entire plants, roots, rhizomes, tubers, and bulbs before they can set seed, which severely limits the regeneration of these species in their natural habitats (Rai et al., 2000). To maximize profits, local collectors often harvest MAPs without following traditional practices (Uniyal *et al.*, 2011).

This unsustainable harvesting of MAPs from their natural habitats has become a serious global concern. Reports indicate that the populations of commercially exploited MAPs are declining in the wild (Ghimire *et al.,* 2005), which has negative ecological, economic, and social impacts on the MAP sector (Shrestha and Bawa, 2013). Over-exploitation and trampling during collection have altered habitat conditions, leading to the gradual loss of associated species (Rai *et al.,* 2000). Currently, the collection process begins early in lower regions, with collectors moving to higher altitudes to be the first to harvest (Ved and Goraya, 2008). Each year, new areas are targeted for exploitation due to the reduced productivity of previously harvested sites (Larsen and Olsen, 2007).

1.1.4 Trade of MAPs: Important Source of Income Generation

Forest resources are essential to the livelihoods of millions of people worldwide and help them to diversify their sources of income (Shackleton *et al.,* 2011). Non-timber forest products (NTFPs), particularly MAPs, are essential to rural communities in the majority of developing nations as they significantly sustain their means of subsistence. A subset of non-timber forest products known as medicinal and aromatic plants (MAPs) are one of the main forest resources that help rural communities make cash income (Ruiz Pérez & Byron, 1999). MAPs are also a vital source of subsistence for rural populations. Due to their low quantity in the wild and high market value, these MAPs are highly collected, as large segments of the local population rely on their seasonal sales and collecting.

Nepal is one of the main exporters of MAPs to India and is home to thousands of medicinal plants due to its location in the center of the Himalaya (Pyakurel *et al.,* 2017). But a few decades prior, Edwards (1996) calculated that 10,000 tons of MAPs from over 100 species were gathered in and out of Nepal, which marked the beginning of the measurement of trade. MAPs might open up novel possibilities for strengthening local farmers' livelihoods and the nation's income. The expansion of the pharmaceutical and agricultural industries in developed nations is a positive indication that the genetic material and related knowledge of MAPs will increase in value in the future.

Many medicinal plants, particularly the aromatic herbs, are grown in home gardens. A small number are also grown as field crops, sometimes as plantation crops, either as solo crops or in intercropping systems. It is uncommon to cultivate MAPs on a large scale for commercial use. Many people attempted small-scale local farming in Nepal, but their efforts were unsuccessful. the numerous issues that they encounter, including healthy

plant development, plant disease, and marketing issues. Consequently, in order to reduce wild pressure on MAPs for commerce, correct cultivation procedures are required.

1.1.5 Sustainability and Conservation of MAPs

Nepal has always been a significant exporter of MAPs to India, however, the trade assessment only began a few decades ago. 10,000 tons of MAPs from over 100 species were reportedly gathered in and out of Nepal, according to Edwards (1996). Olsen (2005) and Ghimire *et al.* (2015) calculated that 10770 tons of MAPs were exported to China and India in 2005 for a total estimated value of US$ 16 million. Pyakurel (2018) estimated that Nepal exported 10770 tons of MAPs for a total estimated value of US$ 60.09 million. The combination of rising prices, rising global demand, and increased contribution to household and local income may have put the MAP species at risk of overexploitation and sustainability challenges.

Similarly, the increasing human activities has led to and is still leading to the development of diverse novel environments in alpine ecosystems (Zhang *et al.,* 2019). Certain plant species and their habitats in the Himalayas have been severely impacted by the international trade in medicinal plants (MAPs) (Olsen, 2005; Pyakurel *et al.,* 2018). The density of high-altitude plant communities may also be influenced by other elements including fire and animal grazing (Niu *et al.,* 2016). Ghimire *et al.* (2008) state that the majority of high-value MAPs are slow-growing, long-lived perennials with strong habitat specificity. One of the major issues for the sustainability of such species is premature and excessive harvesting, which involves uprooting or cutting entire plants (Ghimire *et al.,* 2008; Deb *et al.,* 2015).

Harvesting tolerance varies and depends on a number of factors, including the individual's lifespan, the amount of plant harvested, the species' availability, the range of space in which it grows, the rate at which it grows, etc. For instance, weedy plants are less susceptible to heavy harvesting than slow-growing ones (Peters, 1996; Andel and Havinga, 2008). Thus, the evaluation of the ecological sustainability of harvesting must be dependent on a combined evaluation of several factors, primary among them being the plant parts harvested and their life form (Cunningham, 2001).

However, in order to manage the harvest of wild plants in an effective and environmentally friendly manner, locals frequently rely on local knowledge (Schmidt *et al.,* 2012; Tomasini, 2019). Accordingly, local participation in monitoring programmes

for natural resources and harvesting is thought to be essential to their success (Staddon, 2014). A promising strategy to comprehend the sustainability of harvesting activities could be local knowledge about harvesting techniques and management practices, including observations of plant populations and other harvesters' harvesting activities, in addition to the specific methods used by harvesters prior to, during, or after harvesting (Papageorgiou *et al.,* 2020).

1.2 Rationale of the Study

Chhomrong and Bhujung are two Gurung villages situated in Annapurna Conservation Area (ACA) are rich in natural resources that holds a significant potential for rural development. These villages, situated ate 2201m asl and 1700 m elevations possess rich and diverse plants species including highly valuable medicinal plants. The local people living in the village rely heavily on these natural resources to meet their basic needs and also possess great traditional knowledge regarding their uses.

Traditional ecological knowledge (TEK) has increasingly been recognized for its importance in guiding scientific research by understanding ecological dynamics and for developing sustainable natural resource management strategies (Ghimire *et al.,* 2004). Despite this, enough focus has not been given on diversity of knowledge and practices within and across cultures both in resource management and in advancing scientific insights into the ecological conditions of important resources. Only few researches have addressed the management of Himalayan medicinal plants with respect to indigenous knowledge and practices of local communities (Larsen, 2002; Ghimire, 2004).

Likewise, illegal collection and unsustainable harvesting patterns have threatened the medicinal plant species. Some locals have initiated the cultivation of important plants, indicating the potential for large-scale and commercial cultivation in the area. Among the 138 native vascular plant taxa threatened in Nepal, over 50 species of medicinal plants, including *P. polyphylla* are listed under the Vulnerable Category (V) CAMP and IUCN Red List (Chauhan, 2020). Such study of TEK is crucial for understanding the intricate relationship between local communities and these medicinal plants, as well as for ensuring their sustainable use and conservation (Bhat *et al.*, 2013; Haq *et al.,* 2023). *P. polyphylla* and *N. scrophulariiflora* hold significant cultural and medicinal value in the Himalayan region, including Nepal (Kafle *et al.,* 2018; Kunwar *et al.,* 2020). They have been used for generations to treat various ailments. Investigating their traditional uses and

the associated ecological knowledge provides invaluable insights into the traditional heritage of these communities and the intricate connections between humans and nature in the Himalayan ecosystem (Haq *et al.*, 2023) and pass on this knowledge to future generations.

1.3 Objectives

The major objective was to document and analyze the traditional ecological knowledge (TEK) associated with the medicinal plants *Paris polyphylla* Smith and *Neopicrorhiza scrophulariiflora* (Pennel) D.Y. Hong in the villages of Bhujung and Chhomrong within Annapurna Conservation Area, Central, Nepal. The specific objectives are:

- To document most commonly used medicinal plant species prescribed for traditional medicine in Bhujung and Chhomrong
- To assess the variation in traditional uses (in terms of specific ailments treated and preparation methods) of *Paris polyphylla* and *Neopicrorhiza scrophulariiflora* between study villages and among demographic indicators (informant age, gender, occupation, social status).
- To investigate the TEK related to life history, habitat diversity, localities of growing, and season of harvesting of these plants, and identify major issues and conservation recommendations based on local perception.

1.4 Limitations

Some of the limitations of this study are:

- Some of the names of the plant species were in Gurung language which were difficult to understand
- As the villagers were engaged in farming and herding, it was difficult to find the informants and interview during the household surveys
- Number of informants are high in Bhujung compared to Chhomrong
- Rugged terrain and unpredictable weather conditions also further complicated the travel and fieldwork that also obstructed the collection of voucher specimens

CHAPTER II

MATERIALS AND METHODS

2.1 Study Area

2.1.1 Location and Physiography

The study area lies in the Annapurna Conservation Area, Gandaki Province, Central Nepal, where I focused two Gurung communities lying in Bhujumg and Chhomrong villages. Bhujung is situated in Khwolasothar Rural Municipality Ward No. 4 of Lamjung District and Chhomrong is situated in Annapurna Rural Municipality, Ward No. 11 of Kaski District. Bhujung is a beautiful and probably the largest Gurung village in Nepal. The village has around 500 houses where the majority (90%) of people are Gurungs followed by Dalits (10%). Geographically, it is situated at around 28.331 °N latitude and 84.259 °E longitude at an elevation of around 1700 m above sea level. Likewise, Chhomrong is a picturesque village located in Annapurna region of Nepal. Geographically, it is situated at around 28.419 °N and 84.259 °E longitude at an elevation of around 2200 m above sea level.

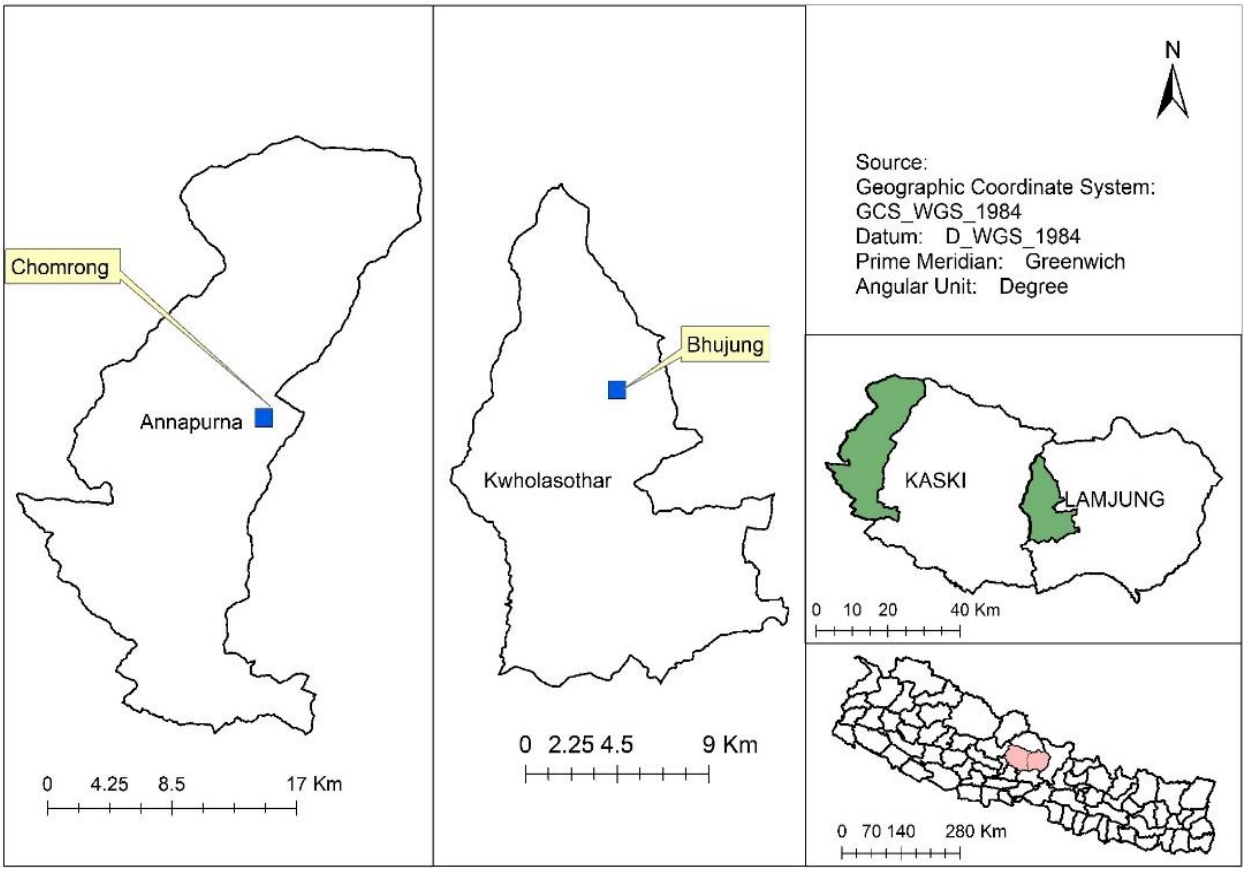

Figure 1. Map of the study area.

2.1.2 Climate

Analysis of the climatic data from 1993 to 2022 (data downloaded from www.climatecharts.net) revealed the mean annual temperature of 16.4^0 C and the annual precipitation of 1676.4 mm in Chhomrong, while in Bhujung the mean annual temperature was recorded as 16^0 C and the mean annual precipitation as 1893 mm. The lowest temperature was recorded in January, which ranged 7.7^0 C in Bhujung to 8^0 C in Chhomrong. Similarly, the highest temperature was recorded in July, with a range of 21.8^0 C in Bhujung and 22^0 C in Chhomrong.

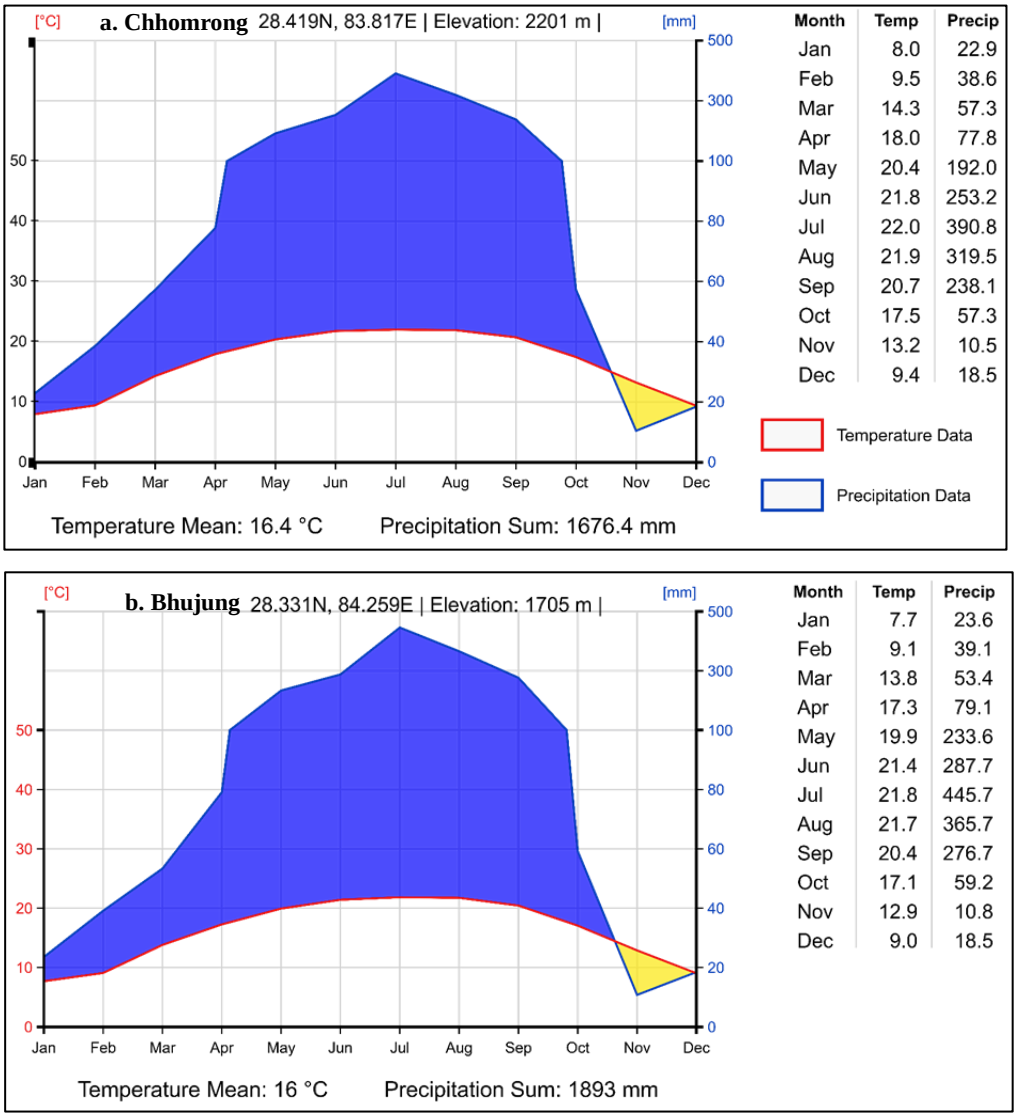

Figure 2. Mean monthly temperature and precipitation in (a) Chhomrong and (b) Bhujung, Kaski (monthly mean of 1993–2022). Source: climatecharts.net developed by Zepner (2020).

2.1.3 Vegetation and Biodiversity

The study area constitutes mixed vegetation types. The area is mainly dominated by trees species like *Daphniphyllum himalayense, Symplocos ramosissa, Eurya acuminate, Lyonia ovalifolia, Elaeagnus parvifolia, Cinnamomum tamala Quercus galuca*. Similarly, others associated herbs and shrubs are *Berbaris aristata, Pyracantha crenulata, Arisaema nepenthoides, Cardiocrinum giganteum, Rubus rosifolius, swertia chirayta, Paris polyphylla, Begonia picta, Eria coronaria, Smilax aspera, Simax menispermoidea, Tetrastigma serrulatum, Hadera nepalensis, Stauntioa angustifloia*.

Fauna like *Panthera pardus, Urunus tribetanus* (black bear), *Himalayan langur,* Small Indian mongoose (*Herpeshes auropunctatus*), *Canis aureus, Vulpes ferrilata, Ursus thibetanus, Lutra lutra, Martes foina, Bandicota bengalensis* and *Naemorhedus goral* are present in the study area.

2.1.4 Culture and Ethnicity

The two villages are predominantly inhabited by the Gurung community. Bhujung has its own name in Gurung (Tamu) language which is called “Facho” where “Fa” means Deer and Cho means “place involved in business”. So, it is believed that Bhujung was a place where Deer were traded so it got the name “Facho”. The Gurung (Tamu) is an indigenous people and an ethnic group of mid hill region of the southern slope of Himalaya in the Central Nepal. Normally Gurung community practices Bonism in the tradition and believe on nature worship. But nowadays, most of them are practicing Buddhism and Hinduism. The people who follow Bonism, they use Pachyu and Khlepri (Ghyabri) and the Buddhism followers use Lama to conduct the rituals of birth, death and other ceremonies.

In the Gurung tradition, they have so many different festivals and ceremonies in the different seasons. Some of the major festivals celebrated by the people are Lhosar or Poush 15 which is the New Year of Gurung community and Kulpuja which is done to offer things to ancestors. Likewise, some of the famous rituals of Gurung are Arghum which is a ritual of death. Similarly, the traditional song, dance and drama like Ghatu, Sorathi and Krishnacharitra are famous in the community.

2.1.5 People's Socioeconomic Status and Dependency

The primary occupation of the people living in Bhujung is agriculture, farming, and agropastoralism. The majority of households are directly or indirectly involved in animal husbandry and traditional agricultural systems. Additionally, Bhujung is famous for its rich Gurung cultural tradition, which has contributed a tourism business centered on conducting homestays and promoting hospitality. Tea production also serves as an additional source of income for many residents.

Chhomrong, situated along the trekking route to Annapurna Base Camp, has a vibrant tourism industry. Many residents operate hotels, lodges, tea houses, souvenir shops, and work as trekking guides. In both Bhujung and Chhomrong, some people engage in the collection and trade of medicinal and aromatic plants (MAPs).

A significant number of men from both villages serve in the Gurkha regiments of the British Army, Singapore Police, Indian Army. The primary income sources for Gurung families include pensions and salaries from the Gurkha regiment, farming, and the trade of sheep and woolen products. Women contribute by producing items such as woolen coats, blankets (Ghumradi), carpets (Radi), shawls, and other woolen goods.

Despite these diverse economic activities, migration remains a major issue in the study area. Many younger individuals have moved abroad, while older generations are migrating to urban centers like Pokhara and Kathmandu. This migration trend poses challenges to the sustainability of the local economy and the preservation of cultural traditions

2.2 Study Species

2.2.1 *Paris polyphylla* Sm.

Paris polyphylla, (Figure 2) belonging to the family Melanthiaceae is one of the vital medicinal plants, commonly known as Himalayan Paris, Satuwa in Nepali and Sudvi in local Gurung language. It primarily grows under the canopy of moist temperate forests (Madhav *et al.*, 2010). It is an erect, herbaceous perennial with a perennating underground rhizome and greenish erect stem that bears no branches. The aerial stem is slender, glabrous, up to 1 m tall with a diameter of 0.9–2.4 cm. It has 2–3 whorls of leaves, each having 4–9 leaves. Leaves are simple, arranged in whorls, petiolate, lanceolate, 7–13 × 1.4–3.4 cm, smooth margined. Flower solitary, terminal with short pedicel; tepals 3–5,

yellowish green, thread-like. Stamens 10, short and free. Ovary 5 × 6 mm; Style 1.7–4.5 mm; stigma lobes usually 4, recurved at tips. Fruit globular; seeds 50–60 per mature fruit, reddish orange.

Its geographical distribution encompasses the Himalayas, extending from India, Nepal and Bhutan to China and Indochina (Ji *et al.,* 2006; Shah *et al.,* 2012). In Nepal, it is distributed in Eastern, Mid and Western regions between 1800–3500 m elevation (DoF, 2017; Kanel *et al.,* 2017). It thrives in moist, shady forests, often found along streams and in dense undergrowth. It is a shade-loving plant that grows well in forests with canopy closure of more than 80% (Deb *et al.,* 2015). It is widely found in temperate mixed broadleaved forest in Nepal, where it grows alongside plants such as *Daphne bholua, Rhododendron* spp., *Berberis asiatica, Aesculus indica, Quercus semecarpifolia, Neolitsea cubeba, Leucas* spp., *Impatiens sulcata* and others. It also grows in bamboo groves, grassy or rocky slopes, stream banks, mixed conifer forests, and scrub thickets in China. *P. polyphylla* flourishes in dense forests with little human influence. It thrives in a humus-rich, well-drained environment (Deb *et al.*, 2015).

Paris polyphylla shows a distinct reproductive phenology characterized by the March-April flowering period (Sharma *et al*., 2015). Flowers are self-pollinated and develop into dark blue or black berries by late summer or early autumn (Deb *et al*., 2015). The capsule is bright and deep purple and the seed is deep reddish in color (Deb *et al*., 2015). Seeds can stay dormant for several years (KC *et al*., 2010). Seed germination is extremely rare in the wild (KC *et al*., 2010). Seed germination typically requires a period of cold stratification, demonstrating dormancy, which helps synchronize germination with favorable environmental conditions. The timing of these reproductive events is influenced by temperature, light, rainfall, and altitude.

Its prevalence in the local area contributes to the cultural and medicinal significance among the local communities. *P. polyphylla* is an important perennial medicinal plant of the Himalayas that is increasingly being used in traditional medicines and pharmaceutical industries (Kunwar *et al.*, 2013, 2020). Rhizome of the plant is widely used in Nepal as an anthelmintic, antispasmodic, digestive stomachic, expectorant and vermifuge (Bhattarai and Ghimire, 2006; IUCN, 2004; Uprety *et al.,* 2010). Rhizomes of *P. polyphylla* is also being used in snake bites, insect bites, to alleviate narcotic effects, wounds, fever and food poisoning (KC *et al.*, 2010; Dutta, 2007). The species is listed as vulnerable in IUCN Red List (Chauhan, 2020).

Scientific research has supported some of the traditional uses of *Paris polyphylla*. Studies have confirmed its antimicrobial activity against bacteria like *Escherichia coli* and *Staphylococcus aureus* and as well as two fungus strains: *Aspergillus niger* and *Trichoderma reesei*. (Mayirnao and Bhat, 2017), study by Qin *et al.,* 2012 has also shown that the Saponins isolated from the stem and leaves of *P. polyphylla* showed antimicrobial activity against *Propionibacterium acnes.* Study by Thapa *et al.,* 2023 has proven the Antioxidant, antibacterial, and cytotoxic effect of rhizome callus from the *P. polyphylla*. *P. polyphylla* rhizome extract and steroidal saponins shown antibacterial and antioxidant action (Thapa *et al.,* 2023). The anticancer activity of *P. polyphylla* is primarily attributed to its steroidal saponins, particularly diosgenyl, pennogenyl, polyphyllin D, and polyphyllin I (Rawat *et al.,* 2023). These saponins exhibit a range of anticancer mechanisms including induction of apoptosis, cell cycle arrest, inhibition of mitochondrial fission, and antiangiogenic effects (Rawat *et al.,* 2023). Diosgenyl saponins isolated from *P. polyphylla* have a noticeable effect on immunostimulant activity (Zhang *et al.,* 2007)

Paris polyphylla faces growing threats to its sustainability. Illegal collection is a major threat to *P. polyphylla* (Pokhrel *et al.,* 2019; Khakurel *et al.*, 2022), and illegal trade fueled by weak database management and porous borders further jeopardizes its sustainability and makes vulnerable to extinction (Kunwar *et al.,* 2020). This has caused uncontrolled and unscientific exploitation, high demand leading to overharvesting, unhealthy competition among collectors, and disruption of its regeneration process due to premature collection of seeds, putting the plant at risk (Rawat *et al.,* 2023). The immediate need of conservation of *P. polyphylla* is needed for future generation because of its economic importance and uncontrolled and unscientific exploitation from natural pockets (Chandra *et al.,* 2015). Conservation efforts for *P. polyphylla* involve sustainable harvesting, cultivation promotion, and awareness raising to ensure its long-term viability due to high demand and overexploitation from the wild (Tariq *et al.,* 2023). To address these threats, conservation efforts are essential to ensure the long-term viability of *P. polyphylla*. This includes promoting sustainable harvesting practices, encouraging the cultivation of the plant, and raising awareness about its importance (Pokhrel *et al.,* 2019). Furthermore, collaboration between local communities, researchers, and conservation organizations is crucial for developing effective conservation strategies and ensuring the sustainable use of this valuable medicinal resource (Pokhrel *et al.,* 2019). Additionally, conservation

efforts should focus on cultivating the plant in forests and bordering areas (Kunwar *et al.*, 2020).

Figure 2. *Paris polyphylla* Sm. (Bhujung, 22 September, 2022).

2.2.2 *Neopicrorhiza scrophulariiflora* (Pennell) D.Y. Hong

Neopicrorhiza scrophulariiflora (Scrophulariaceae) (Figure 3) is a perennial alpine herb found in the subalpine as well as alpine zone of the eastern Himalayas comprising Sikkim, Nepal, Bhutan, and China (Bantawa *et al.*, 2009; Kafle *et al.*, 2018). It occurs in the wild in diverse habitats alpine grassland and gravelly areas, forests, shrublands, meadows, cliffs and screes, between 3600 and 4400 masl (Ghimire *et al*., 2005; Shrestha *et al.*, 2009). It prefers moist north-facing slopes with richer and partially shady soil (Shrestha & Jha, 2009). Its Nepali name is Kutki, which is assessed as being vulnerable in Nepal (Tandon *et al.*, 2001). *Neopicrorhiza* is prioritized by the Government of Nepal for research and economic development among 30 medicinal and aromatic plants (HNCC, 2006).

This plant is characterized by its erect, fleshy rootstock and purple flowers arranged in dense spikes. Its leaves are oblanceolate and toothed, while its most notable feature is the thick, bitter root. The plant's medicinal properties stem from its rich content of glycosides, including picroside I and II, which contribute to its hepatoprotective, anti-inflammatory, antioxidant, and antimicrobial actions. *N. scrophulariiflora* has a long history of use in

traditional medicine, particularly in Ayurveda, where it is valued for treating liver disorders, inflammation, and infections.

It exhibits a late summer flowering period coinciding with the monsoon season. Pollination is primarily by insects, particularly bees and butterflies. Fruit development results in capsule-like fruits containing numerous seeds, maturing during autumn. Seed dispersal is likely wind-driven, with possible contributions from small mammals. Seeds exhibit dormancy, requiring cold stratification for germination, ensuring seedling emergence under favorable conditions. The timing of reproductive events is tightly linked to monsoon rainfall and adapted to high-altitude environments.

Neopicrorhiza scrophulariiflora holds a significant place in the traditional medicine system. Its roots have been used for centuries to treat a wide range of ailments. In Nepali traditional medicine, Kutki is primarily employed as a hepatoprotective agent, particularly for treating jaundice and liver inflammation (Wang *et al.,* 2006). Furthermore, the plant's anti-inflammatory properties are used in the treatment of skin infections and wounds (Rokaya *et al.,* 2020). It is also commonly used as a digestive aid and to alleviate symptoms of indigestion and flatulence (Kafle *et al.,* 2018). In Nepal it is mentioned as beneficial for headache, bile disease, intestinal pain, blood and lung fever, high blood pressure, sore throat, eye disease, gastritis, cough and cold, heart disease, cuts and diarrhea (Ghimire *et al.,* 2001; Lama *et al.,* 2001; Manandhar, 2002). Study has mentioned that 45 types of different Ayurvedic medicines contain some portion of *N. scrophulariiflora* that are used against many types of diseases (Kafle *et al.,* 2018). Pharmacologically, the plant is proven to be anti-atherosclerotic, antidiabetic, and anti-inflammatory in in-vivo studies, and antimicrobial, antimalarial, antioxidative, hepatoprotective, immunomodulatory, and nerve growth factor potentiating from in-vitro studies (Rokaya *et al.,* 2020).

N. scrophulariiflora is closely linked to the livelihood and socio-cultural traditions of the local inhabitants (Ghimire *et al.,* 2023). It is resistant to grazing and domestic consumption is not the major cause of resource depletion in Nepal (Kafle *et al.,* 2018); however, the main threat is the overharvesting (Ghimire *et al.,* 2005). The species in Nepal is listed in CITES II (Olsen, 2005). As the rhizomes of *N. scrophulariiflora* are highly valued in Ayurvedic, Chinese, and Tibetan medical systems for their purported hepatoprotective and anti-inflammatory properties, illegal overharvesting has threatened this species (Kafle *et al.,* 2018).

Figure 3. *Neopicrorhiza scrophulariiflora* (Pennell) D.Y. Hong

2.3 Methods

Primary data were collected by applying ethnobotanical approaches mentioned by Martin (1995) and Cunningham (2001) for household survey and key informant interviews.

2.3.1 Ethical consideration

Prior to conducting the research, the objectives of the study were discussed with respective authorities, and permission was taken to conduct the research from Department of National Parks and Wildlife Conservation (DNPWC), Babarmahal Kathmandu and Annapurna Conservation Area Project (ACAP), Headquarters, Pokhara (Appendix I). Likewise, prior informed consent (PIC) was obtained by discussing the objectives of the study with the respondents (Martin, 1995). Throughout the study, utmost respect was given to cultural sensitivities, and the rights of the local community over their traditional knowledge and natural resources.

2.3.2 Ethnoecological surveys

2.3.2.1 Selection of interviewees

Snowball sampling with exponential non-discriminative selection was used to select theinterviewee. This approach creates a sample population by first identifying a single appropriate participant in a geometric chain sampling sequence. These informants then proceed to refer further potential research subjects and so on until enough respondents are identified for a study (Kolaczyk, 2009; Chan, 2020). Sometimes, some people are hesitant to volunteer for research studies as they do not want their identities to be made public so, in such circumstances, snowball sampling is useful as they ask friends and acquaintances for recommendations.

2.3.2.2 Semi-structured interviews

The field survey was conducted using semi-structured questionnaire during May, 2022 in Chhomrong and June and September, 2022 in Bhujung. Set of questions (Appendix II) were prepared before visiting the study area by reading previous work done on the subject and on the ethnomedicine. After finalizing the questionnaire with the help of supervisor the survey was conducted and the interview was taken in the study area. Local people were interviewed mainly about their concern and traditional ecological knowledge of *P. polyphylla* and *N. scrophulariiflora* on use, habitat and localities of growing, life-history, and the major conservation issues and recommendation based on local perception.

2.3.2.3 Key informant interviews

A total of 14 key informants that included MAP farmers -3, commercial collectors- 5, healers-1, herders- 5, conservation manager- 3 and nursery man – 1 were interviewed during May month in Chhomrong and June, September in Bhujung using exponential non-discriminative snowball sampling method. Written notes and audio records were used to record the responses of the informants.

2.3.3 Data analysis

Data analysis was conducted using both qualitative and quantitative methods. Frequencies, percentages, means, and standard deviations were calculated for plant use categories. All data analyses were performed using SPSS and MS- Excel.

CHAPTER III

RESULTS

3.1 General Ethnobotany of Medicinal Plants

3.1.1 Most Preferred Medicinal Plant Species

Local people from the two studied villages were reported 23 plant species as highly used species for traditional medicine. The use of the species for different ailments, parts use, mode of use and detail processing are presented in Table 1.

3.1.2 Parts Use of the Preferred Species

Different parts of the plants were used. Comprising the data from both the study areas and of the reported parts used, the most commonly utilized parts of plants were rhizomes or tubers accounting 17.0% of the total usage. Likewise, roots were the second most used plant part for the treatment of the ailments accounting for 10.6%. Leaves and fruits were used equally each representing 6.4% of the total usage. The consumption of bark and seeds, as well as the whole plant were relatively lower with each category comprising 4.3%. Among different plant parts used, stem was the least utilized plant part only 2.1% of the total reported parts use. The findings indicate that rhizomes or tuber and roots were used predominantly whereas leaves and fruits were used moderately and other parts like bark, seeds and whole plant were used less and stem being the least common part utilized.

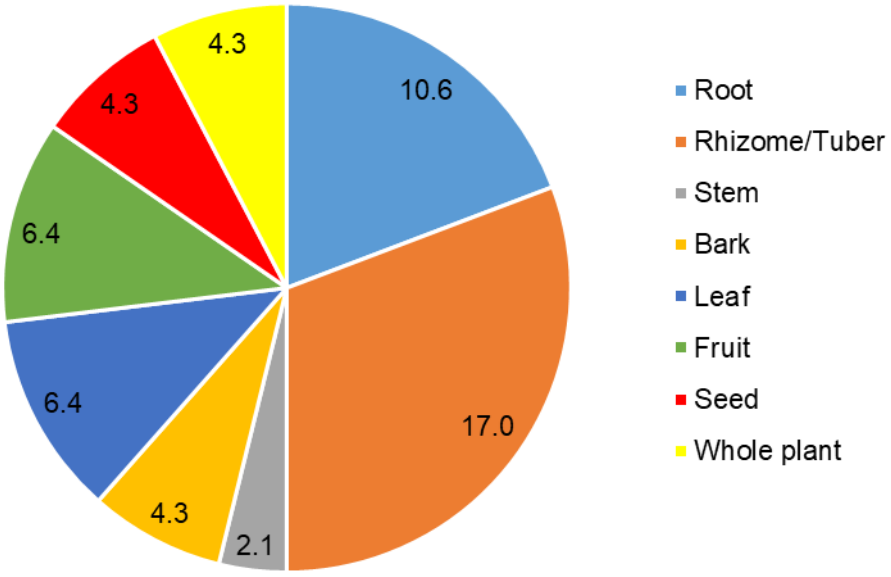

Figure 4. Parts used of the preferred species.

Table 1. List of medicinal plant species most preferred by local people in Bhujung and Chhomrong

Botanical name	Local name	Parts use	Mode of use	Diseases/disorders treated	Detail processing, dose, and ways of treatment
Paris polyphylla Sm.	Sudvi (Satuwa)	Rhizome, Fruits	Paste, Powder, Juice, Chew	Diarrrhoea for animals, stomachache, fire burn, cut, sprain, alcohol intoxication, antidote to insect stings, antidote to other poison, gastritis, flatulence, wounds, cough, headache, sore throat	Dry in the sun or can be stored dry. For animals, make the paste of fresh rhizome or powder of the dried one mix with the fodder, put it in the bamboo and feed until cure. Can also be chewed fresh. For toddlers, make a paste and apply on the forehead.
Neopicrorhiza scrophulariflora (Pennel) D.Y. Hong	Kutki	Roots	Powder/ Decoction	Gastritis, High blood pressure, Stomachache, Diabetes, Diarrhoea, Cough, Cold, Fever, Malaria	Dry in the sun or can be stored dry. Can be consumed fresh or the dried one. Boil the dried roots in water for 5-10 mins and squeeze the extract / filter using a thin cloth and store in a bottle for future use. It can be chewed too.
Aconitum heterophyllum Wall	Mheramsi (Nirmasi)	Roots	Decoction	Stomachache, food poison, flatulence in animal, antidote in livestock as well as in human	For animal consumption mix with dog faeces
Dactylorhiza hategirea (D. Don) Soo	Paanchaule	Tubers	Infusion	Fire Burn, Stomachache	Dried tubers are soaked in water
Cordyceps sinensis	Yarsagumbu	Roots	Decoction	Immune system	Dried fungus is boiled in water
Swertia chirayita	Tindo (Chiraito)	Whole plant, Root, Stem, Leaf	Paste	Stomachache, High blood pressure, Gastritis	Store dry and consume by mixing the paste in water
Aconitum spicatum (Bruhl) Stapf	Nhari (Bikh)	Roots	Decoction	Inflammation, Fever	Boil the processed roots in water
Nardostachys grandiflora DC.	Jatamansi	Roots	Paste, Decoction	Stomachache, Skin disease	Dried roots are grinded with water
Asparagus racemosus	Kurilo	Roots	Paste, Decoction	Stomachache, Diarrhea	Boil the roots in water for 15-20 mins
Litsea cubeba	Sil Timur	Fruit	Paste, Decoction	Stomachache, Gastritis	Drink with tea and can be mixed with ginger

Botanical name	Local name	Parts use	Mode of use	Diseases/disorders treated	Detail processing, dose, and ways of treatment
Zanthoxylum armatum	Pramu (Timur)	Fruit, Seed	Paste, Decoction	Cold, Gastritis, Stomachache, Flatulence	Make a paste and can be consumed as pickle or drink with tea
	Salingo	Bark, Leaf	Decoction	Cancer	Boil in water
Allium ampeloprasum	Lekh Lasun	Leaf, bulb	Paste	Stomachache, Headache, Injuries	Can be consumed directly as part of tea
Amomum subulatum Roxb.	Alaichi	Seeds	Decocitoi n	Cough, Flatulence	Dried seeds are boiled in water
	Kaunu	Roots	Decoction	Diabetes	Boil in water to get the extract
	Harchur	Seed, Root	Paste	Bone fractures, Wound	Apply the paste on the wound and fractures
Bergenia ciliata	Padamved	Roots	Decoction	Body pain, Diabetes, Fractured legs	Boil in water and make tea
Arisaema griffithii	Dhakayo	Leaf	Paste	Inflammation, Cold	Dried leaves are cooked
	Kyon di	Bark	Paste, Decoction	Bone fractures in animals	Boil the dried bark in water to take the extract
	Pachuro	Roots	Paste	Diarrhoea in animals	Mix the paste of roots with fodder to feed the animals
	Muita	Roots	Decoction	Sweetening the beverage	Mix with the dried roots with the beverage to enhance the flavor
	Prem saag	Leaf, Roots	Paste, Decoction	Cold, Stomachache	Boil the dried roots for 10-15 mins in water
	Badamle	Leaf	Paste	Stomachache	Make the paste with water

Table 2. Citation frequency of most preferred medicinal plants from Bhujung and Chhomrong

Scientific name	Local name	Bhujung	Chhomrong	Total
		N = 30	N = 17	N = 47
Amomum subulatum Roxb.	Alainchi	0.07	0.00	0.04
	Badmale	0.10	0.00	0.06
Aconitum spicatum (Bruhl) Stapf	Nhari (Bikh)	0.13	0.00	0.09
Swertia chirayita	Tindo (Chiraito)	0.43	0.00	0.28
Arisaema griffithii	Dhakayo	0.00	0.65	0.23
	Harjur/Harchur	0.17	0.00	0.11
Nardostachys grandiflora DC.	Jatamansi	0.10	0.00	0.06
	Kaunu	0.07	0.00	0.04
Asparagus racemosus	Kurilo	0.03	0.00	0.02
Neopicrorhiza scrophulariflora (Pennel) D.Y. Hong	Kutki	1.00	0.47	0.81
	Kyon di	0.03	0.00	0.02
Allium ampeloprasum	Lekh lasun	0.20	0.24	0.21
	Muita	0.07	0.00	0.04
Aconitum heterophyllum Wall	Nirmasi	1.00	0.94	0.98
	Pachuro	0.03	0.00	0.02
Bergenia ciliata	Padambed	0.00	0.29	0.11
Dactylorhiza hategirea (D. Don) Soo	Panchaule	0.70	0.12	0.49
	Prem saag	0.00	0.47	0.17
	Salingo	0.07	0.00	0.04
Litsea cubeba	Sil timur	0.03	0.00	0.02
Paris polyphylla Sm.	Sudvi (Satuwa)	1.00	1.00	1.00
Zanthoxylum armatum	Pramu (Timur)	0.23	0.18	0.21
	Totha	0.03	0.00	0.02
Cordyceps sinensis	Yarsagumbu	0.23	0.00	0.15

3.1.3 Mode of Use of the Preferred Species

The study identified five modes of use for medicinal plants: chewing, decoction, juice, paste, and powder. Decoction (Figure 5) was the most common mode of use, accounting for 17.0% of the reported uses, followed by paste comprising 14.9%. Similarly, powder followed representing 4.3 % of the usage. Both juice and chew were the least common mode of use each constituting 2.1% of the total reported uses. This study highlighted the significant reliance on decoction and paste as the mode of use for the preparation and use of medicinal plant species traditionally.

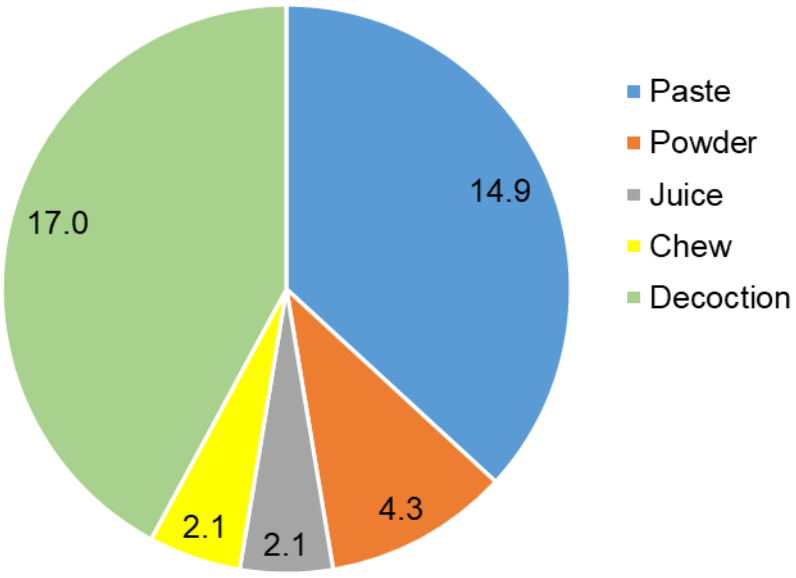

Figure 5. Mode of use of preferred species.

3.2 Variation in Traditional Knowledge Related to *Paris polyphylla* and *Neopicrorhiza scrophulariiflora*

3.2.1 Variation in use practice, purpose of harvest and practice of obtaining

3.2.1.1 Variation in local awareness, use practice and purpose of harvest

The variation in the use practice of *N. scrophulariiflora* and *P. polyphylla* in both the villages was analyzed which showed the distinct patterns in Bhujung and Chhomrong. In Bhujung the awareness in the use of *N. scrophulariiflora* as medicinal plant was found to be 100% with 36.7% of the informants actually using the species for healthcare (Table 3). In contrast, Chhomrong showed slightly lower awareness at 88.2% and only 20% of

the informants using it. Overall, this resulted in an awareness percentage of 95.7% and a self-use percentage of 36.2% for *N. scrophulariiflora* across both the study area.

Likewise, for *P. polyphylla*, awareness in terms of use value was consistently high at 100% in both the villages. The actual use of plant species for healthcare were nearly identical, with 70.0% in Bhujung and 70.6 % in Chhomrong. Additionally, 23.3% of respondents from Bhujung were engaged in both self-use and trade of the species, while Chhomrong had a slightly higher rate of 23.5%. This resulted in a combined total use (self-use and trade) of 93.3% in Bhujung and 94.1% in Chhomrong, averaging to 93.6% in both the villages.

Table 3. Local awareness and use practices (% of informants aware about the study species in terms of their use value and the % of informants actually using the species for healthcare).

Village	*N. scrophulariiflora*		*P. polyphylla*			
	Awareness	Self-use	Awareness	Use		
				Self-use	Self-use and trade	Total
Bhujung	100.0	36.7	100.0	70.0	23.3	93.3
Chhomrong	88.2	20.0	100.0	70.6	23.5	94.1
Total	95.7	36.2	100.0	70.2	23.4	93.6

3.2.1.2 Variation in the practice of obtaining the plant parts

Various practices of the informants actually using the medicinal plant species for self-use and trade were reported. For *N. scrophulariiflora,* people in Bhujung showed higher percentage of self-harvest (45.5%) compared to Chhomrong (16.7%) (Table 4). In Bhujung, 9.1% was harvested by children or grandchildren and 45.5% informants received as a gift form herder, while none obtained from porters and others. Conversely, in Chhomrong, no one had received as a gift from herders but a significant portion (66.7%) had received from the porters and others.

For *P. polyphylla* obtaining the plant through self-harvest was found to be the predominant method in both the villages, but it was more evident in Chhomrong (93.8%) than in Bhujung (75.0%). In Bhujung, a small percentage was harvested by children or grandchildren (3.6%) and received as gifts from herders (3.6%) and porters and others (17.9%). In contrast, Chhomrong didn't involve children or grandchildren in the harvest,

nor any gifts were received from the herders, and only a small percentage (6.3%) was obtained from porters and others.

Table 4. The practice of obtaining the plant parts of *Neopicrorhiza scrophulariiflora* and *Paris polyphylla* for personal use, trade or both. The values indicate % of those informants who actually use these MPs.

Village	*N. scrophulariiflora*				*P. polyphylla*			
	Self-harvest	Harvest by children or grand-children	Gift from herders	Gift from porters and others	Self-harvest	Harvest by children or grand-children	Gift from herders	Gift from porters and others
Bhujung	45.5	9.1	45.5	0.0	75.0	3.6	3.6	17.9
Chhomrong	16.7	16.7	0.0	66.7	93.8	0.0	0.0	6.3
Total	35.3	11.8	29.4	23.5	81.8	2.3	2.3	13.6

3.2.2 Variation in medicinal uses: use reports, ailments treated and parts use

3.2.2.1 Variation in use reports

Notable differences were found in the use of *N. scrophulariiflora* and *P. polyphylla* between two study sites. Overall, use report of *P. polyphylla* was observed more frequent (73) as compared to 59 use reports for *N. scrophulariiflora* (Table 5). The mean use report of *P. polyphylla* was higher (2.0) with a wider range (1 to 4), suggesting a greater or more varied application. In Bhujung, the use report of *N. scrophulariiflora* was found to be 45 (mean 1.5, range 1-3), whereas the use report of *P. polyphylla* was 39 (mean 1.9, range 1-3). In Chhomrong, *N. scrophulariiflora* was less reported with 14 use reports (mean 1.8, range 1-3) whereas *P. polyphylla* was reported a higher number of 34 use reports (mean 2.3, range 1-4).

Table 5. Variation in medicinal use reports of *Neopicrorhiza scrophulariiflora* and *Paris polyphylla* between study villages

Village	*N. scrophulariiflora*			*P. polyphylla*		
	No of use reports	Mean use report	Range	No of use reports	Mean use report	Range
Bhujung	45	1.5	1-3	39	1.9	1-3
Chhomrong	14	1.8	1-3	34	2.3	1-4
Total	59	1.6	1-3	73	2.0	1-4

3.2.2.2 Variation in ailments treated

For *N. scrophularriiflora,* ailments like fever, cough and cold, malaria, diabetes, hypertension, and digestive system disorders were recorded (Figure 6a). Digestive system disorders and hypertension are the most prevalent conditions treated with *N. scrophulariiflora* in Bhujung with around 80% and 60% of respondents, respectively using it for these ailments. In Chhomrong, the use of *N. scrophulariiflora* for this condition was significantly lower. Fever, cough and cold are reported more and only in Chhomrong and malaria is scarcely reported only in Bhujung. Overall, Bhujung showed a higher percentage of using *N. scrophulariiflroa* to treat health issues compared to Chhomrong with digestive system disorders being the most common ailment treated.

Various ailments were treated using the rhizome of *P. polyphylla* (Figure 6 b) in both the localities like antidote to other poison, antidote to insect stings, alcohol intoxication, sprains, skin diseases, burns, cuts and wounds, respiratory system disorder, headache, fever and digestive system disorder. Out of all the ailments reported, both the villages used the rhizome for the treatment of antidote to insect stings, poison, alcohol intoxication, burns, cuts and wounds, and fever. However, for the treatment of fever and insect (bee) stings, people from Chhomrong were found in higher percentage compared to Bhujung. Whereas for the treatment of alcohol intoxication, burns, cuts and wounds higher percentage was found in the informants from Bhujung than Chhomrong.

Likewise, some of the ailments like headache, respiratory system disorder was found to be cure only in Chhomrong and sprains and skin diseases, digestive system disorder only in Bhujung. Additionally, out of all the ailments, higher percentage of people used the rhizome frequently to cure digestive system disorder, followed by burns in Bhujung and respiratory system disorder followed by fever and antidote to bee stings and other poison were recorded high in Chhomrong.

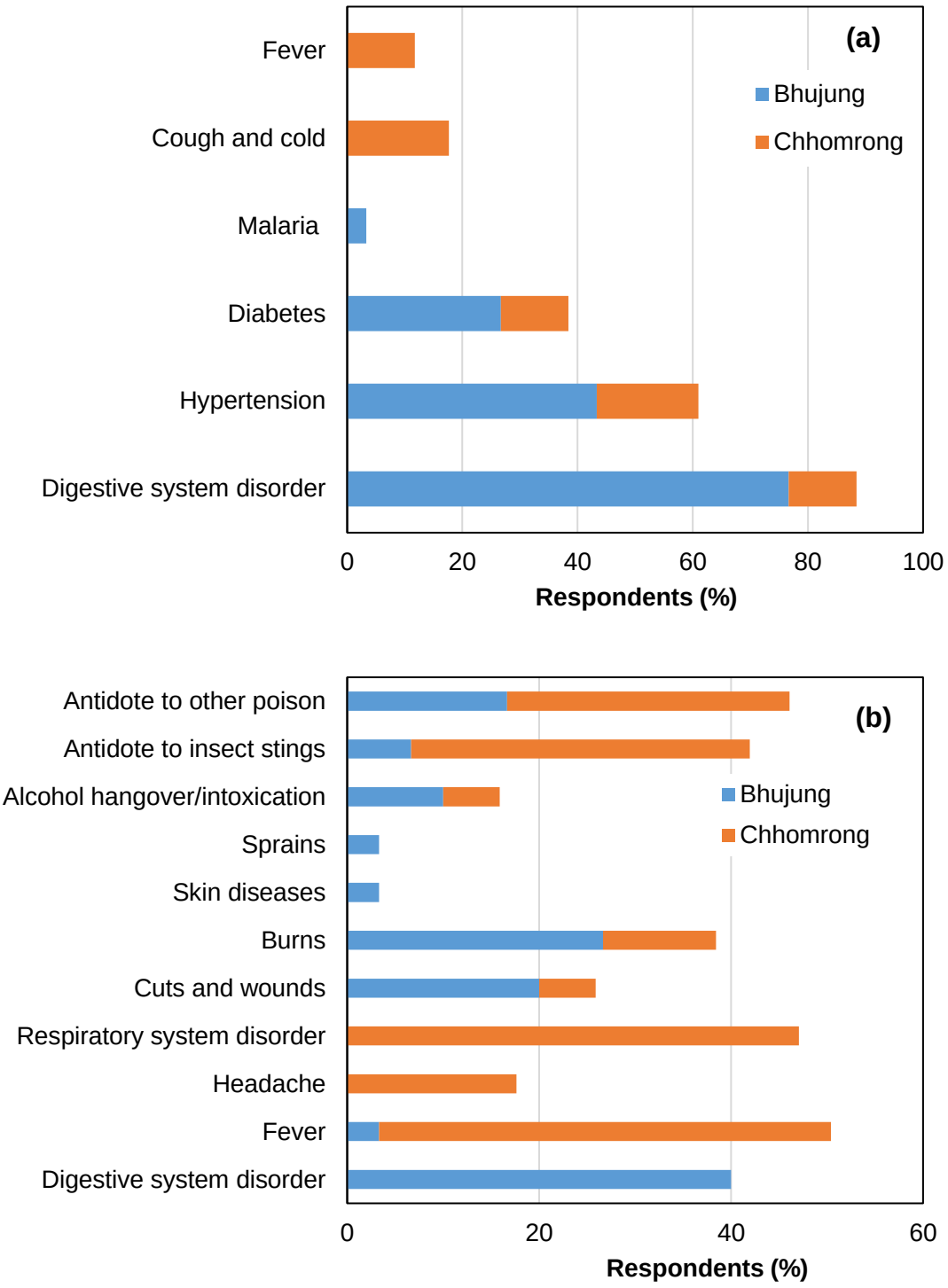

Figure 6. Major ailments treated with the use of (a) *Neopicrorhiza scrophulariiflora* and (b) *Paris polyphylla* rhizome.

3.2.2.3 Variation in parts use

The frequency of the use of different parts varies in the Chhomrong and Bhujung (Table 6). In Bhujung, questionnaire results show that *N. scropulariiflora's* most used part is its root (28 occurrences), with a single frequency of the root, stem, leaf combination and the whole plant being used. In contrast, *P. polyphylla* is exclusively utilized for its rhizome (30 occurrences) in this village. In Chhomrong, *N. scrophulariiflora* is mostly used for its root (17 occurrences), while *Paris polyphylla* exhibits a broader range of part utilization, with 14 occurrences for the rhizome and 3 occurrences for the rhizome and fruits combination, with no other parts recorded. A chi-squared test revealed no significant association between location and plant part usage ($\chi^2 = 6.8388$, df = 4, p = 0.1447). However, it shows statistically significant association between plant species and the parts used ($\chi^2 = 94$, df = 4, $p < 0.001$). In other words, the types of plant parts used are significantly different across the two plant species in the study.

Table 6. Used parts of *N. scrophulariiflora* and *P. polyphylla* and their (frequency) counts in Bhujung and Chhomrong.

Village	Plant species	Part used	Frequency (count)
Bhujung	*N. scrophulariiflora*	Root	28
		Root, stem, leaf	1
		Whole plant	1
	P. polyphylla	Rhizome	30
Chhomrong	*N. scrophulariiflora*	Root	17
	P. polyphylla	Rhizome	14
		Rhizome, Fruits	3

3.2.3 Knowledge about habitat and places of growing

3.2.3.1 Local awareness about habitat

The awareness of local people about the habitats of both the studied species were found to be distinct (Table 7). For *N. scrophulariiflora,* 63.3 % of informants in Bhujung were aware about its habitat compared to 52.9% in Chhomrong with an overall awareness of 59.6%. The mean number of habitats known for *N. scrophulariiflora* is slightly higher in Bhujung (1.5) compared to Chhomrong (1.3). In contrast, *P. polyphylla* awareness was significantly higher in both the villages with 90.0% in Bhujung and 94.1% in Chhomrong resulting in an overall awareness of 91.5%. Thus, *P. polyphylla* was more widely

recognized and its habitats were known better compared to *N. scrophulariiflora* in both villages.

Table 7. Local awareness about habitats of *Neopicrorhiza scrophulariiflora* and *Paris polyphylla*. Values in first two columns of each species indicate % of informants interviewed.

Village	*N. scrophulariiflora*				*P. polyphylla*			
	Aware about habitat	Unaware about habitat	Number of habitats known		Aware about habitat	Unaware about habitat	Number of habitats known	
			Mean	Range			Mean	Range
Bhujung	63.3	36.7	1.5	1-3	90.0	10.0	3.1	2-5
Chhomrong	52.9	47.1	1.3	1-2	94.1	5.9	3.5	2-5
Total	59.6	40.4	1.5	1-3	91.5	8.5	3.2	2-5

3.2.3.2 Habitat diversity as perceived by the local people

Habitat of N. scrophulariiflora is reported to be of 4 categories. They were ‘lekh’, ‘dhunga ko kuna’, ‘buki ghans’, and ‘pakhama’ (Tabel 8). Out of these habitats, the most recognized habitat of N. scrophulariiflora was Lekh (high altitude) with 89.5% followed by Dhunga ko kuna with (rocky habitat) with 52.6% in Bhujung (Table 8). Likewise, in Chhomrong, 100% people identified Lekh as a habitat (Table 8). In overall, 92.9% respondents recognized Lekh as a habitat for N. scrophulariiflora.

In case of P. polyphylla, the most commonly recognized habitats in Bhujung are Jungle ko bich (inside the jungle) (81.5%) followed by Osilo thaun (Shady place) and malilo maato. In Chhomrong, the most recognized habitats were osilo thaun (100 %), Jungle ko bigch (87.5 %) and Lekh (68.8%). Overall, the top habitats identified were osilo thaun (81.4%), Jungle ko bich (83.7%) and lekh (67.4%). These findings highlighted the main habitat being the high-altitude areas for N. scrophulariiflora and shady places and forest being the habitat of P. polyphylla.

Table 8. Habitat diversity of Neopicrorhiza scrophulariiflora and Paris polyphylla as perceived by local people. The values indicate % of those informants who knew the habitats.

Village	*N. scrophulariiflora*				*P. polyphylla*				
	Lekh (high altitude)	Dhunga ko kuna	Buki ghans paune thaun	Pakha	Lekh (high altitude)	Bhiralo kholsa	Jangal ko bich	Malilo kalo mato	Osilo thaun (shady place)
Bhujung	89.5	52.6	10.5	0.0	66.7	25.9	81.5	63.0	70.4
Chhomrong	100.0	0.0	0.0	33.3	68.8	50.0	87.5	43.8	100.0
Total	92.9	35.7	7.1	10.7	67.4	34.9	83.7	55.8	81.4

3.2.3.3 Local awareness about places of growing (localities)

There was higher awareness of localities where *P. polyphylla* grows compared to *N. scrophulariiflora* (Table 9). In Bhujung, 73.3% of informants were aware about the localities where *P. polyphylla* grows knowing an average of 4.8 localities and only 43.3% were aware about the growing localities of *N. scrophulariiflora* with an average of 2.7 localities. Similarly, in Chhomrong, 64.7% informants were aware about the localities of *P. polyphylla* compared to 58.8% awareness on *N. scrophulariiflora* with knowledge of just one locality. In overall, majority of the informants around 70.2% in both the villages were aware about the localities of *P. polyphylla* with an average of 4.1 localities known and 48.9 % were aware about *N. scrophulariiflora* indicating higher level of local knowledge about *P. polyphylla* compared to *N. scrophulariiflora.*

Table 9. Local awareness about the places of growing (localities) for *Paris polyphylla*. The values indicate % of all informants interviewed.

Village	*N. scrophulariiflora*				*P. polyphylla*			
	Aware about locality	Unaware about locality	No. of localities known		Aware about locality	Unaware about locality	No. of localities known	
			Mean	Range			Mean	Range
Bhujung	43.3	56.7	2.7	1-6	73.3	26.7	4.8	2-14
Chhomrong	58.8	41.2	1.0	1	64.7	35.3	2.5	1-4
Total	48.9	51.1	2.0	1-6	70.2	29.8	4.1	1-14

3.2.4 Knowledge about growth stages and life-cycle

Traditional knowledge and perception on local informants about the growth stages and life cycle of *N. scrophulariiflora* and *P. polyphylla* was provided. Both the species showed seasonal growth. The growing season is short, starting in early spring and ends when the winter perennation starts. At the end of each growing season, the aboveground part dries up and the plant dies. The underground rhizomes remain dormant and grow out the next growing season (Figure 7).

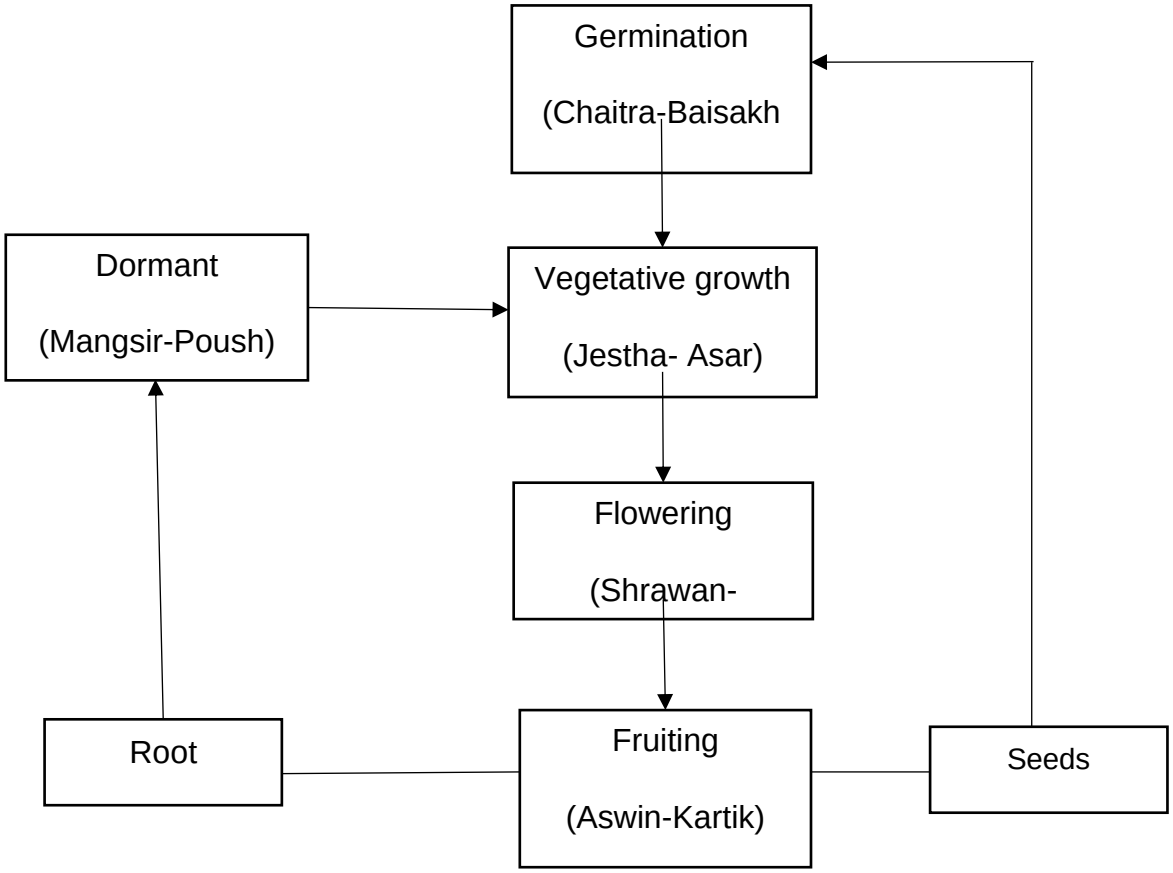

Figure 7 Life-cycle of *P. polyphylla* as per the perception of local informants

3.3 Conservation Issues

Various conservation issues were identified from the respondents related to the overall medicinal plant species reported from the studied sites (Figure 8). The most significant issue was reported to be was overexploitation and unrestricted harvesting from both the villages nearly by 100%. In Bhujung, illegal harvesting and trade was another concern along with trampling, temperature rise and seasonal fluctuation. Likewise, Chhomrong also faced notable issues like pre-mature harvesting and consumption by birds and animals like monkeys. Other threats like invasive species, grazing, and insufficient trade surveillance were mentioned less frequently. As a whole, overexploitation was reported as predominant conservation challenge in the study area.

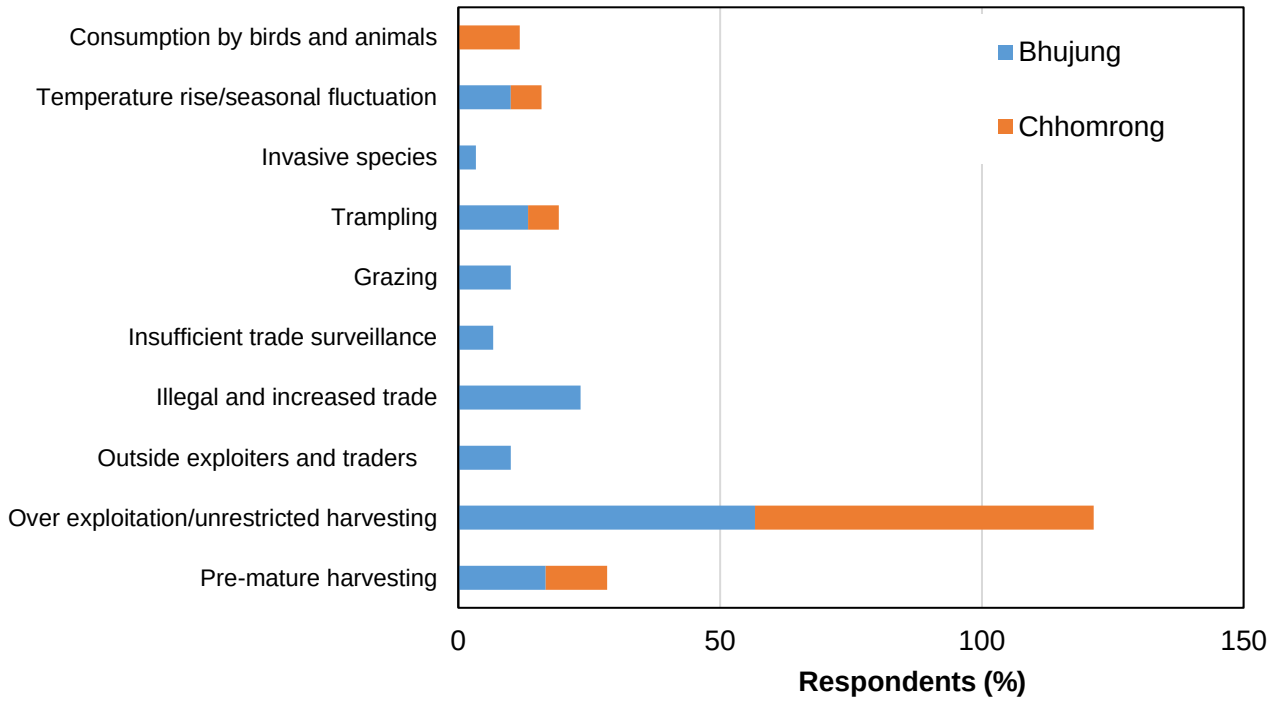

Figure 8 Conservation challenges as per the local's perception

3.4 Local Suggestions to Protect the Species

Some of the local suggestions to protect the species are:

- Local people should have proper knowledge on harvesting time
- There should be limitation in harvesting quantity
- Proper monitoring and trade surveillance should be done by responsible organization
- There should be check post in different places
- Responsible organization should take action
- Government should give more importance for commercial cultivation
- Natural resources should be protected
- Nurseries should be established and overharvesting should not be done

CHAPTER IV

DISCUSSION

4.1 General Ethnobotany of Medicinal Plants

The study examines the traditional ecological knowledge and use practices related to two medicinal plant species, *Neopicrorhiza scrophulariiflora* and *Paris polyphylla* in two villages, Bhujung and Chhomrong, in Nepal. It is found that there is significant differences in traditional knowledge and use practices between the two villages for the two medicinal plant species. The higher awareness and use of *N. scrophulariiflora* in Bhujung compared to Chhomrong, and the broader range of applications and higher use reports for *P. polyphylla*, suggest that local context and cultural factors play a crucial role in shaping the traditional knowledge and utilization of these resources. Our result aligns with the finding of Ghimire *et al*. (2004) where they reported the heterogeneity of the traditional knowledge and management practice between two localities in same species.

4.2 Parts Use and Mode of Use

The findings indicate that local communities in the study area predominantly use the rhizomes/tubers (17 %) and roots (10.6 %) of medicinal plants for their healthcare needs. This preference for underground plant parts may be likely due to fact that Rhizomes, tubers, and roots often contain higher concentrations of the active medicinal compounds compared to other plant parts (Thapa *et al.,* 2023; Kumai *et al.,* 2023). These underground storage organs serve as the primary site of metabolite accumulation, making them more potent for medicinal applications (Murthy *et al.,* 2024). The relatively lower usage of leaves, fruits, bark, seeds, and the whole plant suggests that local communities have a more specialized knowledge and preference for the underground parts of medicinal plants. This specialized knowledge is an important aspect of the traditional medicinal practices in the study area.

The five identified modes of use for medicinal plants were chewing, decoction, juice, paste, and powder. Decoction was the most common mode of use, accounting for 17.0% of the reported uses. Study by Maaiden *et al.,* 2022 also reported that among the mode of uses, decoction allow for more effective extraction and concentration of the active medicinal compounds from the plant materials compared to other methods like chewing

or juice (Maaiden *et al.*, 2022). Paste was the second most common mode, comprising 14.9% of the reported uses. The preference for decoction and paste has likely been passed down through generations as part of the traditional medicinal knowledge and practices of the local communities. Study by Ambu *et al.* (2020) also reported decoction as the major preformed form of mode of use in the community in the Kavreplanchowk, Nepal.

4.3 Variation in Traditional Knowledge Related to *Paris polyphylla* and *Neopicrorhiza scrophulariiflora*

The study reveals significant differences in the use practices and purposes of harvest for the medicinal plants *N. scrophulariiflora* and *P. polyphylla* between the two villages, Bhujung and Chhomrong. The higher awareness and self-use of *N. scrophulariiflora* in Bhujung compared to Chhomrong suggest that local context and cultural factors play a crucial role in shaping the traditional knowledge and utilization of this medicinal plant species. Ghimire *et al.*, 2004 also reported variation in knowledge relating to the diversity of medicinal plant species, their distribution, medicinal uses, biological traits, ecology, and management within and between two culturally different social groups while studying villages located in the Shey-Phoksundo National Park and its buffer zone in northwestern Nepal. However, another study reveals variations in the knowledge and utilization of *N. scrophulariiflora* on geographic location, gender, and age-class, but not ethnicity (Ghimire *et al.*, 2023)

The consistently high awareness and self-use of *P. polyphylla* across both villages indicate that this species is widely recognized and utilized for healthcare purposes by the local communities. One study found *P. polyphylla* growing in all 51 districts in Nepal, but were only able to find use records from 38 of these districts, and trade records from only 39 districts including 19 border districts (Kunwar, 2020). The similar combined total use (self-use and trade) of the two species in both villages highlights the importance of these medicinal plants in the overall healthcare practices and economic activities of the local communities. However, the differences in self-use and trade involvement between the villages suggest that the specific purposes and reliance on these species may vary depending on local needs, preferences, and socio-economic factors. Heterogeneity in levels of knowledge and in practices both within and between these groups corresponds to differences in level of specialization in relation to medicinal plants, to socio-cultural and institutional contexts, and to extra-local factors that govern people's activities

(Ghimire *et al.,* 2004). These findings highlight the importance of documenting and understanding the importance of traditional knowledge and use practices at the local level to inform conservation and sustainable management efforts for these valuable medicinal plant resources. The variations observed between the two villages emphasize the need for locality specific approaches that consider the specific contexts and needs of each community.

There are different ways of obtaining *N. scrophulariiflora* and *P. polyphylla* for self-use and trade in Bhujung and Chhomrong. When comparing the *N. scropulariiflora* and *Paris polyphylla*, self-harvesting is higher for the *P. polyphylla*. But when comparing the community, the higher self-harvesting rate of *N. scrophulariiflora* in Bhujung, along with the significant reliance on gifts from herders, indicates a stronger connection and access to the natural habitats of this species within the local community. In contrast, the greater dependence on gifts from porters and others in Chhomrong suggests that the community may have less direct access to the natural resources and relies more on external sources.

The predominance of self-harvesting for *P. polyphylla* in both villages, with Chhomrong showing an even higher rate, suggests that this species may be more readily available or accessible to the local communities. The lower frequency of other ways, such as gifts from herders or porters, further support the idea that *P. polyphylla* is more integrated into the traditional practices and livelihood strategies of the local people. Understanding the importance of traditional knowledge and resource use practices at the local level is crucial (Nepal ,2023), as they can provide valuable insights for developing conservation and sustainable management strategies for these medicinal plant species.

4.4 Variation in medicinal uses: use reports, ailments treated and parts use

Overall, the use reports were more frequent for *P. polyphylla* (73 use reports) compared to *N. scrophulariiflora* (59 use reports). Suggesting a greater reliance on and trust in *P. polyphylla* for treating a variety of ailments. *P. polyphylla* possesses steroidal saponins, flavonoid glycosides, sterols, triterpenoid saponins that contribute to its various biological activities, including anticancer properties and treatment of abnormal uterine bleeding, dysfunctional uterine bleeding, and menorrhagia. (Rawat *et al.,* 2023). *N. scrophulariiflora* was used to treat a narrower range of ailments, including fever, cough, cold, malaria, diabetes, hypertension, and digestive system disorders. but research by

Kafle *et al.,* (2018) has shown its use across diverse disease categories including cardiovascular system/liver (17), cardiovascular system/blood (6), nervous system (6), dermatological system (4), musculoskeletal system (3), digestive system (2), respiratory system (2), genito urinal system (4), and others (1), highlighting limited knowledge of this species in the study area. *P. polyphylla* was used to treat a wider variety of ailments, such as digestive disorders, fever, headache, respiratory issues, cuts, burns, skin diseases, sprains, alcohol hangover, insect stings, and poisoning. The diverse range of conditions treated by *P. polyphylla* reflects its versatile medicinal properties and suggests a broader pharmacological profile.

The study also found statistically significant differences in the plant parts used between the two species but no significant association between location and plant part usage. This suggests that the choice of plant parts varies significantly between *P. polyphylla* and *N. scrophulariiflora* and this variation is consistent across these two locations. *N. scrophulariiflora* primarily utilizes roots and rhizomes, reflecting the concentration of its active compounds known for medicinal properties. In contrast, *P. polyphylla* employs a wider variety of plant parts, including roots, rhizomes, leaves, and sometimes flowers, due to its extensive range of therapeutic applications (Thapa *et al.,* 2023).

4.5 Knowledge about habitat and places of growing

Local knowledge can be a valuable resource for conservation efforts (Huntington, 2013). In Bhujung, 63.3% of informants were aware of the habitat of *N. scrophulariiflora,* compared to 52.9% in Chhomrong. Awareness about the habitat of *P. polyphylla* was significantly higher in both villages, with 90.0% in Bhujung and 94.1% in Chhomrong. This higher habitat knowledge of the *P. polyphylla* can be linked to the uses value, this study found that *P. polyphylla* is used in wide range of ailment, which makes it popular. This may be the reason for higher awareness of local people on the habitat of *P. polyphylla*. In contrast to this study, one study reported that local knowledge in Nepal about *Paris polyphylla's* habitat is limited, with the plant found in moist, fertile, and sloppy sites while studying in Panchase Protected Forest (Pokhrel *et al.,* 2019). The high-altitude 'lekh' habitat was more widely recognized for *N. scrophulariiflora,* while *P. polyphylla* was associated with shady forest areas and fertile soils.

The level of awareness is higher in *P. polyphylla* and among the village it is higher in Chhommrong. Understanding this variation is crucial for designing effective management

practices (Ghimire *et al.*, 2004). *N. scrophulariiflora* is valuable medicinal plant that can serve as promising source of non-harmful and potential medicinal herbal remedies for human beings (Rokaya et al., 2020). In this study it is used for narrower ailments and the habitat knowledge is also low as compared to *P. polyphylla.*

CHAPTER V

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Paris polyphylla and *Neopicrorhiza scorphulariiflora* are two important medicinal plants that has great use value among the indigenous mountain communities because of the properties they possess for the treatment of various ailments. *P. polyphylla* is an erect, herbaceous perennial plant distributed in the eastern, mid and western regions between 1800-3500 m elevation. The flowering period being March-April. The species is listed in IUCN Red list and its rhizomes are widely used to cure snake bites, alleviate narcotic effect. Likewise, *N. scrophulariiflora* is also a perennial alpine herb prioritized by Government of Nepal for research and economic development and is assessed as being vulnerable in Nepal. The roots are widely used in traditional medicine for treating liver disorders, inflammation and infections. The flowering period coincide with monsoon season. Despite of the valuable use of these MPs they are majorly threatened by illegal collection and over-harvesting due to increase in demand.

It was found that both the studied area Bhujung and Chhomrong were aware about the use-practice of the studied species. However, self-use of *P. polyphylla* was reported more along with the trade only in Bhujung causing over and unsustainable of the species in Bhujung. In Chhomrong, few people have started cultivating *P. polphylla* by collecting the plants from nearby localities. Likewise, both the species were reported in the treatment of various ailments like digestive system disorder, respiratory system disorder, diabetes, antidote to poisons and insect stings etc. Additionally, the habitats and localities of growth of *P. polyphylla* were widely recognized compared to *N. scrophulariiflor* because of the difficult access, rugged terrain and high-altitude habitat of *N. scrophulariiflora*. *P. polyphylla* was reported to found nearby jungles under forest shady places. Due to increasing demand of both the species in the market, the study species was found highly threatened and the population size declining every year. Besides, the conservation challenges, there seems a gap on transfer of traditional ecological knowledge from older generation to younger generation in both the study sites.

The study concludes with the set of recommendations provided by the local people on promoting sustainable harvesting practices, prioritizing the commercial cultivation by the government and aware local communities including younger generation about the importance and status of these important medicinal plants.

5.2 Recommendation

Based on the result of the present study and comprising the solution from local informants following recommendation are provided:

- Awareness should be raised among the locals and young generation about the conservation and sustainable harvesting of the plant
- Prioritize the commercial farming of the medicinal plants by the government so that pressure on wild populated is reduced
- Effective and proper monitoring and trade surveillance should be done by responsible organization

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APPENDICES

5.1 Appendix I: Permission letter

त्रिभुवन विश्वविद्यालय
विज्ञान तथा प्रविधि अध्ययन संस्थान
वनस्पति शास्त्र केन्द्रीय विभाग

पत्र संख्याः- ८२६/७८-७९ कोर्ति

Tribhuvan University
Central Department of Botany
Kirtipur, Kathmandu

कीर्तिपुर, काठमाडौं
नेपाल

मिति : २०७९।०१।१५

श्री महानिर्देशक ज्यू
राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण विभाग,
वबरमहल काठमाण्डौ ।

विषय : अनुसन्धानको लागी अनुमति दिने सम्वन्धमा

उपरोक्त सम्वन्धमा यस विभागको M.Sc. (Biodiversity and Environmental Management) BEM चौथो सेमेष्टरमा अध्ययनरत रोल नं ०९की छात्रा आरती गुरुङले "Conservation ecology of threatened high- altitude Medicinal Plants of Nepal" शिर्षकमा म यस विभागका प्रा.ड। सुरेश कुमार घिमिरेको सुपरिवेक्षणमा सोध अनुसन्धान गर्न लागेको र सो को सिलसिलामा अन्नपुर्ण संरक्षण क्षेत्रको फिल्ड अध्ययन गरी हर्वेरियमहरुको नमुना संकलन गरी विभागमा विज्ञलाइ देखाई नमुना पहिचान गर्नुपर्ने देखिएकोले सो को व्यवस्थाको लागी आवश्यक सहयोग गरिदिनु हुन सिफारिससाथ अनुरोध गरिन्छ ।

प्रा.डा सुरेश कुमार घिमिरे
निमित्त विभागिय प्रमुख

NATIONAL TRUST FOR NATURE CONSERVATION
ANNAPURNA CONSERVATION AREA PROJECT
Headquarters, Pokhara

Ref: ३० /079/080

Date: 2079-04-22

Ms. Arati Gurung
Master Student
Central Department of Botany
TU, Kirtipur, Kathmandu

Re: Permission to conduct research in Annapurna Conservation Area

We received your request letter regarding permission to conduct research on **"Conservation ecology of threatened high-altitude medicinal plants of Nepal"**. You have been given permission to carry out your field research in ACA with the following terms and conditions.

1. The research must be for scientific and academic purpose with the aim of making contribution in conservation and development of conservation area.
2. This permission will be **valid up to December 15, 2022** (2079 Mangshir 29)
3. You have to follow the ACAP Minimum Impact Code and the Conservation Area Management Regulation 2053.
4. You have to follow the terms and conditions mentioned in the research permit provided by Department of National Park and wildlife Conservation.
5. You are **allowed to collect sample only** from the study area.
6. You will have access to the NTNC-ACAP Resource Library in Pokhara.
7. Upon the completion of the research, **you must submit a hard copy and digital copy of your report** to the NTNC-ACAP Headquarters, Pokhara.
8. You have to **coordinate with ACAP Unit Conservation Office** and also to **Conservation Area Management Committee (CAMC)** while performing your field research work.
9. You and your research **team have to strictly follow all rules, guidelines and social norms to keep in safety from COVID-19 while doing your fields work.**
10. Any dispute arose during the execution periods will be solved by mutual understanding.
11. Any unsolved disputes will be handled as per the existing law of Nepal government.

Thank you and wish you all the best.

Raj Kumar Gurung
Project Chief

CC:
NTNC-ACAP Unit Conservation Office, Ghandruk / Bhujung

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5.2 Appendix II: Ethnobotanical Questionnaire

Questionnaire for Ethnobotanical Study

1. Informants Details:

Interview No: …… Name: ……

Sex: ……Age: …… Occupation: ……..

Education: …… Belief System: ……..

Location / Residence

Province No: ……Municipality /Gaaunpalika: ……

Ward no: …… Tole: ……

2. How long have you been living in this area? ……..
3. If you are a herder/ harvester/ user/ healer, how long have you been doing the work?

   ……
4. What is the mechanism of transfer of knowledge to young generation?

   …….
5. What are the major diseases/ disorders most common among the people?

   ……
6. What ingredients are mostly used for the treatment of disease/ disorders?
   - Medicinal plant
   - Minerals
   - Animal parts
   - All of the above
7. What are the most important plants used for medicinal purpose?

S.N.	Name of the plants	Local name	Parts Used	Detail Use	Amount Use

Questionnaire on Traditional Ecological Knowledge of Satuwa/ Kutki

1. Do you know Satuwa/ Kutki? Yes/ No
2. What is its local name? ……..
3. Do you harvest them personally? Yes/ No
4. For what purpose do you harvest Satuwa/Kutki? ……..

5. What are the uses of Satuwa/Kutki?

   Detail use:

Disease	**Dose**	**Precaution**	**Process**

6. How much do you harvest? ……..
7. When do you harvest? ……..
8. What are the other uses beside medicinal purpose?
9. If not, how do you obtain?

From whom?	**How much amount?**	**Price?**

10. If self-harvest:

Name of the locality	**Habitat characteristics**	**No. of individuals**

11. Phenology

What is their life history? (Construct a life cycle graph for each species with different stages and time, the life cycle stage should be in their own terminology)

a. Germination time: ……..
b. Flowering time:……
c. Fruiting time: …….
d. Harvesting time:……..
e. Seed production per plant:……
f. Rate of germination from seed: ……..
g. Rate of germination vegetatively: ……..

<u>Conservation Problem/ Issues</u>

Overharvesting

Grazing

Deforestation

Fire

5.3 Appendix III: Informants Details

S.N.	Name of the respondent	Gender	Age	Rural Municipality	Ward no.	Speicific locality
1	Aita Kumari Gurung	F	47	Khwolasothar	4	Bhujung
2	Sutbir Gurung	M	73	Khwolasothar	4	Bhujung
3	Mai Bahadur Gurung	M	65	Khwolasothar	4	Bhujung
4	San Bir Gurung	M	79	Khwolasothar	4	Bhujung
5	Bodh Bahadur Gurung	M	39	Khwolasothar	4	Bhujung
6	Fadka Bahadur Gurung	M	67	Khwolasothar	4	Bhujung
7	Mabina Gurung	F	83	Khwolasothar	4	Bhujung
8	Dil Bahadur Gurung	M	54	Khwolasothar	4	Bhujung
9	Shree Kumari Gurung	F	46	Khwolasothar	4	Bhujung
10	Ek Bahadur Gurung	M	79	Khwolasothar	6	Bhujung
11	Suras Gurung	M	64	Khwolasothar	4	Bhujung
12	Ananda Kumari Gurung	F	38	Khwolasothar	4	Bhujung
13	Tik Bahadur Gurung	M	54	Khwolasothar	4	Bhujung
14	Sarki Gurung	M	70	Khwolasothar	4	Bhujung
1	Buddhi Prasad Gurung	M	16	Khwolasothar	4	Bhujung
16	Jamani Gurung	F	72	Khwolasothar	4	Bhujung
17	Kal Bahdur Gurung	M	81	Khwolasothar	4	Bhujung
18	Krishna Bahadur Gurung	M	78	Khwolasothar	4	Bhujung
19	Nir Bahadur Gurung	M	63	Khwolasothar	4	Bhujung
20	Nil Gurung	M	28	Khwolasothar	4	Bhujung
21	Jit Bahadur Gurung	M	81	Khwolasothar	4	Bhujung
22	Chandra Kumari Gurung	F	65	Khwolasothar	4	Bhujung
23	Tulsi Maya Gurung	F	45	Khwolasothar	4	Bhujung
1	Khem Bahadur Gurung	M	60	Khwolasothar	4	Bhujung
25	Nista Gurung	F	26	Khwolasothar	4	Bhujung
26	Narkhu Gurung	F	67	Khwolasothar	4	Bhujung
27	Char Bahadur Gurung	M	57	Khwolasothar	4	Bhujung
28	Kamini Gurung	F	84	Khwolasothar	4	Bhujung
29	Su Kumari Gurung	F	40	Khwolasothar	4	Bhujung
30	Miraj Gurung	M	16	Khwolasothar	4	Bhujung
31	Shankarman Gurung	M	50	Annapurna	11	Chhomrong
32	Cheej Kumari Gurung	F	91	Annapurna	11	Chhomrong
33	Balaram Acharya	M	76	Annapurna	11	Chhomrong
34	Rakshya Kumari Gurung	F	63	Annapurna	11	Chhomrong
35	Deepa Gurung	F	42	Annapurna	11	Chhomrong
36	Ban Maya Gurung	F	83	Annapurna	11	Chhomrong
37	Deepak Gurung	M	49	Annapurna	11	Chhomrong
38	Deukaji Gurung	M	50	Annapurna	11	Chhomrong
39	Durga Bhadur Gurung	M	83	Annapurna	11	Chhomrong
40	Banshoppa Gurung	F	83	Annapurna	11	Chhomrong
41	Mim Kumari Gurung	F	70	Annapurna	11	Chhomrong
42	Maan Kumari Gurung	F	69	Annapurna	11	Chhomrong
43	Anish Gurung	M	35	Annapurna	11	Chhomrong
44	Karma Singh Gurung	M	59	Annapurna	12	Chhomrong
45	Bhuvaneshwor Gurung	M	60	Annapurna	13	Chhomrong
46	Purna Kumari Gurung	F	51	Annapurna	11	Chhomrong
47	Reecha Gurung	F	53	Annapurna	11	Chhomrong

PHOTO PLATES

Photo plate I: Study Area

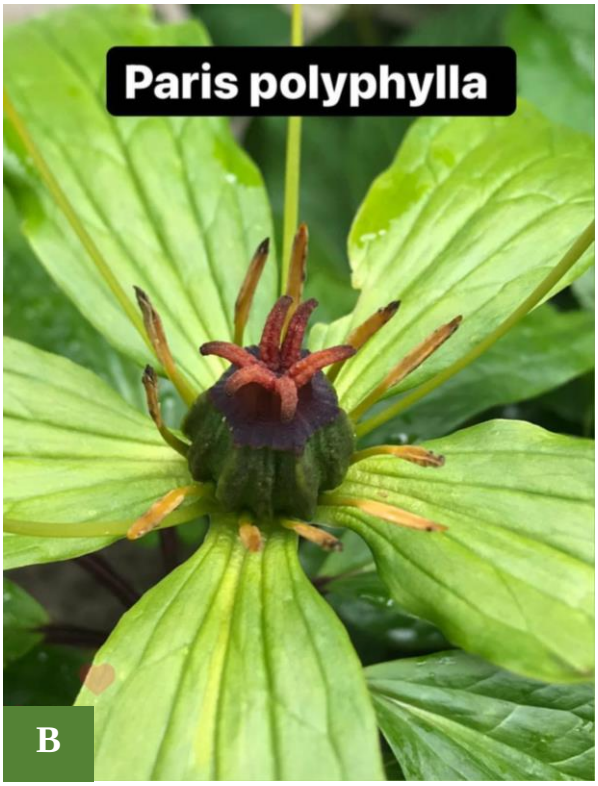
A. Bhujung Village B. Mountains as seen from Chhomrong village C. Habitats of *Paris polyphylla*

Photo plate II: Ethnobotanical survey

A. Interview with elderly people of Chhomrong B. Interveiwing young boy from Chhomrong

C. Interview in Bhujung D. Interviewing herders in Bhujung

Photo plate III: Study species



A. *Paris polyphylla* from Bhujung B. *P. polyphylla* from Chhomrong C. *Neopicrorhiza scrophulariiflora*

Photo plate IV: Plant parts used and storage method

A. Rhizome of P. polyphylla B. Fruits of Satuwa C. Dried roots of Kutki D. Dried and crushed roots of Kutki E. Roots of Kutki stored in a bottle after boiling

Photo plate V: Drying technique and Farm of Satuwa

A. Drying method of Alaichi B. Drying technique of *Arisaema griffithii* (Dhakayo) C. Satuwa farm in Chhomrong D. Satuwa grown in the farm

Photo plate V: Other important medicinal plants used by local people

A. *Berginia ciliata* B. *Amomum subulatum* D. *Cordyceps sinensis* E. *Swertia chiraita* F. *Dactylorhiza hategirea*