FLORISTIC COMPOSITION AND DIETARY RELATIONSHIP BETWEEN LIVESTOCK AND HIMALAYAN TAHR IN SAGARMATHA NATIONAL PARK, NEPAL.

A Dissertation Submitted to Central Department of Environmental Science
Tribhuwan University, Kirtipur, Kathmandu, Nepal.
In Partial Fulfillment of Requirements for the Degree of Masters of Science in Environmental Science.

Submitted by
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2007

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Letter of Recommendation

This is to certify that Mr. **Ranjit Pandey** has prepared this dissertation entitled **"Floristic Composition and Dietary Relationship between Livestock and Himalayan Tahr in Sagarmatha National Park, Nepal"** as partial fulfillment of the requirements for the degree of masters of Sciences in Environmental Science **(Mountain Environment)** under my supervision and guidance.

This dissertation bears the candidate's own work has not been submitted for other purposes.

I therefore recommend this dissertation for approval and acceptance.

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Declaration

I, **Ranjit Pandey**, hereby declare that the piece of work entitled **"Floristic Composition and Dietary Relationship between Livestock and Himalayan Tahr in Sagarmatha National Park, Nepal"** presented herein is genuine work, done originally by me and has not been published or submitted elsewhere for the requirements of a degree program. Any literature data works done by others and cited within this dissertation has been given due acknowledgement and listed in the references.

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ABSTRACT

Floristic composition and the dietary relationship between Himalayan Tahr and livestock were studied in Sagarmatha National Park. The study was carried out in July/August 2006. Main objectives of the study were to study the forage availability and dietary overlap between Himalayan Tahr and livestock. Stratified random sampling was adopted to calculate the floristic composition of the study area. Total numbers of 45 and 55 species were found in Mongla and Phortche respectively. The species compositions of both rangelands were almost similar and the Sørenson's index of similarity (ISs) was calculated 0.83. *Rhododendron lepidotum, Cotoneaster microphyllus*, *Carex anomoea* and *Avena sp*. were the dominant flora of Sagarmatha National Park. Simpson's diversity index was found 0.941 of Mongla and 0.937 of Phortse rangelands. Micro histological technique was applied to determine the food habit of Himalayan Tahr and liuvestock. By analysis of fecal materials, 24 species of plants were identified in the fecal of Tahr and 31 species, in the fecal of livestock. Tahr's diet contains 25% of grasses, 28% sedges and 47% of herbs and shrubs. The livestock diet composed of 18.5% of grasses, 20% sedges and 61.5% of herbs and shrubs. Both Tahr and the livestock used 22 species of common plants. The Morisita index of niche overlap between livestock and Tahr was found 0.83, and the niche breadth of Tahr and livestock was 0.0137 and 0.0175, respectively. The Relative Importance Value of species (RIV) that was eaten by Tahr and Livestock was determined. The highest RIV was found in *Avena sp.* (117.12) followed by the *Carex anomoea* (70.15), *Poa sp.* (23.43), *Gueldeastaedtia himalaica* (20.78), *Potentialla sp.* (18.75) for Tahr's diet and for livestock *Avena sp.* (74.08) followed by *Carex anomoea* (35.04), *Trisetum spicatum* (23.43) have higher RIV.

ACKNOWLEDGEMENT

I would like to express my sincere and hearty gratitude to my supervisor Dr. Shant Raj Jnawali, biologist National Trust for Nature Conservation (NTNC), for his guidance, continuous encouragement, invaluable advices during the research period and the production of this dissertation.

I am grateful to Prof. Dr. Umakant Ray Yadav, Head Centaral Department of Environmental Science, Tribhuwan University for his supports. I am also thankful to all the faculty members and the teachers of Central Department of Environmental Science for their suggestion and help.

I would like to express my heartfelt thanks to Mr. Bikram Shreshta, Forum of Natural Resource Managers (FONAREM) for accommodating me as a research assistance on his project entitle "Himalayan Tahr, Livestock and Predator Interaction in Sagarmatha National Park" funded by National Academy of Science and Technology (NAST). I am very much thankful to Mr. Mani Raj Shrestha for helping in identifying herbarium and valuable suggestions and guidance in every steps of my work. I am thankful to Mr. Bir Bahadur Oli and Miss Anju Thapa for their efforts during slide preparation. I also like to thank all of my friends for their suggestion and encouragement without them this study would not have completed.

Finally yet importantly, I would like to express my sincere gratitude and respect to my parents and family members for their great patience, encouragement in each and every steps of my academic life.

Date: 13th December 2007.

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1. INTRODUCTION

1.1 Himalayan Tahr

i) Physical Characteristics

Tahrs are related to wild goats. They can be distinguished from other goats by the absence of the beard in the bucks, and the comparative shortness of the horns which are placed at the base, and do not greatly exceed the length of the head (Lydekker1990). It is commonly called Jharal in Nepali. The Tahr has long robust limbs, narrow erect ears and backwardly curved horns. The horns are short, laterally flattened and backwardly curved up to 45cm long with a basal circumference of 25cm of male and seldom exceeding 25cm in length in females (Prater 1971). Each horn has growth rings, which can be used as an indicator for age determination of an individual animal (Caughley 1965). The body is covered with tangled mass of coppery brown flowing hairs. The colour depends on age (Prater 1971). At the age of 4-5 years male have a rich brown to black coat with shaggy ruff and a short mantle of hair along the back. The mature males of more than 5 years are handsome with black face and luminous, often light colored and ruff. Adult males measure 90 to 100 cm at the shoulder whereas the female is 84 to 89 cm, and weight ranges from 90 to 160 kg in males and 50 kg in females (Harris 1976).

ii) Habit and habitat:

The Himalayan Tahr prefers sub-alpine to alpine habitat, with topographical features characterized by vertical cliffs, broken mountain terrain and rock caves near the tree line. As with true goats they are good climbers and easily transverse ledges and rock faces (Sharma 1994). The Tahr inhabits a forested hills and alpine meadows, at an elevation from 2,500m to 5,000m. In the winter, the Tahr descends to lower elevations, where more cover is available, and in summer, it ascends to alpine meadows at high elevation. Tahrs spent much of time above timberline during summer and autumn and group often remained on open cliffs throughout the day and male Tahrs are solitary in nature (Schaller 1973).

Tahr is ruminants. It eats herbs, grasses and the leaves of shrubs and trees. Grasses, particularly snow tussocks, contributed 48 to 65% of the diet according to season and area (Parkes and Thompson 1995).

iii) Status and distribution:

The Himalayan Tahr, one of the three species of Tahr i.e. Nilgiri Tahr (*Hemitragus hylocrius)* found in Southern India, Arabian Tahr (*Hemitragus jayakari*) found in Oman and Himalayan Tahr (*Hemitragus jemlahicus*), is native to the Southern range of the Himalayan Mountain, is only the surviving species that is not endangered (Green 1979). In the high inaccessible region of the mountain of India, Nepal and Bhutan, there is numerous population of Himalayan Tahr, but no estimate of the total population is available (Grzimek's encyclopedia 1990).

The National Red data Book of Nepal (BPP 1995), has treated Tahr as a susceptible species to conservation while, IUCN has listed it in its insufficiently known (K) category.

It is reported from high altitude protected areas of Nepal: Annapurna and Manasalu Conservation Areas, Dhorpatan hunting reserve, Sagarmatha, Shey-phoksundo, Langtang, Khapad and Rara national parks. Tahr is also reported from highlands of Taplejung, Ilam, and Sankhuwasabha districts (BPP 1995).

It's current distribution is bounded by the Pir Panjal range in the western Himalayas and Central Bhutan in Eastern Himalayas (Bunard 1925). A large introduced population occurs on New Zealand's South island and small isolated population are present in Ontario in Canada, Woburn Park in England, California in U.S.A. and table mountain near Cape Town in South Africa (Wegge and Oli in press cited in Shrestha 2004).

Fig 1: Range map of Himalayan Tahr (Compiled from Shackleton, 1997).

1.2 Livestock:

Livestock of SNP includes Yak (*Bos grunnies*) and a crossbreed of Yak and hill cow called Chauri. Male Chauris are called Zopkio. Livestock are mainly kept for milk and also used in transportation of goods.

1.3 General Background on livestock and Tahr interaction:

The Himalaya covers approximately 23% of country's landmass along with its Northern border with Tibet (LRMP 1986).This region makes suitable habitat for different kinds of flora and fauna, many of them are endemic. The endemism is provided by the spatial heterogeneity. Himalayan and Tibetan plateau rangelands provide habitat for a unique assemblage of large mammals that have adapted to the harsh climatic and environmental conditions over evolutionary time scale (Schaller 1998 as cited in Jackson 2000). Examples of these mammals includes Snow leopard (*Uncia uncia*), Blue sheep (*Pseudois nayaur)*, Himalayan Tahr (*Hemitragus jemlahicus*) etc.

The number of visitors in SNP has increased from about 1,400 in 1972 (Jefferies 1982) to 16,050 in 2003 (DNPWC/TRPAP 2003). Likewise the demand for meat and cheese by tourist encourages local people to increase their Yak herds. This is certainly leading to overgrazing of wide areas; especially in the vicinity of the village (Yonzon and Hunter 1991). Increasing human and livestock populations are exerting severe pressure on the limited pastoral resource. When the population, number of visitors and the number of livestock is increasing, impact on wildlife in this area have great concern. In order to conserve biodiversity, interaction between human and wildlife needs to be investigated.

Himalayan Tahr and musk deer are the most common species of wild ungulates, in SNP (Lovari 1992). Shrestha (2004 and 2006) reported that 205 Tahrs were observed at various altitudes ranging from 3,685m to 4,380m with a mean elevation of 4,059.18m. He also reported that, about 98 sq. km areas were under common grazing area between Tahr and livestock in SNP. Restricted by natural conditions, the high-frigid rangelands produce a high quality of grass but low yields (Ning 1997). Wildlife-livestock competition for natural resource has widely been regarded as a major management issues, particularly in mountain-protected areas such as Shey-Phoksundo National Park, Rara National Park, Khaptad National Park, Makalu Barun

National Park, Dhorpatan Hunting Reserve, Kanchanjunga Conservation Area and Annapurna Conservation Area (Shrestha *et. al.* 1990, KMTNC 1997, Basnet 2002). In mountain pastures, livestock is widely regarded as competing with wild herbivores by depleting resources and degrading the pastures (Schaller 1997, Shah 1988 and Richari *et. al.* 1992). Buffa *et. al.* (1998) noted the spatial overlap of wildlife (Tahr) with domestic stocks that likely to lead to competition e.g. for food in SNP. This indicates diet overlaps and possibilities of competition between livestock and Tahr in this area. The spontaneous return of the snow leopard into the Mount Everest National Park is also likely to increase conflicts between local people, snow leopard, and domestic and wild prey species. Considering that snow leopard and common leopard are the main predator of Tahrs, conservation of Tahr leads to conservation of pasture land and large predators that in turns plays a critical role in maintaining ecological integrity. In the course of wildlife preservation and livelihood improvement of local people, it becomes highly necessary for management to understand about the interaction between human and wildlife. Therefore, it is utmost necessary to develop a proper conservation strategy for the Tahrs in SNP.

A reliable method for measuring the species composition and proportion of food in the diet of herbivore is especially important, where the management of animal or vegetation is contemplated. Examining the microscopic fragments in feces is one of the reliable methods (Fitzgerald and Waddington 1982). The current emphasis on optimal use of natural resources, in conjunction with domestic livestock grazing and the recent decline in some wildlife species alike (Gurung 1991). There are great varieties of ungulates with diverse feeding strategies that may have different impact on rangeland vegetation. In ruminant three major morphological parameters determines the optimal feeding behavior and degree of selectivity, body size, volume of digestive system and mouth size (Hanley 1982). This behavior and selectivity together with forage availability determines the degree of food overlap and the niche bredth between them.

1.4 Literature review:

Food habit studies using the microhistological technique of identifying diet constituent have appeared in the literature since Bauongartner and Martin (1939), first described technique to study squirrel diet and later revised by Dusi (1949), Storr (1961), Zyoner and Unnon (1969), Willam (1969) and Rogerson *et.al.* (1969) (as cited in Gyawali 1986). Sparks and Malechek (1968) verified the techniques by hand compounding mixture of grasses and forbs. Then after food habit of different animals was determined by this method.

In context of Nepal, Gyawali (1986) is pioneer in microhistological analysis. He analyzed the diet of Greater one-horned rhinoceros (*Rhinoceros unicornis*). Gurung (1991) did the microhistological analysis to study the diet of musk deer and found that trees like Birch (*Betula utilis*) were preferred during autumn and winter, but completely avoided during summer. The musk deer consumed shrubs and forbs in maximum quantity. Grasses and Lichen were also found consumed.

Gurung (1995), studied on population, habitat selection and conservation of Himalayan Tahr. He found that, majority of Tahrs were found in the same area used by livestock. He also found that plants belonging to *Festuca, Cupresia* and *Salix* species have highest prominence value and also reported that, the highest number of plant species were found at 4,200m elevation.

Koirala and Shrestha (1995) studied on niche overlap among Naur (*Pseudois nayaur*), Tibetan argali (*Ovis ammon hodgsonii*), and domestic goat and found the overlap was existed among these ungulates.

Parkes and Thompson (1995), analyzed the rumen content of 253 hunted Tahrs in Alps and reported that, Tahrs preferred herbs, grasses and the leaves of shrubs and trees. Grasses, particularly snow tussocks, contributed 48 to 65% of the diet according to seasons and area. They also reported that Tahr's diet included 55.7% of grass, 26.6% of woody plants, 16.3% of herbs, and 1.1% ferns.

1.5 Significance of the study

Wildlife-livestock competition is widely regarded as one of the important management issues of Sagarmatha National Park. Shrestha (2004) studied the presence of spatial overlapping between Tahr and livestock and reported high mobility of Himalayan Tahrs toward cropland and crop depredation caused large animosity between Khumbu farmers toward Tahr. This might have caused due to inadequate food due to competition between Tahr and livestock grazing. Whether or not the grass covers is enough for the both Tahr and livestock should be understood well. Knowledge of food ecology, focusing on dietary relationship between Himalayan Tahr and domestic animals, is one of the major prerequisites to address the issue of livestock/wildlife conflicts as well as to assess the possibility of multiple-use range resource management in SNP.

Therefore, Himalayan Tahr is representative focal species in Sagarmatha National Park. It's conservation will lead to the conservation of pastureland and large predators that play critical roles in maintaining wildlife population. Conserving of Tahr is intricately linked to conservation of snow leopards. The conservation of Tahr may help in mitigating animosity felt by livestock herders toward snow leopard because less domestic yaks may get attack by snow leopard as long as the Tahrs are preserved in the area.

Awasthi *et al.* (2003) reported that among 12 alpine ungulates species, only four have been studied in detail. Information on the diet composition and food plants of most of the Himalayan ungulates such as Tahr is virtually lacking, analysis of the compiled data on food plants showed that total of 140 wild plant species were palatable. The present study attempts to discuss on the use of microhistological technique to determine the botanical composition of Tahr and livestock feces, niche overlap between two ungulates and the forage availability of their habitat. This study tried to spotlight on floristic composition of SNP and the dietary relationship between Tahr and livestock.

1.6 Objectives:

The overall aim of the study was to investigate the floristic composition and the dietary relationship between the Tahr and livestock in SNP.

The specific objectives were:

- To determine the floristic composition in Tahr's habitat.
- To asses diet composition of Tahr and domestic livestock, and to determine niche breadth and diet overlap between two ungulates.
- To determine forage availability for Tahr and livestock in the study area.

2. STUDY AREA

Sagarmatha National Park (SNP), 27º45’ and 28º07’ North and 86º28’ and 87º07’ East lies in the Solukhumbu district (fig. 2), covering an area of 1,148 sq. km. SNP was declared as National Park on July 1976 and was inscribed on the World Heritage Site list in 1979. The present study was carried out in Mongla and Phortche rangeland (fig. 3).

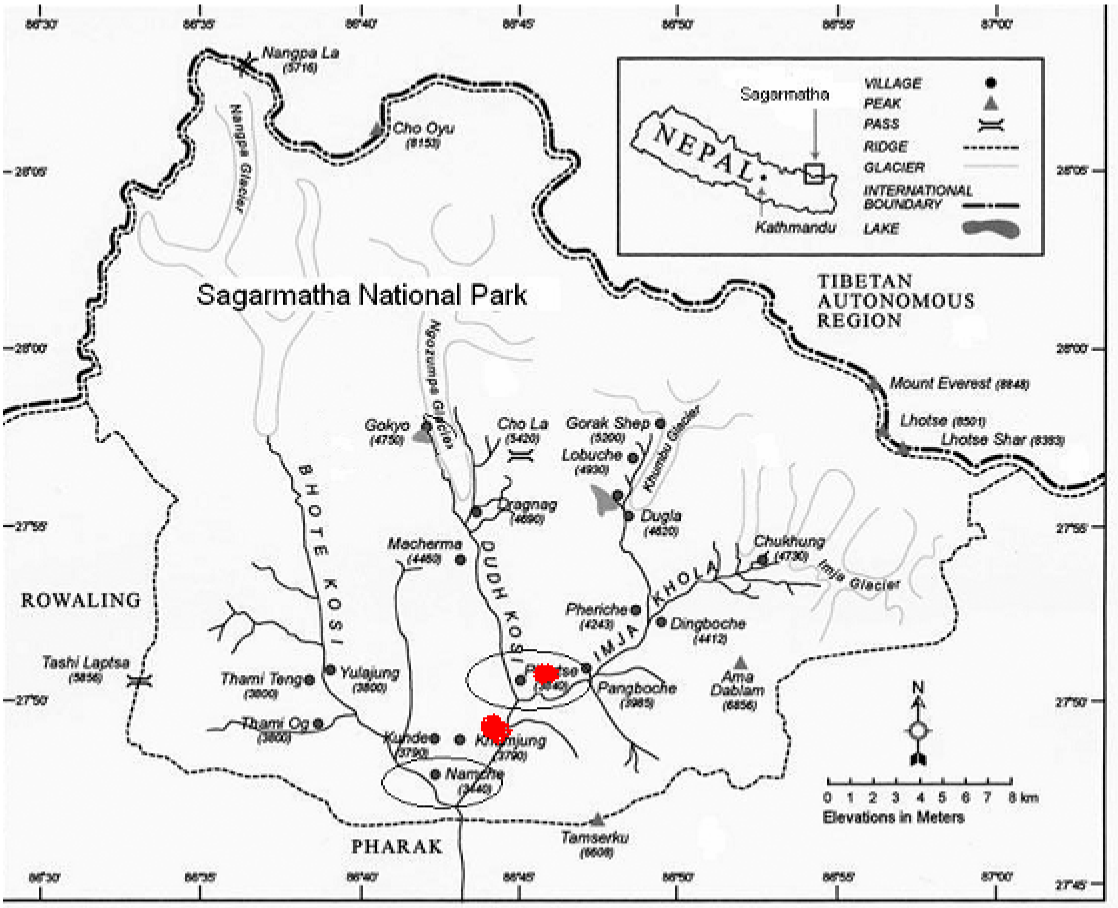

Figure: 2 Showing Sagarmatha National Park.

2.1 Background

Essentially the part comprises the area known as the Khumbu and includes a number of the well-known high peak of the Himalayas, the most significant being Sagarmatha (Mount Everest), the world’s highest mountain. UNESCO listed the park as a World Heritage Site in 1979 for its unique natural, cultural and landscape characteristics. SNP is the IUCN category II protected area.

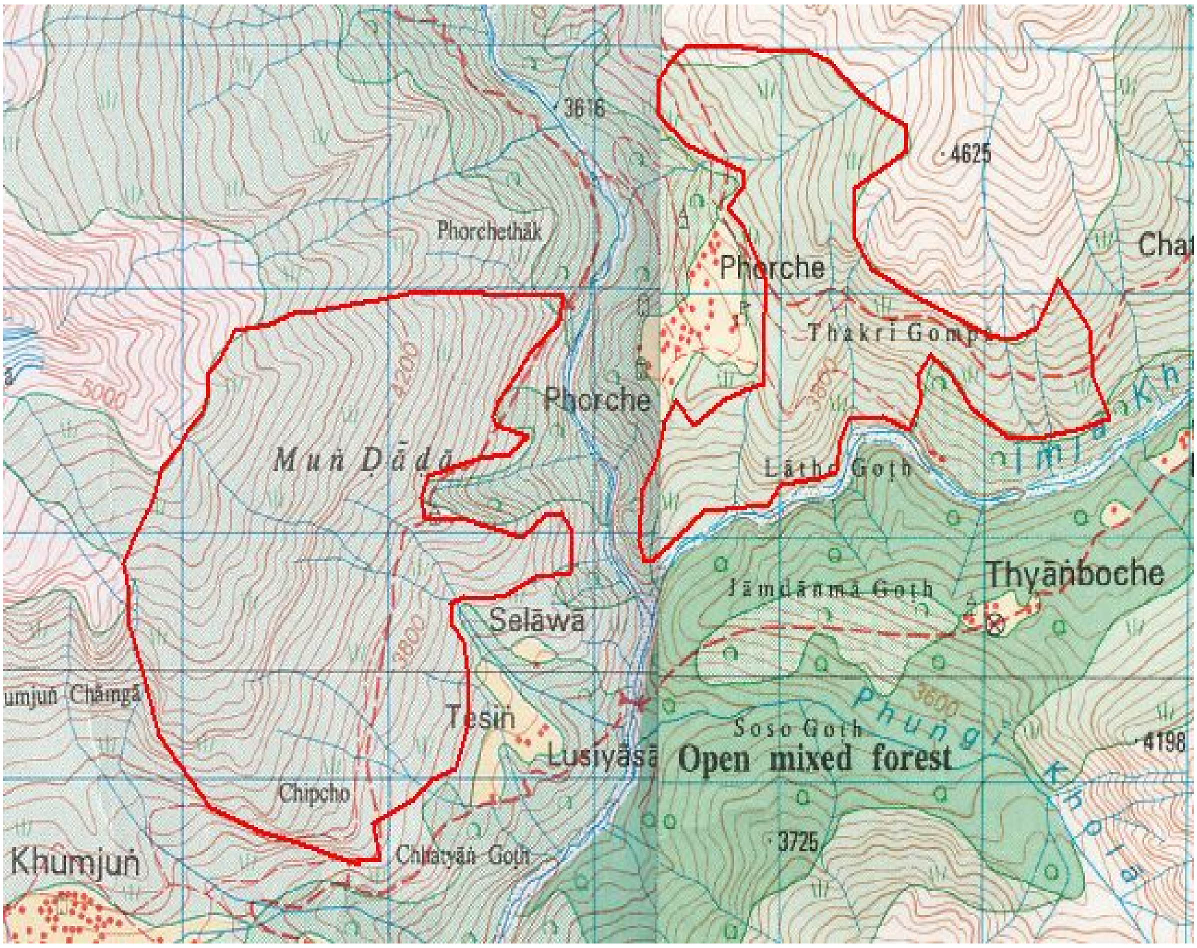

Fig: 3 Showing study areas: Mongla and Phortche.

2.2 Climate

The weather is pleasant during the autumn, months of October and November. But in the winter season the weather is cold and Snowfall is very common. Daytime temperatures do not exceed 5^0 Celsius. During spring season, the days are warmer.

2.3 Biological significance

A) Habitat diversity

Sagarmatha National Park and Buffer Zone harbour rich habitat diversity with diverse floral and faunal species.

a) Aquatic habitat

The snow fed Dudh Koshi and Imja Khola originating from the Himalayas and Tibet are the main aquatic habitats in the Sagarmatha National Park and its buffer Zone. Likewise, there are many glacial lakes that harbour wetland for migratory birds. High diversity of aquatic life is not observed in the region due to extreme cold temperature.

The Sagarmatha region is drained North to South by three major rivers: Imja Khola, Dudh Koshi and Bhote Koshi. Imja Khola originates from Khumbu Glacier while Nguzumpa Glacier feeds the Dudh Koshi. From the confluence at Phungi Thanga, the river is known as Dudh Koshi. Bhote Koshi originates in Tibet and meets Dudh Koshi at Larja Dobhan below Namche Bazaar. Several tributaries feed these river systems. There are altogether 28 rivers and streams in the park and Buffer zone.

b) Terrestrial Habitat

Terrestrial habitat encompasses a variety of ecological units and ecosystems such as forest, alpine meadow, shrub land and farmland. Forest trees include blue pine, *Rhododendron*, and *Juniper*, and alpine scrubs found in the region form dwarf *Rhododendron* in the lower zone to Himalayan sea buckthorn in the upper zone. Variation in terrestrial habitat further encompasses wide range of vegetation and forest types.

The following five main vegetation types are reported from Sagarmatha National Park.

i) Blue pine *(Pinus wallichiana*) forest is predominant mostly between 2,800m and 3,300m in the valleys of the Bhote Koshi, Imja Khola and Dudh koshi.

ii) Fir and fir-juniper *(Abies spectabilis, Juniperus recurva*) forest are mostly found between 3,200m and 3,900m on the slopes of Imja Khola, Dudh Koshi and Bhote Koshi above pine forests. *Rhododendron arboreum* and other shrub species invade open areas of such forests.

iii) Birch-rhododendron forest (*Betula utilis, Rhododendron campanulatum, R. campylocarpum*) is found mostly between 3,600m and 4,200m up slope of the fir-juniper forests and tends to extend further upward of Northern slopes. *Rhododendron campanulatum* usually continues a little higher than the other two species.

iv) Juniper-rhododendron scrub (*Juniperus wallichiana, Rhododendron anthopogon, R. lepidotum)* is seen in the valleys between 4,000m and 4, 700m where climate is drier. It is the dominant vegetation near higher settlements. Juniper and *Rhododendron* species are extensively used as fuel wood species. *Myricaria rosea, Hippophae tibetana* and *salix sp.* are found along the riversides. Rhododendrons and others shrubs reach up to the higher altitudes. The highest limit for rhododendron (*R. nivale*) is about 5,200m. In this region, alpine herbs form an important part of the vegetation.

v) Small scrub communities continue upward to about 6000m beyond which they are rare.

The vegetation types found in the buffer zone are as follows:

i) Broad- leaved mixed forest with pine is found lower altitudes. Himalayan oak (*Quercus semecarpifolia*) forest is found in the buffer Zone. These forests function as an extended habitat for wildlife from the Park and are the main source of fuel wood and fodder for Buffer Zone Communities.

ii) Blue Pine (*Pinus wallichiana*) forest is found mostly between 2,800m and 3,300m in the valleys of the Bhote Koshi, Imja Khola and Dudh Koshi.

B) Faunal Diversity

Twenty-eight species of mammals are reported in SNP. Large mammals commonly seen in the park are the Himalayan Tahr (*Hemitragus jemlahicus*), musk deer (*Moschus chrysogaster*), Himalayan black bear (*Selenarctos thibetanus*), red panda (*Ailurus fulgens*), and Himalayan goral (*Nemarhaedus goral*). Others include common langur (*Semnopithecus entellus*), jackal (*Canis aures*), weasels (*Mustela sp.*), marten (*Martes sp.*) and Himalayan mouse hare or pika (*Ochotana sp.*). Seven species of reptiles, six species of amphibians and 30 species of butterflies have been recorded in the park. The park provides habitat for at least 193 species of birds including impeyan pheasant (*Lophophorus impejonus*), blood pheasant (*Ithaginis cruentus*), Himalayan griffon (*Gyps himalayensis*), chir pheasant (*Catreus wallichi*), yellow billed cough (*Pyrrhocorax graculus*) and red billed cough (*P. pyrrhocorax*).

2.4 Mountains and Glaciers

Glaciers of various sizes can be found at the the Khumbu Valley. The biggest ones are the Khumbu, Lhotse, Imja, Ngozumba, and Nangpa glaciers. Most Himalayan glaciers are 2-3 miles long and are in retreat.

2.5 Culture and Socio-Economic Aspects

The Buffer Zone Communities is engaged in several economic activities such as agriculture, hotel lodge business, trekking, and job/service (teaching, foreign employment, etc.). Recent immigrants to the area are primarily engaged in teashops, trekking and job/ service. Around 22% of the total household are solely dependent on agriculture activities, 8% on hotel operation and 12% on trekking business, 6% and 12% household are involved in job/service and other respectively (SNP/SCAFP household survey 2002). About 3,500 Sherpa people reside in various settlements within the park. Sherpa people owe believe to have originated in the Eastern Tibetan Province of Kham. They left their original home in the late 1400s or early 1500s crossing over the Nangpa-La into Nepal. The Sherpa people follow the Nying-mapa sect of Tibetan Buddhism. The famous Tenboche and other monastries are the common gathering place to celebrate religious festivals such as Dumje and Mani Rimdu.

3. MATERIALS AND METHODS

Following methods were adopted to fulfil the objectives of the study.

3.1 Floristic composition:

Detail vegetation analysis was carried out to describe the floristic composition of the study area. Isolated undulating or small rock is considering as smooth surface. A modular approach was established where a minimum of 2 modules (cross sections cross the valley that are centered in the valley floor and cover the altitudinal range on either side). Modules were evenly spaced throughout the expected range of the Tahr in the region of interest. At each of these modules 6 transects (minimum 100m) in length) are established. Each transect follows the altitudinal contour. Transects placed at a range of altitudes (nominally 100 and 150m altitudinal separation between plots). The modules were evenly spread across study area of interest and they were separated by 3 km. The 100m transects were used to assess the plant cover and livestock use at each plot. A total of 120 quadrates were laid, 60 in each rangeland (Mongla and Phortche). Quadrates in the glacial valley which was covered by the bushes and shrubs were excluded since Tahr spent most of the time on feeding in open land (Schaller 1973).The percent cover of individual species, percentage of bare soil and rock in each quadrates was estimated visually following the procedure described by Smart *et.al.*(1976). Quadrate size was 1m x 1m at 20 m distance interval. A sub-plot of 25 cm x 25 cm was randomly selected at each quadrate and all above ground vegetation were removed and weighed from this area. The fresh weigh of the grass then transformed to estimate biomass per unit area of the pastures. Species area curves (Daubenmire 1968 cited in Jnawali 1995) were plotted to calculate the minimum number of quadrates required to represent the floristic composition of the study area, the minimum number of quadrate required was found to be 18.

Statistical analysis

i) Simpson's Index of Diversity

Simpson's Index of Diversity (Simpson 1949, as describes by Krebs 1994) was applied for measuring floral diversity:

$1\text{-}D = 1 - \sum (P_i^2)$

Where, D = Simpson's index of diversity

P_i = Proportion of individual of species i in the community.

Simpson's diversity index ranges from 0 (low diversity) to a maximum of (1- 1/S), Where "S" is the number of species.

ii) Sørenson's index of similarity (ISs)

Sørenson's index of similarity (ISs) (Sørenson 1948) was employed to compare similarity of plant species between two rangelands.

$$ISs = \frac{2C}{A+B} \times 100$$

Where,

C = number of common species to both area.

A = Total number of species in habitat A.

B = Total number of species in habitat B.

Vegetation analysis:

Formulas used in Vegetation analysis:-

$$\text{Frequency of A species} = \frac{\text{Number of quadrates in which species 'A' occur}}{\text{Total number of quadrates}}$$

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency of 'A' species X 100}}{\text{Sum of all frequencies}}$$

$$\text{Density of 'A' species} = \frac{\text{Number of individuals of 'A' species in all quadrates}}{\text{Total number of quadrates x size of quadrate}}$$

$$\text{Relative Density of 'A' species (RD)} = \frac{\text{Number of individuals of 'A' species X 100}}{\text{Total number of individuals of all species}}$$

$$\text{Abundance of 'A' species} = \frac{\text{Total number of individuals of sp. A}}{\text{Total no. of quadrates in which the sp. has occurred}}$$

$$\text{Relative abundance of 'A' species (RA)} = \frac{\text{Total number of individuals of sp. A X 100}}{\text{Total no. of quadrates in which the sp has occurred}}$$

Importance Value Index (IVI) = RF + RD + RA

Frequency classes

Based on percent frequency values, various species are then distributed into 5 frequency classes (Raunkaier, 1934 as described in Sharma 1998) as follows:

Frequency %	Frequency class
0 – 20	A
21 – 40	B
41 – 60	C
61 – 80	D
81 – 100	E

3.2 Dietary overlap of Tahr and livestock

Methods for studying diet of Tahr and livestock were direct observation, feeding trails, clipping and browsing studies and microhistological techniques. The methods that were employed to study diet of livestock were exactly same as the Tahr, which were as follows:

A. Direct observation

Direct observation was done in Tahr areas with the help of binoculars during active feeding period between 7 am to 12 noon and 3 pm to 5 pm. A fresh signs of plants being eaten such as exudation of sap, crushed tissue, fresh clipping and so on were observed. Then it was examined and identified on the spot. A herbarium sheet of each plant species was prepared and was taken to the Central Department of Environmental Science, T.U. and The National Herbarium, Godabari, Centre in Kathmandu for further authentication.

To estimate the spatial overlap, old sign of dropping was studied in each quadrate to record their presence or absence.

B. Microhistological analysis

The basic principle of this method lies in the microscopic recognition of indigestible plant fragments mainly the epidermal features, which are characteristic of different plant groups (Metcalfe 1960). It is widely used method for ascertaining food preference and studying diets in ungulates due to its simplicity in operation, effectiveness and manageable qualities (Anthony and Smith 1974, Baumgartner and Martin 1939, Holechek *et. al.* 1982), and is the most accurate of all the methods for estimating diets of herbivores (Dearden *et. al.* 1975). The method has a limitation; no definite quantification of the forage consumed could be made. However, it is helpful in ascertaining the food habit of endangered species.

The fecal analysis required of fecal samples, reference materials, and preparation of reference slides, fecal slides and slide interpretation.

a. Collection of fecal sample

Fecal samples were collected by following their fresh tracks and feeding sites from different habitats of Tahr. The samples were collected in paper bags and each day's collection of each sample was labelled and air-dried separately for a minimum of 72 hours. After drying, individual fecal samples collected at one time was mixed thoroughly to make a monthly sample and packed in airtight polythene bag. Later on, the samples were transported to lab of the Nepal Academy of Science and Technology, Kathmandu for further analysis.

b. Collection of reference materials

Different plants species were collected for the preparation of reference slides from the different habitats of Tahr.

c. Slide preparation

Slides were prepared following the method used by Anthony and Smith (1974), modified by Vavra and Holechek (1980), Jnawali (1995), as adopted by Fjellstad and Steinheim (1996) and Chetri (1999).

i. Preparation of reference slides:

The properly dried plant sample was separately grounded to small size using an electric blender. Two sieves (1mm and 0.3mm mesh size) was placed one above the other and the grounded powder was sieved. The powder remained on the 0.3 mm sieve were taken as final sample for slide preparation. Large particles retained on the top sieve and very fine particles passed through the fine mesh were rejected.

A teaspoonful of each final sample was treated with warm 10% NaOH solution in a test-tube and heated in a boiling water-bath for 4-6 minutes. The particles were allowed to settle in a cold water-bath before the supernatant dark fluid will be removed. The procedure was repeated until a relatively clear supernatant solution was obtained. Then, the material was washed 3-5 times with warm distilled water and dehydrated through a series of 25%, 50%, 75%, 90% and 100% alcohol treatments. The alcohol treated samples was finally treated with a series of alcohol and xylene. A small amount of material was dried between tissue paper and mounted in DPX under 24 mm x 50 mm cover slips. The slides were air dried for 5-6 days.

ii. Preparation of fecal slides:

The procedure employed to prepare the fecal samples slide was exactly the same as for reference slides, except that 10% NaOH solution was replaced by a 5% NaOH solution and before treatment with 5% NaOH solution, the fecal sample were lightly washed with warm distilled water to remove dirt attached to them. Five permanent slides were prepared per composite fecal sample and marked.

d. Slide interpretation

The reference slides were studied thoroughly as recommended by Holechek and Gross (1982). A diagnostic key for each plant species was prepared by: free hand sketches; distinct characters were noted and photographed to match with the fecal plant fragments on the basis of distinguishable histological features observed under the microscope. This includes the cell wall structure, shape and size of cells, hairs and trichomes, shape and size of stomata and inter-stomatal cells, fiber structure, and arrangements of veins.

A compound microscope under 100X magnification with an ocular measuring scale was used to read and measure the plant fragments in the fecal slide. On each slide, 10 fragments were determined in at least one transects, using the identification key and photographs of the epidermis of the reference slide. Only fragments recognized as epidermal tissue and consisting of at least four plant cells or with visible stomata were recorded. In total 200 fragments for both livestock and Tahr were determined excluding unidentifiable fragments.

Statistical analysis

Niche breadth (B)

To evaluate the niche breadth of plant species, included in the diet of each animal species Levin's measure of niche breadth (B), was calculated for two ungulates studied, based on following formula described by Krebs (1999).

$$B = \frac{1}{\sum_{i=1}^{n} Pi^2}$$

Where,

P_i = Percentage of total sample belonging to species i (i = 1, 2,……, n)

n = Total number of species in all samples.

For this index, the proportions of the plant species in the dung were recalculated, as the elimination of the unidentified and undetermined fragments produced large disruptions in the pattern. The value for B increases with increasing number of species in the diet. A low value indicates that a species is selective for a few specific forage plant species.

Diet overlap between livestock and Himalayan Tahr

In order to estimate the diet overlap between animal species, simplified Morisita's index (CH) according to Horn (1966) was calculated as follows:

$$C_H = \frac{2\sum P_{ij} P_{ik}}{\sum P_{ij}^2 + \sum P_{ik}^2}$$

Where,

P_{ij} and P_{ik} = Proportion of resource in the total resources used by the two species j and k.

The degree of overlap varies from zero to one; zero when there is no overlap at all and one when there is complete overlap.

Relative frequency percentage

The relative frequency percentage of each species in the fecal sample was estimated using the following formula.

$$RF\% = \frac{n_1 + n_2 \ldots\ldots}{N} \times 100$$

Where,

RF % = Relative frequency percentage,

n= Total number of fragments identified for a given food species or forage category, and

N= Grand total number of fragments counts made in the sample.

Relative Importance Values (RIV)

Relative Importance Values (RIV) of each plant species observe in the fecal sample was calculated as follows using method described by Jnawali (1995).

$RIV_x = D_x (\sqrt{f_x})$

RIV_x = Relative importance value for species x

D_x = Mean percent of species x in fecal sample

f_x = Frequency of species in fecal sample

3.3 Productivity and vegetation analysis

The entire habitat was delineated into different blocks on the basis of distribution of Tahr for a detailed study of vegetation types and forages availability. The distribution pattern of Tahr species was identified by secondary source (Shrestha 2004). Pasture productivity and ground cover was assessed using replicate 1m x 1m plots and transects. A nested plot of 25 cm x 25 cm was randomly laid and all above ground parts of vegetation were removed and weighed. The fresh weight of the grass was then transformed to estimate biomass per unit area of the pastures. The percentage cover of individual species in each Quadrate was estimated visually following the procedure described by Smart *et. al*. (1976). These data were later used to calculate prominence values (PV) for each species (Dinerstein 1979):

Prominence value (PV), were calculated to quantify the abundance of species, in both rangelands as described by Dinerstein (1979) using formula:

$PV_x = M_x (\sqrt{f_x})$

PV_x = Prominence value for species x

M_x = Mean percent cover of x species

f_x = Frequency of occurrence of x species

Then the species abundance was categorized as very rare ($PV < 1$), rare (PV 1 - 5), common (PV 5 - 40) and abundant ($PV>40$).

4. RESULTS

1. Vegetation types and floristic composition

The vegetation composition of two rangelands Mongla and Phortche was almost similar. In Mongla *Rhododendron lepidotum, Cotoneaster microphyllus, Carex anomoea* and *Avena sp*. were the dominant plant species. In the lower elevation of Mongla (ca. 3600-3800m) *Gerbera gossypiana, Cyanthus hookeri, Anaphalis contorta* were associated plants with *Rhododendron-Cotoneaster* bushes while in upper elevation (ca.4000-4200m), *Potentila sp.* and *Herminium josephii* were found as associated species. In Phortche (ca. 3800-4500m), *Rhododendron lepidotum, Cotoneaster microphyllus, Carex anomoea* and *Avena sp.* were again the dominant species. However, increasing with altitude, *Rhododendron lepidotum* and *Cotoneaster microphyllus* association decreased in and replaced by *Rhododendron* bushes. The species like *Potentilla sp*. and *Fragaria daltonina* were appeared abundant in higher elevation.

A number of orchid species like *Hermenium josephii, Satyrium nepalense, Dactylorhiza hatagirea, Habenaria aitchinsonii* were found in regular distribution in higher elevation of the both rangeland. *Dactylorhiza hatagirea* was distributed only in small patches in the study area. The species like *Ephedra gearadiana* was found in certain patch and some species of fern also reported from the study area. They were found in the rocks or area shaded by the rocks in the glacier valley.

In Phortche, 81.64 % ground was covered by vegetation, 14.56 was covered by bare soil and remaining 3.8 % was covered by rock while in Mongla rangeland, 71.48 % of ground was covered by vegetation and remaining 18.29 % area was covered by bare soil and 10.23 % was covered by rock.

Between the two-study areas, the number of species was found greater in Phortche (55 species) than in Mongla (45 species). The species composition of both rangelands was almost similar and the Sørenson's index of similarity (ISs) was calculated 0.83, indicating high species similarity in two study areas.

Simpson's diversity index was found 0.941 in Mongla and 0.937 in Phortche rangeland. In Mongla *Avena sp.* has the highest (27.69) IVI, while other species like *Satyrium nepalense* (10.41), *Rhododendrom lepidotum* (12.03), *Cotoneaster microphyllaus* (13.54), *Persicaria capitatum* (15.81), *Polygonatum hookeri* (14.61), *Carex anomoea* (18.64), *Androsace sarmentosa* (11.10), *Gerbera gossypiana* (12.15), *Cyanthus hookeri* (14.90) and *Anaphalis contorta* (10.12) (Annex 2) have medium IVI value. Similarly, in Phortche IVI value of *Carex anomoea* was 16.89, which were not so sharp for other species like *Avena sp.* (14.07), *Cyanthus hookeri* (12.24), *Gerbera gossypiana* (11.48) and *Androsace sarmentosa* (11.31) (Annex 3).

2. Dietary overlap between Tahr and Livestock

Sampling on presence of droppings (fresh as well as old), showed that occurrence of dropping of both ungulates were found in 45% of quadrates, and in 5% of quadrates, both of the ungulates were absent. Remaining (50%) quadrates had either Tahr or livestock presence in Phortche. Similarly, in the case of Mongla, 33.34% of studied quadrates showed the sign of presence of both livestock and Tahr, 16.67% of quadrates showed no sign of livestock and Tahr. Remaining (49.09%) quadrates showed sign of either Tahr or livestock.

Maximum number of quadrates, which had sign of dropping of livestock and Tahr were found on gentle slope (up to 35 degree), but in steep slopes the sign of Himalayan Tahr was found exclusively. The absence of dropping of both ungulates was recorded from the quadrates near to the foot trails, and in the area with meager ground vegetation cover.

By analysis of fecal samples, 24 species of plants were found in the diet of Tahr and 31 species of plants were identified in the fecal of livestock. Both Tahr and the livestock eating 22 species of common plants. *Morina nepalensis* and *Ephedra gegardiana* were eaten only by the Tahr. The Morisita index of niche overlap between livestock and Tahr was high (0.83 i.e. 83%), and the niche breadth of Tahr and livestock was found to be 0.0137 and 0.0175, respectively.

Out of 24 species of plant eaten by Tahr, more than 50 % was represented by grass and sedge species. The 6 species of sedge and grass i.e. *Cyperaceae sp.* (5.5 %), *Carex anomoea* (13.5%), *Avena sp.* (19 %), *Poa sp.* (6.5 %), *Imperata sp.* (2.5 %) and *Triticum spicatum* (6%) contributed 53% of the diet of Tahr followed by *Gueldesastaedtia himalaica* (6%) and *Potentilla sp.* (5.5 %) where as *Pedicularis syphonanth*a (1.5%), *Persicaria capitatum* (1.5 %), *Androsace sarmentosa* (1.5 %), *Trachyspermum ammi* (1%), *Habeneria aitchinsonii* (1%), and *Ephedra gegardiana* (1%) contributed only a small proportion in the diet (Table 1).

Out of 31 species of plant eaten by livestock, 22 species were common in the diet for both livestock and Tahr while other two species were not recorded in the diet of livestock, but recorded in Tahr's diet. Though livestock used 31 species in their diet, 6 species of grass and sedge i.e., *Avena sp.* (14 %), *Carex anomoea* (8.5%), *Triticum spicatum* (6.5%), *Cyperaceae sp.* (5%), *Poa sp*. (3.5%) and *Imperata sp.* (1 %) contributed 38.5% of total diet of livestock (Table 2).

2.1 Relative Importance Value of Species:

Relative Importance Values of Species (RIV) that was eaten by Tahr and Livestock were determined (Table 1 and 2). The highest RIV was found in *Avena Sp.* (117.12) followed by the *Carex anomoea* (70.15), *Potentialla sp.*, *Gueldeastaedtia himalaica*, *Trisetum spicatum*, *Cyperaceae sp.* and *Poa sp.* Rest of the species had very low RIV in Tahr's diet.

In case of livestock, the RIV of *Avena sp.* was again found highest 74.08 then followed by *Carex anomoea* (35.04) and *Cotoneaster microphyllus* (32). Many of the species with low RIV were *Gentiana sp.* (0.5), *Habenaria aitchsonii* (0.5) and *Androsace sarmentosa* (0.5).

Table 1: Plant species eaten by Tahr with their Relative Percentage and Relative Importance Value

Name of Species	Percentage	Relative Importance Value
Graminoids	**28**	**146.14**
Avena sp.	19	117.12
Imperata sp	2.5	5.59
Poa sp.	6.5	23.43
Sedges	**25**	**109.17**
Carex anomoea	13.5	70.15
Cyperaceae sp.	5.5	18.24
Trisetum spicatum	6	20.78
Herbs and shrubs	**47**	**120.61**
Anaphalis contorta	2.5	5.59
Anaphalis triplinervis	1.5	2.59
Androsace sarmentose	1.5	2.69
Bistorta affinis	3.5	9.26
Cotoneaster microphyllus	4.5	13.5
Cyanthus hookerii	2.5	5.59
Cyperipedium himailaicum	1	2.59
Ephedra gegardiana	1	1.41
Fragaria daltoniana	2.5	5.59
Gueldesastaedtia himalaica	6	20.78
Habenaria aitchsonii	1	1.41
Morina nepalensis	3	7.34
Pedicularis syphonatha	1.5	2.59
Persicaria capitatum	1.5	2.59
Potentilla sp.	5.5	18.24
Rhododendron lepidotum	3.5	9.26
Satyrium nepalense	2	4
Saxifraga brachypoda	2.5	5.59

Table 2: Plant species eaten by Livestock with their Relative Percentage and Relative Importance Value

Name of Species	Percentage	Relative Importance Value
Graminoids	**18.5**	**84.75**
Avena sp.	14	74.08
Imperata sp	1	1.41
Poa sp.	3.5	9.26
Sedges	**20**	**74.28**
Carex anomoea	8.5	35.04
Cyperaceae sp.	5	15.81
Trisetum spicatum	6.5	23.43
Herbs and shrubs	**61.5**	**161.29**
Anaphalis contorta	3	7.34
Anaphalis triplinervis	2.5	5.59
Androsace sarmentose	0.5	0.5
Bistorta affinis	4	11.3
Cotoneaster microphyllus	8	32
Cyanthus hookerii	1.5	2.59
Cyperipedium himailaicum	2	4
Fragaria daltoniana	1	1.41
Gentiana sp.	0.5	0.5
Gerbera gossypiana	1	1.41
Gueldesastaedtia himalaica	3.5	9.26
Habenaria aitchinsonii	0.5	0.5
Nothoriolion macrophyllum	1.5	2.59
Parnasia nubicola	3	7.34
Pedicularis syphonatha	1.5	2.59
Persicaria capitatum	1	1.41
Polygonatum hookerii	3.5	9.26
Polygonum vacciniifolium	2.5	5.59
Potentilla sp.	6.5	23.43
Rhododendron lepidotum	3	7.34
Salvia hains	1	1.41
Satyrium nepalense	2	4
Saxifraga brechypoda	3.5	9.26
Saxifraga parnasifolia	3.4	9.26
Sedum sp.	1	1.41

3. Productivity and forage availability

The productivity of both rangelands were almost similar i.e. 2643 kg/ha (wet weight) and 2276 kg/ha (wet weight) in Mongla and Phortche respectively.

On the basis of prominence value, 4 species (*Avena sp., Carex anomoea, Cotoneaster microphyllus* and *Rhododendron lepidotum)* were found abundant in Mongla, 12 species (*Anaphalis contorta, Androsace sarmentose, Cyanthus hookerii, Fragaria daltoniana, Gerbera gossypiana,Habenaria aitchsonii, Nothoriolion macrophyllum , Persicaria capitatum, Potentilla sp., Satyrium nepalense, Saxifraga brechypoda* and *Saxifraga parnasifolia)* were common, 9 species *(Bistorta affinis, Gueldesastaedtia himalaica, Imperata sp, Cyperaceae sp., Poa sp., Polygonatum hookerii, Salvia hains, Sedum sp.* and *Trachyspermum ammi)* were rare and 4 species *(Anaphalis triplimervis,s Parnasia nubicola, Pedicularis syphonatha* and *Triticum spicatum)* were very rare that were eaten by Tahr and livestock.

Similarly, in Phortche 4 species *(Avena sp. Carex anomoea, Polygonatum hookerii, and Rhododendron lepidotum)* were abundant, 15 species *(Bistorta affinis, Cotoneaster microphyllus, Cyanthus hookerii, Fragaria daltoniana, Gentiana sp., Gerbera gossypiana, Gueldesastaedtia himalaica, Imperata sp., Nothoriolion macrophyllum, Parnasia nubicola, Pedicularis syphonatha, Persicaria capitatum, Polygonum vacciniifolium* and *Potentilla sp.)* were common, 7 species *(Anaphalis contorta, Habenaria aitchsonii, Cyperaceae sp., Poa sp., Saxifraga brechypoda, Saxifraga parnasifolia* and *Trachyspermum ammi)* were rare, and 3 species (*Androsace sarmentose, Salvia hains,* and *Sedum sp.*) were very rare but eaten by Tahr and livestock (Table 3).

Table 3: Prominence Value (PV) of the species eaten by tahr and Livestock in Monglaand Phortche.

S.N	Name of Species	Prominence Value (PV) of the Species	
		Mongla	Phortche
1.	*Anaphalis contorta*	6.89	1.34
2.	*Anaphalis triplimervis*	0.68	-
3.	*Androsace sarmentose*	5.84	-
4.	*Avena sp.*	84.86	58.18
5.	*Bistorta affinis*	3.16	7.09
6.	*Carex anomoea*	44.13	67.69
7.	*Cotoneaster microphyllus*	102.56	21.93
8.	*Cyanthus hookerii*	11.07	17.07
9.	*Fragaria daltoniana*	7.85	8.23
10.	*Gentiana sp.*	-	10.32
11.	*Gerbera gossypiana*	10.07	11.93
12.	*Gueldesastaedtia himalaica*	4.26	6.34
13.	*Habenaria aitchsonii*	5.75	1.25
14.	*Imperata sp.*	1.90	5.96
15.	*Cyperaceae sp.*	1.23	4.98
16.	*Nothoriolion macrophyllum*	9.34	10.32
17.	*Parnasia nubicola*	0.83	18.67
18.	*Pedicularis syphonatha*	0.67	8.23
19.	*Persicaria capitatum*	17.14	16.43
20.	*Poa sp.*	1.31	0.83
21.	*Polygonatum hookerii*	4.31	40.64
22.	*Polygonum vacciniifolium*	-	8.62
23.	*Potentilla sp.*	10.82	11.57
24.	*Rhododendron lepidotum*	55.75	63.6
25.	*Salvia hains*	2.11	0.34
26.	*Satyrium nepalense*	8.76	0.068
27.	*Saxifraga brechypoda*	9.71	1.96
28.	*Saxifraga parnasifolia*	5.65	2.53
29.	*Sedum sp.*	2.10	0.40
30.	*Trachyspermum ammi*	1.65	1.53
31.	*Triticum spicatum*	0.25	-

5. Discussion

5.1 Floristic composition:

Species diversity was found higher in Phortche than in Mongla, this could be due to the fact that species diversity tends to be higher in the transition zone. Simpson's diversity index was calculated to determine the diversity of the study area. Simpson's diversity index was calculated 0.941 in Mongla and 0.937 in Phortche rangeland. Simpson's diversity index gives relatively little weight to the rare species and more weight to the common species (Krebs 1994).

The altitude range of most of the high altitude plants from the Northwest Himalaya lies between 3,600m and 5,500m, though in many cases, it is somewhat less and lies between 3,900m and 4,200m (Mani 1978). Mongla rangeland lies around from 3,400m to 3,800m and the Phortche rangeland lies around 3,600m to 4,200m from asl. Phortche lies in the transition zone and in the transitional zone vegetation diversity tends to be higher. Floristic composition is also affected by the slope and aspect of the rangeland. Gurung (1995) reported highest number of species at 4,250m elevation and concluded that the elevation lies at the ecotone between shrub land and grassland.

Dominancy of *Rhododendron* and *Cotoneaster* was found in both rangelands. Bauer (1990) explained an increase of shrubs in this area. Buffa *et. al.* (1998) reported the *Rhododendron- Cotoneaster* bushes colonizing rapidly in SNP.

In both rangelands, *Rhododendron lepidotum* and *Cotoneaster microphyllus* were dominant plant species. Bushes of *Rhododendron* and *Cotoneaster* form like hedgerows in certain contour interval. Presence of *Rhododendron-Cotoneaster* hedgerow was common in gentle slope than in steep slope.

Some of the species of grass and sedge like *Avena sp.* and *Carex anomoea* was found almost uniform by distribution in both rangelands. The species composition was higher in smooth terrain than in broken and very broken areas. The vegetation of steep area was less disturbed by grazing than in gentle slope.

5.2 Food habit of Tahr and livestock:

Tahr ate a total of 24 species of plants in their diet, where 6 species of grasses and sedges contributed 53% of the total diet. Parkes and Thompson (1995) analysed the rumen content of 253 Tahr shot in Southern Alps and found that grasses particularly snow tussocks constituted 48-65% of the diet. They also reported that herbs are more important than the woody plants. In present study the percentage of woody plants like *Cotoneaster microphyllus* and *Rhododendron lepidotum* was found higher. According to Forsyth and Tustin (2001), male Tahr ate less grasses and sedge but more herbs and woody plants in the time of segregation. My study period (July/ August), was the time of segregation of male and female Tahr. At this time male ate more woody plants and reverse was the case in female. Present study was based on the composite sample of fecal materials of both male and female Tahr therefore the percentage of woody plants might have been overestimated. Moreover the percentage of woody plants was seen higher due to its unrupturalbe/undigestable nature.

Parkes and Thompson (1995) found that Tahr's diet includes 55.7% of grass, 26.6% of woody plants, 16.3% of herbs, and 1.1% ferns. The present study showed similar trend to Parkes and Thompson i.e grass, woody plants, herbs but it was found that fern species were neglected by Tahr in present study. It was also confirmed by both direct observation and microhistological analysis.

Green (1979) analyzed feces of Himalayan Tahr at Langtang valley and reported an average consumption over the year of 34% grasses, 21% sedges, 38% herbs and shrubs, 4% ferns and 4% mosses. But he argued, there were significant seasonal differences in percentage of food. In winter, they supplemented their diet with small amount of mosses and ferns, presumably because other foods were less radialy available. In this study, the percentage of grasses and sedges shoed almost similar trend.

The result showed that livestock used the *Cotoneaster microphyllus* in 8 %, which is considered as unpalatable, and livestock used diverse verities of plant in the study area. Livestock in higher proportion of woody plant like *Cotoneaster microphyllus* and *Rhododendron lepidotum* than the Tahr. However, Tahr's diet contains more soft and herbaceous plants.

The dietary habit of livestock and Tahr was almost similar but the percentage occurrence of plant species in their diet was found different. The grasses and sedges contributed 35% of the diet of livestock and 53% in Tahr. The proportion of woody plants (*Rhododendron* and *Cotoneaster*) were recorded high in livestock than in the Tahr's diet. This might be that livestock graze in the vicinity of the villages where other species are scarce due to harvesting or by overgrazing. 14 species of plants eaten by Yak in the Indian Himalaya was described by Awasti *et. al.* (2003), but many plant species reported in that study were absent in present study area.

5.3 Palatability:

Diet of the herbivore depends on the palatability of the plant in their habitat. The diet depends not only on the abundance of vegetation but also in the palatability of the species. The available literature provide conflicting opinions about the palatability of plants .Species like *Rhododendron, Cotoneaster, Anaphalis contorta, Carex* species and *Bistorta affinis* were considered as unpalatable, (Koirala and Shrestha, 2000; Buffa *et. al.*, 1998; Bauer, 1990). Schaller (1973) reported that *Rhododendron* species was found eaten by Tahr in smaller quantities. Sharma (2000) reported *Anaphalis contorta* and *Cotoneaster microphyllus* used by blue sheep in their diet. Due to similar micro structure of *Cotoneaster* and *Rhododendron* to the *Berberries* species (which was found in the glacial valley of the study area, the present study excluded the quadrates on this area) their proportion might be overestimated. Direct observation and microhistological technique showed that these species were eaten both by Tahr and by livestock. Hence, it showed that palatability not only depends on the plants species but also depends on the availability of other associated plants, its life form, season and the type of herbivore of that ecosystem.

Awasthi *et. al.* (2003), reviewed food habit of Himalayan ungulates, she reported all the ungulate eating *Carex sp*. in their diet.

Wangchuk (1995) studied competition for forage between Blue sheep and Yak, and reported that both ungulates ate *Carex sp*., *Bistorta sp.* and *Potentilla sp.*significantly in high proportion. She also reported *Anaphalis sp.* and *Cotoneaster microphyllus* eaten by both ungulates in visual observation.

All ungulates tended to select plant in the growing stage and early flowering stage presumably because palnt species in these stages are easily digestible than in mature stage (Jarman and Sinclair, 1979; Mc Naughton, 1985; Gohl, 1981; Ghandaki *et al.,* as cited in Koirala and Shrestha, 1997). The present study was more or less similar to the study carried out by different authors (Green 1979, Parkes and Thompson 1995) in different areas but the plants eaten by both the livestock and Tahr were found in higher number than the study done by them. The reason behind this would be the study period was in the early growing season where plants were just bloomed after the snow melt so the tender leaves of many plants might have used by Tahr and livestock.

5.4 Niche breadth and food overlap:

Body size is the most important factor determining the metabolic rate and food requirement. Large bodied mammals have higher food requirement since they have higher cost of maintenance and production compared to smaller mammals (Geist, 1974). The results in two opposing factors restricting ungulates i.e. small bodied ungulates are limited by forage quality and large bodied ungulates are limited by forage quantity (Hanley, 1982). In the present study, livestock are comparatively large sized ungulates and ate more (31 species) plants than Tahr did (24 species).

The number and proportion of plant species in the diet indicated the breadth of an animal's food niche and represent diet diversity. Smaller the animal more will be the selectivity and small niche breadth would be found. This study showed that livestock had niche breadth of 0.0175 and Tahr had only 0.0137. Therefore, Tahr was found more selective in food than the livestock.

The Morisita index for food overlap was calculated 0.83.In present study, the fieldwork was carried out during the monsoon season, when net primary productivity was high, and the forage quality was very good. However, during winter Yak herders have observed that Yak eat any plant matter, including shrubs and tree bark. The same could be applicable to Tahr. Consequently, dietary overlap could be 100% during the winter.

5.5 Potential for food competition:

The food overlap between two ungulates was high (83%). So, there might have been competition between the Tahr and livestock. Bauer (1990) reported that competitive exclusion was operating by differences of utilizing patterns between livestock and Tahr. Buffa *et.al.* (1998) pointed out that spatial overlap between Tahr and livestock likely lead to competition. But the spatial overlap and similar diet may not always lead to competition. Even though, dietary overlap does indicate a possibility of intra-specific competition, it is not by itself evidence of competition (Squires, 1982). There may be different interaction over their food supply as in the case of Serengeti plains of East Africa as described by Krebs (1994).

Forage availability was not so scarce in both rangelands. So high competition would not be expected there. Livestock however, range over any of the Tahr habitat accessible to them (Green 1979). Tahrs, being more agile than livestock, are able to access resources in steep and rocky areas and thereby create spatial separation between two ungulates. The presence of dropping of both ungulates was in the quadrates of gentle slope. However, in the steep slope droppings of Tahr were present. Forage availability not seen restricting the Tahr's population in SNP. Thar's nnumber was observed more in Phortche than in Mongla, where the diversity as well as the forage availability was calculated lower. Gurung (1995) observed more number of Tahr in the same area where livestock grazed. In higher altitudes, Tahrs were seen grazing together with the livestock. Sometimes it was observed in lower altitude too. This might be the defense mechanism of Tahr against predator like snow leopard.

Bauer (1990) described that grassland between 3,400m and 4,000m asl were the most productive grassland. He also reported that grass species had highest coverage. A similar scenario was found in the present study. Both rangelands have higher abundance of grasses and sedge species like *Carex anomoea*, *Avena sp.*and *Poa sp.*

The above ground biomass varies from 1,000 kg/ha to 10,000 kg/ha for warm temperate grassland and 4,000 – 5,000 kg/ha for high altitude grassland (Gupta 1990, Sundriyal 1995 as cited in Rawat 1998). The wet biomass of the Phortche and Mongla rangelands were calculated 2,643 kg/ha and 2,276 kg/ha, respectively.

Whether there is competition between Tahr and livestock for forage or not, an inescapable fact is that signs of overgrazing such as bare and eroded pastures are becoming increasingly visible in SNP. The present study revealed that there is dietary overlap between Tahr and livestock. More elaborative and long term studied are needed to test for actual competition, since the present study was short termed and the number of sample plots may not have been representative enough. Crucial data necessary to study competition are accurate census of both Tahr and livestock and productivity of grassland to estimate carrying capacity.

5.6 Comparison between direct observation and microhistological techniques

Direct observation was easy to determine the food habit of both livestock and Tahr. Livestock did not get disturbed by human activities and possible to view from a close distance. Tahrs are also not shy animal in SNP probably due to higher rate of interaction with human. In the present study, grazing was observed from a distance of about 50 m near to the Tahr's herd. Male Tahr escape very quickly on encounter with human even from a distance but female and kid do not response like male. Direct observation was made closely to study their feeding. However, the problem associated with direct observation was to find the freshly bitten plant. Most of the plant species don't have sap, and difficult to differentiate between freshly bitten and bitten earlier either by livestock or by the Tahr. Some plants were so weak that they break even by trampling which seemed to be eaten by them. In direct observation, some cultivated plants like *Fagopyrum sp.* were found to be eaten by Tahr. Direct observation is a reliable method to estimate the diet of Tahr and livestock. It gives crude idea about their food habit, but it excludes plant species eaten in small quantities of rare species.

Holechek *et.al* (1982) concluded that simplicity, minor equipment, requirements and ease of use are major advantage of direct observation but difficulty in species identification and quantification of how much of a plant was consumed are important problems associated with the procedure.

Although microhistological analysis has diverse arguments about its advantage and disadvantage, this method received greater use for evaluating range herbivore food habit than any other techniques (Holechek *et.al* 1982). The problems associated with fecal analysis are the identification of the plant fragments seen in the microscope (Fitzgerald and Waddington 1979). Grass and sedge species used in the investigation are uniformly overestimated while forbs are uniformly underestimated (Vara and Holechek 1980, Gyawali 1986). In the present study, most of the fragments of grasses were very distinct; *Avenea sp.* had very distinct trichomes and inter-stomatal cell structures, which was seen clearly in the fecal sample too. However, the microstructures of other species like *Carex sp.*, *Cyperaceae sp.*, *Trisetum spicatum* were almost similar and made very confusing. Very smooth plants like *Ephedra gerdiana* and *Saxifraga brachypoda* also had distinct characters. *Potentilla* species showed a distinct and easily recognizable character in reference slide as well as in the fecal.

Many procedures suggested that to prepare reference slide and fecal material without staining but the study showed staining make easier to identify the palnt fragments due to differential staining of tissues.

Since stomata of the plant in reference slide is considered as the important character to identify the plant but the rangeland community adapted to the scarce water supply have reduced stomata. Arrangements of Epidermal cells, trichomes, cell hair were the main basis to identify the plants.

6. CONCLUSIONS AND RECOMMENDATION

Total numbers of 45 and 55 species of plants were found in Mongla and Phortche respectively. The species compositions of both rangelands were almost similar and the Sørenson's index of similarity (ISs) was calculated 0.83. Simpson's diversity index was also found 0.941 in Mongla and 0.937 in Phortche rangeland, respectively. It showed that species diversity is higher in Phortche than in Mongla.

The vegetation survey of the study area showed *Rhododendron lepidotum, Cotoneaster microphyllus, Carex anomoea* and *Avena sp*. were the dominant plant species in both rangelands. *Gerbera gossypiana, Cyanthus hookeri, Anaphalis contorta* were among associated plant species in both rangelands.

The ground vegetation cover was 81.64 %, 71.48 % in Phortche and Mongla respectively, and the non- vegetated ground area was 18.36% and 29.52 in two respective rangelands.

By analysis of fecal samples, 24 species of plants were identified in the fecal of Tahr and 31 species of plants were identified in the fecal of livestock. Both Tahr and the livestock used 22 species of common plants. Dietary overlap between livestock and Tahr was high (83 %), and the niche breadth of Tahr and livestock was 0.0137 and 0.0175 respectively.

Relative Importance Value of Species (RIV) that was eaten by Tahr and Livestock was determined. The highest RIV was calculated in *Avena Sp.* (117.12) followed by the *Carex anomoea* (70.15), *Gueldeastaedtia himalaica* (20.78), *Potentialla sp.* (18.75) for Tahr's diet. For livestock *Avena sp.* (74.08) followed by *Carex anomoea* (35.04), *Trisetum spicatum* (23.43) have higher RIV.

In terms of forage availability, *Cotoneaster microphyllus* (102.56), *Avena sp.* (84.86), *Rhododendron lepidotum* (55.75), *Carex anomoea* (44.13) were the most abundance in Mongla. In Phortche, *Carex anomoea* (67.69), *Rhodendron lepidotom* (63.6), *Avena sp.* (58.18) was among abundant species. The encroachment of livestock in the Tahr's habitat should be monitored. Based on the field study, following recommendations have been made:

1. although, there is high degree of niche overlap, but two ungulate species were coexisting. So the interactoin between the two ungulates should be well studied.
2. The study of the productivity and the carrying capacity of the Tahr's habitat should be studied at the earliest possible.
3. The grass harvesting from the rangeland should be checked. Since, huge quantity of grass harvesting by the locals was seen in summer seasons, to stock for winter seasons.

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Annex: 1

Basis for Identifying Plant Microstructure in Microhistological Analysis

Introduction

The epidermis of plants are made of a thin layer know as cuticle. During ingestion of plant material by herbivores, the epidermis is generally resistant to digestion, passes the digestion tract intact and can therefore be detected in the fecal material. As the cell structure of the epidermis is specific in each plant taxon, small fragments are sufficient to determine the plant species. Therefore, the analysis of fecal material is one of the important features on the qualitative and quantitative composition of the ingested diet by herbivore.

Botanical-taxonomical aspects

Monocotyledon plants (e.g. grasses and sedges) are easily distinguishable from dicotyledons (e.g. trees, shrubs and herbs). Epidermal cells of dicotyledons show a random distribution, mostly circular alignment (Figure 3), while monocotyledons show a clear parallel cell alignment.The family of grasses (e.g. gramineae) show the largest taxon-specific diversity in epidermal structures of all plant families. Consequently, in most cases the determination of even closely related species of the same genus is possible. The most differentiated epidermal structures are found on the abaxial (bottom) side of the grass leaves. The outer basal part and the immediate tip of the lamina can show certain divergence of the cell structure and should therefore not be considered for preparing references. The epidermis can be separated and isolated by mechanical abrasion of the overlaying plant tissue. Usually, colouring of the epidermis is unnecessary.

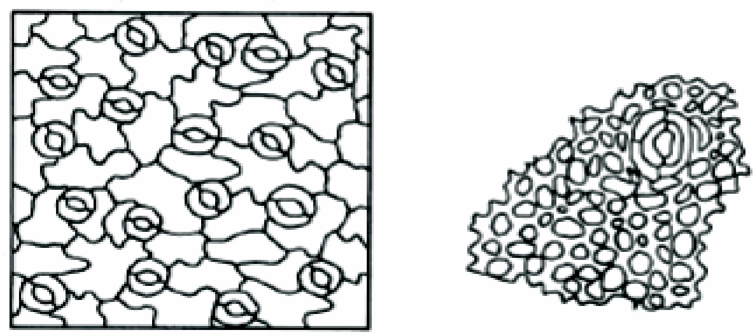


Figure 3: Epidermis of dicotyledonous leave (left) and fruit (right), (Mühlenberg 1993 as cited in Gutbrodt 2006).

Plant micro-morphology

The most striking feature of grass leaves is their parallel venation. The cell stripes above the leaves nerve is called costal, the cell tissue between nerves is intercostals. The features of epidermal cells or specific patterns of these cell forms help to identify the grasses species. (Figure: 4).

Different forms of epidermal cell

There are three different types of epidermal cells: long cells, short cells and trichoma.

Long cells: are not differentiated, cell walls generally interlocked in wavy pattern, sometimes with round papilles: either small and appearing in groups in each long cell, or big and appearing singly in long cells and between stomata.

Short cells are significantly smaller than long cells and generally in pairs in between long cells in the intercostal or in long row of pairs in the costal. The short cells are commonly shaped like a dumb-bell, and are important features of recognition.

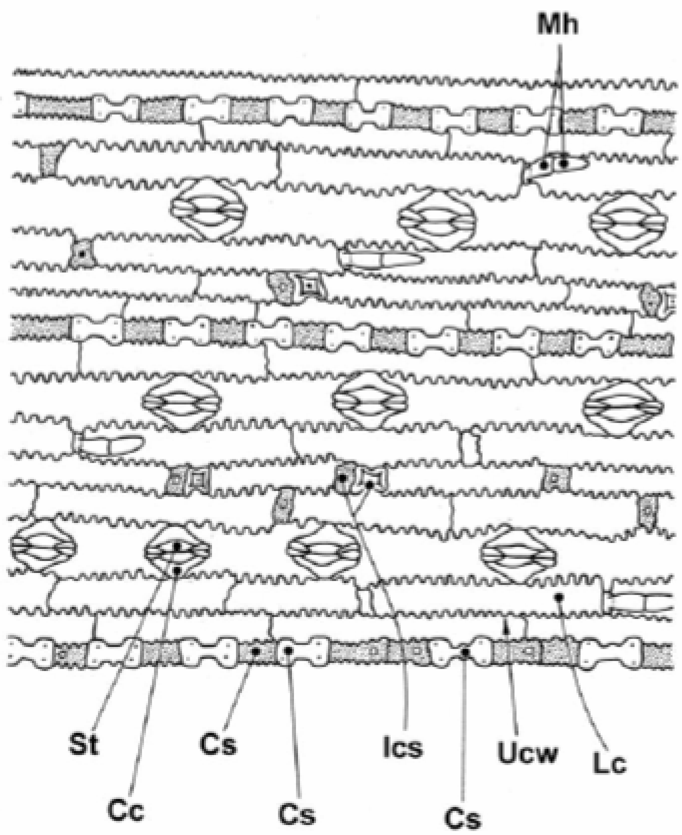


Figure 4: Epidermis of grass with characteristic cell forms: St – Stomata, Cc – Concomitant cell (triangle shaped), Cs – Costal short cell, Ics – Intercostal short cell, Ucw – Undulating cell wall, Lc – Long cell, Mh – Micro hair (Barthlott & Martens 1979 as cited in Gutbrodt 2006).

Trichome

Trichome are also distinguished as micro hair, prickle hair and macro hair.

Micro hair consists of two cells and is very common. The shape and proportion of both cells to each other and to other epidermal cell forms are important features of recognition. The second cell making up the micro hair tip is generally poorly visible, and in this paper, declarations on micro hair length are referring to only the first cell.

Prickle hair: It is found in intercostal and costal parts with single cell having thick cell wall**.** Hook hair, found only in the intercostal cell, are a specific kind of prickle hair with a circular round base and short curved tip. Large prickle hairs are sometimes present in the costal and most species show a row of large prickle hair in the basal costal.

Macro hair: These are long single cellular spiky hairs. A group of pillow like thick-walled epidermis cells surrounds their base. Macro hair can be distinguished from prickly hair by observing the relationship between length and width of hair

Stomata: The stomata consist of one pair of lips, porus and two concomitant cells; these are either round or triangle shaped.

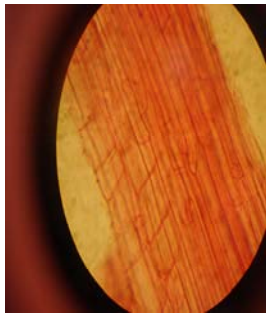
Epidermal cell patterns: It is also the important feature to distinguish the micro histological slides of plant material which includes breadth (number of cell rows) of intercostal and costal fields or the distribution of trichoma, short cells, stomata and homogenous structure of long cells.

Reference:

Gutbrodt, B. 2006. Diet Composition of Wildebeest, Waterbuck and Reedbuck in Relation to Food Qualitys in Moist Savanna of Tanzania. Diploma thesis in environmental science, Swiss Federal Institute of Technology, Zurich.

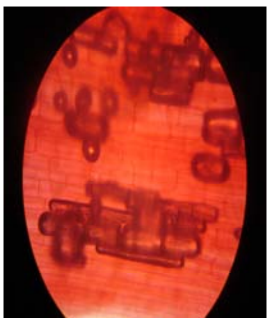
Reference slides of plants with their structure.


Saxifraga brechypoda.


Polygonum vacciniifolium.


Trisetum spicatum.


Berberries mucrifolia

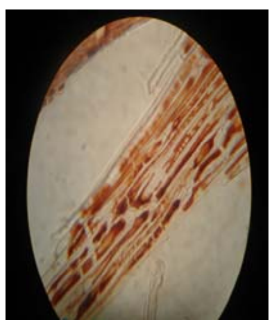

Anaphalis contorta.

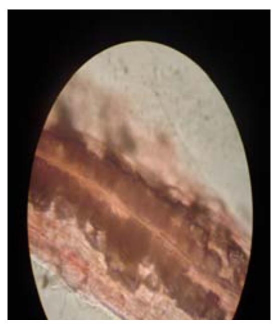

Researcher at lab.

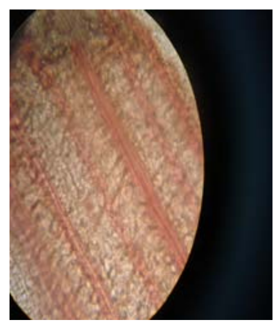

Anaphalis triplinervis

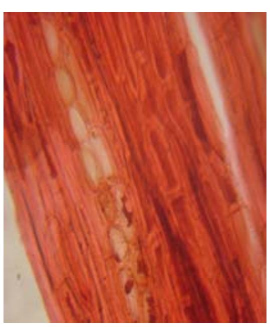

Hermimum josephii

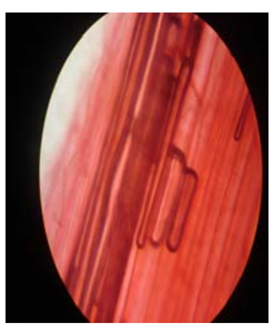

Cypridium himalaicum.


Morina nepalensis.


Poa sp.


Cyperaceae sp.

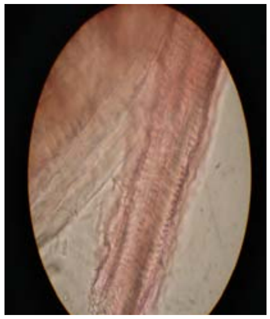

Potentilla sp.


Satyrium nepalense

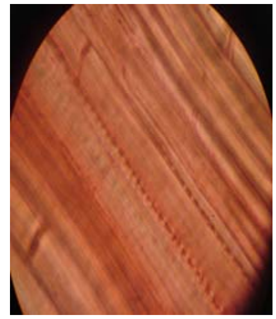

Rhododendron lepidotum

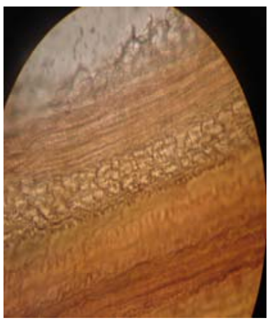

Gueleastaedtia himalaica


Fragaria daltoniana


Nothoriolion macrophyllum


Polypodium sp.

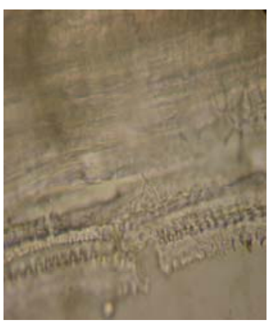

Trachyspermamum ammi

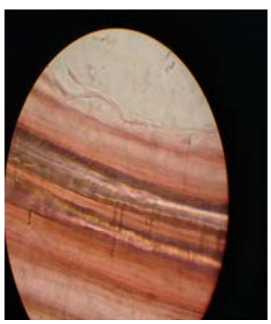

Bistorta affinis.

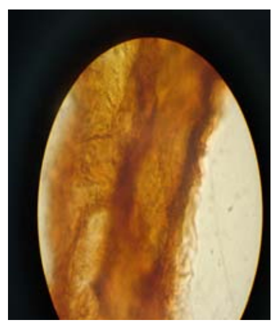

Cotoneaster microphyllus


Persicaria capitatum

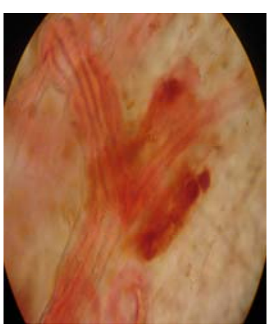

Saxifraga parnasifolia

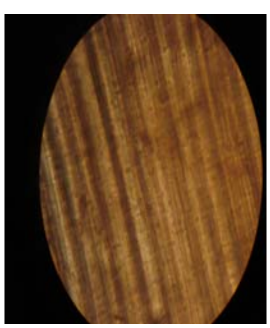

Avena sp.

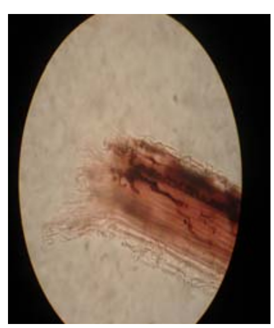

Habenaria aitchsonii.

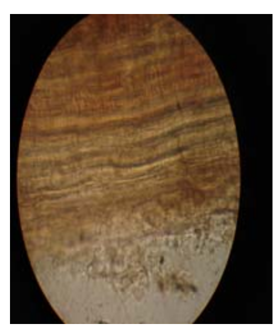

Cyanthus hookeri.

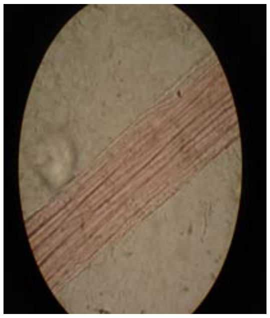

Silene sp.


Androsace sarmentosa.

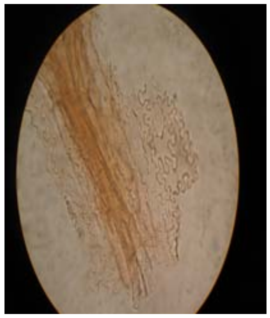

Dorsera peltata.


Corex anomoea

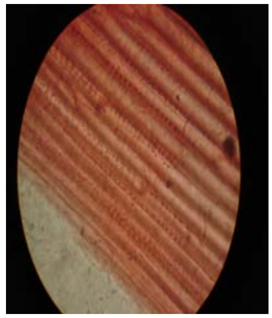

Polygonatum hookeri



Gerbera gossypina.

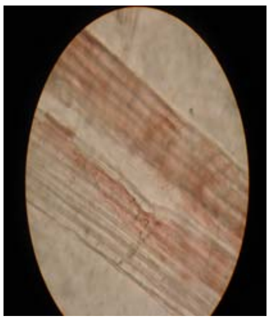


Woordium sp.

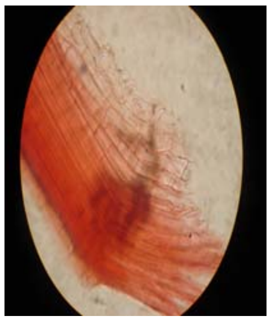


Pedicularis syphonantha.

Sedum sp.



Ephedra gerardiana,



Lentopodium jacotinum.

Thermopsis barbata

Annex 2. Floristic composition of Mongla

S N	Name of plant species	Density	Freq	F C	RF	RD	Ab	RA	IVI
1.	*Anaphalis contorta*	4.619	52.38	C	4.489	3.54	8.818	2.090	10.121
2.	*Anaphalis Triplinervis*	0.619	9.524	A	0.816	0.47	6.500	1.541	2.832
3.	*Androsace sarmentosa*	5.429	52.38	C	4.489	4.16	10.364	2.457	11.108
4.	***Avena sp.***	19.38	90.48	E	7.753	14.9	21.421	5.078	27.694
5.	*Bistorta affinis*	2.048	19.05	A	1.632	1.57	10.750	2.548	5.751
6.	*Brizamedia sp.*	0.952	4.762	A	0.408	0.73	20.000	4.741	5.880
7.	*Buplerium sp.*	0.619	4.762	A	0.408	0.47	13.000	3.082	3.965
8.	*Carex Anomoea*	11.52	66.67	D	5.713	8.84	17.286	4.098	18.648
9.	*Centopodium strocheyi*	0.095	4.762	A	0.408	0.07	2.000	0.474	0.955
10.	*Cheilanthus sp.*	0.333	4.762	A	0.408	0.26	7.000	1.659	2.323
11.	*Compositaea*	0.048	4.762	A	0.408	0.04	1.000	0.237	0.682
12.	*Cotoneaster microphyllaus*	6.238	80.95	D	6.937	4.78	7.706	1.827	13.547
13.	*Cyanthus microphyllus*	9.238	57.14	C	4.897	7.08	16.167	3.832	15.813
14.	*Cyonthus hookeri*	8.381	38.1	B	3.264	6.43	22.000	5.215	14.907
15.	*Cyperipdium himailicum*	0.81	14.29	A	1.224	0.62	5.667	1.343	3.188
16.	*Cypressae sp.(I)*	0.476	4.762	A	0.408	0.37	10.000	2.371	3.144
17.	*Drosera peltata*	3.143	47.62	C	4.080	2.41	6.600	1.565	8.055
18.	*Festuca sp.*	0.286	9.524	A	0.816	0.22	3.000	0.711	1.746
19.	*Fragaria daltonina*	0.333	14.29	A	1.224	0.26	2.333	0.553	2.033
20.	*Gerbera gossypiana*	6.381	47.62	C	4.080	4.89	13.400	3.177	12.150
21.	*Gueldeastaedtia himalaica*	4.095	33.33	B	2.856	3.14	12.286	2.912	8.909
22.	*Habenaria aitchisonii*	0.143	9.524	A	0.816	0.11	1.500	0.356	1.281
23.	*Herrminium josephii*	3.571	38.1	B	3.264	2.74	9.375	2.222	8.226
24.	*Hiary siru*	0.143	4.762	A	0.408	0.11	3.000	0.711	1.229
25.	*Iris sp.*	0.333	4.762	A	0.408	0.26	7.000	1.659	2.323
26.	*Juniperus sp.*	0.048	4.762	A	0.408	0.04	1.000	0.237	0.682
27.	*Microula pustulosa*	0.381	4.762	A	0.408	0.29	8.000	1.896	2.597
28.	*Cyperaceae sp.*	1.19	19.05	A	1.632	0.91	6.250	1.482	4.027
29.	*Nothoriolion macrophyllum*	1.619	19.05	A	1.632	1.24	8.500	2.015	4.889
30.	*Parnasia nabicola*	0.095	4.762	A	0.408	0.07	2.000	0.474	0.955
31.	*Pedicularis syphonatha*	0.048	4.762	A	0.408	0.04	1.000	0.237	0.682
32.	*Persicaria capitatum*	1.81	14.29	A	1.224	1.39	12.667	3.003	5.615
33.	*Poa sp.*	1.143	23.81	B	2.040	0.88	4.800	1.138	4.055
34.	*Polygonatum hookeri*	8.286	42.86	C	3.672	6.35	19.333	4.583	14.610
35.	*Potentialla sp.*	6.952	19.05	A	1.632	5.33	36.5	8.653	15.616
36.	*Rhododendron lepidotum)*	5.381	71.43	D	6.121	4.13	7.533	1.786	12.033
37.	*Salvia hains*	1.048	19.05	A	1.632	0.8	5.500	1.304	3.739
38.	*Satyrium nepalense*	4.667	57.14	C	4.897	3.58	8.167	1.936	10.411
39.	*Saxifraga brechypoda*	3.143	28.57	B	2.448	2.41	11.000	2.608	7.466
40.	*Sedem sp.*	1.905	9.524	A	0.816	1.46	20.000	4.741	7.018
41.	*Sedum sp.*	0.048	4.762	A	0.408	0.04	1.000	0.237	0.682
42.	*Sexifraga parnasifolia*	2.714	57.14	C	4.897	2.08	4.750	1.126	8.104
43.	*Silene edgeworthii*	0.143	9.524	A	0.816	0.11	1.500	0.356	1.281
44.	*Trisetum spicatum*	0.333	4.762	A	0.408	0.26	7.000	1.659	2.323
45.	*Unidentified graminnae (15)*	0.238	4.762	A	0.408	0.18	5.000	1.185	1.776

Annex 3: Floristic composition of Phortche

SN	Name of plant species	Den	Fre%	FC	RF	RD	Abu	RA	IVI
1	*Bistorta affinis*	2.833	46.67	C	3.111	1.824	6.071	1.19	6.128
2	*Rhododendron lepidotum*	3.1	60	C	4	1.996	5.167	1.02	7.011
3	*Cotoneaster microphyllaus*	1.933	43.33	C	2.8889	1.245	4.462	0.88	5.01
4	*Cyanthus microphyllus*	5.167	50	C	3.3333	3.327	10.33	2.03	8.69
5	*Polygonatum hookeri*	29.7	56.67	C	3.777	19.12	52.41	10.3	33.2
6	*Dorsea peltata*	5.433	46.67	C	3.111	3.499	11.64	2.29	8.896
7	*Poa sp.*	0.567	20	A	1.333	0.365	2.833	0.56	2.255
8	*Avena sp.*	9	96.67	E	6.444	5.795	9.31	1.83	14.07
9	*Carex Anomoea*	12.17	100	E	6.6667	7.834	12.17	2.39	16.89
10	*Cyperus sp.*	4	43.33	C	2.888	2.576	9.231	1.81	7.277
11	*Gerbera gossypiana*	7.233	73.33	D	4.888	4.658	9.864	1.94	11.48
12	*Cyonthus hookeri*	8.4	63.33	D	4.222	5.409	13.26	2.61	12.24
13	*Anaphalis contorta*	0.167	6.667	A	0.444	0.107	2.5	0.49	1.043
14	*Gueldeastaedtia himalaica*	2.733	46.67	C	3.111	1.76	5.857	1.15	6.021
15	*Persicaria capitatum*	5.567	36.67	B	2.444	3.584	15.18	2.98	9.01
16	*Hermimum josephii*	0.333	6.667	A	0.444	0.215	5	0.98	1.641
17	*Satyrium nepalense*	0.4	10	A	0.666	0.258	4	0.79	1.71
18	*Saxifraga brechypoda*	2.433	40	B	2.666	1.567	6.083	1.2	5.428
19	*Sexifraga parnasifilia*	1.367	36.67	B	2.444	0.88	3.727	0.73	4.056
20	*Trachyspermaum ammi*	0.7	13.33	A	0.888	0.451	5.25	1.03	2.371
21	*Salvia hains*	0.7	20	A	1.333	0.451	3.5	0.69	2.471
22	*Nothoriolion macrophyllum*	1.7	20	A	1.333	1.095	8.5	1.67	4.097
23	*Cheilanthus sp.*	0.233	10	A	0.666	0.15	2.333	0.46	1.275
24	*Parnasia nubicola*	1.967	33.33	B	2.222	1.266	5.9	1.16	4.647
25	*Sedum sp.*	0.233	13.33	A	0.888	0.15	1.75	0.34	1.383
26	*Compositaea*	0.033	3.333	A	0.222	0.021	1	0.2	0.44
27	*Cypressae sp.*	0.167	3.333	A	0.222	0.107	5	0.98	1.311
28	*Potentialla sp.*	105	26.66	B	1.778	0.965	5.625	1.1	4.5
29	*Fragaria daltoniana*	2.867	56.67	C	3.7778	1.846	5.059	0.99	6.617
30	*Gramineae sp.*	3.3	43.33	C	2.8889	2.125	7.615	1.5	6.509
31	*Pedicularis syphonatha*	3.367	66.67	D	4.4444	2.168	5.05	0.99	7.604
32	*Thermopsis barbata*	4.933	26.67	B	1.7778	3.177	18.5	3.63	8.588
33	*Morina nepalensis*	3.533	36.67	B	2.4444	2.275	9.636	1.89	6.612
34	*lentopodium jacotinum*	2.967	20	A	1.3333	1.91	14.83	2.91	6.157
35	*Gentiana depressa*	6.567	23.33	B	1.5556	4.228	28.14	5.53	11.31
36	*Sedum sp.*	0.6	6.667	A	0.4444	0.386	9	1.77	2.598
37	*Gentiana sp.*	1.033	23.33	B	1.5556	0.665	4.429	0.87	3.091
38	*Alllium wallichii*	0.033	3.333	A	0.2222	0.021	1	0.2	0.44
39	*Primula spp.*	2.233	6.667	A	0.4444	1.438	33.5	6.58	8.461
40	*Dubyea hispida*	1.233	6.667	A	0.4444	0.794	18.5	3.63	4.872
41	*Polypodium sp.*	0.4	3.333	A	0.2222	0.258	12	2.36	2.836
42	*Ephedera gerdiana*	0.167	6.667	A	0.4444	0.107	2.5	0.49	1.043
43	*Neottianthe calcicola*	1.6	23.33	B	1.5556	1.03	6.857	1.35	3.932
44	*Halewia elliptica*	1.5	20	A	1.3333	0.966	7.5	1.47	3.772

45	*Thesium emodi*	0.367	6.667	A	0.4444	0.236	5.5	1.08	1.761
46	*Cypripedium himalaicum*	0.6	6.667	A	0.4444	0.386	9	1.77	2.598
47	*Euphrasia himalaica*	2.333	13.33	A	0.8889	1.502	17.5	3.44	5.828
48	*Polygonum vacciniifolium*	0.967	16.67	A	1.1111	0.622	5.8	1.14	2.873
49	*Polygonatum cirrhifolium*	0.2	3.333	A	0.2222	0.129	6	1.18	1.529
50	*silene sp.*	0.067	3.333	A	0.2222	0.043	2	0.39	0.658
51	*Cassiope fasitague*	1.733	10	A	0.6667	1.116	17.33	3.4	5.187
52	*Dactylorhiza hatagirea*	0.1	3.333	A	0.2222	0.064	3	0.59	0.876
53	*Woordium sp.*	0.1	6.667	A	0.4444	0.064	1.5	0.3	0.803
54	*Campanula pallida*	2	10	A	0.6667	1.288	20	3.93	5.882
55	*Cperipedium himailiacum*	0.7	10	A	0.6667	0.451	7	1.38	2.492

Note:
Den. = Density
Fre% = Frequency percentage
FC = Frequency class
RF = Relative frequency
RD = Relative density
Abu = Abundance
RA = Relative abundance
IVI = Important Value Index