HERBACEOUS FLORA IN HIGH ALTITUDE OF IMJA VALLEY, SAGARMATHA NATIONAL PARK NEPAL HIMALAYA

A Dissertation submitted to

Central Department of Botany, Tribhuvan University

For the partial fulfillment of the requirements for

Master of Science in Botany (Plant Systematics)

Submitted by

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KIRTIPUR, KATHMANDU
NEPAL

Recommendation

This is to certify that the dissertation work entitled "**Herbaceous Flora in High Altitude of Imja Valley, Sagarmatha National Park, Nepal Himalaya**" submitted by **Mr. Ekananda Paudel** has been carried out under our joint supervision. The entire work is primarily based on the results of his research work and has not been submitted for any other degree. We recommend this dissertation work to be accepted for the partial fulfillment of Master of Science in Botany (Plant Systematics and Phytogeography).

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LETTER OF APPROVAL

This dissertation paper entitled "**Herbaceous Flora in High Altitude of Imja Valley, Sagarmatha National Park, Nepal Himalaya**" submitted at the Central Department of Botany, Tribhuvan University by **Mr. Ekananda Paudel**, has been accepted for the partial fulfillment of requirements for Master of Science in Botany (Plant Systematics and Phytogeography).

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September, 2009 **Ekananda Paudel**

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ABSTRACT

This study has been carried out in the Imja valley, north-east part of the Sagarmatha National Park. The present study starts from Phungitanga (3400m asl) to Chhukung (4,650m asl) between 27º49'58.08"N to 27º54'18.48"N and 86º30'57.06"E to 86º99'15.96"E. This research work aims to study the floristic composition, altitude-species richness relationship and disturbance-species richness relationship of herbaceous flora. The sampling was conducted at 60 sites in varying altitudes (3600-4100m) to cover all types of forest and different aspects. Total number of species and sign of human impacts were recorded in each sampling plots. Species were observed and collected en-route as well as with in the sampling plots.The Generalized Linear Models (GLM) was used to elucidate the relationship of species richness with elevation as well as disturbance. Analysis of Covariance (ANCOVA) was also used to evaluate the effect of categorical variables like grass cutting, litter fodder collection along with altitude on species richness. Altogether 180 species of herbaceous angiosperms under 93 genera and 35 families were recorded. Asteraceae is observed as the largest family with 26 species. Similarly, *Saxifraga* is the largest genus comprising 9 species. 20 species are added as with new locality in Eastern Nepal and 43 species with different altitudinal ranges than recorded in Press *et al.* (2000). Monotonic decrease in herbaceous species richness with increasing altitude is found between 3600-4100m and with generating a high-elevation plateau between 3600-4000m as observed by Grytnes and Vetaas (2002). Only grass cutting and litter/fodder collection are found to be significant to the species richness supporting the "Intermediate Disturbance Hypothesis-IDH".

Key words: floristic composition, species richness, altitudinal gradient, disturbance.

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ABBREVIATIONS AND ACRONYMS

ANCOVA	Analysis of Covariance
asl	Above Sea Level
DNPWC	Department of National Park and Wildlife Conservation
FAO	Food and Agriculture Organization
Fl. & Fr.	Flowering and Fruiting
GLM	Generalized Linear Model
GPS	Global Positioning System
ICIMOD	International Centre for Integrated Mountain Development
IDH	Intermediate Disturbance Hypothesis
IPCC	Intergovernmental Panel on Climate Change
KATH	National Herbarium and Plant Laboratory
LCCS	Land Cover Classification System
SNP	Sagarmatha National Park
SNPBZ	Sagarmatha National Park and Buffer Zone
SPCC	Sagarmatha Pollution Control Committee
TUCH	Tribhuvan University Central Herbarium
UNESCO	United Nations Educational, Scientific and Cultural Organization
VDC	Village Development Committee
WCMC	World Conservation Monitoring Centre
WHC	World Heritage Centre

1. INTRODUCTION

1.1 Enumeration and floral diversity of Sagarmatha National Park

The geographical profile of Nepal varies with a great altitudinal range from 60m Kechanakalan, Jhapa to the highest peak, 8848m Mt. Everest, Solukhumbu. This altitudinal range along with various climates and edaphic conditions made this small area (147,181 sq. Km) biologically diverse. The total number of estimated flowering plants from Nepal is 6,500 species which gives 10^{th} rank in Asia and 31^{st} position in the world in biodiversity richness (WCMC 1994). About 4% of the total estimated numbers of plant species are endemic to the country (Shrestha 2001) and 30% species are endemic to the Himalayas (Shrestha & Blackmore 1999). Of the Earth's surface, the alpine zone alone (above the tree line) makes up 3% land surface, but contains at least 4% of all vascular plant species (ICIMOD 2008). Therefore, mountains have attracted the attention of the researchers for the study of plants and their distribution pattern.

The exploration of Nepal's unique floristic diversity began in early nineteenth century (1802 A.D.) with collection made by F. Buchanan Hamilton. The exploration of eastern Nepal was started by Hooker in 1848 with the collection of several plant specimens and documented in his Flora of British India volumes (1875-1897). Similarly, several plant specimens from Himalaya of Eastern Nepal were collected by Hara and his colleagues are reported in the Flora of Eastern Himalaya (Hara 1966, 1971; Ohashi 1975). In 1948, M.L. Banerji explored 417 specimens from central and eastern part of Nepal (Banerji 1965).

The Solukhumbu area, i.e., Sagarmatha National Park and its adjoining areas are explored by different explorers at various times. In 1964, Stainton *et al.* made the collection of 350 plant specimens from Solukhumbu and Rolwaling area (Stainton 1972). Similarly, J.D.A. Stainton (1969) with several collections, and Tabata *et al.* (1978) with ca. 10,000 specimens explored the central and eastern Nepal along with Solukhumbu area (Rajbhandari 2002). G. Miehe and S. Miehe collected ca. 380 specimens from the Khumbu area in 1982 (Miehe 1987). N. Joshi described 123 species of wild flowers from Sagarmatha National Park and its adjoining area (Joshi 2005). Likewise, the Darwin Initiative Project made expeditions in 2004 and 2005 representing collection of 344 and 413 species respectively with 21 new records of

flowering plants for Nepal from Sagarmatha National Park (Rajbhandari *et al.* 2004, 2008; Pendry *et al.* 2009).

1.2 Species richness and altitude

Species richness of plant communities changes along environment gradients in a predictable way (Huston 1994; Rosenzweig 1995; Pausas & Austin 2001). At present, tropical rain forests are considered as the richest plant communities on the earth at larger spatial scales and the plant species decreases from the tropical rain forests towards higher latitudes (Leps 2005). The decrease is, however, not always monotonous; there are extremely species-rich communities in various parts of the subtropical and temperate zones: the temperate grasslands in various parts of the world, or even semi-deserts are among the most species-rich communities (Cantero *et al.* 1999). For instance, in Kilimanjaro (South Africa), the highest diversity of ferns is found in the lower montane forest between 1600 and 2000m (Hemp 2002). Moreover, the species richness of some Mediterranean heathlands (e.g., fynbos in South Africa) is extraordinary. However, neither of those is comparable to tropical rain forest as functional diversity and diversity of higher taxonomic units (Leps 2005).

The species richness is positively correlated with growing-seasons temperature (Rannie 1986), the pattern that applies to both latitudinal (Engelskjon & Skifte 1995; Begon *et al.* 1996; Murray 1997; Leps 2005) and altitudinal gradients (Rahbek 1995). Species richness patterns along the altitudinal gradients have been frequently studied in recent years. In general, there are three main patterns: a monotonic decline in species richness from low to high elevation, a hump-shaped pattern with a maximum at mid-elevations, or essentially a constant from the lowlands to mid-elevations followed by a strong decline further up (Rahbek 1995, 1997). Species richness is thought to decrease with increase in elevation (Woodward 1987; Stevens 1992; Korner 1995; Brown & Lomolino 1998; Fossa 2004). However, approximately half of the studies have found a mid-altitude peak in species richness (Whittaker 1960; Rahbek 1995, 1997; Vetaas & Grytnes 2002; Grytnes 2003; Hua & Saprunoff 2005).

Altitude is a typical complex environmental gradient which means that there are changes in many environmental variables along an altitudinal gradient (Austin *et al.* 1996). This altitudinal gradient itself has no direct effect on the physiology of plants

but it acts indirectly as collective environmental variable (Puscher 1996). Change in altitudinal gradient results in the change in different climatic factors as well as land area surface (Korner 2007), i.e., shrinking land area, thereby narrowing opportunities for life (Rahbek 1995). The climatic factors that vary with elevation include temperature, air pressure, solar radiation, and ultra violate radiation, which can all have an influence on the distribution of species along the gradient (Korner 2007). Temperature affects species distribution and abundance directly or indirectly by influencing soil development, evaporation, microbial activity and nutrient availability (Korner 1999).

Altitudinal gradient has been studied for different plant groups of Nepal Himalaya. Flowering plants (Grytnes & Vetaas 2002; Vetaas & Grytnes 2002; Bhattarai & Vetaas 2003; Carpenter 2005; Acharya 2008), ferns (Bhattarai *et al.* 2003), and liverworts and mosses (Grau *et al.* 2007) have shown unimodal relationship with altitude. However, richness peak varies for each functional group. The maximum richness of flowering plants has been found between 1,500 and 2,500m asl with a very little variation between 3,000 and 4,000m asl (Grytnes & Vetaas 2002) generating a high-elevation plateau. At local scale, Bhattarai and Vetaas (2003) reported maximum species richness at 800m asl, a local mid-elevation peak along a subtropical elevation gradient. Similarly, Subedi (2006); Shrestha (2006) and Rijal (2007) reported hump shaped pattern with maximum species richness at 3,500m; near forest limit and 4,100-4,300m asl respectively. However, Panthi *et al.* (2007) reported a plateau in species richness at the elevation range of 3,000–4,000m asl at the local scale in a trans-Himalayan inner valley.

1.3 Species richness and disturbance

A disturbance is an event that may, directly or indirectly, disrupt a peaceful or ordered environment and change resource availability. Disturbance is one of the important factors influencing variations in species richness (Connell 1978; Huston 1979, 1994; Noss 1996). The anthropogenic and natural disturbances interact to affect the pattern of plant species diversity and composition (Bhuju & Ohsawa 2001). Disturbance, such as burning, grazing, or drought, can increase or decrease richness, depending on whether common or uncommon species are most affected (Huntly 1991; Belsky 1992; Tilman 1993; Wilson 1994a; Collins *et al.* 1998; Gough & Grace 1999).

Frequency of disturbance may influence both habitat heterogeneity and productivity. Thus, it has been hypothesized that the species richness of communities is highest at intermediate levels of disturbance to produce a humped shaped curve. This relationship is often called "Intermediate Disturbance Hypothesis - IDH" (Grime 1973; Conell 1978; Huston 1979, 1994). The intermediate disturbance hypothesis predicts that diversity will be highest in communities with intermediate levels of disturbance. If disturbances are too rare, the competitive dominants will eliminate other species and reduce diversity as equilibrium conditions develop. If disturbances are too frequent, most species will go locally extinct, which lowers diversity, because they can not tolerate repeated disturbances. Under intermediate levels of disturbance, diversity is maximized because disturbance-tolerant species and competitively dominant species coexist. This hypothesis is generally accepted (Katriona *et al.* 2004) and verified by different studies (Sousa 1980; Armesto & Pickett 1985; Robinson & Marshall 1986; Wilson 1994b; Collins *et al.*, 1995; Collins & Glenn 1997; Bhuju & Ohsawa 2001).

The effect of different parameters of disturbance on species composition and richness has been studied and verified the intermediate disturbance hypothesis in the Nepal Himalaya (Gurung 1995; Vetaas 1997; Bhuju & Rana 2000; Shrestha 2006). Medium disturbance created by human and livestock had positive role in terms of species diversity and richness compared to high and low disturbances (Gurung 1995; Bhuju & Rana 2000; Shrestha 2006). Similarly, Vetaas (1997) reported a unimodal response of canopy disturbance on species richness of herbaceous plants. Bhuju and Rana (2000) reported the increase in species richness in relatively more disturbed site as they studied the human impact on vegetation in Khumbu region.

1.4 Research questions

- How species richness is varied along altitudinal gradient?
- How much variation in species richness is affected by disturbance?

1.5 Hypotheses

Based on these research questions, following null hypotheses are tested.

- Species richness is independent of altitude.
- There is no effect of disturbance on species richness.

1.6 Objectives

This research work aims to study the floristic composition, altitude-species richness relationship and disturbance-species richness relationship of herbaceous flora of Imja valley in Sagarmatha National Park. The specific objectives are:

- documentation and identification of herbaceous flora;
- analysis of the relationship of species richness with altitude; and
- analysis the relationship of species richness and disturbance.

1.7 Rationale

Most of the botanical explorations in Nepal have been done in the lower and middle parts of Nepal (Rajbhandari 2001) and so many places are waiting for exploration (Shrestha 2001). Hence, the exploration and documentation of plant species occurring in Imja valley and the findings of the research will contribute in the publication of Flora of Sagarmatha area and also provide as a reference for the Flora of Nepal.

The variation in species richness along Himalayan elevation gradients of Nepal has been documented by several studies (Grytnes & Vetaas 2002, Vetaas & Grytnes 2002, Grau *et al.* 2007, etc.), but all these studies show the relationship in regional scale and they have followed interpolation method for the generalization of the pattern. There has been sparse work which can illustrate the pattern between species richness and altitude as well as other disturbance indicators at local scale like Imja valley through point sampling. Hence, it is relevant to find out the effect of altitude and other parameters of disturbance on the species richness at local scale.

2. STUDY AREA

2.1 Location and Physiography

Sagarmatha National Park is located in the north-eastern region of Nepal in Solukhumbu District of Sagamatha Zone. The park was established in 19 July, 1976, and declared as 120th UNESCO World Heritage Site in 1979 and is one of the most attractive Parks in the world. Essentially the park comprises the area known as Khumbu and includes a number of well-known high peaks of the Himalayas-the most significant being Sagarmatha (Mount Everest, 8,848m), the world's highest mountain and other high peaks such as Lhotse Shar, Cho Oyu, Ama Dablam, Pumori, Kangtega, Gyachung Kang, Thamserku and Kwangde.

Sagarmatha National Park forms a roughly triangular geographical unit of 1,148 Km^2 enclosing high mountains country ranging from deep valley bottoms 2,845m elevation at Monjo, the park entrance, to the world's highest peak at 8,848m , a range of over 6,000m. The park is located between 27º46'19" to 27º06'45" North latitudes and 86º30'53" to 86º99'08" East longitudes. The SNP covers two VDCs Namche and Khumjung, and is bounded in the north by the summits of the Himalaya (the Nepal-China border); Makalu-Barun National Park in the east; Beni, Taksindu, Juving and Waku VDCs of Solukhumbu in the south and Rolwaling (Dolakha) in the west.

The park consists mostly of steep and rugged terrain broken by deep ravines and glacial valleys, the valleys divided by ridges rising to high rock and snow peaks. The mountain terrain of the park looks like a three fingered palm. The landscape is mainly traversed by three tributaries of the Sapta Koshi River Systems, namely Imja Khola, Dudh Koshi and Bhote Koshi. Above 4000m the landscape has been lined into the broad U-shaped valleys which indicate glaciers imprimatur (Hagen 1969).

This study has been carried out in the Imja valley and lies within the Khumjung VDC. This valley lies in the north-east part of the park. The present study starts from Phungitanga (3400m asl) to Chhukung (4,650m). It lies between 27º49'58.08" to 27º54'18.48" North latitudes and 86º30'57.06" to 86º99'15.96" East longitudes.

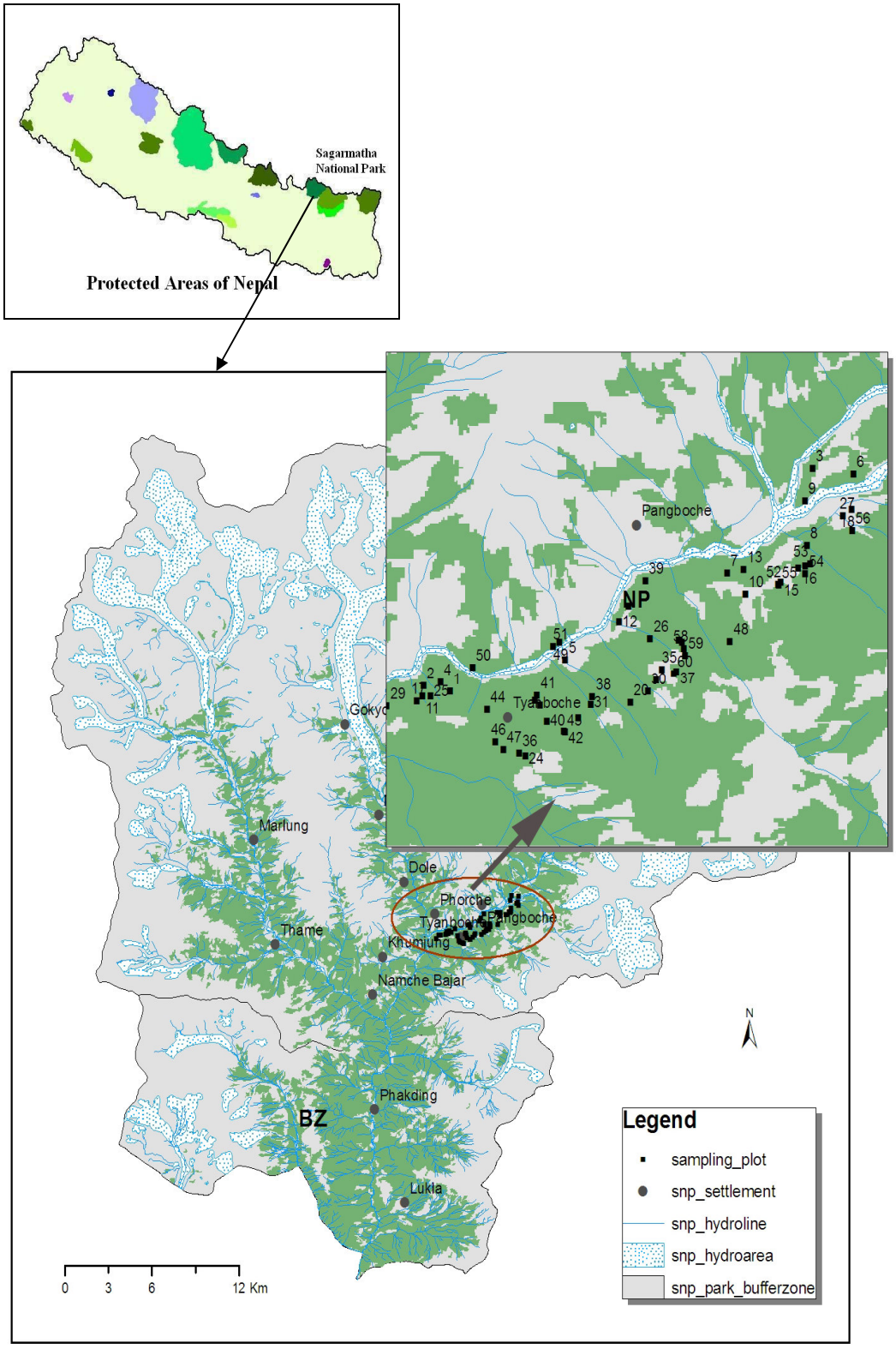

Fig. 2.1: *Location of the study area: Imja valley in Sagarmatha National Park and sampling plots.*

2.2 Vegetation

The diverse climate and complex topography in the park area shelters the occurrence of a number of vegetation type. Six out of 11 vegetation zones as described for the Nepal Himalaya by Dobremez (1975) exist in the Park. The dominant vegetation in the protected area is alpine meadow and scrub. The following are the main forest and vegetation types in the Park (Garratt 1981; Chaudhary 1998):

i) Temperate mixed Forest: The *Quercus* species is used to be the dominant species in the upper mountain zone (up to 3,000m) but former stands of this species and *Abies spectabilis* have been colonized by *Pinus* spp. *Rhododendron arboreum*, *R. triflorum*, and *Taxus wallichiana* are associated with pine at lower altitudes. Shrubs include *Pieris formosa*, *Cotoneaster microphyllus* and *Rhododendron lepidotum*. *Parthenocissus himalayan* and *Clematis montana* are the common vines. The low altitude trees include maple *Acer campbelli* and white beam (*Sorbus cuspidata*).

ii) Lower sub-alpine forests: The lower sub-alpine forests above 3,000m altitude represent blue pine (*Pinus wallichiana*), silver fir (*Abies spectabilis*) and juniper (*Juniperus recurva*). The common associated species are *Rhododendron campanulatum*, *R. barbatum, Viburnum* sp., *Lonicera anguistifolia* etc.

iii) Upper sub-alpine forest: The forest above 3,600m to timber line represents birch-rhododendron forest and various Rhododendrons show their brilliant colors in spring and monsoon. The dominant species are *Betula utilis*, *Rhododendron campanulatum* and *R. campylocarpum*. The patches of Abies-*Betula* forests are also common. The other associated species are *Lyonia ovalifolia, Sorbus* sp., *Ligustrum* sp., *Acer* sp., *Salix* sp. etc.

iv) Lower alpine zone: The forest lies above the timber-line (3,800-4,050m) to 4,500m is comparatively drier. The dominant species are *Juniperus indica*, *Rhododendron anthopogon* and *R. lepidotum* along with dwarf rhododendrons and cotoneasters, shrubby cinquefoil (*Potentilla fructicosa* var. *rigida*), willow (*Salix sikkimensis*) and *Cassiope fastigiata*.

v) Upper alpine zone: Above 4,500m, grassland and dwarf shrubs are predominant. Dwarf shrubs include *Hippophae tibetana, Ephedra gerardiana, Juniperous indica* along with a variety of herbs such as *Gentiana prolata*, *G. stellata, Leontopodium stracheyi, Codonopsis thalictrifolia, Thalictrum chelidonii*, *Lilium nepalense*, *Fritillaria cirrhosa* and *Primula denticulata*, *P. atrodentata*, *P. wollastonii* and *P. sikkimensis*. The shrub layer diminishes as conditions became cooler and above 5,000m *Rhododendron nivale* is the sole representative of its genus.

vi) Sub-nivale zone: Cushion plants above 5,500m include *Arenaria polytrichoides* and *Tanacetum gossypinum*. Up to the permanent snow line at about 5,750m, plant life is restricted to lichens, mosses, dwarf grasses and sedges. Above this conditions are arctic.

2.3 People and Land Use Pattern

Khumbu is the home of the famous Sherpa people. There are currently about 6,000 people living inside SNPBZ, with around 90% of the population being Sherpa. Most settlers spend between nine and twelve months in the area each year, with Kathmandu serving as a retreat during the winters for more affluent households. In addition to the local Sherpa population, tourism has grown considerably in the Sagarmatha National Park since 1994 (SPCC 1997) leading extensive deforestation (Jefferies 1982; Bjonness 1983). For instance, numbers of trekkers grew from 4,254 in 1975/76 to slightly more than 27,000 in 2006/07 as well as thousands of migrant workers who work in the tourism industry as porters and guides (Mallarach 2008).

The Sherpas make a living by farming mainly Potato (*Solanum tuberosum*), and barley (*Hordeum vulgare*) and graze their yaks in high altitude pastures. Young Sherpas have also made their name in mountaineering and the trekking industry has of late become the community's economic mainstay. Tourism is showing significant promise in uplifting the economy of the country and to create jobs for the rural poor. In the absence of proper management, however tourism can have significant negative impacts on the environment and culture of the area.

Large amount of land surface of the national park together with buffer zone is covered by barren land including snow-covered surfaces. In 1978, forestland, shrub land,

grassland and agriculture land had covered 27.3% of total land surface while it is reduced to 14.38% in 1992 and comprises only 3.4% of forest along with shrub land 3.15%, grassland 7.18%, and agriculture land 0.65% whereas 85.62% of area is covered by barren land including snow-covered surfaces (DNPWC 2004). Above 5,000m most of the Park (69%) comprises of barren land, 28% is grazing land and only 3% is forested (Sherpa 1985).

2.4 Climate

The climate of the SNP ranges from temperate to alpine with altitudinal and seasonal moisture and temperature variations, i.e., from lower settlement to higher one and from winter to summer. Climatic data recorded at Pyramid Observatory Laboratory (5,050m) shows that the monthly average temperature is -9.1^{o}C in February and 4.1^{o}C in July while Namche Bazar (about 3,400m) records -0.4^{o}C as monthly average temperature in winter (January) and 12.1^{o}C in July. Considerable variation in precipitation is recorded. Average precipitation is less than 1,000mm per year (DNPWC 2004). About 80% precipitation falls during June to September and about 10% falls from May to October (Miehe 1989). The July is the wettest month for Khumjung (Byers 1986). Khumbu Region is characterised by a semi-arid climate and shows that the climatological features near the Pyramid Station are more similar to those of the valley stations, rather than to those of the ridge and peak stations (Tartari *et al.* 2000).

However, since the mid-1970s, the average air temperature has risen by 1°C in the Himalaya - almost twice as fast as the global average warming of 0.6°C reported by the IPCC (UNESCO/WHC 2007). Climate warming is reducing the glaciers, especially those not insulated by debris and 12 new glacier-foot lakes have formed in the region. There is high potential for lake outburst floods triggered by falling ice blocks: three such floods have already occurred since 1977 (Byers 2007). The loss of snow will diminish the scenery and yield drastically less water to populations in India, though during the monsoon, together with rapid glacial melt, catastrophic floods will also occur downstream. And higher temperatures will alter the growth of vegetation and may induce invasion by alien pests and diseases (UNESCO/WHC 2007).

3. MATERIALS AND METHODS

3.1 Collection and Identification of plant specimens

Recent collection of the flowering plants from the Imja Valley was conducted by Darwin Initiative expedition team in 2005. As a follow up the exploration in Imja valley, with emphasis on herbaceous flora, field visit was made from 27th September to 19th October 2007. Plants specimens were collected from study area within sample plots as well as en-route. For each species, at least 3 specimens were collected as far as possible. The voucher specimens were properly tagged during collection with appropriate field notes. The collected specimens were dried and mounted on herbarium sheets. The identification of collected specimens was done by comparing herbarium specimens deposited at Tribhuvan University Central Herbarium (TUCH), and National Herbarium and Plant Laboratory (KATH) as well as by using relevant literatures such as: Hooker (1875-1897), Polunin and Stainton (1984), Stainton (1997), Grierson and Long (1983-2001), Noltie (1994, 2000, 2002), Sharma and Balkrishnan (1993), Zheng-yi *et al.* (1996-2003) etc. The herbarium specimens are deposited in Tribhuvan University Central Herbarium (TUCH).

3.2 Description

The Engler system of Melchior (1964) has been followed in the arrangement of families. The nomenclature of species was validated using latest taxonomic literatures (Hara *et al.* 1978, 1979 and 1982; Press *et al.* 2000). The basionyms and synonyms are also given. The local names were given which were noted in the field if not from secondary literature (Shrestha 1998).

Description format:

Family (Capital and Bold)

Genus (Capital and Bold) Followed by author citation

Species (Bold letters) followed by authors and bibliographic citations. Local name(s)/Vernacular name(s): (Italics) in Roman English.

Basionyms and *Synonyms* (if any) in italics.

Description of species: Normal letters. The descriptions of species basically follow the pattern of Flora of Bhutan and Flora of China.

Habitat: **Phenology:** Fl. & Fr.:

Representative collection: District, exact locality, altitude, latitude, longitude, date of collection, collector(s), collection no.

Distribution: Worldwide distribution followed by Nepal (regional, altitudinal).

3.3 Sampling strategy and sample size

Sampling sites were generated by stratified random sampling on the map. Each site, thus, contained latitudes and longitudes which were located in the field with the help of GPS (Etrex Co.). Such sampling plots were designed to cover all types of forest present within the altitudinal range of 3600-4100m of study site. Stratification of the forest area was done on the basis of forest types that were classified according to FAO, Land Cover Classification System (LCCS), version 2. The land cover map of SNPBZ, prepared by ICIMOD, was followed for the work. Samplings were done under different forests *viz.* broad leaved closed forest, broad leaved open forest, multilayer mixed forest, needle leaved closed forest and needle leaved open forest.

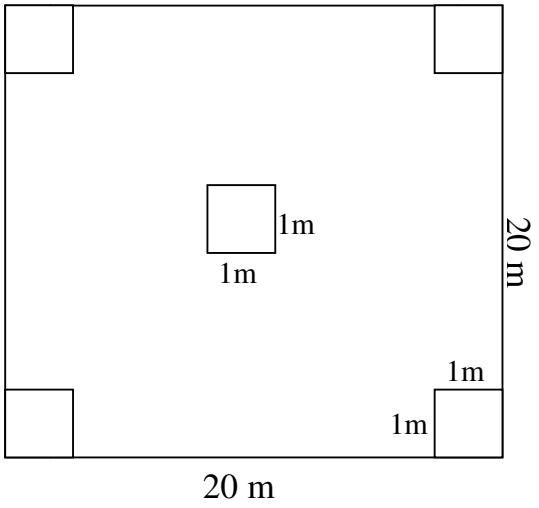

Fig 3.1: Sampling design

Firstly, large plots of size 20m×20m was laid at each sampling point for tree category. Within each large plot, 5 small plots of size 1m×1m were established for herbaceous plant species. The sampling was conducted at 60 sites in varying altitudes (3600-4100m) and different aspects (Appendix II). Thus, there were altogether 60 large plots (50 of 20m×20m and 10 of 10m×10m at shrub layer) and 300 plots of size 1m×1m were laid. All the herbaceous species with in the sample plots were recorded. Sampling design is shown in Fig. 3.1.

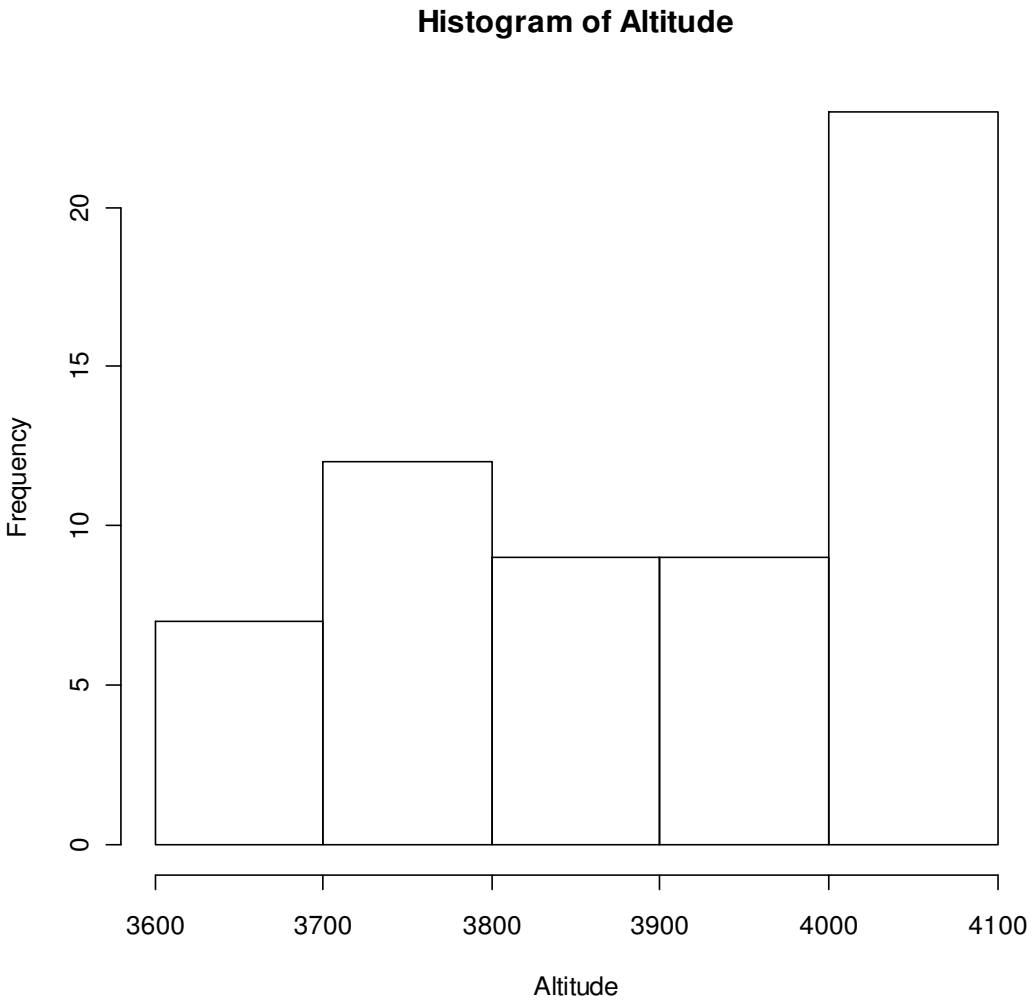

Fig 3.2: Sampling frequencies along the altitude

As sampling plots were designed to cover all types of forest in the SNP, sampling frequencies were not equal in all altitudinal intervals. The sampling frequencies for different altitudinal ranges i.e. 3,600-3,700m, 3,700—3,800m, 3,800-3,900m, 3,900-4,000m and 4,000-4,100m were 7, 12, 9, 9 and 23 respectively (Fig. 3.2).

Sign of human impact like fire, lopping, logging, grass cutting, grazing were recorded in each sampling plots to evaluate the relationship between disturbance and species richness. All the parameters are recorded in terms of presence and absence. But fire scars were not observed and hence excluded during the analysis.

3.4 Species Richness

Species richness is currently the most widely used measure of diversity (Stirling & Wilsey 2001). It is a simple and easily interpretable indicator of biological diversity. Species richness is the number of species per unit of area. Species richness of the landscape comprises both the species richness in individual habitat, and the degree of variation in species composition among the different habitats. Whittaker (1975) has divided richness into alpha, beta, and gamma diversity. The species richness (S) is the number of species in a given area. In this study, species richness is defined as the number of herbaceous plant species occurring within each sample plot (1mx1m). The species richness (S) of a sample representing a particular habitat has been regarded as homogenous and is an alpha (α) or within-habitat diversity. Beta (β) or between-habitat diversity is the change in species composition from one site to the next along a gradient, also referred to as species turnover. Unlike alpha diversity, which provides information about diversity at a local site, beta diversity provides information about how diversity changes along environmental gradients. Finally, gamma (γ) diversity is a measure of the diversity across habitats or community types within a landscape or region.

3.5 Numerical data analysis

a) Regression

Regression models are mathematical postulates about the relationship between a dependent variable, one or several independent variables, and residuals (Vogt 1999). The residual specify the size of the part, which is unexplained by the regression equation. The equation consists of a Y (the dependent variable, also called a response), a-the intercept of y-axis, and one or more terms with coefficients (b_1-b_n) and independent variables (X_1-X_n), also called the predictors.

$$Y= a + (b_1-b_n). (X_1-X_n)$$

If the regression model predicts the relationship between response and predictors to be linear, the term of model will not be raised to a power, the model predicts a curvilinear relationship between a response and predictor, and the model is quadratic or cubic respectively

Generalized linear model (GLM)

GLM is parametric model. It assumes that the probability distribution for the residuals is adequately described as Gaussian (normal) or Poisson (Palmer 2007). GLM models are all members of the exponential family of distribution, and allow the modeling of responses, or dependent variables, that take the form of counts, proportions, dichotomies (1/0), positive continuous values, as well as values that follow the normal Gaussian distribution.

GLMs were used to test the relationship between species richness and each of the predictor variables. Species richness was used as the response variable and elevation as the explanatory variable. The response variable, species richness, is discrete data (counts) and a Poisson distribution of error was assumed, and a logarithmic link was used in the GLM (McCullagh & Nelder 1989, Pausas 1994).

When there is count data as response variable and one discrete variable as response and one or more categorical response variables with two or more levels, ANCOVA is the best method to evaluate the pattern among the response and predictor variables (Crawley 2007). Analysis of Covariance (ANCOVA) was used to evaluate the effect of categorical variables like grass cutting, litter fodder collection along with altitude on species richness.

b) Software used

R Console version 2.7.1 (R Development Core Team 2008) was used to analyze the relationship between species richness and each of the predictor variables.

4. RESULTS

4.1 Floristic composition

Altogether 180 species, including 2 subspecies and 3 varieties, of herbaceous angiosperms under 93 genera and 35 families were recorded from the study area (Appendix IV & V). Among them, 146 species were Dicotyledoneae belonging to 76 genera and 30 families and 34 species were of Monocotyledoneae belonging to 17 genera and 5 families. Out of 180 species, 4 species were identified up to generic level whereas 15 species up to only family.

Table 4.1: Floristic composition of the study area

Category	Dicotyledoneae		Monocotyledoneae		Total
	Number	Percentage	Number	Percentage	
Family	30	85.71	5	14.29	35
Genus	76	81.72	17	18.28	93
Species	146	81.11	34	18.89	180

The study area was found to be dominated by Asteraceae with 26 species and it is followed by Poaceae and Polygonaceae consisting 24 species and 13 species respectively. Other larger families were Saxifragaceae (10 species); Gentianaceae, Rosaceae and Apiaceae consisted 9 species each (Fig. 4.1); Ranunculaceae and Scrophulariaceae with 8 species each; Crassulaceae (6 speceis); Boraginaceae and Campanulaceae with 5 species each; and so on.

The largest genus recorded was *Saxifraga* comprising 9 species and it was followed by *Potentilla* with 7 species; *Anaphalis*, *Bistorta* and *Pesicularis* each consisting 5 species. The other larger genera were *Cyananthus, Epilobium*, *Poa* and *Rhodiola* each with 4 species (Fig. 4.2); and so on.

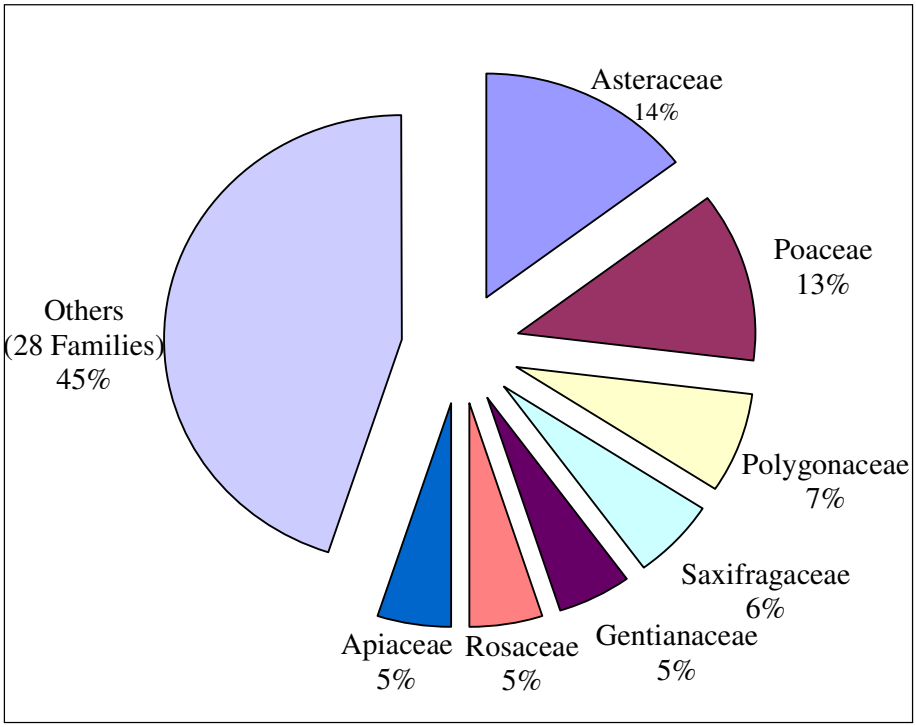

Fig. 4.1: Family wise distribution of the species

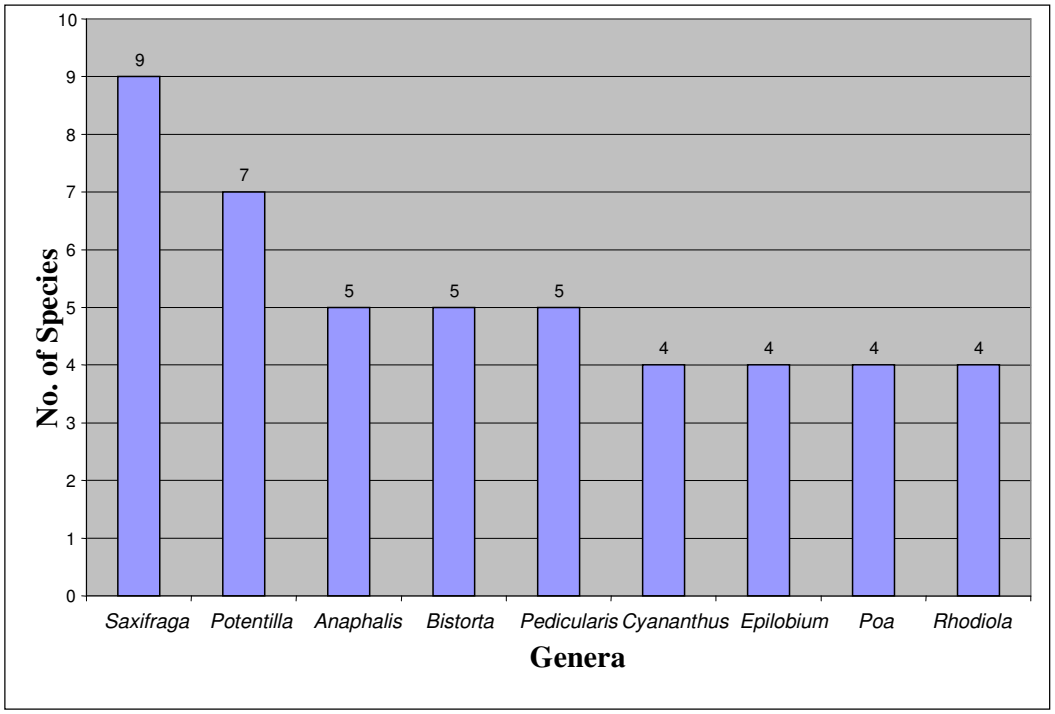

Fig. 4.2: Major genera along with their species number

4.2 Species richness pattern along altitudinal gradient

A significant negative relationship was found between altitude and species richness (Table 4.2). Species richness monotonically decreased with increasing altitude (Fig. 4.3). Species richness was estimated to be 5.1 (intercept) when there was no effect of the altitude. However, it is expected to decrease by 0.0008 (slope) with each unit increase in the altitude.

Sampling frequencies were found to be increased from 3,600 to 3,800 m whereas it decreases slightly from 3,800 to 4,000m. Finally sampling intensity increased from 4,000m up to the top of the gradient. Highest sampling frequency was not followed by the higher richness and vice versa. Thus, there was no correlation between sampling and observed pattern in species richness. Sampling bias had no effect on the observed species richness along the altitude in this study (Fig. 3.2 & 4.3).

Table 4.2: Summary statistics for the regression of species richness against altitude (I st order GLM)

Call: glm (formula = sprichness ~ Altitude, family = poisson)

Coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	5.1059129	1.2656140	4.034	5.48e-05 ***
Altitude	-0.0008074	0.0003258	-2.478	0.0132 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Null deviance: 122.61 on 59 degrees of freedom
Residual deviance: 116.53 on 58 degrees of freedom

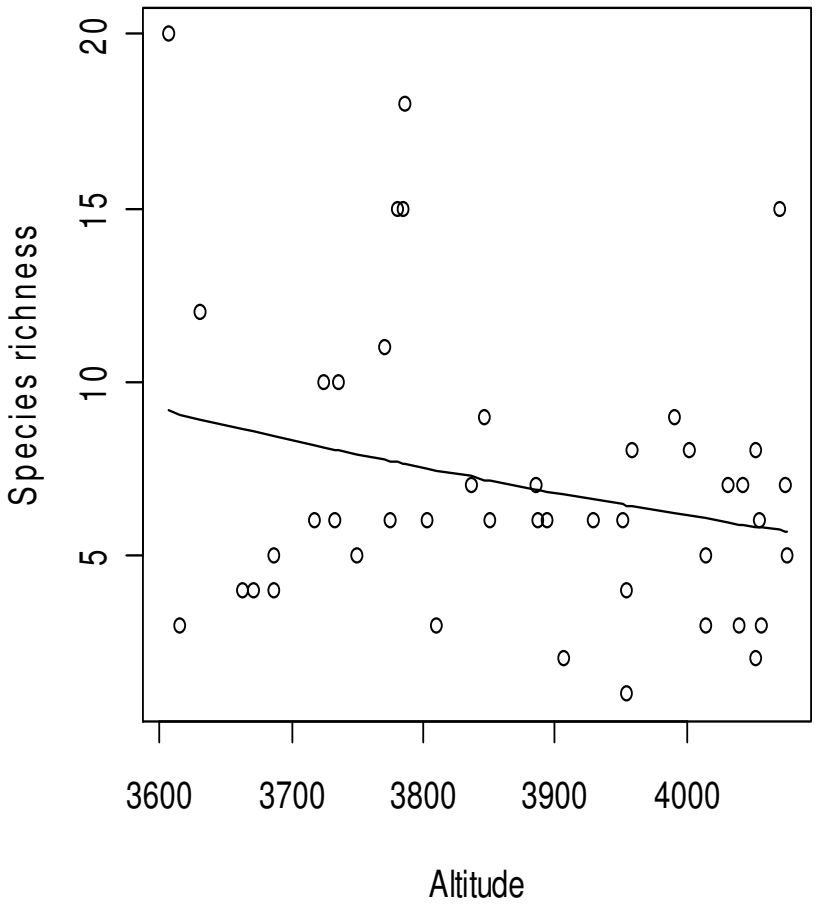

Fig. 4.3: Relationship between altitude and species richness

4.2 Species richness and disturbance along with altitudinal gradient

Out of the different parameter of disturbances *viz*. lopping, logging, fuel wood collection, litter/fodder collection, grass cutting, grazing; only grass cutting and litter/fodder collection are found significant to the species richness. Species richness is found to be least, i.e., 5.692 in the absence of both disturbance parameters and result is also found to be similar when there is only one disturbance parameter, i.e., litter/fodder collection. The species richness is found to be highest, i.e., 16.25 in the presence of only grass cutting. Species richness is found to be moderate, i.e., 8.25 when there are both disturbance parameters. A monotonic positive correlation is found between species richness and disturbance parameters. However, extreme disturbance is found to be unfavorable to species richness (Table 4.3).

Species richness is found to be decreased due to the effect of altitude and litter/fodder collections. Species richness is found to be 5.84 when there was no effect of litter/fodder collection. Species richness is found to be decreased by 0.00097 times with each unit increase in altitude. Similarly, it is decreased by 0.23 times where there was litter/fodder collection (Table 4.4 & Fig. 4.4).

Table 4.3: Mean number of species according to disturbance (ANCOVA, I st order GLM)

	Litter/fodder collection	
Grass cutting	NO	YES
NO	5.692308	5.70
YES	16.250000	8.25

Table 4.4: Summary statistics for the regression of species richness against altitude and litter/fodder collection (I st order GLM)

Call: glm (formula = sp.richness ~ altitude + litter..fodder.collection,
family = poisson)

Coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	5.8463484	1.4686370	3.981	6.87e-05 ***
altitude	-0.0009719	0.0003818	-2.546	0.0109 *
litter..fodder. collectionyes	-0.2300583	0.1130509	-2.035	0.0419 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Null deviance: 99.941 on 44 degrees of freedom
Residual deviance: 88.979 on 42 degrees of freedom

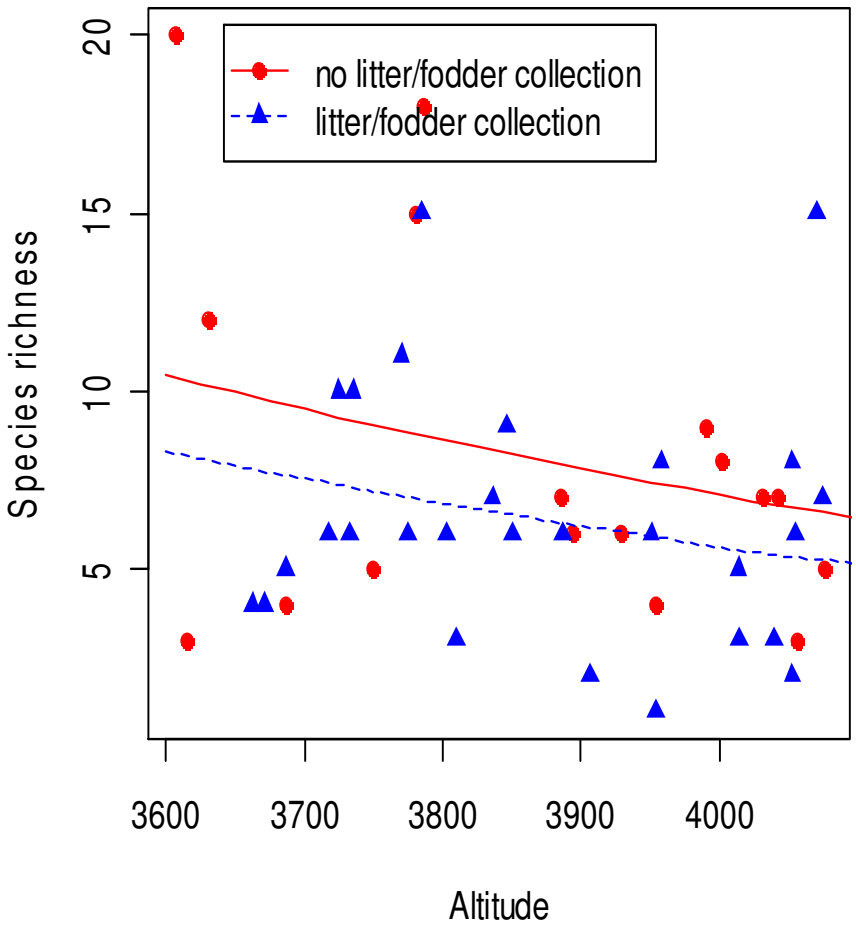

Fig. 4.4: Regression of species richness against altitude and litter/fodder collection

Table 4.5: summary statistics for the regression of species richness against altitude and grass cutting (I st order GLM)

Call: glm (formula = sp.richness ~ altitude * grass.cutting, family = poisson)

Coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.2347911	2.0575831	0.114	0.9092
altitude	0.0003853	0.0005259	0.733	0.4638
grass.cuttingyes	8.1108757	3.6696814	2.210	0.0271 *
altitude:grass.cuttingyes	-0.0019649	0.0009638	-2.039	0.0415 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Null deviance: 99.941 on 44 degrees of freedom
Residual deviance: 64.493 on 41 degrees of freedom

Effect of interaction of altitude and no grass cutting is found to be statistically insignificant (Table 4.5). However, presence of grass cutting is found to decrease the species richness along the altitude (Table 4.5 and Fig. 4.5). Intercept (0.234) stands for no grass cutting and altitude (0.00038) stands for the slope of no grass cutting, both of which are found to be insignificant. The grass cutting parameter (8.11) represents the difference of the intercept of the no grass cutting and grass cutting (0.234+8.11= 8.344). Altitude and grass cutting interaction term represents the difference in the slope of no grass cutting and grass cutting (0.00038-0.0019 = -0.00152).

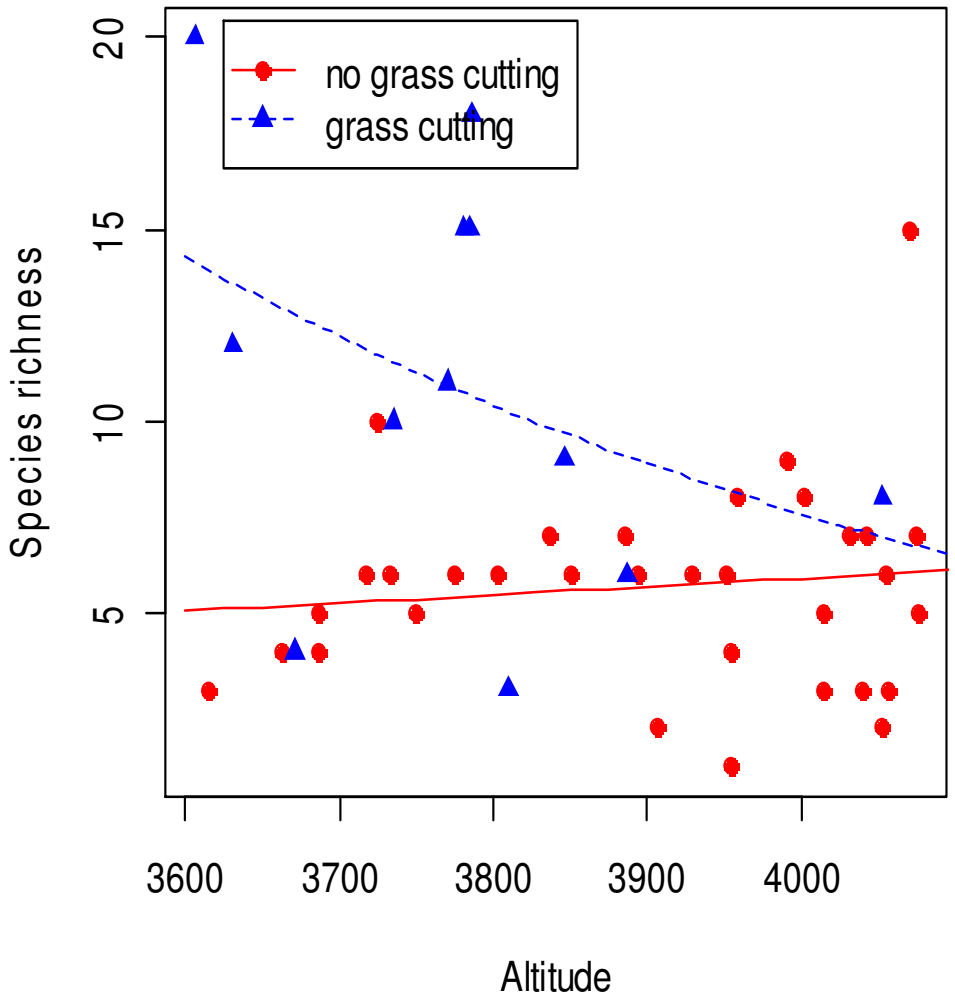

Fig. 4.5: Regression of species richness against altitude and grass cutting

4.3 Description of plant species

DICOTYLEDONEAE

Family 1: POLYGONACEAE

1. ACONOGONUM Rchb.

1. Aconogonum sibiricum (Laxm.) H. Hara, *Fl. E. Himalaya*: 632 (1966). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 237 (2000).

Polygonum sibiricum Laxm., *Nov. Com. Acad. Sci. Petrop.* **18**: 53 (1773).

Perennial dwarf glabrous herb up to 20cm. leaves oblong-lanceolate, 1-4×0.5-1cm, obtuse, base shortly hastate-lobed, tapering into a broad petiole; ocrea membranous. Flowers in capitate whorls or sometimes short racemes. Achenes brown.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Pangboche surrounding, 4000m, 27°51.39'N, 86°47.57'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP53 (TUCH).

Distribution: Central Asia, Himalaya (Kashmir-Sikkim, Bhutan), East Siberia, Mongolia, North & West China. Nepal (Western-Eastern: 4000-4700m).

Note: Previously reported only from the Western and Central Nepal (Press *et al.* 2000).

2. Aconogonum tortuosum (D. Don.) H. Hara in *Fl. E. Himalaya*: 632 (1966). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 237 (2000).

Polygonum tortuosum D. Don., *Prodr. Fl. Nep.:* 71 (1825).

Perennial erect, divertically branched subshrub, up to 40cm. Leaves ovate-elliptic, 2-3.5×1-2cm, acute or obtuse, base rounded, pubescent. Flowers in dense terminal panicles. Perianth whitish, 5mm. Thick achenes ca. 5mm, pale brown.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Pangboche surrounding, 4000m, 27°51.39'N, 86°47.57'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP54 (TUCH).

Distribution: Afghanistan, Himalaya (Kashmir-Bhutan), China (Xizang). Nepal (Western-Eastern: 3300-5600m).

2. BISTORTA Scop.

1. Bistorta affinis (D. Don) Greene, *Leafl.* **1**: 21 (1904). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 237 (2000).

Polygonum affine D. Don, *Prodr. Fl. Nep.:* 70 (1825).

Perennial tufted glabrous herb with prostrate woody rootstock. Flowering stem erect, 10-30cm. Leaves elliptic-lanceoalte, 4-10×0.5-1.5cm, acute, short petiolate. Flowers in dense terminal racemes, 3-6cm, bright red.

Habitat: Dry shrubland of *Rhododendron anthopogon*. **Fl. & Fr.:** Jun.-Oct.
Representative collection: Solukhumbu, above Yaren forest, Pangboche, 4220m, 27º50.48'N, 86º47.63'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP130 (TUCH).
Distribution: Himalaya (Uttar Pradesh-Bhutan), North-East India, Western and Central China. Nepal (Western-Eastern: 2700-4500m).

2. Bistorta amplexicaulis (D. Don) Greene, *Leafl.* **1**: 21 (1904). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 237 (2000).

Polygonum amplexicaule D. Don, *Prodr. Fl. Nep*. 70 (1825).

Erect herb with thick rhizomes. Stems 30-75cm. Leaf blade ovate, 4-10×2-4mm, base cordate; margin entire; apex acuminate; upper leaves sessile, amplexicaul glabrous; ocreae brown, membranous. Flowers in racemes of 2-7cm. Perianth pink. Achenes 5-6mm, brown.
Habitat: *Rodhodenron campylocapum* forest. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, Deboche forest, 3930m, 27º50.18'N, 86º46.37'E, October 10, 2007, E.N. Paudel and S.R. Maharjan, SNP207 (TUCH).
Distribution: Afghanistan, Himalaya (Kashmir-Bhutan), China (Xizang). Nepal (Western-Eastern: 2100-4800m).

3. Bistorta milletii Lev., *Feede. Repert. Spec. Nov. Regni Veg.* **12(325-330)**: 286 (1913). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 237 (2000).

Polygonum milletii Lev. in *Feede. Repert. Spec. Nov. Regni Veg.* **12(325-330)**: 286 (1913).

Rootstocks thick, fibrous. Stems 20-30cm; lower leaves lanceolate, 8-15×0.7–4.5cm, gradually acuminate, lamina base abruptly narrowed and decurrent on petiole, margins flat; upper leaves sessile. Flowers in racemes of 2.5-6 cm. Achenes ca. 4mm, brown.
Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Aug.-Nov.
Representative collection: Solukhumbu, Pangboche surrounding, 4020m, 27°51.40'N, 86º47.39'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP65 (TUCH).
Distribution: Himalaya (Nepal, Bhutan), Western China. Nepal (Western-Eastern: 3000-4020m).
Note: Previously reported only from the Western and Central Nepal up to 3400m (Press *et al.* 2000).

4. Bistorta vaccinifolia (Wall. ex Meisn.) Greene, *Leafl.* **1**: 21 (1904). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 237 (2000).

Polygonum vaccinifolium Wall. ex Meisn., Wall., *Pl. As. Rar.* **3**: 54 (1832).

Prostrate subshrub with trailing stoliniferous stems. Flowering shoots suberect, up to 30cm. Leaves ovate-elliptic; 1-2×0.6-1cm, acute, base cuneate, glabrous, sessile. Flowers in terminal racemes, pink. Achenes ca. 2mm, brown.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Aug.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4010m, 27°51.29'N, 86°48.02'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP81 (TUCH).

Distribution: Himalaya (Kashmir-Bhutan). North East India (Manipur), China (Xizang). Nepal (Western-Eastern: 3000-4500m).

5. Bistorta vivipara (L.) Gray, Nat. *Arr. Brit. Pl*. **2**: 168 (1821). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 237 (2000).

Polygonum viviparum L.*, Sp. Pl.:* 360 (1753).

Erect herb, stems simple, 8-30cm. Lower leaf blade ovate, 1.5-11×0.5-2cm, base rounded or cordate, margin entire, apex acute, usually finely pubescent beneath; upper leaves linear, sessile. Flowers in racemes of 2-7cm. Achenes ca. 1.5mm, brown.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 3,950m, 27°51.38'N, 86°47.78'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP105 (TUCH).

Distribution: Europe, West and Centre Asia, Himalaya, China, Japan, Siberia, North America, Greenland. Nepal (Western-Eastern: 3300-5000m).

3. FAGOPYRUM Mill., nom. cons.

1. Fagopyrum esculentum Moemch, *Meth*.: 290 (1794). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 238 (2000). '*Phapar'* (फापर).

Polygonum fagopyrum L., *Sp. Pl.* 364 (1753).

Annual herbs up to 70cm. Leaves blade triangular heart-shaped, 2-5×2-5cm; upper leaves sessile. Flowers in terminal branched clusters, pink. Nutlets ca. 6mm, with smooth faces and angles.

Habitat: Open grassland. **Fl. & Fr.:** Aug.-Mar.

Representative collection: Solukhumbu, Between Pangboche & Somare, 4,030m, 27°52.00'N, 86°48.20'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP152 (TUCH).

Distribution: Central Asia. Nepal (Western-Eastern: 1800-4100m).

4. KOENIGIA L.

1. Koenigia deliculata (Meisn.) H. Hara, *Fl. E. Himalaya*: 70 (1966). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 238 (2000).

Polygonum delicatulum Meisn. in DC., *Prodr*. **14(1)**: 127 (1956).

Annual slender, 5-20cm. Leaves alternate, ovate, 3-10×1.5-5mm, acute, base rounded, subsessile, glabrous; Flowers 3-4 in axillary clusters, white. Achenes trigonous, ca. 2mm.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Aug.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4010m, 27°51.29'N, 86º48.02'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP80 (TUCH).

Distribution: Himalaya (Kashmir-Bhutan), Northern Myanmar. Nepal (Western-Eastern: 2700-4000m).

5. OXYRIA Hill.

1. Oxyria digyna (L.) Hill, *Hort. Kew*: 158 (1768). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 238 (2000).

Rumex digynus L., *Sp. Pl.* 337 (1753).

Stems 5-60cm. Leaves 2-8 cm, fleshy, pale green rounded or kidney-shaped, acute or obtuse; ocreae brown, acute, brittle. Flowers in branched terminal racemes. Fruit orbicular, notched at apex; surrounded by a brown, membranous wing.

Habitat: Open grassland. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Dingboche, 4370m, 27º53.79'N, 86º50.35'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP164 (TUCH).

Distribution: Europe, Western and Central Asia, Himalaya (Kashmir to Bhutan), Siberia, West China, Japan, North America, Greenland. Nepal (Western-Eastern: 2400-5000m).

6. PERSICARIA Mill.

1. Persicaria nepalensis (Meisn.) H. Gross*, Bot. Jaharb*. **49**: 277 (1913). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 239 (2000).

Polygonum nepalense Meisn., *Monogr. Polyg*. 84, t. 7, f 2 (1826).

Prostrate annual herb, stem branched, 10-30cm. Leaves ovate or elliptic, 1-5×0.7-3cm, acute, base rounded, lamina decurrent; petioles auriculate at base, glabrous. Flowers in globose heads, pink.

Habitat: *Rhododendron* forest. **Fl. & Fr.:** Apr.-Oct.

Representative collection: Solukhumbu, near Tenboche, 3,880m, 27º50.09'N, 86º45.92'E, October 16, 2007, E.N. Paudel and S.R. Maharjan, SNP266 (TUCH).

Distribution: Tropical Africa, Afghanistan, Himalaya, India, East to China and Japan, Malaysia. Nepal (Western-Eastern: 1200-4100m).

7. RHEUM L.

1. Rheum acuminatum Hook. f. & Thomson ex Hook., *Bot. Mag.* **81**: t. 4877 (1855). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 240 (2000).

Perennial herbs, 0.5-1m. Basal leaves 15-30×15-30cm, shortly acuminate, base cordate, sparsely pubescent beneath; upper leaves smaller; ocreae brown. Flowers in axillary or terminal panicles, dark red. Fruits orbicular, notched at base and apex.

Habitat: Dry shrubland of *Rhododendron anthopogon*. **Fl. & Fr.:** Jun.-Sep.

Representative collection: Solukhumbu, above Yaren forest, Pangboche, 4270m, 27º50.54'N, 86º47.62'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP132 (TUCH).

Distribution: Himalaya (Nepal-Bhutan), North-East India, North Myanmar. Nepal (Central-Eastern: 3300-4300m).

Note: Previously reported only up to 4200m (Press *et al.* 2000).

Family 2: CARYOPHYLLACEAE

1. ARENARIA L.

1. Arenaria depauperata (Edgew.) H. Hara., *J. Jap. Bot.* **51**: 129 (1976). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 39 (2000).

Stellaria depauperata Edgew. ex Edgew. & Hook. f. in *Fl. Br. Ind.* **1**: 234 (1874).

Annual, slender suberect herb 5-12cm. Stem 4-angular stems bearing a line of pubescence. Leaves linear-lanceolate, 4-10×1.5-2mm, acuminate, glabrous. Flowers solitary or few in cyme, white. Fruit a capsule.

Habitat: On the river bank. **Fl. & Fr.:** Sep.-Oct.

Representative collection: Solukhumbu, Near Chhukum, 4610m, 27º54.31'N, 86º52.26'E, October 8, 2007, E.N. Paudel and S.R. Maharjan, SNP181 (TUCH).

Distribution: Himalaya (Uttar Pradesh-Bhutan). Nepal (Western-Eastern: 3500-4600m).

Note: Previously reported only from the Western and Central Nepal up to 4400m (Press *et al.* 2000).

2. SILENE L.

1. Silene indica Roxb. ex Otth, *Prod.* **1**: 368 (1824). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 42 (2000).

Lychnis indica (Roxb. ex Otth) Benth. in Royle, *Illus. Bot. Himal* **1**: 81 (1824).

Perennial, 25-70cm. Stems erect, retrose pubescent throughout, apically glandular hairy. Leaves lanceolate, 1.5-2.5×0.6-1cm, hirtellous, sometimes glandular hairy; margin ciliate. Flowers in loose cyme, sometimes solitary terminal. Capsule ovoid.

Habitat: Open grassland. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Between Pangboche & Somare, 4030m, 27º52.00'N, 86º48.20'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP149 (TUCH).
Distribution: Himalaya (Kashmir to Assam), China, Bhutan. Nepal (Western-Eastern: 2000-4500m).

2. Silene khasiana Rohrb., *Linnaea* **36**: 258 (1870). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 42 (2000).

Perennial, 40-80cm. Stems tufted, decumbent, glandular hairy. Leaves ovate, 3-5.5×1.5-2.7cm, sessile, sparsely hairy, 3-5 nerved. Flowers in terminal cymes or few flowered lax cymes with smaller lateral one; and often with single flowered; pale pink. Capsule ovoid, open with 6 teeth.
Habitat: Near the trail. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, Phungitanga, 3430m, 27º49.97'N, 86º44.95'E, 30th Sep. 2007, E.N. Paudel and S.R. Maharjan, SNP41 (TUCH).
Distribution: North-East India (Meghalaya). Nepal (Eastern: 2850-3430).
Note: Previously reported from Nepal without regional and altitudinal range (Press *et al.* 2000).

3. Silene stracheyi Edgew., *Fl. Brit. India* **1(2)**: 221 (1874). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 42 (2000).

Perennial, stems slender, climbing, pubescent. Leaves lanceolate, 2.5-5×0.7-1.2cm; base cuneate, subsessile, sparsely hairy; margin ciliate; apex acute or acuminate. Flowers in 1-3 flowered loose cyme at the end of branch. Capsule obovate, 6 toothed.
Habitat: Near the trail. **Fl. & Fr.:** Aug.-Oct.
Representative collection: Solukhumbu, Phungitanga, 3430m, 27º49.97'N, 86º44.95'E, 30th Sep. 2007, E.N. Paudel and S.R. Maharjan, SNP40 (TUCH).
Distribution: Himalaya (Uttar Pradesh-Bhutan). Nepal (Western-Eastern: 2750-3450m).
Note: Previously reported from Western and Central Nepal without altitudinal range (Press *et al.* 2000).

Family 3: RANUNCULACEAE

1. ACONITUM L.

1. Aconitum spicatum Stapf, *Ann. Roy. Bot. Gard. (Calcutta)* **10(2)**: 165, t. 106 & 107 (1905). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 249 (2000). 'Bish' (विश).

Perennial herbs. Stems 1.2-1.8m. Leaves 10-16cm in diameter, lobes and teeth acute. Flowers solitary or few to numerous on racemes, zygomorphic, purple-violate in colour. Follicles oblong, pubescent.
Habitat: Near the trail towards Yaren forest. **Fl. & Fr.:** Jun.-Sep.
Representative collection: Solukhumbu, Yaren forest, Pangboche, 4030m, 27^{0}51.32'N, 86^{0}47.99'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP84 (TUCH).
Distribution: Himalaya (Nepal-Bhutan), China (Xizang). Nepal (Western-Eastern: 1800-4200m).

2. CLEMATIS L.

1. Clematis montana Buch.-Ham. ex DC., *Syst. Nat.* **1**: 164 (1817). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 252 (2000). 'Junge Lahara' (जुङगे लहरा).

Woody climber. Leaves ternate, leaflets ovate, 1.5-7×1-3cm, acute, base rounded, margins toothed. Flowers 2-3 in axillary fascicles. Sepals 4, elliptic, obtuse or acute, pubescent out side, glabrous with in. Achenes ovate, compressed, glabrous.

Habitat: Open grassland. **Fl. & Fr.:** Apr.-Jul.

Representative collection: Between Pangboche & Somare, 4130m, $27^0$51.82'N, $86^0$48.03'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP147 (TUCH).

Distribution: Afghanistan, Himalaya (Kashmir, Uttar Pradesh-Bhutan), North East India, West and Central China, Taiwan. Nepal (Western-Eastern: 1600-4150m).

Note: Previously reported only up to 4000m (Press *et al.* 2000).

3. DELPHINIUM L.

1. Delphinium stapeliosum Bruhl ex Huth, *Bot. Jahrb.* **20**: 419, t. 8, f. 18 (1895). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 254 (2000).

Erect perennial herbs. Stems up to 1.5m, pubescent with deflexed hairs. Leaves suborbicular in outline, palmatisect acutely 3-5 lobed, ultimate segments lanceolate. Racemes lax, 2-4(-6) flowered, blue-black in colour. Follicles without wings.

Habitat: *Betula utilis* forest. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3720m, $27^0$50.33'N, $86^0$45.58'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP220 (TUCH).

Distribution: North East India (Meghalaya), Northern Myanmar. Nepal (Western-Eastern: 1200-3700m).

Note: Previously reported only up to 3000m (Press *et al.* 2000).

4. RANUNCULUS L.

1. Ranunculus brotherusii Freyn, *Bull. Herb. Boiss.* **6**: 885 (1898). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 255 (2000).

Annual, suberect herb up to 25cm. basal leaves 1.3-3cm long and broad, leaflets deeply cut in to linear-lanceolate segments, sparsely hirsute beneath glabrous above. Flowers usually solitary, yellow. Fruit a head or spikes of achenes.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Apr.-Oct.

Representative collection: Solukhumbu, Pangboche surrounding, 4020m, $27^0$51.42'N, $86^0$47.37'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP60 (TUCH).

Distribution: Central Asia, Himalaya (Kashmir, Uttar Pradesh-Arunachal Pradesh), China (Xizang, West & Central China). Nepal (Western-Eastern: 3000-5000m).

2. Ranunculus tricuspis Maxim., *Fl. Tangut.* **1**: 12 (1889); Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 257 (2000).

Perennial herbs, stolons 7–35 cm. Basal leaves 5–16; leaf blade 0.5–2.8×0.5–2.2cm, glabrous or puberulent, 3-cleft to 3-sect; central segment cuneate; lateral segments lanceolate-linear. Scapes 1–13cm, puberulent. Flowers 1-2, 7–11 mm in diam.

Habitat: Open grassland. **Fl. & Fr.:** May–Oct.

Representative collection: Solukhumbu, Near Chukkum, 4320m, $27^0$54.31'N, $86^0$52.27'E, October 8, 2007, E.N. Paudel and S.R. Maharjan, SNP172 (TUCH).

Distribution: Pamir, Himalaya (Kashmir, Uttar Pradesh-Bhutan), China, Mongolia. Nepal (Western-Eastern: 2600-4400m).

5. THALICTRUM L.

1. Thalictrum alpinum L., *Sp. Pl.* 545 (1753). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 257 (2000).

Thalictrum microphyllum Royle in *Ill. B. Him.*: 51 (1834).

Perennial stemless herb. Rhizomes slender. Leaves all basal, pinnate or bipinnate; leaflets broadly obovate, often 3 lobed, lobe apex subacute or rounded. Flowers in racemes, few flowered. Fruit a head of sessile achenes, winged.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jun.-Oct**.**

Representative collection: Solukhumbu, Pangboche surrounding, 4020m, $27^0$51.42'N, $86^0$47.37'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP56 (TUCH).

Distribution: North America, Arctic and Alpine Europe and Asia; Nepal (Western-Eastern: 2800-5000m).

2. Thalictrum elagens Wall. ex Royle, *Ill. Bot. Himal. Mts.* **1(2)**: 51 (1834). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 257 (2000).

Erect perennial herbs. Stems slender, 15-60cm. Leaflets elliptic-ovate, 2-4×1-2mm, bluntly 2-3-lobed, glabrous. Flowers in racemes and greenish red. Achenes obliquely obovate, each with a strong median and two finer marginal ribs, narrowly winged on back.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, North part of Dingboche, 4040m, $27^0$53.58'N, $86^0$49.33'E, October 07, 2007, E.N. Paudel and S.R. Maharjan, SNP168 (TUCH).

Distribution: Himalaya (Kashmir, Uttar Pradesh-Bhutan), North-East India, China (Xizang). Nepal (Western-Eastern: 3100-4100m).

3. Thalictrum reniforme Wall., *Pl. Asiat. Rar.* **2(6)**: 26 (1831). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 258 (2000).

Erect perennial herbs. Stems up to 2m, glabrous. Leaves 6-30cm, leaf lets broadly ovate 0.7-4×0.5-2.5cm, margin lobed. Flowers in racemes, purplish. Achenes obliquely obovate, compressed, minutely pubescent.

Habitat: Near the trail. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Phungitanga, 3430m, 27°49.97'N, 86°44.95'E, September 30, 2007, E.N. Paudel and S.R. Maharjan, SNP38 (TUCH).

Distribution: Himalaya (Nepal-Bhutan). Nepal (Central-East: 2800-3450m).

Note: Previously reported only up to 3300m (Press *et al.* 2000).

Family 4: DROSERACEAE

1. DROSERA L.

1. Drosera peltata var. **lunata** (Buch.-Ham. ex DC.) C.B. Clarke in *Fl. Brit. India* **2(5)**: 425 (1878). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 99 (2000). '*Pamga'* (पाम्गा).

Drosera lunata Buch.-Ham. ex DC., *Prodr. Syst. Natur. Reg. Veg.* **1**: 319 (1824).

A tuberous perennial herb, 10-30cm. Leaves alternate; radical leaves, smaller, rosulate, deciduous; cauline leaves lunate, palate. Inflorescence racemes, 2-8 flowered. Capsule subglobose, enclosed within the persistent calyx and corolla.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3670m, 27°50.29'N, 86°45.58'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP233 (TUCH).

Distribution: Himalaya, India, China and Japan, Malaysia, Australia, Tasmania. Nepal (Western-Eastern. 2500-3700m).

Note: Previously reported only up to 3600m (Press *et al.* 2000).

Family 5: PAPAVERACEAE

1. CORYDALYS L.

1. Corydalis casimiriana Prain in *J. Asiat. Soc. Bengal* **65(2)**: 27 (1896). Press, Shrestha & Sutton, *Ann.Check. Fl. Pl. Nep*.: 228 (2000).

Perennial, diffuse herb up to 30cm. Leaves numerous, broadly ovate, 1-3×1-3cm, deeply and equally biternisect; ultimate segments obovate or oblanceolate, 1.5-3mm broad. Flowers in few-flowered lax racemes, yellow. Capsule linear.

Habitat: On river bank. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4015m, $27^0$51.33'N, $86^0$47.79'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP92 (TUCH).
Distribution: Himalaya (Nepal-Bhutan), ?South West China. Nepal (Western-Eastern: 2700-4700m).

2. MECONOPSIS Viguier

1. Meconopsis paniculata Prain, *J. Asiat. Soc. Bengal* **64**: 316 (1896). Press, Shrestha & Sutton, *Ann.Check. Fl. Pl. Nep*.: 232 (2000).

Meconopsis wallichii Hook in *B. Maag.* **78**: t. 4668 (1852).

Monocarpic herbs up to 2.5m, yellowish villous. Rosette leaves elliptic 15-50×5-15cm, deeply pinnatified; stem leaves smaller. Flowers yellow, pendulous; upper flowers single; lower flowers in 2-6-flowered lateral cymes. Capsule ellipsoid.
Habitat: Moist open grass land. **Fl. & Fr.:** Jun.-Aug.
Representative collection: Solukhumbu, Yaren, Pangboche, 3750m, $27^0$50.75'N, $86^0$46.46'E, 6October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP249 (TUCH).
Distribution: Himalaya (Uttar Pradesh-Arunachal Pradesh), North East India. Nepal (Western-Eastern: 3000-4400m).

Family 6: BRASSICACEAE (CRUCIFERAE)

1. CAPSELLA Medik., nom. cons.

1. Capsella bursa-pastoris (L.) Medik., *Pfl.-Gatt*. **1**: 85 (1792). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 80 (2000).

Thlapsi bursa-pastosis L., *Sp. Pl.*: 647 (1753).

Annual herbs. Stems up to 70cm, simple hairs. Basal leaves runcinate-pinnatifid, 3-10×0.3-4cm, acute, base shortly petiolate. Stem leaves ovate-lanceolate, 1.5-5×0.1-2cm, acute, sharply auriculate at base. Pods 6-7mm long and broad, septum elliptic.
Habitat: Open grassland. **Fl. & Fr.:** Mar.-Oct.
Representative collection: Solukhumbu, Dingboche, 4320m, 27º53.49'N, 86º49.49'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP161 (TUCH).
Distribution: Widely distributed in temperate region. Nepal (Western-Eastern: 1800-4500m).

Family 7: CRASSULACEAE

1. RHODIOLA L.

1. Rhodiola bupleuroides (Wall. ex Hook. f. & Thomson) S.H. Fu in Acta *Phyt. Sin. Addit*. **1**: 124 (1965). Press, Shrestha & Sutton, *Ann. Chek. Fl. Pl. Nep*.: 76 (2000).

Sedum bupleuroides Wall. ex Hook. f. & Thom. in *J. Linn. S. B.* **2**: 98 (1878).

Perennial herbs. Annual stem arises from axils of scale at rhizome apex. Caudex leaves scale like. Flowering stems up to 15cm. Leaves alternate, obovate, 0.3-4×0.4-2cm, margin sparsely serrate, apex rounded, acute. Flowers in terminal corymbs, purple-red.

Habitat: *Rhododendron* forest at shrub land. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4100m, 27º50.92'N, 86º47.61'E, October 3, 2007, E.N. Paudel and S.R. Maharjan, SNP111 (TUCH).

Distribution: Himalaya (Uttar Pradesh-Bhutan), North West Myanmar, China (Xizang, Yunnan). Nepal (Western-Eastern: 2000-5100m).

2. Rhodiola chrysanthemifolia (Leveille) Fu, *Acta Phytotax. Sin., Addit.* **1**: 127 (1965). Press, Shrestha & Sutton, *Ann. Chek. Fl. Pl. Nep*.: 76 (2000).

Sedum chrysanthemifolium Leveille*, Repert. Spec. Nov. Regni Veg.* **12**: 283 (1913).

Perennial herb with creeping root stock. Flowering stems 5-20cm, deciduous. Leaves clustered near the stem apex, oblanceolate or obovate, 1.5-7×0.5-2.5cm, obtuse, base attenuate, pinnatified with 1-7 pairs of obtuse lobes. Flowers in a densely corymbose cyme, 10-30 flowered, pink creamson.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jul.-Sep.

Representative collection: Solukhumbu, Deboche surroundings, 3660m, 27º50.36'N, 86º45.41'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP225 (TUCH).

Distribution: Himalaya (Nepal-Butan), China (Sichuan, Yunan). Nepal (Eastern: 3650m).

3. Rhodiola crenulata (Hook. f. & Thomson) H. Ohba, *J. Jap. Bot.* **51:** 386 (1976). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 76 (2000).

Sedum crenulatum Hook. f. & Thomson, *Proc. Linn. Soc., Bot.* **2**: 96 (1858).

Perennial herbs up to 25cm. Stems glabrous, older ones turning reddish brown, glabrous. Leaves alternate, broadly ovate, 0.5-2×0.5-1.5cm, Subacute, sessile, margin create. Flowers 20-40 forming compact corymbose dark violet.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Chalunche, 4070m, 27º51.53'N, 86º48.08'E, October 6, 2007, E.N. Paudel and S.R. Maharjan, SNP142a (TUCH).

Distribution: Himalaya (Nepal-Bhutan), China (Xizang, Yunan). Nepal (Central-Eastern: 4050-5300m).

Note: Previously reported only from 4800m to 5300m (Press *et al.* 2000).

4. Rhodiola wallichiana (Hook.) S.H. Fu., *Acta Phyt. Sin. Assit.* **1:** 125 (1965). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 77 (2000).

Sedum wallichianum Hook., *Icon. Pl.* **7**: t. 604 (1844).

Perennial herbs 15-40cm. Rhizomes up to 3cm thick. Stems glabrous, deciduous. Leaves linear 0.7-2.5×1-3mm, acuminate, margins with 2-3 pairs of small teeth in upper half. Flowers in dense compact corymbs, greenish-yellow.

Habitat: On the river bank. **Fl. & Fr.:** Jul.-Sep.

Representative collection: Solukhumbu, Yaren, Pangboche, 4020m, 27º51.33'N, 86º47.78'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP96 (TUCH).

Distribution: Himalaya (Kashmir, Nepal, Sikkim), China (Xizang). Nepal (Western-Eastern: 3300-4200m).

2. SEDUM L.

1. Sedum triactina Berger, *Pflanzenfam.* ed. 2, **18a**: 460 (1930). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 78 (2000).

Perennial ascending herb 10-25cm. Stems weak, succulent. Leaves usually opposite or in whorls of 3, oblanceolate 10-15×2-2.5mm, obtuse, base attenuate. Flowers in loosely corymbose cymes, yellow.

Habitat: *Betula utilis* forest. **Fl. & Fr.:** Jun.-Sep.

Representative collection: Solukhumbu, Deboche surroundings, 3690m, 27º50.38'N, 86º45.52'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP224 (TUCH).

Distribution: Himalaya (Nepal-Bhutan), North East India, West China. Nepal (Central-Eastern: 2700-3900m).

2. Sedum trullipetalum Hook. & Thomson in *J. Linn. Soc., Bot.* **2**: 102 (1858). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 78 (2000).

Perennial decumbent herbs, up to 10cm. Leaves scale like, lanceolate, appressed to stem, 4-6×1-1.5mm, acuminate to a fine hair-like tip; margin entire. Flowers up to 20 in dense rounded heads, yellow.

Habitat: open grass land with sandy soil. **Fl. & Fr.:** Aug.-Sep.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 3930m, $27^0$51.34'N, $86^0$47.75'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP73 (TUCH).

Distribution: Himalaya (Uttar Pradesh-Bhutan), North East India, Myanmar, China (Yunnan). Nepal (Western-Eastern: 3600-4700m).

Family 8: SAXIFRAGACEAE

1. BERGENIA Moench

1. Bergenia purpurascens (Hook. f. & Thomson) Engl., *Bot. Zeitung (Berlin)* **26**:841 (1868). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 286 (2000).

Saxifraga purpurascens Hook. f. & Thomson, *J. Proc. Linn. Soc., Bot.* **2**: 61 (1858).

Perennial herbs. Stems up to 30cm, reddish brown, glandular pubescent. Leaves elliptic or ovate elliptic, 5-30×5-20cm; apex rounded; base cuneate or rounded; margin shallowly sinuate, glabrous or ciliate near base. Flowers up to 8 in branches cymes, nodding, bright pink.
Habitat: *Abies-Betula* forest. **Fl. & Fr.:** May-Jul.
Distribution: Himalaya (Nepal-Bhutan), North East India, North Myanmar, West China. Nepal (Central-Eastern: 3800-4700m).

2. SAXIFRAGA L.

1. Saxifraga andersonii Engl. in *Bot. Jahrb.* **48**: 609 (1912). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 287 (2000).

Perennial herb, 2.5-8cm, forming cushions. Leaves coriaceous, oblanceolate-linear, abaxially convex, adaxially concave, 5-10×1.2-2.5mm; margin ciliate near base; apex obtuse. Flowers 2-5 on leafy peduncles, pinkish.
Habitat: On the river bank. **Fl. & Fr.:** Jun.-Aug.
Representative collection: Solukhumbu, Near Chhukum, 4610m, 27º54.31'N, 86º52.26'E, October 8, 2007, E.N. Paudel and S.R. Maharjan, SNP180 (TUCH).
Distribution: Himalaya (Nepal-Bhutan), China (Xizang). Nepal (Western-Eastern: 3400-5500m).

2. Saxifraga aristulata Hook. f. & Thomson in *J. Linn. Soc*., *Bot.* **2**: 68 (1857). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep*.: 287 (2000).

Perennial herb, densely caespitose. Stems slender, 2-8cm, brownish-lanate at base, usually glandular-pubescent above. Leaves linear-lanceoalte, 4-10 × ca. 1mm, acuminate to bristle-like point, subpetiolate, margin narrowly inrolled. Flowers solitary, yellow.
Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, Pangboche surrounding, 4020m, 27°51.40'N, 86º47.39'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP64 (TUCH).
Distribution: Himalaya (Uttar Pradesh-Sikkim). Nepal (Western-Eastern: 4000-5600m).
Note: Previously reported only from 4200m to 5600m (Press *et al.* 2000).

3. Saxifraga brachypoda D. Don, *Trans. Linn. Soc. London* **13**: 378 (1821). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 287 (2000).

Saxifraga glandulosa Wall. ex DC., *Prodr*. **4**: 45 (1830).

Perennial herb. Stems simple, 5-15cm, leafy throughout, often with a scaly bud in axils of upper leaves, glabrous below, pubescent above. Leaves stiff, lanceolate, 5-10×2-3.5mm, sharp prickly pointed, base rounded, sessile, margin serullate. Flowers often solitary, yellow.
Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, Pangboche surrounding, 4000m, 27º51.39'N, 86º47.57'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP51 (TUCH).
Distribution: Himalaya (Uttar Pradesh-Bhutan), North east India, Myanmar, West China. Nepal (Western-Eastern: 3300-5000m).

4. Saxifraga filicaulis Wall. ex ser., *Prodr*. **4**: 46 (1830). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 287 (2000).

Perennial densely caespitose herb, erect, 5-12cm. Stem sparsely glandular pubescent, often bearing scaly buds in leaf axils above. Leaves elliptic, 4-8×05-1.5mm, apex bristle like point, margin inrolled. Flowers solitary, pinkish-yellow.
Habitat: Dry shrubland of *Rhododendron anthopogon*. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, above Yaren forest, Pangboche, 4220m, 27º50.48'N, 86º47.63'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP127 (TUCH).
Distribution: Himalaya (Kashmir-Bhutan), West China. Nepal (Western-Central: 2700-3800m).
Note: Previously reported only from the Western and Central Nepal, up to 3800 m (Press *et al.* 2000).

5. Saxifraga hispidula D. Don in Trans. *Linn*. *Soc*. *London* **13**: 380 (1821). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 288 (2000).

Saxifraga evolvuloides Wall. ex DC., *Prodr*. **4**: 46 (1830).

Perennial caespitose herb; 3-10cm. Stems leafy throughout, a few scaly buds near base, pubescent. Leaves ovate, 3-12×2-4mm, acute, base rounded, sessile, margin with 1-2 teeth on each side. Flowers solitary, yellow.
Habitat: Dry shrubland of *Rhododendron anthopogon*. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, above Yaren forest, Pangboche, 4220m, 27º50.48'N, 86º47.63'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP128 (TUCH).
Distribution: Himalaya (Uttar Pradesh-Bhutan), North East India, Myanmar, West China. Nepal (Western-Eastern: 3300-4500m).

6. Saxifraga montana H. Sm., *Acta hort. Gothoburg*. **1**: 9, f. 2 e-l, t. 6 (1924). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 289 (2000).

Perennial caespitose herbs, 3-12cm. stems brown lanate especially in the upper part. Basal leaves elliptic-lanceolate, 5-15×2-5mm, subacute, base attenuate into petiole 5-15mm, margins ciliate. Flowers solitary or few, yellow.

Habitat: On the river bank. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Near Chhukum, 4610m, 27º54.31'N, 86º52.26'E, October 8, 2007, E.N. Paudel and S.R. Maharjan, SNP171 (TUCH).

Distribution: Himalaya (Kashmir-Bhutan). Nepal (Central-Eastern: 4100-5000m).

Note: Previously reported only from the Central Nepal (Press *et al.* 2000).

7. Saxifraga parnassifolia D. Don, *Trans. Linn. Soc. London* **13**: 405 (1821). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 289 (2000).

Saxifraga diversifolia var. *parnassifolia* Seringe in DC., *Prodr*. **4**: 44 (1830).

Perennial, herbs 10-20 cm. Stem densely brown crisped glandular villous. Basal leaf blades cordate-ovate, 1.5-4×1.3-3cm, crisped villous, apex acute; cauline leaves 6-7, sessile, ovate-cordate, 0.9-3.5×0.5-2.3cm, apex obtuse. Flowers 5-10, yellow.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jul.-Sep.

Representative collection: Solukhumbu, Pangboche surrounding, 4000m, 27º51.39'N, 86º47.57'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP55 (TUCH).

Distribution: Himalaya (Uttar Pradesh-Bhutan). Nepal (Western-Eastern: 1900-4900m).

8. Saxifraga saginoides Hook. f. & Thomson, *J. Linn. Soc*., Bot. **2**: 68 (1857). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 290 (2000).

Perennial caespitose herbs, forming tight mats. Stems 2-6cm, pubescent throughout, glandular hairy above. Leaves linear-elliptic, 3-5×1-1.5mm, acuminate, base narrowed to sheathing petiole, lamina glabrous. Flowers solitary, yellow.

Habitat: On the river bank. **Fl. & Fr.:** Jun.-Sep.

Representative collection: Solukhumbu, Near Chhukum, 4610m, 27º54.31'N, 86º52.26'E, October 8, 2007, E.N. Paudel and S.R. Maharjan, SNP182 (TUCH).

Distribution: Himalaya (Uttar Pradesh- Bhutan), West China. Nepal (Western-Eastern: 4200-5200m).

9. Saxifraga strigosa Wall. ex Ser., *Prodr*. **4**: 41 (1830). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 291 (2000).

Perennial herb 5-15cm. Stems solitary or few. Largest leaves clustered and rosetted in lower part; cauline leaves smaller, scaly buds in axils; leaves oblanceolate or obovate, 1-2×0.5-1cm, acuminate, margin with 2-3 pairs bristle-pointed teeth. Flowers solitary or up to 6, yellow.

Habitat: Near the trail towards the Yaren forest. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4000m, 27º51.29'N, 86º47.93'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP83 (TUCH).

Distribution: Himalaya (Uttar Pradesh-Bhutan), North East India, Myanmar, West China. Nepal (Western-Eastern: 2100-4200m).

Family 9: PARNASSIACEAE

1. PARNASSIA L.

1. Parnassia nubicola Wall. ex Royle, *Ill. Bot. Himal. Mts.* **1(7)**: 227, t. 50, f. 3 (1835). Press, Shrestha & Sutton, *Ann. Check Fl. Pl. Nep.*: 232 (2000).

Perennial herbs, erect, 15-35 cm. Leaf blade ovate, 3-10x1.5-4.5 cm, base attenuate, margin entire, apex acute; cauline leaves smaller, subsessile, sheath bearing long brown hairs at base. Flower single, creamy white. Capsule obovate-ellipsoid 1-1.5 cm.

Habitat: Open grassland with sandy soil. **Fl. & Fr.:** Jun-Oct.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 4000m, $27^0$51.28'N, $86^0$47.93'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP76 (TUCH).

Distribution: Afghanistan, Himalaya (Kashmir-Bhutan), China (Xizang). Nepal (Western-Eastern: 2900-4200m).

Family 10: ROSACEAE

1. FRAGARIA L.

1. Fragaria nubicola Lindl. ex Lacaita in *J. Linn. Soc.*, *Bot*. **43**: 467 (1916). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 263 (2000). '*Bhui Ainselu'* (भुई ऐसेलु) '*Shafaltang'* (शफल्ताङ).

Fragaria vesca var. *nubicola* Hook. f. in *Fl. Brit. Ind.* **2**: 344 (1878).

Perennial herbs with slender prostrate stolons. Leaflets obovate or elliptic, 2-5×1-3cm, obtuse, base cuneate, margins serrate, silky whitish pubescent beneath. Flowers white. Achenes borne on succulent red globose receptacle.

Habitat: *Juniperus recurva* forest. **Fl. & Fr.:** Apr.-Jun.

Representative collection: Solukhumbu, Lato Goth, Near Imja, 3600m, $27^0$50.45'N, $86^0$45.71'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP256 (TUCH).

Distribution: Himalaya (Kashmir-Bhutan), North Myanmar, West China. Nepal (Western-Eastern: 1600-4000m).

2. POTENTILLA L.

1. Potentilla coriandrifolia D. Don, *Prodr. Fl. Nepal*.: 232 (1825). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 265 (2000).

Potentilla meifolia Wall. ex Lehm.; *Pugill*. **3**: 29 (1831).

Herbs perennial, 4-13 cm. Radical leaves 3-9cm including petiole, leaf blade pinnate with 2-8 pairs of leaflets, abaxially densely appressed villous or glabrescent, segments fascinated to lanceolate, apex acuminate; cauline leaves 1 or 2. Flowers 1-5, yellow.

Habitat: *Rhododenfron campylocarpum* forest. **Fl. & Fr.:** Jul.-Sep.

Representative collection: Solukhumbu, Milingo forest, deboche, 3990m, 27º50.33'N, 86º46.80'E, October 11, 2007, E.N. Paudel and S.R. Maharjan, SNP217 (TUCH).

Distribution: Himalaya (Uttar Pradesh-Bhutan), China (Xizang). Nepal (Central-Eastern: 3900-5600m).

2. Potentilla cuneata Wall. ex Lehm., *Nov. Stirp. Pug.* **3**: 34 (183). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 265 (2000).

Potentialla cuneifolia Bertol., *Misc*. **24**: 15, t. 2 (1863).

Perennial herbs. erect or ascending, 4-15cm. Leaves 2-3cm including petiole; leaf blade 3-foliate; leaflets obovate, 0.6-1.5×4-8mm, subleathery, base cuneate, apex 3-dentate. Flowers terminal, 1-2, yellow.

Habitat: On the river bank. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4020m, 27º51.33'N, 86º47.78'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP98 (TUCH).

Distribution: Himalaya (Kashmir-Bhutan), China. Nepal (Western-Eastern: 2400-4900m).

3. Potentilla josephiana H. Ikeda & H. Ohaba, *J. Linn. Soc., Bot.* **112**: 168 (1993). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 266 (2000). '*Bajradanti'* (वज्रदन्ती)

Potentilla fulgens var. *intermedia* Hook. F. in *Fl. Br. Ind*. **2**: 350 (1878).

Erect or spreading perennial herb, 15-35cm, whitish hairy. Leaves interruptedly pinnate 6-20cm; larger leaflets 4-8 pairs, elliptic, margins sharply serrate, silvery white sericeous beneath; minor alternating leaflets similar. Flowers in corymbose cymes, yellow. Achenes ovoid.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4060m, 27º51.32'N, 86º48.01'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP88 (TUCH).

Distribution: Himalaya (Uttar Pradesh-Sikkim), China (Xizang, Yunan). Nepal (Central-Eastern: 2400-4100m).

Note: Previously reported only from the Central Nepal (Press *et al.* 2000).

4. Potentilla peduncularis D. Don, *Prod. Fl. Nep*.: 230 (1825). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep*.: 266 (2000).

Potentilla peduncularis var. *obscura* Hook. f. in *Fl. Br. Ind.* **2**: 352 (1878).

Perennial erect herb. Rootstock stout, covered with old leaf bases. Stems hairy. Pinnate leaves, to 20cm, mostly basal, silvery-haired when young, oblong, deeply toothed leaflets, 1.3-2.5cm, long soft silvery hairs beneath, hairless above. Flowers yellow.
Habitat: Dry shrubland of *Rhododendron anthopogon*. **Fl. & Fr.:** Jun.-Sep.
Representative collection: Solukhumbu, above Yaren forest, Pangboche, 4220m, 27º50.48'N, 86º47.63'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP126 (TUCH).
Distribution: Himalaya, China. Nepal (Western-Eastern: 3000-4700m).

5. Potentilla polyphyla Wall. ex Lehm. in Nov. Strip. Pug. **3**: 13 (1831). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep*.: 266 (2000).

Potentilla sordida Klotzsch in *B. Reise Pr. Waldem.* t. 9 (1862).

Spreading perennial herb. Slightly silky throughout only when young. Stems 15-40cm, pilose-hairy. Leaves interruptedly pinnate 6-20cm; leaflets green beneath, broadly elliptic, margins bluntly toothed. Flowers in corymbose cymes, yellow. Achenes ovoid.
Habitat: Near the trail. **Fl. & Fr.:** Jun.-Sep.
Representative collection: Solukhumbu, Pangbocche-Tengboche, 3840m, 27º50.62'N, 86º46.71'E, October 13, 2007, E.N. Paudel and S.R. Maharjan, SNP235 (TUCH).
Distribution: Pakistan, Himalaya (Uttar Pradesh-Bhutan), North-Earth India, China (Yunan), Java. Nepal (Central-Eastern: 2700-4600m).

6. Potentilla saundersiana Royle in *Ill. Bot. Himal. Mts* **1(6)**: 207, t. 41(1835). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep*.: 266 (2000).

Potentilla multifida var. *saundersiana* (Royle) Hook. f. in *Fl. Brit. Ind.* **2**: 354 (1878).

Perennial herb. Stem 10-20cm, white tomentose and pilose. Leaf blade palmately 3-5 foliate; radical leaves 2-5cm, leaflets oblong-obovate, 0.5-1.5cm×4-10mm, abaxially white tomentose, margin serrate, cauline leaves 1 or 2. Flowers terminal, 1 or 2, yellow.
Habitat: Open grassland. **Fl. & Fr.:** May-Sep.
Representative collection: Solukhumbu, Between Pangboche & Somare, 4130m, 27º51.80'N, 86º48.03'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP146 (TUCH).
Distribution: Himalaya (Nepal, Bhutan), China. Nepal (Central-Eastern: 3100-4900m).

7. Potentilla sp.

Perennial herb. Flowering stem slender, hairy, up to 15cm. Leaves white pubescent, mostly basal, leaflets 3-6 pairs, margin parted to midvein; leaves on flowering stem up to 4 pairs; leaflets 1-pinnatifid, ultimate segments ca. 2 mm wide, both surfaces pilose and granular sessile glandular, apex obtuse; stipules proximally adnate to petiole for ca. 1/2 their length; Inflorescences cymose, many flowered . Flowers in lax racemes.

Habitat: *Abies-Betula* forest.

Representative collection: Solukhumbu, Deboche surroundings, 3670m, 27º50.29'N, 86º45.58'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP229 (TUCH).

Family 11: FABACEAE (LEGUMINOSAE)

1. ASTRAGALUS L.

1. Astragalus himalayanus Klotzsch in *Bot. Ergebn. Reise. Waldemar.* 160, t. 4 (1862). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 166 (2000).

Astragalus carinalis Benth. ex Bunge in *Mem. Acad. Sci. St. Pet.* ser 7, **11(16)**:23 (1868).

Erect or spreading perennial herbs. Stem 30-60cm, appressed hairy throughout. Leaves usually 3-5cm; leaflets many, 4-10mm, oblong, blunt or notched, pale green with white hairs. Flowers often many in each cluster, lilac or mauve. Pods 9-13mm, with black hairs.

Habitat: *Abies spectabilis* forest. **Fl. & Fr.:** May-Jun.

Representative collection: Solukhumbu, Deboche surroundings, 3790m, 27º50.60'N, 86º46.25'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP241a (TUCH).

Distribution: Himalaya (Kashmir-Nepal). Nepal (Western-Eastern: 3500-4500m).

2. Astragalus strictus Graham ex Benth., *Ill. Bot. Himal. Mts.* **1(6)**: 198 (1835). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 167 (2000).

Perennial; stems prostrate or ascending up to 15cm, appressed white pubescent. Leaves 2-4cm, leaflets 13-19, elliptic, 4-6×2-2.5mm, obtuse or acute, base cuneate, glabrous, appressed, white pubescent beneath. Flowers in short, dense racemes, purple. Pods oblong.

Habitat: *Abies spectabilis* forest. **Fl. & Fr.:** May-Jun.

Representative collection: Solukhumbu, Deboche surroundings, 3790m, 27º50.60'N, 86º46.25'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP241b (TUCH).

Distribution: Himalaya (Kashmir-Sylhet). Nepal (Central-East: 2100-5000m).

2. HEDYSARUM L.

1. Hedysarum sikkimense Benth. ex Baker in *Fl. Brit. India* **2(5)**: 146 (1878). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 175 (2000).

Perennial herbs up to 20cm, sparsely pubescent. Leaves odd-pinnate, 5-10cm, leaflets 15-25, ovate-elliptic, 5-12×2.5-8mm, obtuse, base rounded, glabrous, sparsely pubescent beneath. Flowers in racemes, purple. Pods constricted into 1-3 segments.

Habitat: On the river bank. **Fl. & Fr.:** Jun.-Sep.

Representative collection: Solukhumbu, Near Chhukum, 4610m, 27º54.31'N, 86º52.26'E, October 8, 2007, E.N. Paudel and S.R. Maharjan, SNP175 (TUCH).

Distribution: Himalaya (Nepal-Bhutan), West China. Nepal (Eastern: 3500-4700m).

3. PAROCHETUS Buch.-Ham. ex D. Don

1. Parochetus communis Buch.-Ham. ex D. Don in *Prodr. Fl. Nep.:* 240 (1825). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 178 (2000). **'***Cemgi phul'* (केम्गी फूल), *'Jangali badame jhar'* (जन्गली बदामे झार).

Parochetus major D. Don, *Prodr. Fl. Nep.***:** 241(1825).

Prostrate perennial herbs, rooting at lower nodes. Leaves digitately 3-foliate, leaflets obovate, 0.5-2.5×0.5-2cm, base cuneate, margin crenate, glabrous, appressed pubescent beneath. Flowers 1 or 2 on axillary peduncles, blue. Pods linear-oblong, inflated.

Habitat: *Juniperus recurva* forest. **Fl. & Fr.:** Mar.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3610m, 27º50.46'N, 86º45.72'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP257 (TUCH).

Distribution: Africa, Himalaya (Himanchal Pradesh-Bhutan), Sri Lanka, North-East India, South East Asia, Malaysia, China. Nepal (Western-Eastern: 900-4000m).

4. THERMOPSIS R. Br.

1. Thermopsis barbata Royle, *Ill. Bot. Himal. Mts.* **2**: t. 32 (1833-1840). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 181 (2000).

Perennial tufted herbs with woody root stocks. Annual stems erect, 15-45cm, densely hairy, branching from base. Leaflets 3, lanceolate-elliptic, 1.5-3×0.5-1cm, acute, leaflets decurrent on petiole. Flowers in terminal clusters. Pod oblong 2.5-3.5cm, hairy.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4060m, 27º51.32'N, 86º48.01'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP87 (TUCH).

Distribution: Himalaya (Kashmir-Bhutan). Nepal (Western-Eastern: 2700-4600m).

Note: Previously reported only from the Western and Central Nepal (Press *et al.* 2000).

Family 12: GERANIACEAE

1. GERANIUM L.

1. Geranium donianum Sweet, *Geraneaceae* **4**: sub t. 338 (1827). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 119 (2000).

Geranium multifidum D. Don, *Prodr. Fl. Nep.*: 207 (1825).

Perennial erect, stout herb 10-30cm. Basal leaves suborbicular, 2.5-4.5cm across, lobes deeply incised into long linear segments with acute tips; apex acute. Flower solitary, deep pink-purple, 2.8-3.6cm across, not reflexed. Capsule 5-lobed.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4000m, 27º50.91'N, 86º47.18'E, October 4, 2007, E.N. Paudel and S.R. Maharjan, SNP118 (TUCH).

Distribution: Himalaya (Nepal-Bhutan), China (Xizang). Nepal (Western-Eastern: 3200-4800m).

Family 13: BALSAMINACEAE

1. IMPATIENS L.

1. Impatiens edgeworthii Hook. f., *Fl. Br. India* **1(3)**: 476 (1875). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 22 (2000).

Annual fleshy herbs up to 20cm. Leaves grouped in a terminal rosette, petiolate, margin serrate, elliptic, acute-acuminate. Flowers in cluster at the top, pale yellow.

Habitat: *Betula utilis* forest. **Fl. & Fr.:** Jun.-Sep.

Representative collection: Solukhumbu, Deboche surroundings, 3720m, 27º50.33'N, 86º45.57'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP221 (TUCH).

Distribution: Himalaya (Kashmir, Nepal). Nepal (Central-East: 1500-3800m).

Family 14: VIOLACEAE

1. VIOLA L.

1. Viola biflora L., *Sp. Pl.*: 936 (1753). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 326 (2000).

Viola manaslensis F. Mackawa in *Acta. Phyt. Geobot*. **15**: 173 (1954).

Perennial herbs with nodular rootstock. Stem absent or very short or stoloniferous. Leaf blade broadly ovate, 10-16×12-20mm, pubescent especially on upper surface; stipules ovate, leafy, 2.5-5mm, entire. Flowers in pair, axillary, yellow. Capsule ovoid, glabrous.

Habitat: *Juniperus recurva* forest. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3610m, 27º50.46'N, 86º45.72'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP262 (TUCH).

Distribution: Europe, Siberia, Central Asia, Himalaya (Kashmir-Arunanchal Pradesh), China, North Korea, Japan, West North America. Nepal (Western-Eastern: 2100-4500m).

Family 15: ONAGRACEAE

1. EPILOBIUM L.

1. Epilobium brevifolium subsp**. trichoneurum** (Hausskn.) P.H. Raven in *Bull. Brit. Mus. (Nat. Hist.), Bot.* **2**: 362 (1962). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 206 (2000).

Epilobium trichoneurum Hausskn., Oesterr. Bot. Z. 29: 54 (1879).

Perennial, erect or ascending herb. Stems up to 1m, simple or branched above, appressed hairy throughout. Leaves elliptic–lanceolate to ovate, 1.5- 5×0.5 -2cm, acute, stiffly hairy on veins and margin, weakly serrulate. Flowers in axillary racemes, pink. Capsule elongaed 3-7cm.

Habitat: On the river bank. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4020m, 27º51.33'N, 86º47.78'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP94a (TUCH).

Distribution: Himalaya, North East India, Myanmar, West and South China, Philippines. Nepal (Eastern: 2100-4000m).

Note: Previously reported only up to 3600 m (Press *et al.* 2000).

2. Epilobium latifolium subsp. **speciosum** (Decne.) P.H. Raven in *Bull. Brit. Mus. (Nat. Hist.), Bot.* **2**: 349 (1962). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 207 (2000).

Epilobium speciosum Decne., *Voyage dans l'Inde* 4 (Bot.): 57, pl. 69 (1844).

Perennial; stems up to 30cm, often spreading. Leaves narrow elliptic, 4-8×0.5-2.5cm; hairy beneath, appressed stiffly hairy on veins, denticulate. Flowers in racemes of leafy axils bracts, rose-purple. Capsules up to 7cm.

Habitat: On the river bank. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4020m, 27º51.33'N, 86º47.78'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP94c (TUCH).

Distribution: Himalaya (Kashmir-Nepal). Nepal (Western-Eastern: 3600-4200m).

Note: Previously reported only from the Western and Central Nepal (Press *et al.* 2000).

3. Epilobium royleanum Hausskn., *Oesterr. Bot. Z.* **29**: 55 (1879). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 207 (2000).

Perennial erect herbs. Stems up to 70cm. Leaves ovate to lanceolate, 2-6×1-3cm, acute, appressed stiffly hairy on veins and margin, densely serrulate. Flowers in erect racemes, rose-purple to pink. Capsule 4-7cm, appressed stiffly hairy.

Habitat: *Betula-Sorbus* forest. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3740m, 27º50.71'N, 86º46.72'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP238 (TUCH).

Distribution: Afghanistan, Himalaya (Kashmir-Sikkim), North-East India, West China. Nepal (Western and Eastern: 3700-4100m).

Note: Previously reported only from 4100m (Press *et al.* 2000).

4. Epilobium wallichianum Hausskn. in *Oesterr. B. Zeits*. **19**: 54 (1879). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 207 (2000).

Perennial suberect herbs up to 50cm. Leaves subcoriaceous, oblong to elliptic, 2-4×0.5-1.5cm, obtuse, base cuneate, sparsely appressed stiffy hairy on veins and margins, serrulate, shortly petiolate. Flowers nodding, pink. Capsule elongate, slender.

Habitat: On the river bank. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4020m, 27º51.33'N, 86º47.78'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP94b (TUCH).

Distribution: Himalaya (Nepal-Bhutan), Tibet, North Burma, West China. Nepal (Western-Eastern: 1700-4100m).

Family 16: APIACEAE (UMBELLIFERAE)

1. ACRONEMA Edgew.

1. Acronema johrianum Babu, *Brittonia* **25**: 159 (1973). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 310 (2000).

Perennial herbs up to 30cm. Stem slender, glabrous. Leaves alternate, pinnately divided, glabrous, ovate in outline; petioles winged at base; leaflets linear, 1-3×0.1-0.2mm. Flowers in compound umbels, white; rays 5-10. Fruit narrowly ovoid.

Habitat: Open grassland with sandy soil. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Pangboche, 3980m, $27^0$51.36'N, $86^0$47.45'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP69 (TUCH).

Distribution: Nepal (Central-Eastern: 3700-4300m).

Note: Previously reported only from the Central Nepal (Press *et al.* 2000).

2. CORTIA DC.

1. Cortia depressa (D. Don) C. Norman, *J. Bot.* **75**: 96 (1937). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 300 (2000).

Athamantha depressa D. Don, *Prodr. Fl. Nep.*: 184 (1825).

Perennial ascending herbs up to 25cm. Leaves 1.5-8×1-3cm, pinnae disjunctly spaced in rachis, pinnatisect. Flowers in 3-6 rayed umbels, slightly fragrant, white, purplish to deep purple red.
Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, North part of Dingboche, 4040m, $27^0$53.58'N, $86^0$49.33'E, October 07, 2007, E.N. Paudel and S.R. Maharjan, SNP167 (TUCH).
Distribution: Himalaya (Uttar Pradesh, Nepal, Bhutan), China (Xizang). Nepal (Western-Eastern: 3600-4900m).

3. HERACLEUM L.

1. Heracleum nepalense D. Don, *Prodr. Fl. Nepal.:* 185 (1825). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 313 (2000).

Heracleum nepalense var. *bivittata* C.B. Clarke in *Fl. Br. Ind.* **2**: 714 (1879).

Perennial herb, stout up to 2m. Stems solitary, pubescent. Basal leaves long-petiolate; leaf blade broad-ovate, 20-45×20-35cm, trifoliate or 1-2-pinnate; leaflets broadly ovate, finely pubescent. Flowers in umbels 15-25cm wide, white. Fruits with broad wings.
Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun.-Oct.
Representative collection: Solukhumbu, Yaren forest, Pangboche, 3990m, $27^0$50.60'N, $86^0$47.31'E, October 4, 2007, E.N. Paudel and S.R. Maharjan, SNP114 (TUCH).
Distribution: Himalaya (Uttar Pradesh, Nepal, Bhutan), North East India. Nepal (Western-Eastern: 1800-4000m).
Note: Previously reported only up to 3700 m (Press *et al.* 2000).

4. PLEUROSPERMUM Hoffm.

1. Pleurospermum apiolens C. B. Clarke, *Fl. Brit. India* **2(6)**: 705 (1879). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 316 (2000).

Perennial nearly glabrous herbs 15-30cm. Base of stems often clothed with leaf remains. Leaves mostly basal, pinnate, 7-20×2-4cm; pinnae 4-5 pairs, ovate in outline, petioles winged at base. Flowers in umbels of 5-12 rays. Fruits ovoid.
Habitat: On the river bank. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, Near Chhukum, 4610m, 27º54.31'N, 86º52.26'E, October 8, 2007, E.N. Paudel and S.R. Maharjan, SNP177 (TUCH).
Distribution: Himalaya (Nepal, Sikkim). Nepal (Western-Eastern: 3600-4600m).
Note: Previously reported only up to 3800 m (Press *et al.* 2000).

2. Pleurospermum brunois (DC.) C.B. Clarke, *Fl. Brit. India* **2(6):** 706 (1879). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 316 (2000).

Hymenolaena bruninis DC., *Prodr*. **4**: 245 (1830).

Perennial herb, 5-30cm, papillose. Stem one or more, branched from base. Leaves pinnately dissected, 2-4-pinnate, deeply toothed lobes. Flowers in umbels, white; primary rays 5-10. Fruit oblong with broad wings.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 3930m, 27º51.34'N, 86º47.75'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP72 (TUCH).

Distribution: Himalaya (Kashmir, Nepal). Nepal (Western-Eastern: 3900-5000m).

Note: Previously reported only from the Western and Central Nepal, from 4400m to 5000 m (Press *et al.* 2000).

3. Pleurospermum hookeri C. B. Clarke, *Fl. Brit. India* **2(6)**: 705 (1879). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 316 (2000).

Perennial herb, 5-50cm, glabrous except papillose umbels. Leaves mostly basal, pinnately divided, 8-20×1.5-5cm; petiole base winged. Flowers in umbels of 4-10 rayed. Fruits scarsely winged.

Habitat: Open grass land with rocky soil. **Fl. & Fl.:** May-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4000m, 27º51.29'N, 86º47.93'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP79 (TUCH).

Distribution: Nepal (Central-Eastern: 3900-5200m). Himalaya (Nepal, Bhutan), China (Sichuan, Xizang).

5. PHYSOSPERMOPSIS H. Wolff.

1. Physospermopsis obtusiuscula (DC.) C. Norman in *J. Bot*. **76**: 231, t. 2, f. c (1938). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 315 (2000).

Hymenolaena obtusiuscula DC., *Prodr.* **4**: 246 (1830).

Perennial herbs up to 40cm. Stems dark purple-green. Leaf blade ovate in outline, 4-16×2-4cm, mainly basal, pinnae 6-25mm, deeply lobed. Flowers in umbels of 8-14 rayed, rays 2-13cm long, white or purple. Fruit ovoid, slightly flattened laterally.

Habitat: Dry shrubland of *Rhododendron anthopogon*. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, above Yaren forest, Pangboche, 4200m, 27º50.67'N, 86º47.66'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP133 (TUCH).

Distribution: Eastern Himalaya (Nepal-Bhutan), Assam, Tibet. Nepal (Central-Eastern: 300-4600m).

Note: Previously reported only from the Central Nepal (Press *et al.* 2000).

6. SELINUM L.

1. Selinum candollei DC., *Prodr*. **4**: 165 (1830). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 317 (2000).

Peucedanum wallichianum DC., *Prodr*. **4**: 181 (1830).

Perennial herb usually 75-125cm. Stem mainly glabrous,often green. Leaves more finely and sparsely divided with ultimate segments, lanceolate-acuminate, 0.4-0.6mm wide. Flowers in umbels of 30-50 rayed. Fruits oblong-elliptic.

Habitat: Near the trail. **Fl. & Fr.:** Aug.-Sep.

Representative collection: Solukhumbu, Phungitanga, 3430m, 27°49.97'N, 86°44.95'E, September 30, 2007, E.N. Paudel and S.R. Maharjan, SNP34a (TUCH).

Distribution: Himalaya (Kashmir, Nepal, Sikkim). Nepal (Western-Eastern: 3000-3800m).

Note: Previously reported only from the Western and Central Nepal, up to 3800 m (Press *et al.* 2000).

2. Selinum wallichianum (DC.) Raizada & Saxena, *Indian Forester* **92**: 323 (1966). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 315 (2000).

Peucedanum wallichianum DC., *Prodr. Syst. Natur. Regni Vege.* **4**: 181 (1830).

Perennial dwarf herbs up to 80cm. Stem erect, surrounded by fibrous leaf remains at base. Leaves 3-pinnate, leaflets ovate-oblong, acute, finely pubescent on the rachis and veins beneath. Flowers in umbels of many rayed, white. Fruit elliptic, winged ribs.

Habitat: Near the trail. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Phungitanga, 3430m, 27°49.97'N, 86°44.95'E, September 30, 2007, E.N. Paudel and S.R. Maharjan, SNP34b (TUCH).

Distribution: Himalaya (Kashmir-Bhutan), North-East India, China (Xizang). Nepal (Western-Eastern: 2700-4800m).

Family 17: ERICACEAE

1. CASSIOPE D. Don

1. Cassiope fastigiata (Wall.) D. Don in *Ednb. New Philos J*. **17**: 157 (1834). Press, Shrestha & Sutton, *Ann.Check.Fl, Pl.Nep.*: 101(2000). Sunpati (सुनपाती), Phursan (फुर्सान).

Andromeda fastigiata Wall., *As.Research* **13**: 344 (1820).

Perennial erect subshrubs up to 30cm. Leaves simple, ovate-oblong with two limbs at base, membranous white, ciliate margin, 3-5×1.2mm. Flowers solitary, white.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 3950m, 27°51.38'N, 86°47.78'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP104 (TUCH).

Distribution: Himalaya (Kashmir-Bhutan). Nepal (Western-Eastern: 2800-5000m).

Family 18: PRIMULACEAE

1. ANDROSACE L.

1. Androsace sarmentosa Wall., *Fl. Ind. (Roxburgh) ed.* 2, **2**: 14 (1824). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 243 (2000).

Androsace sarmentosa var. *watkinsi* Hook. f. in *Fl. Br. Ind.* **3**: 498 (1882).

Perennial stoliniferous, tufted. Leaves dimorphic, covered with long silky adpressed white hairs; winter rosette leaves sessile, elliptic, acute, spreading; spring leaves narrowly elliptic 10-25×3-7mm, acute or rounded. Flowers 8-12 in umbels, 1 per rosette, rose-pink.

Habitat: *Abies spectabilis* forest. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3790m, 27º50.60'N, 86º46.25'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP242 (TUCH).

Distribution: Himalaya (Kashmir-Sikkim). Nepal (Western-Eastern: 2500-4000m).

2. PRIMULA L.

1. Primula atrodentata W.W. Sm. in *Rec. Bot. Surv. India* **4**: 217 (1911). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 244 (2000).

Perennial evergreen herbs up to 30cm. Stem base with dead leaves. Leaves spathulate, 1-5×0.5-2cm, obtuse, base attenuate margin denticulate; minute glandular hairy above. Flowers in a compact globose head, mauve or pink. Capsule oblong included within calyx.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Pangboche surrounding, 4000m, 27º51.39'N, 86º47.57'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP52 (TUCH).

Distribution: Himalaya (Uttar Pradesh-Bhutan), North East India, China (Xizang). Nepal (Western-Eastern: 3500-4900m).

2. Primula capitata Hook. f. in *Bot. Mag*. **76**: t. 4550 (1850). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 244 (2000).

Perennial herb without winter buds or persistent bud scales. Leaves oblanceolate, 3-18×1-3.5cm, acute or obtuse, base attenuate, margin denticulate. Flowers numerous pendant in head, purple. Capsule subglobose.

Habitat: Open grassland. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3750m, 27º50.75'N, 86º46.96'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP250 (TUCH).

Distribution: Himalaya (Nepal-Bhutan), China (Xizang). Nepal (Eastern: 3700m).

Note: Previously reported only from the 3800m (Press *et al.* 2000).

3. Primula wigramiana W.W. Sm., *Notes Roy. Bot. gard. Edinburgh* **18**: 182 (1934). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 247 (2000).

Perennial robust herb. Leaves in compact rosette, blade oblong-oblong lanceolate, 3-20×2-15cm, glabrous; margin shallowly lobed. Flowering stem up to 25cm. Flowers 6-7, white, fragnant, pendent.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun.-Jul.

Distribution: Nepal (Central: 4100-5200m).

Note: Previously reported only from the Central Nepal (Press *et al.* 2000).

Family 19: GENTIANACEAE

1. COMASTOMA (Wettst.) Toyok.

1. Comastoma pedunculatum (Royle ex D. Don) Holub, *Folia Geobot. Phytotax.* **3**: 218 (1968). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 113 (2000).

Eurythalia pedunculata Royle ex D. Don, London Edinburgh Philos. Mag. & J. Sci. **8**: 76 (1836).

Annual herb. Stem erect or ascending, up to 25cm. stems branching from base and often further up. Leaves lanceoalte, 5-25×2-10mm, acute, sessile. Flowers in loose cymes, salty blue. Capsule narrowly ellipsoid.

Habitat: *Abies-Rhododendron* forest. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Chalunche, 3990m, 27º51.53'N, 86º47.84'E, October 6, 2007, E.N. Paudel and S.R. Maharjan, SNP138 (TUCH).

Distribution: Himalaya (Kashmir, Nepal-Bhutan), India, China. Nepal (Western-Eastern: 4000m).

Note: Previously no altitudinal range is reported (Press *et al.* 2000).

2. GENTIANA L.

1. Gentiana depressa D. Don., *Prodr. Fl. Nepal.*: 125 (1825). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 114 (2000).

Gentianodes depressa (D. Don) Love & Love in *B. Notiser* **125**: 257 (1972).

Mat forming perennial. Stems decumbent, ca. 4cm. Leaves in dense square-shaped rosettes, ovate elliptic or spathulate, 7-25×3-15mm, apex acute or rounded. Flowers terminal, solitary, sessile, bright blue or violet inside. Capsules narrowly cylindrical.

Habitat: Near the trail. **Fl. & Fr.:** Aug.-Oct.

Representative collection: Solukhumbu, Phungitanga, 3430m, 27º49.97'N, 86º44.95'E, September 30, 2007, E.N. Paudel and S.R. Maharjan, SNP42 (TUCH).

Distribution: Himalaya (Nepal-Bhutan), India, China (Xizang). Nepal (Central-East: 2900-4300m).

2. Gentiana ornata (G. Don) Griseb., *Gen. Sp. Gent.*: 277 (1838). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 114 (2000).

Pneumonanthe ornata G. Don, *Gen. Syst.* **4**: 194 (1837).

Trailing procumbent perennial. Flowering stems up to 8cm. Lower leaves elliptic, 4-10×1.5-3mm; upper leaves lanceolate-linear, 10-15×1.5-3mm, curved to one side, acute. Flowers terminal solitary, pale blue striped white or green. Fruit capsule.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Sep.-Nov.

Representative collection: Solukhumbu, Yaren, Pangboche, 4000m, 27°51.29'N, 86°47.93'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP75 (TUCH).

Distribution: Himalaya (Nepal, Sikkim), China (Xizang). Nepal (Central-East: 3400-5500m).

3. Gentiana tubiflora (G. Don) Griseb., *Gen. Sp. Gent.*: 277 (1838). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 116 (2000).

Ericala tubiflora G. Don, *Gen. Syst.* **4**: 189 (1837)

Tufted perennial up to 5cm. stems solitary, arising from basal rosette. Basal leaves rosulate, spathulate; stem leaves spathulate, 2-8×1-4mm, conduplicate, acute, margins thinly cartilaginous, scabrous. Flowers solitary, terminal, sessile, dark blue. Capsule ellipsoid.

Habitat: Near the trail. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Phungitanga-Tenboche, 3450m, 27°50.01'N, 86°45.05'E, September 30, 2007, E.N. Paudel and S.R. Maharjan, SNP45 (TUCH).

Distribution: Himalaya (Punjab-Bhutan). Nepal (Western-Eastern: 4000-5700m).

3. HALENIA Borkh.

1. Halenia elliptica D. Don, *London Edinb. Philos. Mag. J. Sc1.* **8**: 77 (1836). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 116 (2000).

Swertia peloris Griff., *Itin. Notes* 197 (1848).

Erect about 50cm. Leaves elliptic or ovate, 0.5-6×0.3-1.5cm, acute, upper leaves sessile. Flowers in axillary cymes, forming a loose terminal panicle, white. Capsule ovoid-ellipsoid, 7-9×3-5mm, enclosed by persistent calyx and corolla.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3670m, 27°50.29'N, 86°45.58'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP232 (TUCH).

Distribution: West Asia, Himalaya (Uttar Pradesh-Bhutan), North East India, Myanmar, North and West China. Nepal (Western-Eastern: 2000-4500m).

4. LOMATOGONIUM A. Braun.

1. Lomatogonium chumbicum (Burkill.) H. Sm., *Grana palynol.* **7**: 145 (1967). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 117 (2000).

Swertia chumbica Burkill in *J. As. S. Beng. n.s*., **2**: 323 (1906).

Annual decumbent, diffusely branched above base. Stems up to 30cm long. Leaves ovate or elliptic, 2-15×2-7mm, acute, sessile. Flowers in loose cymes, pale or salty blue. Capsule ovoid.
Habitat: On the river bank. **Fl. & Fr.:** Aug.-Oct.
Representative collection: Solukhumbu, Yaren, Pangboche, 4020m, 27º51.33'N, 86º47.78'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP95 (TUCH).
Distribution: Himalaya (Nepal-Bhutan), China (Xizang). Nepal (Eastern: 3900-4000m).
Note: Previously reported only from the 3900m (Press *et al.* 2000).

2. Lomatogonium sikkimense (Burkill) H. Sm. in *Grana Palynol*. **7**: 145 (1947). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 117 (2000).

Swertia sikkimensis Burkill in *J. As. S. Beng. n. s*., **2**: 322 (1906).

Annual, erect herbs about 12cm. Leaves ovate or spathulate, 5-12×3-5mm, acute or obtuse, sessile apical stem leaves. Flowers solitary, blue violet. Capsule ovoid.
Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Sep.-Oct.
Representative collection: Solukhumbu, Yaren, Pangboche, 3900m, 27º51.00'N, 86º47.39'E, October 4, 2007, E.N. Paudel and S.R. Maharjan, SNP113 (TUCH).
Distribution: Himalaya (Nepal-Bhutan). Nepal (Central-Eastern: 3000-5000m).

5. SWERTIA L.

1. Swertia ciliata (D. Don ex G. Don) B.L. Burtt, *Not. B. G. Edinb.* **26**: 272 (1965). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.:* 118 (2000). '*Chiraita'* (चिराईता), *'Kalen'* (कालेन).

Ophelia ciliata D. Don ex G. *Don, Gen. Syst.* **4:** 178 (1837).

Annual or biennial herbs, up to 60cm. Stems quadrangular. Leaves lanceolate 1.5-4×0.3-1cm, base attenuate, margin entire, apex acute, sessile. Flowers in loose panicles. Petals pale blue or bluish white with purple markings. Capsule ovoid.
Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Aug.-Oct.
Representative collection: Solukhumbu, Deboche surroundings, 3670m, 27º50.29'N, 86º45.58'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP228 (TUCH).
Distribution: Afghanistan, Himalaya (Kashmir-Sikkim). Nepal (Western-Eastern: 2800-4000m).

2. Swertia racemosa (Griseb.) C. B. Clarke, *Fl. Brit. India* **4(10)**: 124 (1883). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 118 (2000).

Ophelia racemosa Griseb., *Gen. sp. Gent.* 319 (1838).

Annual herb up to 40cm. Stem erect, glabrous. Leaves lanceolate, 1.5-4×0.6-1.2cm; margin entire, ciliate; apex acute; veins 1-3. Flowers in panicle cymes, pale blue to pale blue-purple. Capsule 0.7-1.5cm.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Sep.-Oct.

Representative collection: Solukhumbu, Malinga forest, Panboche, 3770m, $27^0$50.305'N/ $86^0$46.116'E, 12.10.2007, E.N. Paudel and S.R. Maharjan, SNP211 (TUCH).

Distribution: Himalaya (Nepal-Bhutan), North East India, China (Xizang). Nepal (Western-Eastern: 1700-5000m).

Family 20: RUBIACEAE

1. GALIUM L.

1. Gallium acutum Edgew., *Trans. Linn. Soc. London* **20**: 61 (1846). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 273 (2000).

Gallium himalayense Klotzsch, *B. Reise Pr. Waldem.* 88. t. 73 (1862).

Prostrate, mat forming, delicate perennial herb. Stem 30–45cm or more, glabrous. Leaves on main stems in whorls of 6, sessile linear oblanceolate, 2.2-10×0.5–2mm on main stem, acuminate, cuspidate, base shortly attenuate. Flower axillary solitary, pale green.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Aug.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3670m, 27º50.29'N, 86º45.58'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP227 (TUCH).

Distribution: Himalaya (Kashmir-Bhutan), China (Xizang). Nepal (Western-Eastern: 2000-4100m).

2. Galium aparine L., *Sp. Pl.*: 108 (1753). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 273 (2000).

Scrambling or trailing annual (?), sometimes forming mats or patches. Leaves in whorls of 6-8, linear-oblanceolate, 7-30×0.6-3mm abruptly and shortly cuspidate. Flowers axillary and terminal, leafy, 3-flowered cymes, pale green or whitish.

Habitat: Open grassland. **Fl. & Fr.:** Jul.-Sep.

Representative collection: Solukhumbu, Dingboche, 4320m, 27º53.49'N, 86º49.49'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP162 (TUCH).

Distribution: Africa, Temperate, Eurasia, Asia. Nepal (Western-Eastern: 900-4300m).

Note: Previously reported only from the Western and Central Nepal, up to 3600 m (Press *et al.* 2000).

3. Gallium asperifolium Wall., *Fl. Ind. (Roxburgh)* **1**: 381 (1820). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 273 (2000).

Galium parvifloum D. Don, *Prodr. Fl. Nep.*: 207. (1825).

Prostrate, straggling perennial herb. Stem diffuse, 4-angles, almost glabrous. Leaves in whorls of 6, linear oblanceolate, 2-9×1-3mm, apex rounded, base gradually attenuate. Flowers in few flowered cymes, greenish. Capsule smooth.

Habitat: Near the trail. **Fl. & Fr.:** May-Sep.

Representative collection: Solukhumbu, Phungitanga, 3430m, 27°49.97'N, 86°44.95'E, September 30, 2007, E.N. Paudel and S.R. Maharjan, SNP43 (TUCH).

Distribution: Afghanistan, Himalaya (Kashmir-Sikkim), India, Thailand. Nepal (Western-Eastern: 1500-3400m).

Note: Previously reported only up to 3000 m (Press *et al.* 2000).

Family 21: BORAGINACEAE

1. CYNOGLOSSUM L.

1. Cynoglossum zeylanicum (Vahl ex Hornem.) Thunb. ex Lehm., *Neue Schriften Nature. Ges. Halle* **3(2)**: 20 (1817). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 29 (2000).

Anchusa zeylanica Vahl. ex Hornem., *Enum. Hafn.*: 3 (1807).

Biennial herb. Stems 20-100cm, densely and softly appressed-pubescent. Cauline leaves numerous, shortly petiolate, upper sessile; lamina elliptic 3-10×0.8-2cm, acute, upper surface pubescent. Flowers in scropoid cymes, deep blue. Nutlets ovate.

Habitat: Open grassland. **Fl. & Fr.:** Apr.-Oct.

Representative collection: Solukhumbu, Between Pangboche & Somare, 4030m, 27°52.00'N, 86°48.20'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP148 (TUCH).

Distribution: Afghanistan, Himalaya (Kashmir-Bhutan), India, Ceylon, East to China and Japan, Malaysia. Nepal (Western-Eastern: 1200-4100m).

2. HACKELIA Opiz.

1. Hackelia obtusiloba R.R. Mill in *Edinburgh J. Bot.* **53**: 118 (1996). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 30 (2000).

Perennial herbs. Stems usually decumbent, 5-40cm, shortly appressed-strigose above. Radical leaves petiolate; lamina ovate, apex mucronate; upper surface shortly pilose, lower surface glabrous except on veins. Flowers in terminal and lateral cymes, pale blue. Nutlets glochidiate.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Pangboche surrounding, 4020m, 27°51.42'N, 86°47.37'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP61 (TUCH).

Distribution: Himalaya (Nepal-Bhutan). Nepal (Eastern).

2. Hackelia uncinata (Benth. in Royle) C.E.C. Fisch., *Kew Bull.* **1932**: 298 (1932). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 30 (2000).

Cynoglossum uncinatum Benth. in Royle, *Ill. Bot. Himal. Mts.* **1**: 34 (1836).

Perennial herbs. Stems erect or ascending, up to 80cm, weakly pilose. Radical leaves petiolate; cauline leaves short petiolate; ovate 2-8×1-4cm, densely hairy on lamina beneath as well as on veins. Flowers in terminal and lateral cymes, paler blue. Nutlets heteromorphic.
Habitat: Open grassland. **Fl. & Fr.:** Jun.-Oct.
Representative collection: Solukhumbu, Between Pangboche & Somare, 4030m, 27º52.00'N, 86º48.20'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP151 (TUCH).
Distribution: Himalaya (Kashmir-Bhutan), North East India, China (Xizang, Yunan). Nepal (Western-Eastern: 2700-4200m).

3. MICROULA Benth.

1. Microula sikkimensis (C.B. Clarke) Hemsl., *Icon Pl.* **26**: sub t. 2562 (1898); Hara in *Enum. Fl. Pl. Nep.* **3**: 102 (1982); R.R. Mill in *Fl. Bhu*. **2(2)**: 904 (1999) Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 31 (2000).

Anchusa sikkimensis C. B. Clarke in *Fl. Br. Ind.* **4**: 168 (1883).

Annual?, usually robust, up to 60cm. Stem decumbent, usually branched, hispid with hyaline bristles. Leaves ovate to lanceolate, 2-6×1-3cm, acute, surfaces weakly hispid. Flowers in terminal bracteate cymes, deep brilliant sky with whitish tube. Nutlets irregularly ovoid.
Habitat: Open grassland. **Fl. & Fr.:** Jun.-Oct.
Representative collection: Solukhumbu, Between Pangboche & Somare, 4030m, 27º52.00'N, 86º48.20'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP150 (TUCH).
Distribution: Himalaya (Nepal-Bhutan), West China. Nepal (Central-Eastern: 3500-4600m).

Family 22: LAMIACEAE (LABIATAE)

1. CLINOPODIUM L.

1. Clinopodium umbrosum (M. Bieb.) K. Koch, *Linnea.* **21**: 673 (1848). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 152 (2000).

Melissa umbrosa M. Bieb., *Fl. Taur.-Caw*. **2**: 63(1808).

Perennial ascending herbs about 30cm, pubescent. Leaves ovate, 1.5-4.5×0.5-3cm, acute, base rounded to broadly cuneate, margin serrate, sparsely pilose. Flower 10-20 in verticillasters in axils of upper leaves, pink. Nutlets ellipsoid.
Habitat: Open grassland. **Fl. & Fr.:** May-Sep.

Representative collection: Solukhumbu, Deboche surroundings, 3750m, 27º50.75'N, 86º46.96'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP251 (TUCH).

Distribution: Iran, Afghanistan, Pakistan, Himalaya (Kashmir-Bhutan), India, Myanmar, Sri Lanka, Tibet, China, Taiwan, Malaysia. Nepal (Western-Eastern: 1800-3750m).

Note: Previously reported only up to 3400m (Press *et al.* 2000).

2. ELSHOLTZIA Willd.

1. Elsholtzia eriostachya (Benth.) Benth. in *Labiat. Gen. Spec.* **2(3)**: 163 (1833). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 153 (2000).

Aphanochilus eriostachyus Benth. in Wall., *Pl. As. Rar.* **1**: 29 (1830).

Annual herb, 5-15cm.Stem erect, with or without slender erect branches at the nodes, pilose. Leaves ovate-elliptic to ovate-oblong, 1-3.5×0.5-1.5cm, acute, cuneate, serrate, pubescent. Flowers in spikes, yellow. Nutlets obovoid.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun.-Oct.

Distribution: Himalaya (Uttar Pradesh-Sikkim), India, China (Xizang). Nepal (Western-Eastern: 3000-4800m).

3. PHLOMIS L.

1. Phlomis bracteosa Royle ex Benth. in Hooker's *J. Bot. Kew Gard. Misc.* **3**: 383 (1833). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 157 (2000).

Phlomis lamiilolia Royle ex Benth. Hook., *B. Misc.* **3**:383 (1833).

Perennial herbs, 15-100cm, pubescent throughout. Stems conspicuously 4-angled. Leaves opposite, lamina heart-shaped 4-10×2-7cm, toothed, acute, petiolate, hairy. Flowers in crowded whorls of interrupted spikes, pink-purple.

Habitat: Open grassland. **Fl. & Fr.:** Jul.-Sep.

Representative collection: Solukhumbu, Deboche surroundings, 3750m, 27º50.75'N, 86º46.96'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP247 (TUCH).

Distribution: Afghanistan, Punjab, Himalaya (Kashmir-Bhutan), India. Nepal (Western-Eastern: 2400-4100m).

Family 23: SOLANACEAE

1. ANISODUS Link ex Spreng.

1. Anisodus luridus Link & Otto, *Icon. Pl. Select.*: 77 (1825); Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 302 (2000); Mill in *Fl. Bhu.* **2(3)**: 1041 (2001).

Perennial herbs. Stem up to 2m, succulent, branched. Leaves alternate, ovate or elliptic 4.5-20×3-10cm, base obtuse or cuneate, margin entire. Flowers solitary and axillary, pendent, yellowish green. Fruit a spherical capsule, enclosed within calyx.

Habitat: *Juniperus recurva* forest **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3610m, $27^0$50.46'N, $86^0$45.72'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP260 (TUCH).

Distribution: Himalaya (Kashmir-Nepal), China (Sichuan, Xizang, Yunnan). Nepal (Western-Eastern: 2500-3800m).

Family 24: SCROPHULARIACEAE

1. HEMIPHRAGMA Wall.

1. Hemiphragma heterophyllum Wall. in *Trans. Linn. Soc. London* **13**: 612 (1822). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 292 (2000).

Slender creeping perennial herbs up to 25cm. Stems sparsely pubescent. Leaves dimorphic; cauline leaves opposite, orbicular-reniform, base cordate, margin crenate; radical leaves many, 4-6mm long. Flowers axillary, pink. Fruit ovoid, fleshy and shining red.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Feb.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3670m, 27º50.29'N, 86º45.58'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP230 (TUCH).

Distribution: Himalaya (Uttar Pradesh-Bhutan), North East India, Myanmar, West and Centre China, Taiwan, Philippines. Nepal (Western-Eastern: 1800-3700m).

Note: Previously reported only up to 3500 m (Press *et al.* 2000).

2. PEDICULARIS L.

1. Pedicularis gracilis Wall. ex Benth., *Scroph. Ind.*: 52 (1835). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 296 (2000).

Annual herbs up to 90cm. stem branched, pubescent. Leaves opposite or in whorls of 4; lamina lanceolate, 1-5×0.5-2cm, pinnatified; segments 4-8 pairs. Flowers in a lax terminal raceme of 3-10 in 2-4-flowered whorls. Capsules ovate, 5-10×3-4mm.

Habitat: On the bank of Imja river. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 4050m, $27^0$51.43'N, $86^0$47.78'E, October 9, 2007, E.N. Paudel and S.R. Maharjan, SNP99b (TUCH).

Distribution: Himalaya (Kashmir-Bhutan), China (Xizang). Nepal (Western-Eastern: 2200-4050m).

Note: Previously reported only up to 3800 m (Press *et al.* 2000).

2. Pedicularis oederi Prain, *J. asiat. Soc. Bengal* **58(2)**: 276 (1889). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 298 (2000).

Perennial herb up to 5cm. Stems single-few, densely villous in young. Leaves mainly radical; lamina oblong-lanceolate, 2-3×0.3-1cm, pinnatified. Flowers 4-10 in a terminal spike, yellow-purple. Capsule lanceolate.

Habitat: *Abies-Rhododendron* forest. **Fl. & Fr.:** Jun.-Sep.

Representative collection: Solukhumbu, Chalunche, 3990m, 27º51.53'N, 86º47.84'E, October 6, 2007, E.N. Paudel and S.R. Maharjan, SNP139 (TUCH).

Distribution: Himalaya (Uttar Pradesh-Bhutan), China (Xizang). Nepal (Western-Eastern: 3000-5500m).

3. Pedicularis oxyrhyncha T. Yamaz., *J. Jap. Bot.* **61(3)**: 297 (1986). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 298 (2000).

Perennial herb up to 30cm. Leaves mostly cauline, opposite, linear-oblong, 3-15×2-5cm, pinnatified; segments 4-6 paired, oblong, acuminate-serrate. Flowers solitary or axillary or in short racemes with 2 flowers in each node. Capsule 3-8×2-4mm.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3670m, 27º50.29'N, 86º45.58'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP229 (TUCH).

Distribution: Nepal (Central-Eastern: 3650-4400m).

Note: Previously reported only from 3900m to 4400m (Press *et al.* 2000).

4. Pedicularis siphonantha D. Don., Prodr. Fl. Nepal.: 95 (1825). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 299 (2000).

Perennial herb up to 20cm. Stems erect or decumbent. Leaves alternate, mostly radical, lamina linear-oblong, 2-5×0.5-2cm, with narrowly winged rachis, pinnatified. Flowers axillary in upper part, purple-pink.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4000m, 27º50.90'N, 86º47.13'E, October 4, 2007, E.N. Paudel and S.R. Maharjan, SNP116 (TUCH).

Distribution: Himalaya (?Uttar Pradesh, Nepal-Bhutan), ?NE India, China (Xizang). Nepal (Western-Eastern: 3000-4000m).

5. Pedicularis trichoglossa Hook. f., *Fl. Brit. India* **4(11)**: 310 (1884). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 299 (2000).

Perennial herb up to 1m. stems unbranched, densely adnate with whitish hair. Leaves cauline, alternate, sessile, linear-oblong, 2-7×0.5-2cm, acute, pinnatified. Flowers in a terminal racemes. Capsule oblong-lanceolate, 7-15×3-6mm.

Habitat: On the bank of Imja river. **Fl. & Fr.:** Jul.-Sep.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 4050m, $27^0$51.43'N, $86^0$47.78'E, October 9, 2007, E.N. Paudel and S.R. Maharjan, SNP99a (TUCH).

Distribution: Nepal (Western-Eastern: 4000-4800m). Himalaya (Uttar Pradesh-Bhutan), West China.

3. VERONICA L.

1. Veronica ciliata var. **cephaloides** (Pennell) Hong, *Acta Phytotax. Sin*. 16:24 (1978); Li, S.G. & Pennington, T.D. in *Fl. China* **18**: 72 (1996), Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 300 (2000); Mill in *Fl. Bhu.* **2(3)**: 1141 (2001).

Veronica cephaloides Pennell, *Acad. Nat. Sci. Philadelphia Monogr*. 5: 84 (1943).

Perennial herb up to 30cm. Stem slender, white pubescent. Leaves opposite, sessile, lanceolate, 1-2.5×0.5-1cm; apex acute; margin serrate; surface pilose. Flowers in terminal racemes and 1-3 upper most pair of leaves, deep blue. Capsule oblong.

Habitat: Open grassland. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Churo near Dingboche bridge, 4220m, 27º52.87'N, 86º49.15'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP157 (TUCH).

Distribution: Central Asia, Pakistan, North West India, Himalaya (Kashmir, Nepal, Sikkim), Russia. Nepal (Western-Eastern).

2. Veronica sp.

Perennial herb up to 8cm. Stem slender, white pubescent. Basal leaves opposite; upper leaves alternate, sessile, 0.3-1×0.2-0.4cm, lanceolate, white pubescent; margin white hairy; acute. Flowers in terminal clusters of axillary branches, woolly. Capsule notched.

Habitat: Open grassland.

Representative collection: Solukhumbu, Churo near Dingboche bridge, 4220m, 27º52.87'N, 86º49.15'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP156 (TUCH).

Family 25: OROBANCHACEAE

1. BOSCHNIAKIA C.A. Mey.

1. Boschniakia himalaica Hook. & Thomson ex Hook. f., *Fl. Brit. India* **4(11)**: 327 (1884). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 227 (2000).

?Perennial herbs, root parasites. Flowering shoots 15-45cm, pale brown; stems stout, bearing numerous ovate-lanceolate scales 1-2cm. Flowers in dense racemes, yellow. Fruit a capsule.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun.-Oct.

Distribution: Himalaya (Uttar Pradesh-Arunachal Pradesh), China, Taiwan. Nepal (Central-East: 2900-4300m).

Family 26: VALERIANACEAE

1. NARDOSTACHYS DC.

1. Nardostachys grandiflora DC., *Prodr.* **4**: 624 (1830). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 323 (2000). 'Jatamansi' (जटामासी).

Nardostachys jatamansi DC., *Prodr.* **4**: 624 (1830).

Perennial herb. Flowering stem up to 30cm, with rootstock covered by fibers of old leaves, aromatic. Leaves mostly basal; basal leaves linear-spathulate 4-15×0.3-1.5cm, margin entire; cauline leaves narrowly ovate-oblong, smaller. Flowers in capitate heads, purple to whitish.
Habitat: Dry shrubland of *Rhododendron anthopogon*. **Fl. & Fr.:** Jun.-Sep.
Representative collection: Solukhumbu, above Yaren forest, Pangboche, 4250m, $27^0$50.67'N, $86^0$47.65'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP134 (TUCH).
Distribution: Himalaya (Garhwal-Bhutan), Tibet, West China. Nepal (Western-Eastern: 3200-5000m).

2. VALERIANA L.

1. Valeriana hardwikii Wall., *Fl. Ind. (Roxburgh)* **1:** 166 (1820). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 323 (2000).

Valeriana elata D. Don, *Prodr. Fl. Nep.*: 159 (1825).

Perennial stoliniferous, herbs, nodes often densely white hairy. Basal leaves on non-flowering stem rosettes simple, cordate. Cauline leaves pinnate with 1-3 pairs of leaflets, 2-10×1.5-4cm, margin dentate, lateral leaflets smaller. Flowers in corymbose cymes, pink.
Habitat: *Juniperus recurva* forest. **Fl. & Fr.:** Jun.-Oct.
Representative collection: Solukhumbu, Deboche surroundings, 3610m, $27^0$50.46'N, $86^0$45.72'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP258 (TUCH).
Distribution: Himalaya (Kashmir-Bhutan), North Myanmar, East-West China, Sumatra, Java. Nepal (Western-Eastern: 1200-4000m).

Family 27: MORINACEAE

MORINA L.

1. Morina nepalensis D. Don, *Prodr. Fl. Nep.:* 161 (1825). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 99 (2000).

Morina nata Wall. ex DC., *Prodr.* **4**: 645 (1830).

Perennial herbs about 50cm, pubescent upwards. Leaves linear or linear-lanceolate, 2-10×0.5-1.5cm, entire, glabrous; margins always spiny; upper leaves narrowly ovate. Flowers few approximate whorls, forming one small terminal head. Fruit an achene.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Chalunche, 4070m, 27º51.53'N, 86º48.08'E, October 6, 2007, E.N. Paudel and S.R. Maharjan, SNP142b (TUCH).

Distribution: Himalaya (Nepal-Bhutan), North East India, North Myanmar, West China. Nepal (Western-Eastern: 3000-4500m).

Family 28: CAMPANULACEAE

1. CAMPANULA L.

1. Campanula pallida Wall., *Asiat. Res.* **13**: 375 (1820). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 33 (2000). '*Nepali Bis*' (नेपाली बिष).

Campanula colorata Wall., Roxb., *Fl. Ind.* **2**: 101 (1825).

Herbs up to 60cm. Stems hirsute throughout. Leaves sessile, 1-4×0.2-1.5cm, antrosely hirsute; margin serrate. Flowers 1-2 at branches end. Calyx lobes triangular, margin dentate. Corolla campanulate, purple, lobes ovate. Capsule obovate.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Pangboche, 3730m, $27^0$50.34'N $86^0$45.58'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP231 (TUCH).

Distribution: Afghanistan, Himalaya, India, Myanmar, Indo-China, West China. Nepal (Western-Eastern: 1000-4500m).

2. CYANANTHUS Wall.

1. Cyananthus incanus Hook. f. & Thomson, *J. Linn. Soc. Bot.* **2**: 20 (1858). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 35 (2000).

Cyananthus incanus var. *leiocalyx* Franch. in *J. de B.* **1**: 279 (1887).

Perennial; stems prostrate, up to 20cm, white pilose to tomentose. Leaves sessile, elliptic 5-8×1.5-4m, base attenuate, margin entire, apex acute. Calyx tubular, yellowish brown villous; lobes triangular. Corolla tubular-campanulate, violet. Capsule ovate equal to calyx.

Habitat: Open grassland. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Chalunche forest, 4049m, 27^0 51.53'N, $86^0$48.30'E, October 6, 2007, E.N. Paudel and S.R. Maharjan, SNP141 (TUCH).

Distribution: Eastern Himalaya (Nepal-Bhutan), South Tibet, West China. Nepal (Central-East: 2100-5000m).

2. Cyananthus inflatus Hook. f. & Thomson, *J. Linn. Soc., Bot.* **2**: 21 (1857). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 35 (2000).

Annual; stems prostrate, 10-45cm, pilose, glabrescent. Leaves ovate-semicircular, 5-15×3-10mm, margin entire or dentate, base attenuate. Flowers solitary at apex and on branches. Calyx inflated in fruits, ovate. Capsule ovate, scarcely exceeding calyx.
Habitat: Dry shrubland of *Rhododendron anthopogon*. **Fl. & Fr.:** Aug.-Oct.
Representative collection: Solukhumbu, above Pangboche, 4200m, $27^0$50.58'N, $86^0$47.53'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP125 (TUCH).
Distribution: Himalaya (Nepal-Bhutan), North-East India, Myanmar, West China. Nepal (Central-East: 2700-4500m).

3. Cyananthus microphyllus Edgew., *Trans. Linn. Soc. London* **20(1)**: 81 (1846); Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 35 (2000).

Trailing or ascending perennial. Stems tufted 5-15 cm. Leaves alternate, oblong to elliptic 5.8 mm long. Flowers solitary, blue-violet, funnel-shaped 2-2.5cm, with a tuft of white hairs within the corolla tube. Sepals with conspicuous long dense dark hairs.
Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Aug.-Oct.
Representative collection: Solukhumbu, Malinga forest, Debuche, 3850m, $27^0$50.16'N, $86^0$46.12'E, October 11, 2007, E.N. Paudel and S.R. Maharjan, SNP216 (TUCH).
Distrubution: Himalaya (Uttar Pradesh-Sikkim), China (Xizang). Nepal (Western-Eastern: 2900-4800m).

4. Cyananthus pedunculatus C.B. Clarke, *Fl. Brit. India* **3(8)**: 434 (1881). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 35 (2000).

Perennial. Stems procumbent, 5-30cm, pilose-pubescent, unbranched. Leaves sessile, oblong, 4-17×2-6mm, margin entire, pubescent. Flower solitary at apex, violate-blue. Pedicels with spreading black hairs. Capsule ovate.
Habitat: Open shrub land. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, above Pangboche, 4220m, $27^0$50.84'N, $86^0$47.80'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP137 (TUCH).
Distribution: Himalaya (Nepal-Sikkim), China (Xizang). Nepal (Central-East: 3000-4800m).

Family 29: ASTERACEAE (COMPOSITAE)

1. ADENOCAULON Hook.

1. Adenocaulon himalaicum Edgew., *Trans. Linn. Soc. London* **20(1)**: 64 (1846). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 49 (2000).

Perennial herb up to 50cm. Stems erect, araneous. Leaf blade broadly ovate or reniform, 4.5-10×4.5-10cm, subacute, deeply cordate at base irregularly toothed. Capitula 5mm across; phyllaries ovate, reflexed in fruit. Achenes clavate.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Aug.-Oct.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 3950m, $27^0$51.38'N, $86^0$47.78'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP102b (TUCH).

Distribution: Himalaya (Nepal-Bhutan), China, Japan. Nepal (Western-Eastern: 2000-4000 m).

2. Adenocaulon nepalense M. Bittmann, *Candollea* **45**: 403 (1990). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 49 (2000).

Perennial herb up to 50cm. Stems erect, araneous. Leaf blade triangular, acute, truncate, denticulate, petioles decurrent at base; Capitula 5mm across; phyllaries ovate, reflexed in fruit. Achenes often hairy at base.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Aug.-Oct.

Representative collection: Solukhumbu, Yaren forest, Pangboche around, 3950m, $27^0$51.381'N/ $86^0$47.781'E, 2.10.2007, E.N. Paudel and S.R. Maharjan, SNP102a (TUCH).

Distribution: Himalaya (Nepal, Sikkim). Nepal (Central-East: 2550-3950m).

Note: Previously reported only up to 3750 m (Press *et al.* 2000).

2. AINSLIAE DC.

1. Ainsliea aptera DC., *Prodr.* **7(1)**: 14 (1838). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 49 (2000).

Perennial herb up to 1m. Stems sparsely araneous. Leaves ovate, 3-11×2.5-8cm, acute, cordate at base, dentate, subglabrous above; petiole unwinged. Flowers entirely cleistogamous. Phyllaries linear-lanceolate, acute, margin scarious. Achenes obovoid.

Habitat: Moist *Abies-Betula* forest. **Fl. & Fr.:** Feb.-Dec.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 3670m, $27^0$50.29'N, $86^0$45.40'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP226b (TUCH).

Distribution: Himalaya (Kashmir-Bhutan). Nepal (Western and Eastern: 1600-3700m).

Note: Previously reported only up to 3500 m (Press *et al.* 2000).

2. Ainsliea latifolia (D. Don) Sch. Bip., *Jahresber. Pollichia* **18-19**: 169 (1861). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 49 (2000).

Liatris latifolia D. Don, *Prodr. Fl. Nep.*: 169 (1825).

Perennial herb up to 1m. Stems sparsely araneous. Leaf ovate or elliptic, 1.5-10×1-7cm, acute, rounded to tapering at base, often with linear denticles; petiole winged. Flowers entirely cleistogamous. Phyllaries linear; margin scarious. Achenes obovoid.

Habitat: Moist *Abies-Betula* forest. **Fl. & Fr.:** Mar.-Nov.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 3670m, $27^0$50.299'N, $86^0$45.407'E, October 12, 2007, E.N. Paudel and S.R. Maharjan, SNP226a (TUCH).

Distribution: Himalaya (Kashmir to Bhutan), North East India, North Myanmar, Indo-China, Central and South China, Taiwan, Philippines. Nepal (Western-Eastern: 1700-3500m).

3. ANAPHALIS DC.

1. Anaphalis contorta (D. Don) Hook. f., *Fl. Br. Ind.* **3(8)**: 284 (1881). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 50 (2000). '*Pansan'* (पान्सन).

Antennaria contorta D. Don, *Prodr. Fl. Nep.*: 175 (1825).

Tufted plant, 15-30cm. Stems often spreading, slender, wooly. Leaves lower rosetted, obovate, 1-2×0.2-0.5cm, margin inrolled, apex acute, white wooly beneath; upper leaves linear. Capitula clusters terminal, compact 1.5cm across; bracts white involucral.

Habitat: On open grassland. **Fl. & Fr.:** Jul.-Nov.

Representative collection: Solukhumbu, Deboche surrounding, 3750m, $27^0$50.74'N, $86^0$46.54'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP248 (TUCH).

Distribution: Afghanistan, Himalaya (Kashmir-Bhutan), North-East India, South-West China. Nepal (Western-Eastern: 1700-4500m).

2. Anaphalis margaritacea (L.) Benth., Benth. & Hook. f., *Gen. Pl.* **2**: 303 (1873). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 50 (2000).

Gnaphalium margaritaceum L., *Sp. Pl.*: 850 (1735).

Herbs about 20-40cm. Stems greyish tomentose. Leaves narrowly elliptic or lanceolate, 2-9×0.4-2cm, acuminate, sessile, thinly tomentose. Capitula clusters in dense corymbs. Involucre many seriate, phyllaries white, oblong, acuminate. Achenes papillose.

Habitat: Open grassland with sandy soil. **Fl. & Fr.:** Jul.-Dec.

Representative collection: Solukhumbu, Pangboche, 3980m, $27^0$51.36'N, 86^0 47.45'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP70 (TUCH).

Distribution: North America, North Pakistan, Himalaya (Kashmir to Bhutan), Indo-China, China, Japan. Nepal (Central-East: 1800-4000m).

Note: Previously reported only up to 3100 m (Press *et al.* 2000).

3. Anaphalis subumbellata C.B. Clarke, *Comp. Ind.*: 108 (1876). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 50 (2000).

Herbs up to 35cm. Stem erect, whitish tomentum deciduous except from inflorescence branches. Leaves lanceolate, 2-4(-6)×0.2-1.2cm, acuminate, whitish tomentose. Capitula in compact corymbs. Flowers predominantly male or female. Achenes papillose.
Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, Malinga forest, Panboche, 3770m, 27^0 50.305'N/ 86^0 46.116'E, 12.10.2007, E.N. Paudel and S.R. Maharjan, SNP212 (TUCH).
Distribution: Himalaya (Nepal, Sikkim). Nepal (Central-Eastern: 3750-4300m).
Note: Previously reported only from the Central Nepal and 4300m (Press *et al.* 2000).

4. Anaphalis triplinervis var. **intermedia** (DC.) Airy Shaw, *Bot. Mag.* **158**: t. 9369 (1935). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 50 (2000). '*Phosorsan'* (फोसोर्सान).

Anaphalis nubigena DC., *Prodr.* **6**: 272 (1838).
A. nepalensis (Spreng.) Hand.-Mazz., *Symb. Syn.* **7**: 1099 (1936).

Herbs 10-50cm. Stems whitish tomentose. Lower leaves spathulate, 1-7×0.5-2.2cm, acuminate, 1-3-veined, whitish tomentose, upper leaves narrower, sessile. Capitula (1-)5-15 in corymbs. Flowers predominantly male or female. Phyllaries white, lanceolate. Achenes papillose.
Habitat: Dry shrubland of *Rhododendron anthopogon*. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, Yaren forest, Pangboche, 4130m, $27^0$50.68'N, $86^0$47.46'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP122 (TUCH).
Distribution: Afghanistan, North Pakistan, Himalaya, West China. Nepal (Western-Eastern: 2900-4150m).
Note: Previously reported only up to 4100 m (Press *et al.* 2000).

5. Anaphalis xylorhiza Sch.-Bip. ex Hook. f., *Fl. Brit. India* **3(8)**: 281 (1881); Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 50 (2000).

Tufted herb, 2-20cm; tap root woody, twisted. Stems grayish tomentose. Leaves oblanceolate or spathulate, 1-3.5×0.2-1cm, attenuate at base, tomentose; cauline leaves sessile, acuminate. Capitula in compact corymbs. Flowers predominantly female or male. Achenes papillose.
Habitat: Open sandy grassland. **Fl. & Fr.:** Jun.-Sep.
Representative collection: Solukhumbu, Dingboche surrounding, 4340m, 27^0 53.58'N, $86^0$49.33'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP170 (TUCH).
Distribution: Himalaya (Uttar Pradesh-Bhutan), China (Xizang). Nepal (Western-Eastern: 3400-5000m).

4. ARTEMISIA L.

1. Artemisia dubia Wall. ex Besser, *Nouv. Mem. Soc. Imp. Naturalistes Moscou* **3**: 39 (1834). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 51 (2000).

Perennial herb up to 1.5m. Stems minutely appressed pubescent. Lower leaves pinnatisect, 8×5cm, sparsely pubescent above; lateral segments 5-6, lanceolate 2.5-4×0.6-0.8cm, acuminate, entire. Capitula numerous in dense panicles. Involucres subglobose, 1.5-2mm in diameter. Phyllaries ovate to oblong. Central flowers male.

Habitat: On the river bank. **Fl. & Fr.:** Aug.-Oct.

Representative collection: Solukhumbu, on the way of Dingboche-Chukkum, 4130m, $27^0$54.30'N, $86^0$52.26'E, October 8, 2007, E.N. Paudel and S.R. Maharjan, SNP183 (TUCH).

Distribution: Himalaya, China, Korea, Japan. Nepal (Western-Eastern: 1200-4150m).

Note: Previously reported only up to 3400m (Press *et al.* 2000).

2. Artemisia stricta Edgew., *Trans. Linn. Soc. London* **20(1)**: 73 (1846). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 51 (2000).

Artemisia edgeworthii Balak. in *J. Bombay Nat. Hist. S.* **63(2)**: 329 (1967).

Annual or biennial, up to 50cm. Stem brownish hairy above. Mid cauline leaves 1-2 pinnatisect, 1-3cm; primary segments 1-3 pairs; ultimate segments linear 1.5-10×0.2-0.5mm, thinly brownish, villous. Capitula numerous, in dense panicles. Central flowers male.

Habitat: Open grassland with sandy soil. **Fl. & Fr.:** Aug.-Oct.

Representative collection: Solukhumbu, Pangboche surrounding, 4020m, $27^0$51.40'N, 86^0 47.38'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP62 (TUCH).

Distribution: Himalaya, China, (Xizang, Yunnan). Nepal (Western-Eastern: 2100-5000m).

5. CREMANTHODIUM Benth.

1. Cremanthodium oblongatum C.B. Clarke, *Comp. Ind.*: 168 (1876). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 56 (2000).

Cremanthodium nalaoi Kitam. in *Acta Phyt. Geobot.* **15:** 105 (1954).

Stems 10-25cm, appressed pubescent throughout. Basal leaves ovate, 1.5-9×1.5-6cm, obtuse or acute, base cuneate or cordate, margins obscurely toothed, puberulent. Capitula solitary. Ray florets yellow; ligule shallowly toothed. Achenes oblong.

Habitat: Open grassland with sandy soil. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 4000m, $27^0$51.28'N, $86^0$47.93'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP77 (TUCH).

Distribution: Himalaya (Uttar Pradesh-Sikkim), West China. Nepal (Western-Eastern: 2900-5000m).

2. Cremanthodium reniformae (DC.) Benth., *Icon. Pl.* **12**: 37, t. 1141 (1873). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 57 (2000).

Ligularia reniformis DC., *Prodr*. **6:** 315 (1838).

Stems 15-45cm, glabrous. Basal leaves reniform, 2-8×2-7cm, dentate, glabrous; cauline leaves reduced to a sheath. Capitulum solitary. Phyllaries violet-black hairy. Ray corolla ligules oblanceolate, yellow. Disc corollas brownish. Achenes narrowly obovoid.

Habitat: Near the trail. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 4010m, $27^0$51.29'N, $86^0$48.01'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP82 (TUCH).

Distribution: Himalaya (Nepal-Bhutan). Nepal (Central-East: 3000-4600m).

6. DUBYAEA DC.

1. Dubyaea hispida DC., *Prodr.* **7(1)**: 247 (1838). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 58 (2000).

Lactuca dubyaea Clarke, *Comp*. *Ind*.: 271 (1876).

Stems 10-65cm; hirsute. Leaves acuminate, denticulate; lower leaves simple to lyrate-pinnatified, lanceolate in outline, 5.5-12×2-5cm; upper leaves lanceolate, sessile. Capitula 1-5 in corymbs, cernuous. Phyllaries blackish hirsute. Ligules yellow. Achenes brown.

Habitat: Open grass land with sandy soil. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 3930m, $27^0$51.34'N, $86^0$47.75'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP72 (TUCH).

Distribution: Himalaya (Uttar Pradesh to Bhutan), North-East India, North Myanmar, China (Xizang, Yunnan). Nepal (Western-Eastern: 2700-4300m).

7. ERIGERON L.

1. Erigeron multiradiatus (Lindl. ex DC.) C.B. Clarke, *Comp. Ind*. 56 (1876). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 59 (2000).

Stenactis multiradiatus Lindl. ex DC. in *Prodr.* **5**: 299 (1836).

Erect herbs up to 40cm, sparsely pubescent and glandular above. Leaves acute, basal oblanceoloate, 3-8×0.5-2cm, sparsely pubescent; upper oblong, sessile, semi-amplexicaul. Capitula solitary. Flowers dimorphic. Ligules mauve. Disc corollas yellow. Achenes oblong.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 3990m, $27^0$50.60'N, $86^0$47.31'E, October 4, 2007, E.N. Paudel and S.R. Maharjan, SNP115 (TUCH).

Distribution: Himalaya (Kashmir-Bhutan), China. Nepal (Western-Eastern: 2600-4400m).

8. LEONTOPODIUM R. Br.

1. Leontopodium jacotianum Beauverd, *Bull. Soc. Bot. Geneve,* ser. 2 **1**: 190, 373 (1909). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 62 (2000).

Stoloniferous, mats forming, 6-20cm, greyish tomentose. Leaves 0.7-2.5cm; rosette leaves linear-oblanceolate, 1-3mm wide; cauline leaves lanceolate, margins recurved, 1-5mm wide. Capitula 4-9(-18). Flowers predominantly male or female; bracts lanceolate, whitish tomentose. Phyllaries lanceolate. Achenes pubescent.

Habitat: Dry shrub land of *Rhododendron anthopogon*. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 4130m, $27^0$50.68'N, 86^0 47.46'E, 5.10.2007, E.N. Paudel and S.R. Maharjan, SNP123a (TUCH).

Distribution: Himalaya (Kashmir to Bhutan), Myanmar, China (Yunnan). Nepal (Western-Eastern: 2700-4900m).

2. Leontopodium stracheyi (Hook. f.) C.B. Clarke ex Hemsl., *J. Linn. Soc., Bot.* **30**: 136 (1894). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 63 (2000). '*Booki Phool'* (बूकि फूल).

Leontopodium alpinum var. *stracheyi* Hook. f., *Fl. Br. Ind.* **3**: 279 (1881).

Thick stoloniferous, 20-40cm. Stem brownish, glandular pubescent. Leaves narrowly oblong-lanceolate 2-3x0.3-0.7cm, closely white tomentose beneath. Capitula 5-11, crowded. Bracts similar to leaves, white tomentose. Phyllaries ovate to oblanceolate. Achenes pubescent.

Habitat: Dry shrub land of *Rhododendron anthopogon*. **Fl. & Fr.:** Sep.-Oct.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 4130m, $27^0$50.68'N, $86^0$47.464'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP123b (TUCH).

Distribution: Himalaya (Kumaun-Bhutan), Tibet, West China**.** Nepal (Western-Eastern: 2200-4500m).

9. LIGULARIA Cass.

1. Ligularia amplexicaulis DC**.,** *Prodr*. **6**: 314 (1838). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 63 (2000).

Senecio amplexicaulis Wall. ex C.B. Clarke, *Comp*. *Ind*.: 204 (1876).

A robust, nearly hairless perennial. Lower leaves large rounded heart shaped, 10-15cm broad, interruptedly winged leaf-stalk; upper leaves broadly sheathing, basal lobes boat-shaped. Flowers in terminal racemes. Achenes with pappus.

Habitat: Open grassland with sandy soil. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Pangboche, 3980m, $27^0$51.36'N, $86^0$47.45'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP68 (TUCH).

Distribution: Himalaya (Kashmir-Bhutan). Nepal (Western-Eastern: 2900-4000m).

Note: Previously reported only up to 3300 m (Press *et al.* 2000).

10. SAUSSUREA DC.

1. Saussurea auriculata (DC.) Sch. Bip., *Linnaea* **19**: 331 (1846). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 64 (2000).

Saussurea DC. *Annales du muséum national d'histoire naturelle* **16**: 156, 198-203, pl. 10-13. (1810).

Stems 30-160cm, glabrous. Leaves lyrate pinnatisect, 7-15×3-8cm, sparsely pubescent above, lower leaves petiolate, remotely denticulate. Capitula cernuous, solitary at branch ends, 2-3cm in diameter. Phyllaries lanceolate-linear, glabrous. Achenes obovoid.
Habitat: *Juniperus recurva* forest. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, Lato Goth, Near Imja, 3600m, $27^0$50.45'N, $86^0$45.71'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP255 (TUCH).
Distribution: Himalaya (Kashmir-Bhutan). Nepal (Western-Eastern: 3100-3800m).

2. Saussurea nepalensis Spreng., *Syst. Veg.* **3**: 380 (1826). Grierson & Springate in *Fl. Bhu.* **2(3)**: 1446 (2001).

Saussurea eriostemon Wall. ex C.B. Clarke, *Comp. Ind.*: 229 (1876).

Stems up to 30cm, whitish pubescent above. Basal leaves pinnatisect, oblanceolate, 5-14×1-3cm, pubescent on veins; lateral segments 4-8 pairs, acute; cauline leaves few, smaller. Capitulum solitary, purple. Phyllaries recurved. Achenes oblong, ribbed.
Habitat: In shrub land of *Rhidodendron anthopogon*. **Fl. & Fr.:** Jul.-Oct.
Representative collection: Solukhumbu, Lato Goth, Near Imja, 3850m, $27^0$50.15'N, $86^0$46.17'E, October 9, 2007, E.N. Paudel and S.R. Maharjan, SNP200 (TUCH).
Distribution: Himalaya (Nepal-Bhutan), China (Xizang). Nepal (Central-East: 3200-4900m).

11. SENECIO L.

1. Senecio alatus Wall. ex DC., *Prodr.* **6**: 368 (1838). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 66 (2000).

Stems up to 1m, pubescent above. Leaves alternate, subrosulate, lamina 6-20×4-12cm, acuminate, coarsely dentate; petioles winged. Capitula panicled. Capitula disciform; phyllaries 5, oblong. Female flowers 2. Bisexual flowers usually 3. Achenes glabrous; disc pappus.
Habitat: Near the trail. **Fl. & Fr.:** Sep.-Jan.
Representative collection: Solukhumbu, Panboche-Tenboche, 3780m, $27^0$50.27'N, $86^0$46.10'E, October 13, 2007, E.N. Paudel and S.R. Maharjan, SNP236 (TUCH).
Distribution: Himalaya (Uttar Pradesh-Bhutan). Nepal (Western-Eastern: 2500-3800m).

2. Senecio chrysanthemoides DC., *Prodr.* **6**: 365 (1838). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 66 (2000).

Perennial, 40-90cm. Leaves alternate; radical leaves dentate, petioles winged; cauline leaves lyrate-pinnatified, sessile; upper leaves oblong, 8-10×1.5-3cm, irregularly pinnatisect, sessile. Capitula radiate in terminal corymbs. Phyllaries oblong, acute. Achenes obovoid, glabrous.

Habitat: Near the bank of Imja river. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Yaren forest, Pangboche, 4050m, $27^0$51.43'N, $86^0$47.78'E, October 9, 2007, E.N. Paudel and S.R. Maharjan, SNP101 (TUCH).

Distribution: Pakistan, Himalaya (Kashmir-Arunachal Pradesh), North-East India, South China. Nepal (Western-Eastern: 1400-4050m).

Note: Previously reported only up to 4000m (Press *et al.* 2000).

12. WALDHEIMIA Kar. & Kir.

1. Waldheimia glabra (Decne.) Regel, *Acta Hort. Petrop.* **6**: 309 (1879). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 71 (2000).

Allardia glabra Decne. in *Jacquem.*, *Voy*. 4 (Bot.): 88, t. 96 (1844).

Fragrant tufted herbs 5-15cm, sparsely araneous hairy. Leaves alternate, 1-2cm on sterile shoots, to 3cm on flowering ones, lobes often 5, acute-obtuse, hairy. Capitula radiate, solitary at branch ends. Phyllaries oblong, obtuse. Achenes oblong.

Habitat: Open grassland. **Fl. & Fr.:** Jul.-Sep.

Representative collection: Solukhumbu, Somare, 4180m, $27^0$52.85'N, $86^0$49.06'E, October 8, 2007, E.N. Paudel and S.R. Maharjan, SNP184 (TUCH).

Distribution: Pamir-Altai, Pakistan (Chitral), Karakoram, Himalaya (Kashmir-Bhutan). Nepal (Western-Eastern: 4100-5400m).

MONOCOTYLEDONEAE

Family 1: LILIACEAE

1. ALETRIS L.

1. Aletris pauciflora (Klotzsch) Hand.-Mazz., *Symb. Sin.* **7**: 1220 (1936). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 183 (2000).

Perennial rhizomatous herbs. Rosette leaves 5-10, blade 4-16×0.3-0.5cm, veins 8 or more. Scape 5-15cm, upper part felted with short white hairs. Flowers 10-20 in a raceme, pinkish. Capsule ovoid, acute.

Habitat: Dry shrubland of *Rhododendron anthopogon*. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, above Yaren forest, Pangboche, 4250m, 27º50.67'N, 86º47.65'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP135 (TUCH).

Distribution: Himalaya (Kashmir-Bhutan), West China. Nepal (Western-Eastern: 2500-4900m).

2. POLYGONATUM Mill.

1. Polygonatum oppositifolium (Wall.) Royle, *Ill. Bot. Himal. Mts.* **1(10):** 380 (1839). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 187 (2000).

Convallaria oppositifolia Wall., *Asiat. Res*. **13**: 380 (1820).

Perennial rhizomatous herbs, 40-100cm. Scale leaves triangular to oblong, membranous. Leaves strictly opposite, 5-14×2-5cm, lanceolate to narrowly elliptic, acuminate. Flowers 1 or more on a common peduncle in leaf axils, white. Berry scarlet.

Habitat: Open grassland. **Fl. & Fr.:** May-Apr.

Representative collection: Solukhumbu, Deboche surroundings, 3750m, 27º50.75'N, 86º46.46'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP254 (TUCH).

Distribution: Himalaya (Nepal, Sikkim), North East India (Meghalaya, Manipur). Nepal (Central-Eastern: 1800-3750m).

Note: Previously reported only from 1800m (Press *et al.* 2000).

Family 2: JUNCACEAE

1. JUNCUS L.

1. Juncus concinnus D. Don, *Prodr. Fl. Nepal.*: 44 (1825). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 149 (2000).

Perennial, rhizomatous densely tufted herb with flowering stem 8-40cm. Scale leaves reddish brown; stem leaves normally two, blade cylindric, 10-50×0.5-1.5mm, upper leaf shorter than basal leaf. Flowers 10-25 in dense, subglobose capitula. Capsule ellipsoid-trigonous.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Pangboche surrounding, 4020m, 27°51.42'N, 86º47.37'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP57 (TUCH).

Distribution: Himalaya (Kashmir-Bhutan), North East India (Meghalaya), West China. Nepal (Western-Eastern: 1800-5200m).

2. Juncus thomsonii Buchenau, *Bot. Zietung (Berlin)* **25**: 148 (1867). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 150 (2000).

Perennial, rhizomatous tufted herbs up to 12cm. Scale leaves reddish-brown. Stem leaves usually 2, sub-basal, blades linear, 3-6×0.1cm. Sheaths with membranous margins, auricles curved, acute. Flowers 3-10 aggregated in to capitula. Capsule ellipsoid-trigonous.

Habitat: On the river bank. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Near Chhukum, 4610m, 27º54.31'N, 86º52.26'E, October 8, 2007, E.N. Paudel and S.R. Maharjan, SNP179 (TUCH).

Distribution: Central Asia, Himalaya, Mongolia, China. Nepal (Western-Eastern: 2700-5200m).

Family 3: POACEAE (GRAMINEAE)

1. AGROSTIS L.

1. Agrostis pilosula Trin. in *Mem. Acad. Sci. Petersb. ser*. 6, **6**: 372 (1841). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 122 (2000).

Calamagrostis pilosula (Trin.) Hook. f., *Fl. Brit. Ind*. **7**: 263 (1896).

Slender, tufted perennial. Culms about 40cm. Culm leaf blades up to 30×0.5cm, linear lanceolate, acute, glabrous. Sheaths smooth, ligule truncate-lacerate. Inflorescence greenish, laxly pyramidal, branches filiform.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4000m, 27º51.29'N, 86º47.93'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP78 (TUCH).

Distribution: Himalaya (Kashmir-Sikkim), India. Nepal (Western-Eastern: 2000-4600m).

2. ANTHOXANTHUM L.

1. Anthoxanthum hookeri (Griseb.) Rendle, *J. Linn. Soc., Bot.* **36**: 380 (1904). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 123 (2000).

Ataxia hookeri Griseb., *Nachr. Königl. Ges. Wiss. Georg-Augusts-Univ.* **3**: 77 (1868).

Tufted perennial. Culms 15-70cm. Base decumbent and rooting from nodes. Culm leaves 3-6, blades 5-20×0.2-0.5cm, acute, hairy upper surface; sheaths hairy on margin; ligules truncate-lacerate. Spikelets on panicle, narrowly lanceolate.

Habitat: *Abies spectabilis* forest. **Fl. & Fr.:** Jun.-Nov.

Representative collection: Solukhumbu, Deboche surroundings, 3760m, 27º50.58'N, 86º46.22'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP246 (TUCH).

Distribution: Himalaya (Nepal, Sikkim). Nepal (Western-Eastern: 2600-3400m).

3. BROMUS L.

1. Bromus himalaicus Stapf. in Hook. f., *Fl. Brit. India* **7**: 358 (1896). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 126 (2000).

Tufted perennial. Culms 25-80cm, glabrous. Leaf blade 10-30×0.3-0.6cm. spreading hairs on veins above; basal auricles pointed, sheaths glabrous; ligule rounded, lacerate. Panicles 10-25cm, branches drooping. Spikelets oblong-elliptic.

Habitat: *Abies-Rhododendron* forest. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Chalunche, 3990m, 27º 51.53'N, 86º47.84'E, October 6, 2007, E.N. Paudel and S.R. Maharjan, SNP140 (TUCH).

Distribution: Himalaya (Nepal-Bhutan). Nepal (Central-Eastern: 2500-4000m).

Note: Previously reported only from the Western and Central Nepal, up to 3700 m (Press *et al.* 2000).

4. CALAMOGROSTIS Adans

1. Calamogrostis sp.

Tufted perennials, stoloniferous. Culms erect up to 30cm, leafy. Leaves flat, glabrous, leafblade 2.5-8×0.1-0.4cm, acute. Inflorescence a panicle, branches whorled, spreading, spikelets brown, 4-7mm.

Habitat: Dry shrubland of *Rhododendron anthopogon*.

Representative collection: Solukhumbu, above Yaren forest, Pangboche, 4250m, 27º50.67'N, 86º47.65'E, October 5, 2007, E.N. Paudel and S.R. Maharjan, SNP136 (TUCH).

5. DANTHONIA DC., nom. cons.

1. Danthonia comminsii Hook. f. in *Fl. Brit. Ind*. **7**: 282 (1896). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 128 (2000).

Danthonia cachemyriana var. *minor* Hook. f., *J.C*. (1896).

Tufted perennial. Culms about 20cm. Leaf blades 10-13×0.3cm, filiform, glabrous above, hairy beneath, sheaths glabrous. Inflorescence ca. 6cm, racemose with ascending branches. Spikelets variable in size, the lowest largest. Callus hairy ca. 2mm.

Habitat: Near the trail. **Fl. & Fr.:** Jul.-Nov.

Representative collection: Solukhumbu, Pangbocche-Tengboche, 3780m, 27º50.28'N, 86º46.10'E, October 13, 2007, E.N. Paudel and S.R. Maharjan, SNP236 (TUCH).

Distribution: Himalaya (Swat-Bhutan), China, Malaysia. Nepal (Western-Eastern: 2200-4100m).

6. DEYEUXIA (L.) Stapf.

1. Deyeuxia scabrescence (Griseb.) Munro ex Duthie, *Gaz. N.W. Prov. Ind*.: 628 (1882). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 129 (2000).

Calamogrostis scabrescence Griseb., *Nachr. Königl. Ges. Wiss. Georg-Augusts-Univ*. **3**: 79 (1868).

Tufted perennial, rhizomatous. Leaves mainly basal, blades erect, 10-50×0.2-0.8cm, sheaths stout; papery, persistent. Culms stouter, 2-3 leaves, inrolled or sometimes flat, sheaths narrow. Inflorescence 7-15cm, spikelets dense branches, awned.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun.-Nov.

Representative collection: Solukhumbu, Deboche forest, 3840m, 27º50.94'N, 86º46.79'E, October 10, 2007, E.N. Paudel and S.R. Maharjan, SNP202 (TUCH).

Distribution: Hills of North and East India, Himalaya (Kashmir-Bhutan), Myanmar, China. Nepal (Western-Eastern: 3000-4600m).

7. ELYMUS L.

1. Elymus nutans Griseb., *Nachr. Ges. Wiss. Gottingen* **1868**: 72 (1868). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 131 (2000).

Tufted perennial. Culms 25-80cm, glabrous. Leaf blade 10-30×0.3-0.6cm, spreading hairs on veins above; basal auricles pointed, sheaths glabrous; ligule rounded, lacerate. Panicles 10-25cm, branches drooping. Spikelets oblong-elliptic.

Habitat: Open grassland. **Fl. & Fr.:** Jun.-Nov.

Representative collection: Solukhumbu, Dingboche, 4320m, 27º53.49'N, 86º49.49'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP159 (TUCH).

Distribution: Central Asia, Himalaya, Eastern Turkistan, Mongolia, China. Nepal (Western-Eastern: 3600-4600m).

2. Elymus schrenkianus (Fisch. & C.A. Mey.) Tzvelev, *Not. Syst. (Leningrad)* **20**: 428 (1960). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 131 (2000).

Triticum schrenkianum Fisch. & C.A. Mey., *Bull. de la Classe Physico-Mathematique de l'Academie Impwriale de Saint-Petersbourgh* **3:** 305 (1845).

Tufted perennial. Culms up to 75cm. Basal leaves linear, acute hairy; culm leaves sparsely hairy, 4-12×0.1-0.3cm; sheaths glabrous, ligule minutely ciliate. Inflorescence drooping; spikelets borne singly, overlapping, awned.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Pangboche surrounding, 4020m, 27°51.42'N, 86º47.37'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP58 (TUCH).

Distribution: Central Asia, Himalaya (Nepal, Bhutan), China. Nepal (Western-Eastern: 2700-4300m).

Note: Previously reported only from the Western and Central Nepal (Press *et al.* 2000).

3. Elymus sikkimensis (Melderis) Melderis. Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 131 (2000).

Agropyron sikkimense Melderis, *Grasses of Burma, Ceylon, India, & Pakistan (excluding Bambuseae)*: 694 (1960).

Tufted perennials. Culms more than 20cm, erect, slender. Leaf blades 6-15×0.2-0.5cm, linear, flat, acute, glabrous beneath, scattered, hairy above; sheaths glabrous, ligule minutely ciliate. Inflorescence erect; spikelets just overlapping, borne singly, awned.

Habitat: Open grassland. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Churo near Dingboche bridge, 4220m, 27º52.87'N, 86º49.15'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP158 (TUCH).

Distribution: Himalaya (Nepal, Sikkim). Nepal (Central-Eastern: 4220m).

Note: Previously reported only from the Central Nepal (Press *et al.* 2000).

8. FESTUCA L.

1. Festuca leptopogon Stapf, *Numer. List:* 354 (1832). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 133 (2000).

Loosely tufted perennial. Culms 40-100cm. Leaves of vegetative shoots erect. Culm leaf blades 15-25×0.1-0.2cm, inrolled; sheath dull, reddish-brown; ligule truncate. Inflorescence 15-30cm, branches in distant. Spikelets laterally compressed.

Habitat: *Betula-Acer* forest. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Deboche forest, 3870m, 27º50.29'N, 86º46.47'E, October 10, 2007, E.N. Paudel and S.R. Maharjan, SNP204 (TUCH).

Distribution: Himalaya (Bhutan-Nepal), North-East India (Meghalaya), China, Taiwan, Malaysia. Nepal (Western-Central: 1800-3700m).

2. Festuca polycolea Stapf, *Numer. List:* 349 (1832). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 133 (2000).

Densely tufted perennial. Culms 5-35cm, erect. Culm leaves 2-6× ca. o.1cm, inrolled, apex acute; auricles blunt; ligule ciliate. Inflorescence 3-10cm, spikelets borne singly.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Deboche forest, 3840m, 27º50.94'N, 86º46.79'E, October 10, 2007, E.N. Paudel and S.R. Maharjan, SNP203 (TUCH).

Distribution: Himalaya (Nepal-Bhutan), North East India, China (Xizang). Nepal (Western-Central: 3600-4700m).

9. HELICTROTRICHON Besser ex Roem. & Schult.

1. Helictrotricon virescens (Nees ex Steud.) Henrard, *Blumea* **3**: 425 (1940). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 134 (2000).

Trisetum virescens Nees ex Steud., *Synopsis Plantarum Glumacearum* **1**: 226 (1854).

Tufted perennial. Basal leaves 20-30×0.2-0.4cm, usually glabrous. Culms up to 1m, leafblade3 4-25×0.1-0.3mm, inrolled, hispid on veins, glabrous; sheaths usually glabrous. Inflorescence green, more than 10cm, branched, bearing 1-12 spike lets.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Yaren, Pangboche, 4060m, 27º51.32'N, 86º48.01'E, October 2, 2007, E.N. Paudel and S.R. Maharjan, SNP90 (TUCH).

Distribution: Himalaya (Kashmir-Nepal), West China. Nepal (Central-Eastern: 2100-4400m).

10. ORYZOPSIS Michx.

1. Oryzopsis munori Stapf, *Numer. List:* 234 (1832). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 137 (2000).

Tufted perennial, 60-100cm, glabrous. Leaf blades 10-30×0.4-0.8cm, smooth above, minutely hispid on veins, glaucous beneath; ligule rounded. Inflorescence 15-35cm, branched; spikelets dorsally compressed, lanceolate.

Habitat: Abies spectabilis forest. **Fl. & Fr.:** Aug.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3760m, 27º50.58'N, 86º46.22'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP245 (TUCH).

Distribution: Himalaya, Nepal , China (Xizang). Nepal (West-Eastern: 3800-4600m).

Note: Previously reported only from the Western Nepal, 3800 to 4600m (Press *et al.* 2000).

11. POA L.

1. Poa annua L., *Sp. Pl.*: 68 (1753). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 138 (2000).

Small tufted annual. Culms up to 20cm, smooth. Leaf blades 5-60×1.5-4mm, flat, glabrous; sheaths smooth, ligule blunt. Inflorescence 2-6cm, lax, triangular in outline. Spikelets green, narrowly elliptic.

Habitat: Open sandy grass land. **Fl. & Fr.:** Feb.-Nov.

Representative collection: Solukhumbu, Between Pangboche & Somare, 4030m, 27º52.00'N, 86º48.20'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP169 (TUCH).

Distribution: Cosmopolitan. Nepal (Central-Eastern: 2300-4050m).

Note: Previously reported only up to 3500m (Press *et al.* 2000).

2. Poa hirtiglumis Hook. f., *Numer. List*: **343** (1832). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 139 (2000).

Densely tufted perennial. Culms 5-25cm, smooth. Leaf blades 2-10×0.2-0.5cm, glabrous; sheaths smooth; ligule truncate. Inflorescence lax panicled, branches spreading; spikelets green.

Habitat: Open grass land with rocky soil. **Fl. & Fr.:** Jul.-Oct.

Representative collection: Solukhumbu, Pangboche surrounding, 4020m, 27º51.42'N, 86º47.37'E, October 1, 2007, E.N. Paudel and S.R. Maharjan, SNP58 (TUCH).

Distribution: Himalalya (Nepal, Sikkim). Nepal (Eastern: 4000-4900m).

3. Poa nemoralis L., *Sp. Pl.*: 69 (1753). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 139 (2000).

Densely tufted perennial. Culms 12-30cm, slender, smooth, leafy. Leaf blades 3.5-10×0.1-0.3cm, glabrous; sheaths smooth; ligule truncate. Inflorescence lax panicled; spikelets pale green.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Churo, 4220m, 27º52.87N, 86º49.15'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP144 (TUCH).

Distribution: Widespread in temperate region. Nepal (Centre: 2600-4200m).

Note: Previously reported only from the Central Nepal, up to 4100 m (Press *et al.* 2000).

4. Poa pagophila Bor, *Kew Bull.* **1949**: 239 (1949). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 139 (2000).

Tufted perennial, sometimes producing slender rhizomes. Basal leaves short, filiform. Culms often short, up to 30cm, smooth, leafy in lower half. Leaf blades 1.5-4×0.1-0.2mm, flat, glabrous; sheaths smooth, blunt. Inflorescence lax, 4.5-8cm, branched.

Habitat: On the river bank. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Near Chhukum, 4610m, 27º54.31'N, 86º52.26'E, October 8, 2007, E.N. Paudel and S.R. Maharjan, SNP174 (TUCH).

Distribution: Himalaya, North East India. Nepal (Western-Eastern: 3600-5200m).

Family 4: CYPERACEAE

1. CAREX L.

1. Carex daltonii Boott. , *Ill. Gen. Carex.* **1**: 5 (1858). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 87 (2000).

Creeping herbs. Leaves mainly in basal rosettes, sheath bases golden brown, shining. Fascicles with 11-18 peduncles, slender. Female spikes 1-4, lax. Male spikes 1-4 single or paired.

Habitat: *Rhododenfron campylocarpum* forest. **Fl. & Fr.:** May-Oct.

Representative collection: Solukhumbu, Milingo forest, deboche, 3990m, 27º50.33'N, 86º46.80'E, October 11, 2007, E.N. Paudel and S.R. Maharjan, SNP219 (TUCH).

Distribution: Himalaya (Nepal-Bhutan). Nepal (Centre).

2. Carex sp.

Rhizomatous, nearly smooth, grass-like tufted herbs, up to 50cm. Leaves often near the base only, 10-40×0.2-0.5cm, glabrous. Inflorescence branched, 10-20cm.

Habitat: *Rhododenfron campylocarpum* forest.

Representative collection: Solukhumbu, Milingo forest, deboche, 3990m, 27º50.33'N, 86º46.80'E, October 11, 2007, E.N. Paudel and S.R. Maharjan, SNP218 (TUCH).

2. KOBRESIA Willd.

1. Kobressia fragilis C.B. Clarke, *J. Linn. Soc., Bot.* **36**: 267 (1903). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 94 (2000).

Densely tufted perennial herb, culms 5-40cm. Leaves basal and sub-basal, V-shaped, inrolled; sheath persisting as fibers. Inflorescence a linear spike-like panicles, often curved; lateral spikes 2-5, with 1-4 single flowered male and 2-7 single flowered female spikelets.

Habitat: *Abies-Betula* forest. **Fl. & Fr.:** Jun.-oct.

Representative collection: Solukhumbu, Churo, 4220m, 27º52.87'N, 86º49.15'E, October 7, 2007, E.N. Paudel and S.R. Maharjan, SNP145 (TUCH).

Distribution: Himalaya (Nepal-Sikkim), China (Sichuan). Nepal (Western-Eastern: 3500-4200m).

Note: Previously reported only up to 3800 m (Press *et al.* 2000).

2. Kobressia nepalensis (Nees) Kuk., *Pflanzenr. (Engler)* **IV-20(HT. 38)**: 40, f. 9 (1909). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 94 (2000).

Uncinia nepalensis Nees, *Contributions to the Botany of India:* 129 (1834).

Extremely densely tufted perennial herb, culms stiffly erect, filiform. Inflorescence a linear spike, dense above, laxer below. Spikelets all single-flowered. Upper few male, majority female. Nut stipitate, body oblong, pale brown.

Habitat: *Rhododendron anthopogon* forest.

Representative collection: Solukhumbu, Yaren, Pangboche, 4100m, 27º 50.92'N, 86º47.61'E, October 3, 2007, E.N. Paudel and S.R. Maharjan, SNP110 (TUCH).

Distribution: Himalaya (Kashmir-Sikkim). Nepal (Western-Eastern: 2900-5700m).

Family 5: ORCHIDACEAE

1. HERMINIUM L.

1. Herminium macrophyllum (D. Don) Dandy, *J. Bot.* **70**: 328 (1932). Press, Shrestha & Sutton, *Ann. Check. Fl. Pl. Nep.*: 59 (2000).

Neottia macrophylla D. Don, *Prodr. Fl. Nep.*: 27 (1825).

Perennial herb up to 10-20cm. Leaves oblanceolate, 5-15×1-3cm, glabrous. Flowers in a terminal spike of 5-10cm long, flowers drooping, green. Sepals and petals usually forming a hood.

Habitat: Open grassland. **Fl. & Fr.:** Jun.-Oct.

Representative collection: Solukhumbu, Deboche surroundings, 3750m, 27º50.75'N, 86º46.46'E, October 14, 2007, E.N. Paudel and S.R. Maharjan, SNP252 (TUCH).

Distribution: Himalaya (Nepal-Bhutan), China (Xizang). Nepal (Central-Eastern: 3800-4600m).

5. DISCUSSION

5.1 Floral diversity of Imja Valley

Altogether 180 species, including 2 subspecies and 3 varieties, of herbaceous angiosperms under 93 genera and 35 families were recorded from the study area. Out of 180 speecies, 4 species were identified up to generic level whereas 15 species up to only family.

Three species *viz*. *Acronema johrianum* Babu, *Pedicularis oxyrhyncha* T. Yamaz. and *Primula wigramiana* W.W. Sm. are the endemic species of Nepal and recorded from this study (Dobremez *et al.* 1967-2005; Press *et al.* 2000).

The result showed that study area was dominanated by family Asteraceae with 26 species, followed by Poaceae and Polygonaceae consisting 24 species and 13 species respectively. Other larger families were Saxifragaceae (10 species); Gentianaceae, Rosaceae and Apiaceae consisted 9 species each; Ranunculaceae and Scrophulariaceae with 8 species each; Crassulaceae (6 speceis); Boraginaceae and Campanulaceae with 5 species each (Fig. 4.1); and so on. Balsaminaceae, Brassicaceae, Droseraceae, Ericaceae, Geraniaceae, Morinaceae, Orobanchaceae, Parnassiaceae, Solanaceae, Violaceae and Orchidaceae are found with single species at herbaceous habit.

Altogether 20 species are added as with new locality in Eastern Nepal and 43 species are found with different altitudinal ranges in which 31 species recorded at higher altitude, 9 species recorded at lower altitude and 3 species with no altitudinal range reported in Hara *et al.* (1978, 1979 and 1982) and Press *et al.* (2000) (Appendix I).

Hara *et al.* (1978, 1979 and 1982) and Press *et al.* (2000) enumerated the plants found in Nepal in which top 10 position is reserved by Asteraceae representing the largest family and, is followed by Poaceae, Orchidaceae, Fabaceae, Rosaceae, Cyperaceae, Scrophulariaceae, Lamiaceae, Ranunculaceae, Apiaceae. However, this study revealed that the sequence of largest families on Asteraceae at the top followed by Poaceae, Polygonaceae, Saxifragaceae, Gentianaceae, Rosaceae, Apiaceae, Ranunculaceae, Scrophulariaceae, Crassulaceae, Boraginaceae and Campanulaceae. This change may be due to the fact that the present study was focused in a small valley as compared to

the Nepal as a whole and it includes only the part of sub-alpine to alpine vegetational zones.

Joshi (2005) described 123 species of wild flowers from Sagarmatha National Park and its adjoining area with Rosaceae at the top and followed by Ericaceae, Primulaceae, Asteraceae, Ranunculaceae and others whereas *Potentilla* (10 species), *Rhodendron* (9 species) and *Primula* (7 species) were the dominant genera. However, it is quite differ in species composition from present study. It may be due to the present study is only focused on the herbaceous species and differ in the collection season.

5.2 Species richness pattern along altitudinal gradient

Altitudinal gradients in species richness are widespread and well known (Rohde 1992; Stevens 1992; Huston 1994). Elevation can influence the species composition through different climatic factors such as temperature, air pressure, solar radiation, and ultra violate radiation, which can all have an influence on the distribution of species along the gradient (Korner 2007). Temperature could be the most important factor that influences the decrease in species richness covarying with altitude. Knight *et al.* (1982), Austin (1987), Pausas (1994), Austin *et al.* (1996), Vetaas (2000) and Mark *et al.* (2001) have all reported low species richness at lower temperatures. As elevation increases, temperatures decreases with the reduction of evapotranspiration on the slopes (Eklund *et al.* 2000) and the increased environmental stress result in a shorter growing period and also have a negative impact on species richness. Grime (1979) implied lower species richness in areas of high ecological stress and Pausas (1994) noted that there are no or few deciduous species at very high altitudes compared to lower altitudes due to the colder temperatures. Korner (2004) described climate and other five potential causes *viz*. adaptation limits, limited area, limited functional space, seasonal time constraints and geological time constraints, for a decline in species richness with altitude. The lapse rate is 0.53℃/100m elevation (Bhattarai and Vetaas 2003) of altitude in Nepal Himalaya means that the temperature is low in high-alpine area, but at a local scale, temperature can be higher due to enhanced radiation especially in open places (Korner 1995).

In the Nepal Himalaya, the change in species composition and richness is remarkable (Grytnes & Vetaas 2002; Vetaas & Grytnes 2002; Bhattarai & Vetaas 2003) and is associated with the temperature gradient, topography, land-use and other human-

induced disturbances. I found a monotonic decrease in herbaceous species richness with increasing altitude (Fig. 4.1) following the same pattern as studied by Woodward (1987); Stevens (1992); Korner (1995) etc. Thus, the null hypothesis, i.e., no effect of altitude on species richness is rejected. However, a unimodal relationship between species richness and altitude has been reported elsewhere at a larger geographical scale (Whittaker 1960; Whittaker & Niering 1975; Rahbek 1997; Grytnes & Vetaas 2002; Bhattarai & Vetaas 2003). My study was restricted to an elevation range from 3600-4100m and is unlikely to produce a unimodal relationship. It can be explained with the help of different studies on unimodal relationship with findings mid-altitude peak in species richness (Whittaker 1960; Rahbek 1995, 1997; Vetaas & Grytnes 2002; Grytnes 2003) besides higher altitudes.

For Nepal Himalaya, the maximum richness of flowering plants has been found between 1500 and 2500m asl (Grytnes and Vetaas 2002) and decreasing onwards. However, Bhattarai and Vetaas (2003) reported maximum species richness at 800m asl, a local mid-elevation peak along a subtropical elevation gradient. Similarly, Subedi (2006) and Rijal (2007) reported hump shaped pattern with maximum species richness at 3500m and 4100-4300m asl respectively. These species optima are a local mid-elevation peak (Rahbek 1995) and could also be the result of the intermediate location between the different vegetation zones, which increases the chances for immigration from both directions, i.e., mass effect (Grytnes & Vetaas 2002).

The decline in species richness on increasing the elevation in Imja valley could be due to harsh climatic conditions like, high radiation, low precipitation, low temperature and high snowfall. This could also be due to ecophysiological constrains, such as reduced growing season and low ecosystem productivity in high elevation (Korner 2000). Availability of channels for immigration of the species is reduced resulting in the reduction of species number that occupies high elevation sites. The limited species pool of vascular plants will also affect the species richness in high elevation, as environmental constraints are expected to exclude species from high elevation habitats (Korner 2000). Mountains generally have a conical shape and as the elevation increase the area of the elevation band with certain set of environmental and climatic conditions decrease. With a reduced area, there are fewer micro-sites for plants to occupy through the development of specific adaptive traits (Hua & Saprunoff 2005). Therefore, the area

effect could also account for the decline of species richness of vascular plant species in high altitude Himalaya (Rosenzwieg 1995, Zobel 1997, Korner 2000).

Bhattarai and Vetaas (2003) reported no relationship of herbaceous species with any of the climatic variables, in comparison to woody species. Ohlemuller and Wilson (2000) found no relationship between herbaceous species richness and elevation. However, the monotonic decrease in herbaceous species in the present study may be the influence of local factors, such as soil conditions, disturbance, and degree of canopy cover in the landscape (Vetaas 1997; Bhattarai and Vetaas 2003), rather than macro scale. Kharkwal *et al.* (2004) reported the variation in herb species composition at different altitudes and is due to change in local abiotic factors such as soil temperature, moisture and altitude. The change in species composition at various altitudes may also lead to change in the species richness.

Grytnes and Vetaas (2002) have reported a very little variation in species richness between 3000 and 4000m asl generating a high-elevation plateau as they studied the total species richness (<100 to 6000m asl) in Nepal. Although this result is based on the interpolation method, my empirical result also followed the same pattern of species richness between 3600 and 4000m asl (Fig. 4.1). Panthi *et al.* (2007) reported a plateau in species richness at the elevation range of 3000–4000m asl at the local level in a trans-Himalayan inner valley of Manang district. The small variation in species number may be due to seasonal movement of animals as we found the symptoms of grazing in sampling plots. Researches indicate that lower altitude pastures (Garratt 1981; Jefferies 1982; Luhan 1989) and alpine pastures (4000–5200m) (Byers 2005) within the Imja and Gokyo valleys have been noticeably degraded due to tourism impact including overgrazing. Seed dispersal via animal dung, hooves and coats (Sykora *et al.* 1990; Poschlod *et al.* 1998; Moe 2001) may be important in reducing disparities in species number along the elevation gradient.

Sampling frequencies was not equal for all altitudinal ranges (Fig. 4.2) and found to be increased from 3600 to 3800m whereas it decreased slightly from 3800 to 4000m and again increased from 4000m up to the top of the gradient. Highest sampling frequency (at 4000 to 4100m) was not followed by the higher richness and vice versa. Thus, there is no correlation between sampling frequency and observed pattern in species richness.

Sampling bias has no effect on the observed species richness pattern along the altitude in this study (Fig 3.2 and 4.1).

5.3 Species richness and disturbance along with altitudinal gradient

The intermediate disturbance hypothesis (Huston 1979) predicts that maximum species richness occurs at intermediate levels of disturbance because: high disturbance levels allow persistence of those species that are disturbance-adapted and low disturbance levels allowing competitive dominance by some species, causing local extinctions of others. However, many species can coexist and persist at intermediate levels of disturbance. I found highest species richness in the presence of only grass cutting. Leps (2005) has described that most of the disturbances are more destructive to the dominant species. Even by simple mowing the proportion of tall species removed is higher than the proportion of low or creeping species. As the higher species are better competitors for light, it leads to a mosaic community structure, with patches of various successional stages resulting complex species-rich community. Although, disturbance has some effect (either positive or negative) on species composition or number, litter fodder collection has less effect on the species number. In this study, presence of less number of species in the absence or presence of both disturbance parameters and highest number of species when there was effect of single disturbance parameters (grass cutting) gives insight to Intermediate Disturbance Hypothesis. Thus, the null hypothesis, i.e., no effect of disturbance on species richness is rejected. However, each disturbance parameter has shown a negative linear relation with species richness when considered along with altitude. This might be due to larger effect of altitude than either disturbance parameters. Nevertheless, I do not have quantitative data to quantify the real effect of the disturbance parameter on the species richness.

6. CONCLUSION

Floristics is the study of plant life, including the preparation of flora. The main aim of the present study was to explore and document of herbaceous plant species and determine the species richness pattern along altitudinal gradient and disturbance of Imja valley. The findings of this research may contribute in the publication of Flora of Sagarmatha National Park and also serve as a reference for the Flora of Nepal; and floristic composition supports to develop strategies for conservation, sustainable management and utilization of biodiversity of that area. From above results and discussion, it can be concluded that:

The study area comprises 180 species with 81.11% dicots and 18.89% monocots.

Asteraceae is observed as the largest family with 26 species and it is followed by Poaceae and Polygonaceae consisting 24 species and 13 species respectively.

Saxifraga is recorded as the largest genus comprising 9 species and it is followed by *Potentilla* with 7 species; *Anaphalis*, *Bistorta* and *Pedicularis* each consisting 5 species.

20 species are added as with new locality in Eastern Nepal and 43 species with different altitudinal ranges than recorded in Press et al. (2000).

The resulting pattern i.e. monotonic decrease and high-elevation plateau in species richness followed the same pattern as reported by previous works for Nepal Himalaya.

Highest sampling frequency (alt. 4000 - 4100 m) was not followed by the higher species richness and vice versa. So, sampling bias has no effect on the observed species richness pattern along the altitude.

Only grass cutting and litter/fodder collection are found to be significant to the species richness supporting the “Intermediate Disturbance Hypothesis-IDH”.

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Appendix-I

List of the species with different regional or altitudinal distribution or both than recorded in Press *et al.* (2000)

S.N.	Name of the species	Press *et al.* 2000	Collection from Imja Valley
1	*Aconogonum sibiricum* (Laxm.) H. Hara	Western-Central: 4000-4700m	*4000m
2	*Acronema johrianum* Babu	Central: 3700-4300m	*3980m
3	*Adenocaulon nepalense* M. Bittmann	Central-Eastern: 2550-3750m	#3950m
4	*Ainsliae aptera* DC.	Western & Eastern: 1600-3500m	#3670m
5	*Anaphalis margaritacea* (L.) Benth.	Central-Eastern: 1800-3100m	#3980m
6	*Anaphalis subumbellata* C.B. Clarke	Central: 4300m	*#3770m
7	*Anaphalis triplinervis* var. *intermedia* (DC.) Airy Shaw	Western-Eastern: 2900-4100m	#4130m,
8	*Arenaria depauperata* (Edgew.) H. Hara.	Western-Central: 3500-4400m	*#4610m
9	*Artemisia dubia* Wall. ex Besser	Western-Eastern: 1200-3400m	#4130m
10	*Bistorta milletii* Lev.	Western-Central: 3000-3400m	*#4020m
11	*Bromus himalaicus* Stapf. apud. Hook. f	Central-Eastern: 2500-3700m	#3990m
12	*Clematis montana* Buch.-Ham. ex DC.	Western-Eastern: 1600-4000m	#4130m
13	*Clinopodium umbrosum* (M. Bieb.) K. Koch	Western-Eastern: 1800-3400m	#3750m
14	*Comastoma pedunculatum* (Royle ex D. Don) Holub	Western-Eastern	#3990m
15	*Delphinium stapeliosum* Bruhl ex Huth	Western-Eastern: 1200-3000m	#3720m
16	*Drosera peltata* var. *lunata* (Buch.-Ham. ex DC.) C.B. Clarke	Western-Eastern. 2500-3600m	#3670m
17	*Elymus schrenkianus* (Fisch. & C.A. Mey.) Tzvelev	Western-Central: 2700-4300m	*4020m
18	*Elymus sikkimensis* (Melderis) Melderis	Central	*#4220m
19	*Epilobium brevifolium* subsp. *trichoneurum* (Hausskn.) P.H. Raven	Eastern: 2100-3600m	#4020m
20	*Epilobium latifolium* subsp. *speciosum* (Decne.) P.H. Raven	Western-Central: 3600-4200m	*4020m
21	*Epilobium royleanum* Hausskn.	Western and Eastern: 4100m	#3740m
22	*Galium aparine* L	Western-Central: 900-3600m	*#4320m
23	*Gallium asperifolium* Wall.	Western-Eastern: 1500-3000m	#3430m
24	*Hemiphragma heterophyllum* Wall.	Western-Eastern: 1800-3500m	#3770m
25	*Heracleum nepalense* D. Don	Western-Eastern: 1800-3700m	#3990m
26	*Kobressia fragilis* C.B. Clarke	Western-Eastern: 3500-3800m	#4220m
27	*Koenigia deliculata* (Meisn.) H. Hara	Western-Eastern: 2700-4000m	#4050m
28	*Ligularia amplexicaulis* DC.	Western-Eastern: 2900-3300m	#3980m
29	*Lomatogonium chumbicum* (Burkill.) H. Sm	Eastern: 3900m	#4020m
30	*Oryzopsis munori* Stapf	Western: 3800-4600m	*#3760m
31	*Pedicularis gracilis* Wall. ex Benth	Western-Eastern: 2200-3800m	#4050m

32	*Pedicularis oxyrhyncha* T. Yamaz.	Central-Eastern: 3900-4400m	#3670m
33	*Physospermopsis obtusiuscula* (DC.) C. Norman	Central: 300-4600m	*4200m
34	*Pleurospermum apiolens* C. B. Clarke	Western-Eastern: 3600-4500m	#4610m
35	*Pleurospermum brunois* (DC.) C.B. Clarke	Western-Central: 4400-5000m	*# 3930m
36	*Poa annua* L.	Central-Eastern: 2300-3500m	#4030m
37	*Poa nemoralis* L.	Central: 2600-4100m	*#4220m
38	*Polygonatum oppositifolium* (Wall.) Royle	Central-Eastern: 1800m	#3750m
39	*Primula capitata* Hook. f.	Eastern: 3800m	#3750/4050m
40	*Primula wigramiana* W.W. Sm.	Central: 4100-5200m	*#3770m
41	*Rheum acuminatum* Hook. f. & Thomson ex Hook.	Central-Eastern: 3300-4200m	#4270m
42	*Rhodiola crenulata* (Hook. f. & Thomson) H. Ohba	Central-Eastern: 4800-5300m	#4070m
43	*Saxifraga aristulata* Hook. f. & Thomson	Western-Eastern: 4200-5600m	#4020m
44	*Saxifraga filicaulis* Wall. ex ser.	Western-Central: 2700-3800m	*#4220m
45	*Saxifraga montana* H. Sm.	Central: 4100-5000m	*4610m
46	*Selinum candollei* DC.	Western-Central: 3000-3800m	*34030m
47	*Senecio chrysanthemoides* DC.	Western-Eastern: 1400-4000m	#4050m
48	*Silene khasiana* Rohrb.		*# 2850-3430m
49	*Silene stracheyi* Edgew.	Western-Central	*#2750-3450m
50	*Thalictrum reniforme* Wall.	Central-Eastern: 2800-3300m	#3430m
51	*Thermopsis barbata Royle*	Western-Central: 2700-4600m	*4060m

Note: *= not reported from Eastern Nepal in Press *et al*. (2000)
= with different altitudinal distribution

Appendix-II

Plot Characters with number of species

S.N.	Plot No.	Latitude	Longitude	Altitude (m)	No. of species
1	1	$27^0$50.327'	$86^0$45.577'	3724	5
2	2	$27^0$50.358'	$86^0$45.412'	3662	4
3	3	$27^0$51.560'	$86^0$47.828'	3958	8
4	4	$27^0$50.378'	$86^0$45.519'	3686	5
5	5	$27^0$50.502'	$86^0$46.292'	3717	6
6	6	$27^0$51.528'	$86^0$48.079'	4071	15
7	7	$27^0$50.983'	$86^0$47.297'	3954	1
8	8	$27^0$51.136'	$86^0$47.791'	4015	3
9	9	$27^0$51.381'	$86^0$47.781'	3951	6
10	10	$27^0$50.867'	$86^0$47.410'	4053	8
11	11	$27^0$50.299'	$86^0$45.407'	3671	4
12	12	$27^0$50.713'	$86^0$46.625'	3735	10
13	13	$27^0$51.000'	$86^0$47.399'	3907	2
14	14	$27^0$50.800'	$86^0$46.685'	3775	6
15	15	$27^0$50.930'	$86^0$47.627'	4040	3
16	16	$27^0$51.008'	$86^0$47.738'	4053	2
17	17	$27^0$50.272'	$86^0$45.370'	3750	5
18	18	$27^0$51.332'	$86^0$48.070'	4075	7
19	19	$27^0$51.022'	$86^0$47.781'	4071	2
20	20	$27^0$50.266'	$86^0$46.695'	4032	7
21	21	$27^0$50.177'	$86^0$46.372'	3929	6
22	22	$27^0$50.610’	$86^0$46.997’	4002	6
23	23	$27^0$50.610'	$86^0$46.997'	4002	8
24	24	$27^0$49.967'	$86^0$46.044'	3887	6
25	25	$27^0$50.298	$86^0$45.456'	3733	6
26	26	$27^0$50.620'	$86^0$46.818'	3886	7
27	27	27^0 51.298'	$86^0$48.016'	4014	5
28	28	$27^0$50.391'	$86^0$46.857'	4030	9
29	29	$27^0$50.245'	$86^0$45.184'	3686	4
30	30	$27^0$50.329'	$86^0$46.804'	3991	9
31	31	$27^0$50.253'	$86^0$46.450'	3894	6
32	32	$27^0$50.248'	$86^0$46.136'	3803	6

33	33	$27^0$50.252'	$86^0$45.105'	3615	3
34	34	$27^0$50.278'	$86^0$46.102'	3725	10
35	35	$27^0$50.448'	$86^0$46.890'	4039	13
36	36	$27^0$49.984'	$86^0$46.006'	3846	9
37	37	$27^0$50.437'	$86^0$46.982'	4052	3
38	38	$27^0$50.294'	$86^0$46.460'	3869	5
39	39	$27^0$50.940'	$86^0$46.789'	3836	7
40	40	$27^0$50.158'	$86^0$46.177'	3851	6
41	41	$27^0$50.305'	$86^0$46.116’	3770	11
42	42	$27^0$50.102’	$86^0$46.289’	3954	4
43	43	$27^0$50.104’	$86^0$46.282’	3944	7
44	44	$27^0$50.226'	$86^0$45.807'	3810	3
45	45	$27^0$50.132'	$86^0$45.011'	3631	12
46	46	$27^0$50.045'	$86^0$45.859'	3786	18
47	47	$27^0$50.005'	$86^0$45.907'	3781	15
48	48	$27^0$50.603'	$86^0$47.313'	3992	13
49	49	$27^0$50.600'	$86^0$46.255'	3785	15
50	50	$27^0$50.459'	$86^0$45.716'	3606	20
51	51	$27^0$50.576'	$86^0$46.216'	3763	13
52	52	$27^0$50.921'	$86^0$47.611'	4100	7
53	53	$27^0$51.031'	$86^0$47.810'	4056	3
54	54	$27^0$50.980'	$86^0$47.781'	4076	5
55	55	$27^0$50.915'	$86^0$47.615'	4042	7
56	56	$27^0$51.218'	$86^0$48.071'	4090	6
57	57	$27^0$50.599'	$86^0$47.015'	4010	5
58	58	$27^0$50.563’	$86^0$47.029’	4050	7
59	59	$27^0$50.526’	$86^0$47.035'	4043	7
60	60	$27^0$50.426’	$86^0$46.967’	4056	7

Appendix-III

List of the species within the sampling plots

S.N.	Name of the Species	Family
1	*Adenocaulon nepalense* M. Bittmann	Asteraceae
2	*Anaphalis contorta* (D. Don) Hook. f.	Asteraceae
3	*Anaphalis margaritacea* (L.) Benth.	Asteraceae
4	*Anaphalis triplinervis* var. *intermedia* (DC.) Airy Shaw	Asteraceae
5	*Cremanthodium reniformae* (DC.) Benth.	Asteraceae
6	*Erigeron multiradiatus* (Lindl. ex DC.) C.B. Clarke	Asteraceae
7	*Saussurea nepalensis* Spreng.	Asteraceae
8	*Senecio alatus* Wall. ex DC.	Asteraceae
9	*Impatiens edgeworthii* Hook. f.	Balsaminaceae
10	*Rhodiola bupleuroides* (Wall. ex Hook. f. & Thomson) Fu	Crassulaceae
11	*Rhodiola chrysanthemifolia* (Leveille) Fu	Crassulaceae
12	*Rhodiola wallichiana* (Hook.) S.H. Fu.	Crassulaceae
13	*Sedum triactina* Berger	Crassulaceae
14	*Carex daltonii* Boott.	Cyperaceae
15	*Carex* sp.	Cyperaceae
16	*Kobressia nepalensis* (Nees) Kuk.	Cyperaceae
17	*Cassiope fastigiata* (Wall.) D. Don.	Ericaceae
18	*Astragalus strictus* Graham ex Benth.	Fabaceae
19	*Parochetus communis* Buch.-Ham. ex D. Don	Fabaceae
20	*Thermopsis barbata* Royle	Fabaceae
21	*Gentiana ornata* (G. Don) Griseb.	Gentianaceae
22	*Halenia elliptica* D. Don	Gentianaceae
23	*Swertia ciliata* (D. Don ex G. Don) B. L. Burtt	Gentianaceae
24	*Geranium donianum* Sweet	Geraniaceae
25	*Juncus concinnus* D. Don	Juncaceae
26	*Elsholtzia eriostachya* (Benth.) Benth.	Lamiaceae
27	*Morina nepalensis* D. Don	Morinaceae
28	*Epilobium royleanum* Hausskn.	Onagraceae
29	Unidentified 8	Orchidaceae
30	*Boschniakia himalaica* Hook. & Thomson ex Hook. f.	Orobanchaceae
31	*Parnassia nubicola* Wall. ex Royle	Parnassiaceae
32	Unidentified 6	Plumbaginaceae
33	*Anthoxanthum hookeri* (Griseb.) Rendle	Poaceae
34	*Bromus himalaicus* Stapf. in Hook. f.	Poaceae
35	*Deyeuxia scabrescence* (Griseb.) Munro ex Duthie	Poaceae
36	*Festuca leptopogon* Stapf	Poaceae
37	*Festuca polycolea* Stapf	Poaceae
38	Unidentified 9	Poaceae
39	Unidentified 11	Poaceae
40	Unidentified 12	Poaceae

41	Unidentified 13	Poaceae
42	Unidentified 14	Poaceae
43	Unidentified 15	Poaceae
44	*Aconogonum sibiricum* (Laxm.) H. Hara	Polygonaceae
45	*Bistorta amplexicaulis* (D. Don) Greene	Polygonaceae
46	*Bistorta vaccinifolia* (Wall. ex Meisn.) Greene	Polygonaceae
47	*Bistorta vivipara* (L.) Gray	Polygonaceae
48	*Koenigia deliculata* (Meisn.) H. Hara	Polygonaceae
49	*Persicaria nepalensis* (Meisn.) H. Gross	Polygonaceae
50	Unidentified 5	Polygonaceae
51	*Rheum acuminatum* Hook. f. & Thomson ex Hook.	Polygonaceae
52	*Androsace sarmentosa* Wall.	Primulaceae
53	*Primula atrodentata* W.W. Sm.	Primulaceae
54	*Primula capitata* Hook. f.	Primulaceae
55	*Primula wigramiana* W.W. Sm.,	Primulaceae
56	*Aconitum spicatum* (Bruhl) Stapf	Ranunculaceae
57	*Delphinium stapeliosum* Bruhl ex Huth	Ranunculaceae
58	*Fragaria nubicola* Lindl. ex Lacaita	Rosaceae
59	*Potentilla josephiana* H. Ikeda & H. Ohaba	Rosaceae
60	*Potentilla polyphyla* Wall. ex Lehm.	Rosaceae
61	Unidentified 4	Rosaceae
62	*Bergenia purpurascens* (Hook. f. & Thomson) Engl.	Saxifragaceae
63	*Saxifraga brachypoda* D. Don	Saxifragaceae
64	*Saxifraga parnassifolia* D. Don	Saxifragaceae
65	*Hemiphragma heterophyllum* Wall.	Scrophulariaceae
66	*Pedicularis siphonantha* D. Don.	Scrophulariaceae
67	*Pedicularis trichoglossa* Hook. f.	Scrophulariaceae
68	*Pleurospermum brunois* (DC.) C.B. Clarke	Umbelliferae
69	*Pleurospermum hookeri* C. B. Clarke	Umbelliferae
70	Unidentified 7	Valerianaceae
71	*Valeriana hardwikii* Wall.	Valerianaceae
72	*Viola biflora* L.	Violaceae

Appendix-IV

List of Families with Number of Genera and Species

S.N.	Family	No. of Genera	No of species (including subspecies and varieties)
1	Asteraceae	12	26
2	Poaceae	11	24
3	Polygonaceae	7	13
4	Saxifragaceae	2	10
5	Gentianaceae	5	9
6	Rosaceae	2	9
7	Umbelliferae	6	9
8	Ranunculaceae	5	8
9	Scrophulariaceae	3	8
10	Crassulaceae	2	6
11	Boraginaceae	4	5
12	Campanulaceae	2	5
13	Leguminosae	4	5
14	Caryophyllaceae	2	4
15	Cyperaceae	2	4
16	Onagraceae	1	4
17	Primulaceae	2	4
18	Rubiaceae	1	3
19	Valerianaceae	2	3
20	Juncaceae	1	2
21	Labiatae	2	2
22	Liliaceae	2	2
23	Orchidaceae	1	2
24	Papaveraceae	2	2
25	Balsaminaceae	1	1
26	Brassicaceae	1	1
27	Droseraceae	1	1
28	Ericaceae	1	1
29	Geraniaceae	1	1
30	Morinaceae	1	1
31	Orobanchaceae	1	1
32	Parnassiaceae	1	1
33	Plumbaginaceae	1	1
34	Solanaceae	1	1
35	Violaceae	1	1
Total		93	180

Appendix-V

List of the Unidentified specimens

S.N.	Family	Coll. No.	Coll. date	Habitat	Locality	Altitude	Latitude	Longitude
Unidentified 1	Asteraceae	SNP124	October 5, 2007	Dry shrubland of *Rhododendron* spp.	Above Yaren forest, Pangboche	4200m	27º50.58'N	86º47.54'E
Unidentified 2	Asteraceae	SNP264	October 15, 2007	*Rhododendron* forest	near Tenboche	3840m	27º50.22'N	86º45.84'E
Unidentified 3	Asteraceae	SNP160	October 7, 2007	Open grassland	Dingboche	4320m	27º53.49'N	86º49.49'E
Unidentified 4	Rosaceae	SNP237a	October 13, 2007	Near the trail	Pangbocche-Tengboche	3780m	27º50.28'N	86º46.10'E
Unidentified 5	Polygonaceae	SNP239	October 14, 2007	*Betula-Sorbus* forest	Deboche surroundings	3740m	27º50.71'N	86º46.72'E
Unidentified 6	Plumbaginaceae	SNP244	October 14, 2007	*Abies spectabilis* forest	Deboche surroundings	3790m	27º50.60'N	86º46.25'E
Unidentified 7	Valeriaanaceae	SNP97	October 2, 2007	On the river bank	Yaren, Pangboche	4050m	27º51.43'N	86º47.78'E
Unidentified 8	Orchidaceae	SNP142a	October 6, 2007	*Abies-Betula* forest	Chalunche	4070m	27º51.53'N	86º48.08'E
Unidentified 9	Poaceae	SNP103	October 2, 2007	*Abies-Betula* forest	Yaren, Pangboche	3950m	27º51.38'N	86º47.78'E
Unidentified 10	Poaceae	SNP243	October 14, 2007	*Abies spectabilis* forest	Deboche surroundings	3790m	27º50.60'N	86º46.25'E
Unidentified 11	Poaceae	SNP205	October 10, 2007	*Betula-Acer* forest	Deboche forest	3870m	27º50.29'N	86º46.47'E
Unidentified 12	Poaceae	SNP214	October 11, 2007	*Rhododendron* forest	Milingo forest, Deboche	4050m	27º50.45'N	86º46.89'E
Unidentified 13	Poaceae	SNP245	October 14, 2007	Abies spectabilis forest	Deboche surroundings	3760m	27º50.58'N	86º46.22'E
Unidentified 14	Poaceae	SNP112	October 4, 2007	*Abies-Betula* forest	Yaren, Pangboche	3900m	27º51.00'N	86º47.39'E
Unidentified 15	Poaceae	SNP120	October 5, 2007	*Abies-Betula* forest	Omaka forest, Pangboche	4050m	27º50.86'N	86º47.41'E

Appendix-VI

Families and species index

MONOCOTYLEDONEAE