The Diversity of Vascular Plants along the Altitudinal Gradient of the Merak Himalaya, Sakteng Wildlife Sanctuary, Bhutan

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

Master of Science in Botany

Prince of Songkla University

2013

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Thesis Title	The Diversity of Vascular Plants along the Altitudinal Gradient of the Merak Himalaya, Sakteng Wildlife Sanctuary, Bhutan
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ชื่อวิทยานิพนธ์ **ความหลากหลายของพรรณไม้ที่มีท่อลำเลียงตามแนวลาดเขาที่สูงขึ้นบริเวณเทือกเขาหิมาลัยในเขต** Merak **เขตรักษาพันธุ์สัตว์ป่า** Sakteng **ในประเทศภูฏาน**

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สาขาวิชา พฤกษศาสตร์

ปีการศึกษา 2013

บทคัดย่อ

ศึกษาสำรวจพรรณไม้ที่มีท่อลำเลียง ตลอดจนสังคมพืชในบริเวณ เทือกเขาหิมาลัยในเขต Merak เขตรักษาพันธุ์สัตว์ป่า Sakteng ในประเทศภูฏาน ระหว่างเดือน มีนาคม ถึง กันยายน พ.ศ. ๒๕๕๕ พบพรรณไม้จำนวน ๑๑๑ ชนิด จาก ๗๒ สกุล ๓๖ วงศ์ ในจำนวนนี้เป็นพืชกลุ่มเฟินและใกล้เคียง (Pterophytes) ๖ ชนิด พืชกลุ่มเมล็ดเปลือย (Gymnosperms) ๔ ชนิด และเป็นไม้ดอก ๑๐๑ ชนิด พืชวงศ์ที่พบทั่วไปได้แก่ วงศ์ Ericaceae (๑๗ ชนิด) วงศ์ Asteraceae และวงศ์ Rosaceae พบพืชวงศ์ละ ๑๐ ชนิด วงศ์ Polygonaceae พบพืช ๘ ชนิด วงศ์ Ranunculaceae และวงศ์ Primulaceae พบพืชวงศ์ละ ๗ ชนิด และจากการวิเคราะห์สังคมพืชตามความคล้ายคลึงกันของ องค์ประกอบพรรณไม้ สามารถแบ่งสังคมพืชออกเป็น ๕ ประเภทได้แก่ ๑) Riverine Community ๒) Abies – Rhododendron Woodland Community ๓) Juniperus Scrub Community ๔) Rhododendron Krummholz และ ๕) Alpine Meadow การศึกษาในครั้งนี้ ยังแสดงให้เห็นว่า ความหลากหลายของพรรณไม้ตามแนวลาดเขาที่สูงขึ้นในเขต Merak Himalaya นี้ไม่ได้เป็นแบบ hump-shaped ที่มีความหลากหลาย ของจำนวนชนิดมากที่สุดในบริเวณความสูงที่อยู่ตรงกลาง หรือมิได้ค่อยๆลดลงอย่างต่อเนื่องตามความสูงที่เพิ่มขึ้นดังที่คาดไว้ แต่ค่อยเพิ่มขึ้นแล้วลดลง แบบกระทันหันบริเวณความสูงที่อยู่ช่วงกลาง แล้วค่อยเพิ่มขึ้นอีกเมื่อสูงขึ้น ซึ่งรูปแบบการกระจาย ของความหลากหลายพรรณไม้ตามลาดเขาที่ความสูงเพิ่มขึ้นอันไม่ปกติที่พบนี้น่าจะเป็นผลเนื่องมาจากความแปรผันของภูมิประเทศเฉพาะที่ และการรบกวนจากกิจกรรมหลากหลาย ของมนุษย์ ที่อาศัยในบริเวณดังกล่าว ยิ่งไปกว่านั้น การศึกษาในครั้งนี้ยังชี้ให้เห็นว่าสภาพแวดล้อมอันเปราะบางแบบ alpine ของเขต Merak Himalaya นี้มีความหลากหลายของพรรณไม้สูง รวมทั้งยังมีพันธุ์ไม้ที่มีสถานะเป็นพืชถิ่นเดียว และพืชหายากหลายชนิดที่ถูกคุกคามจากกิจกรรมของมนุษย์ซึ่งเป็นกลุ่มชนพื้นเมืองที่เร่ร่อนอาศัยในบริเวณดังกล่าวดังนั้นการใช้นโยบายในเชิงอนุรักษ์ในบริเวณดังกล่าวนี้จึงมีความจำเป็นเพื่อคง สภาพตามธรรมชาติของพืชพรรณ และ ยังสามารถรักษาวัฒนธรรมการใช้ชีวิตของชน พื้นเมืองเร่ร่อนไปด้วยนั้น มีความจำเป็นยิ่ง

Thesis Title The Diversity of Vascular Plants along the Altitudinal Gradient of the Merak Himalaya, Sakteng Wildlife Sanctuary, Bhutan
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Major Program Botany
Academic Year 2013

ABSTRACT

A survey had been conducted from March to September 2012 along the altitudinal gradient of the Jomokungkhar trail in the Merak Himalayan, Sakteng Wildlife Sanctuary, Bhutan to study the floristic composition and the vegetation pattern of the area. A total of 111 species of vascular plants that comprised 38 families and 72 genera were collected, identified, and described. Of the total, six species are pterophytes, four species are gymnosperms, and 101 species are angiosperms. Some of the most common families occurring in the Merak Himalaya are Ericaceae (17 species), Asteraceae and Rosaceae (10 species each), Polygonaceae (8 species), and Ranunculaceae and Primulaceae (7 species each). The vegetation of Merak Himalaya was classified into five community types, i.e. 1. Riverine Community; 2. *Abies–Rhododendron* Woodland Community; 3. *Juniperus* Scrub Community; 4. *Rhododendron* Krummholz and 5. Alpine Meadow, based on the floristic composition. The present study also showed that the diversity of vascular plants along the altitudinal gradient is neither hump-shaped with mid-elevation peak nor monotonically decreasing with an increasing altitude as it could be expected; rather it changed randomly and uniquely with very distinct fall in the species distribution at the mid elevation ranges. This unusual trend might be due to variation in the local topography as well as the influence of various anthropogenic activities from the nomadic tribe in the areas. Moreover, the data also showed that the fragile alpine environment of the Merak Himalaya has high plant diversity including endemic and rare species and important plants that are susceptible to anthropogenic pressures. Therefore, implementation of strict conservation polices to assure conservation of both the nomadic culture and the fragile natural environment was found necessary.

ACKNOWLEDGEMENT

A man would do nothing if he waited until he could do it so well that no one would find fault with what he has done. - Cardinal Newman. Accordingly, the following individual persons, agencies, and institutions are duly thanked for the successful completion of my work.

I would like to sincerely acknowledge and express my heartfelt gratitude to my principal advisor, Assoc. Prof. Dr. Kitichate Sridith, for his continuous guidance and all kinds of support rendered during my 2 years of stay in Thailand as a post graduate student.

The chairperson of the thesis examination committee Prof. Dr. Thaweesakdi Boonkerd, Department of Botany, Faculty of Science, Chulalongkorn University Bangkok; committee members Asst. Prof. Dr. Charan Leeratiwong and Assoc. Prof. Dr. Kitichate Sridith, Department of Biology, Faculty of Science, Prince of Songkla University are thanked for their valuable time to conduct my thesis examination.

Acknowledgement is also due to the Council for RNR Research of Bhutan (CoRRB), Ministry of Agriculture, Thimphu; RNRRC, Yusipang, Thimphu; and the management team of Sakteng Wildlife Sanctuary, Trashigang, Bhutan for the approval to conduct research within the vicinity of Sakteng Wildlife Sanctuary.

I am deeply indebted to Mr. Tashi Gyeltshen and Mr. Kezang Duba of Merak School for being so generous in providing me with the basic amenities and sparing their valuable time accompanying me in the field for the data collection. Truly, you are highly acknowledged.

Acknowledgement is also due to Mr. Choki Gyeltshen, Biodiversity Officer, National Biodiversity Center (NBC), Thimphu for his help in transferring plant specimens from Bhutan to Thailand; Mr. Phuntsho, Park Range Officer of Merak, Sakteng Wildlife Sanctuary, Trashigang for his necessary help and giving me

some photographs and maps of the area; and Mr. Jas Raj Subba, Lecturer, Paro College of Education for hiring the necessary study materials.

I am also grateful to all the members of PSU Herbarium, Prince of Songkla University, Thailand; Dr. Sahut Chantanaorrapint, Dr. Thamarat Putthani, Mr. Jarearnsak Sae Wai, Ponlawat Pattarakulpisutti, Ms. Milica Stankovic, Ms. Naiyana Tetsana, Ms. Kanakon Bunpha, and Mr. Boonchoo Hassama for their help rendered in various ways. Mrs. Jittima Phosena, officer at International and Public Relations Office is also equally acknowledged for her timely help whenever needed.

The President Scholarship Committee of Graduate School, Prince of Songkla University; Department of Biology, Faculty of Science, Prince of Songkla University; and National Research University Project of Thailand's Office of the Higher Education Commission (NRU), Thailand, are thanked for the financial support without which my work would have been impossible.

Her Majesty the Royal Queen Mother of Bhutan and the Royal Bhutan Embassy in Bangkok, Thailand are thanked for introducing PSU-President Scholarship for Bhutanese students and processing my admission at Prince of Songkla University, respectively.

Last but not the least, Mrs. Dungchen Lhamo, my spouse and Karma Euphel Wangmo, my daughter are sincerely acknowledged for their moral supports and sacrifices made in supporting my studies. They made my work easy and possible to complete within the stipulated time.

Karma Jamtsho

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List of Abbreviations and Symbols

Abbreviations

asl.	above sea level
ca.	about
cm	centimeter
dbh	diameter at breast height
diam.	diameter
et al.	and others
i.e.	that is
k.m.	kilometer
m	meter
mm	millimeter
sp.	species (singular)
spp.	species (plural)
subsp.	subspecies
var.	variety

Symbols

>	larger/more than
≥	larger than or equal to
±	more or less
<	smaller/less than
≤	smaller or equal to

CHAPTER I

INTRODUCTION

The Himalayas is one of the young fold mountains in the world situated in Asia and separates the plains of Indian subcontinent with the Tibetan Plateau. The formation of the Himalayas dates back to ca. 40–45 million years ago (Swaminathan, 1992). Extending form west to east, it passes through Pakistan, India, Nepal, Bangladesh, Myanmar, China, and Bhutan. The Himalayas is characterized by a complex geologic structure, snowcapped peaks, large valley glaciers, deep river gorges, and rich vegetation (Kienholz et al., 1983).

The Bhutan Himalaya is the main part of the East Himalaya, which span ca. 700 km (Ohsawa, 1987), located at the junction of two major biogeographic realms of the Indo-Malayan and the Palaearctic (Wildlife Institute of India, 2005). The region rather composed of mountains of simple slopes separated by deep river gorges and valleys consists of number of unique habitats, ranging from tropical jungles in the south to alpine zones in the north, due to the variation in topography and climate. Owing to the facts that the region is rich in biodiversity, from the conservation point of view, such areas particularly the fragile alpine ecosystem should be prioritized for conservation. Moreover, the study of vegetation in the Bhutan Himalaya would still serve the best to know clearly about the structure of diversification of the Eurasian vegetation (Ohsawa, 1987).

Although, the forests of Bhutan are still well managed under the strict rule of conservation policies, its success is likely to become a questionable issue due to ever increasing pressures on natural environment from increasing population and associated anthropogenic disturbances. Moreover, poorly recorded damages and depletion imparted to the natural forest by the motor road and dam constructions are spreading almost throughout the country. However, with a high proportion of the original forest cover still remaining in the Bhutan Himalaya, its flora and vegetation should be further explored scientifically to ensure continuity, protection, and enjoyment of its pristine condition. Very least about its flora and conservation strategies is known today, despite the remarkable efforts put in and literatures

available. The botanical studies of the recent past in the Bhutan Himalaya have focused mostly on the endemic, rare, and threatened plants or a particular taxon rather than the general biodiversity. Therefore, floristic records of Bhutan may be incomplete and may require further surveys and studies. Today, Bhutan has 51.32% of its land cover protected through protected area systems and biological corridors (Nature Conservation Division, 2009; World Wildlife Fund Bhutan and Sakteng Wildlife Sanctuary, 2011).

Sakteng Wildlife Sanctuary (referred to as SWS hereon) was declared as the protected area of Bhutan in 2003. It is located in Trashigang district in the east of Bhutan and shares border with the adjacent Himalayan Range of Arunachal Pradesh in India. SWS is one of the protected areas in Bhutan with very rich biodiversity and amazingly houses ca. 35 species of *Rhododendron* L. (Wangchuk, 2010) out of 46 recorded so far in the country (Pradhan, 1999). Many other endemic, rare, and threatened plants also occur in SWS. In spite of the facts known, the previous account of botanical study in SWS is rather scarce. Thus, the forests of these areas are under huge pressure from the local inhabitants and animal grazing.

One ecologically important area of SWS is Merak, perhaps one of the remotest and difficult areas to access for vegetation surveys and related researches. Mountainous Merak is also known to have the rich diversity of species of *Rhododendron* L. and many other endemic, rare, and threatened plants. In general, the vegetation of Merak is apparently composed of three types of forests: cool-temperate forest, subarctic forest, and dry alpine scrubs (Ohsawa, 1987; Grierson and D.G. Long, 1983), with the major forest type composed of *Abies densa* Griff. This area is one among the scientifically underexplored and pressurized by anthropogenic disturbances, on the other hand. A few surveys conducted in the past were insubstantial or obsolete because no significant report was made. It is believed that some studies by the management team are in pipeline that would help to understand the local flora. This would help to plan, manage, and resolve the conservation issues before the serious threat of biodiversity loss encroaches in the area.

OBJECTIVES

1. To document the composition of plant species in the Merak Himalaya and prepare a checklist.
2. To describe plant species collected from the study areas in detail.
3. To evaluate vegetation composition and patterns.
4. To achieve the diversity of vascular plants along the altitudinal gradient of the Merak Himalaya.

LITERATURE REVIEWS

Account of altitude-gradient based botanical studies in the Himalayan Ranges

The account of various researches conducted in the Himalayan Ranges clearly indicate that less scientific studies were conducted in the East Himalayan region as compared to the West Himalayan region.

Bhattaria et al. (2004) provided relationship between the pattern of fern richness and altitude in their surveys conducted along the central Himalayan elevational gradient in Nepal. They obtained a unimodal relationship with maximum fern richness at ca. 2000 m asl. They concluded that unimodal richness of ferns along the elevational gradient is attributed by climatic factors, and thereby rejected the hard boundary attribution concept enumerated by Colwell and Hurtt in 1994, and Grytnes and Vetaas in 2002. According to their surveys, 4800 m is the limit for the distribution and occurrence of ferns in the Himalayas.

Khan et al. (2013) identified vascular plant species and communities across the environmental gradient (2450 m – 4150 m) of Naran valley in northwest Pakistan of the Western Himalayas. A total of 198 vascular plant species including tree, herbs, and shrubs that belonged to 150 genera were identified. They have observed maximum species richness within the range from 2800 m to 3400 m asl. as areas below 2800 m and above 3400 m were influenced by anthropogenic disturbances. Their species matrix based analysis showed 5 different communities: 3 temperate vegetation and 2 subalpine and alpine species dominated communities.

The hump-shaped distribution pattern of vascular plants was obtained along the altitudinal gradient (4180 m to 6622 m asl.) of east Ladakh in northwest Himalayas by Klimes (2003). He observed maximum species number (>200) between 4500 m to 4750 m asl. Based on Raunkiaer life-forms, six life-forms were distinguished among the total vascular flora. Hemicryptophytes consisted of 251 species followed by therophytes with 90 species making 62.1% and 23.3% of the total flora, respectively. 22 species belonged to chamaephytes and 17 species to geophytes making 5.4% and 4.2% of the total flora, respectively. The two rarest life-forms were phanerophytes with 14 species making 3.5 % and hydrophytes with 7 species making 1.7 % of the total flora, respectively. All the six life-forms occurred mostly at an altitudinal range between 4200 m and 4900 m asl. Above this altitudinal range, their number gradually declined and only 4 species of hemicryptophytes were recorded at altitudes above 5900 m asl.

Shimono et al. (2010) studied the patterns of plant diversity at high altitudes, from 3200 m to 5200 m asl. on the Qinghai-Tibetan Plateau. Their relationship between species richness and altitude was rather vague; however, they observed a weak monotonous increase in species richness with increase in altitude. They have reasoned that the trend along altitudinal gradient is more obscure than that of an area containing ecotones. The other reasons for the weak trend in the richness were animal grazing and related anthropogenic disturbances.

Bhattarai and Vetaas (2003) studied about the plant species richness of different life-forms along a subtropical elevation gradient in the Himalayas of the east Nepal. In general, they obtained a hump-shaped pattern of diversity with maximum species richness between 600 m and 800 m asl. While they found no significant statistical trend for herbaceous life-forms, woody life-forms were found to have significant relationship with the climate.

Vetaas and Grytnes (2002) studied about the distribution of vascular plant species richness and endemic richness along the Himalayan elevation gradient in Nepal. In general, vascular plant richness, including endemic plants, showed hump-shaped pattern in richness with mid elevation peak at ca. 2500 m asl. However, they found no statistical significant trend when they excluded endemic plant species from

the group. In short, group of endemic species alone clearly showed hump-shaped pattern with maximum richness between 3500 m and 4500 m asl. Finally, they have concluded that there is no overlap in the maxima of total richness and endemic richness, or the attributes of the hard boundary concept except that the species with very narrow elevation range decrease from low to high elevations. With this statement, this study empirically rejects the Rapoport's elevational rule, which states endemic species should increase towards the lowlands since by definition they have a narrow geographical range.

Forest vegetation patterns along an altitudinal gradient (2800 – 3600 m asl.) in sub-alpine and alpine zone of Garhwal and Pindari regions of the west Himalaya in India were studied by Gairola et al. in 2008. They observed an apparent decline in total tree density and total basal area with increasing altitude. It was assumed that the decline could be due to the sub-alpine forest transition in west Himalaya exhibiting diversity in compositional patterns. The differences in species composition in different locations of the two regions, according to them, are due to high degree of variation in physical setting of the landscapes and disturbance regimes. In addition, they also reported that the regional patterns of species richness are consequences of many interacting factors such as plant productivity, competition, geographical area, historical or evolutionary development, regional species dynamics, regional species pool, environmental variables, and human activity.

Account of botanical studies in Bhutan

The study on the Bhutanese flora began as far back as 1838, when William Griffith collected ca. 1200 plants and published them in the Flora of British India (Grierson and Long, 1983). Following Griffith, many botanists visited and surveyed the forests of Bhutan. Among them were J.C. White, R.E. Cooper, Kingdon Ward, F.M. Bailey, B.J. Cloud, F. Ludlow, G. Sherriff, K. Lumsden, and many others (Grierson and Long, 1983). However, no significant record of their works can be accessed today. Therefore, botanical works pertaining to the flora and vegetation of Bhutan are rather very limited.

A massive work on angiosperms and gymnosperms of Bhutan ever recorded in the history was conducted by Grierson and Long (1983; 1984; 1987; 1991; 1999; 2001). They recorded and described 4,695 species of angiosperms and gymnosperms excluding the species from Poaceae and Orchidaceae. They also classified the vegetation of Bhutan into 12 major recognizable zones. However, Oshawa (1987) reclassified them into six zones: five forests and a scrub.

Pearce and Cribb (2002) studied the orchids of Bhutan and recorded 369 species, forming the largest family recorded so far in the Flora of Bhutan. Gurung (2006) collected 54 species, which were recorded for the first time in Bhutan. Today, the family Orchidaceae has 423 recorded species out of which 14 species are endemic to Bhutan.

Grasses (Poaceae) of Bhutan were studied by Noltie (2000). Including both native and introduced grasses, 389 species in 126 genera of grass were recorded. Poaceae is the second largest family of angiosperm recorded so far in the Bhutanese flora.

Wangda and Ohsawa (2006) studied about the gradational forest change along the climatically dry valley slopes of Punatsangchhu. Five altitudinal forest zones were identified through cluster analysis based on dominance of the tree species. The five zones are: Zone 1, warm-dry west Himalayan type of *Pinus roxburghii* forest; Zone 2, wide ranging east-west Himalayan type of *Querqus lanata* - *Q. griffithii* - *Rhododendron arboreum* mixed broad-leaved forest; Zone 3, humid east Himalayan evergreen broad-leaved forest of *Q. semecarpifolia* - *Q. glauca* - *Q. oxyodon* forest; Zone 4, cool humid east Himalayan conifer type of *Tsuga dumosa* - *Abies densa* forest; and Zone 5, wide ranging cold humid conifer forest of *A. densa* - *Juniperus recurva* forest.

Darabant et al. (2007) studied relation between the cattle grazing and tree generation in a conifer forest with palatable bamboo understory in Chumey valley in central Bhutan. They found that reduction of bamboo height through grazing facilitated recruitment of all conifer tree species, particularly *Tsuga dumosa*, mainly through increased light interception on the forest floor. They further asserted that tree species composition of seedlings and the overstory did not differ in ungrazed plots,

while in grazed plots they observed a shift towards dominance of *T. dumosa*. They found amazing higher growth rates of *T. dumosa* and *Picea spinulosa* in grazed plots as compared to ungrazed plots.

Account of the botanical studies in Sakteng Wildlife Sanctuary

Adhikari (2005) conducted a general survey and studied the floristic characteristics and vegetation patterns of SWS. A checklist of 203 plant species was prepared. The checklist included tree, shrubs, climbers, and herbs collected from various plots along the main path, altitudinal gradient, and random points. Based on occurrence of the dominant species, 10 major forest types were identified in SWS.

Gyeltshen (2012) conducted orchid survey in Dochula, Thimphu; Nahi, Wangdue Phodrang; and Merak and Sakteng under SWS. The team discovered two new records of orchids in Bhutan: *Sunipia* sp. and *Bulbophyllum depressum* King & Pantl. They also observed some part of SWS, e.g. Joenkar, has the highest diversity of orchids.

For better management of the conservation strategies, Wild Wildlife Fund Bhutn and SWS (2011) divided Sakteng Wildlife Sanctuary into four zones, *viz.*, core zone, multiple-use zone, buffer zone, and recreational zone. The zonation has long term objective of contributing towards ecosystem contiguity, ecological connectivity, and ensuring species persistence within the Bhutan's Biological Conservation Complex, while fulfilling the needs of the resident communities and deriving national benefits from conservation.

CHAPTER II

MATERIALS AND METHODS

THE STUDY AREA

Location

Merak is located in Trashigang, the easternmost district of Bhutan and lies within the preserved area of SWS (Figure 1). It shares border with the adjacent Himalayan Range of Arunachal Pradesh in India. Merak is very rich in biodiversity and amazingly houses maximum number of *Rhododendron* L. in the country (Wildlife Institute of India, 2005).

The field survey was conducted along the altitudinal gradient of the Jomokungkhar trail (N27^{o}17.762'-E091^{o}50.268' to N27^{o}15.382'-E091^{o}48.758') of Merak. The trail is ca. 10.5 km in length, ranging from 3,320 m asl. (Ngera Ama river bank, Plot 1; Table 1) to as high as 4510 m asl. (Jomokumhkhar top, Plot 12; Table 1). Within the range, various plant habitats, *viz.*, woodland, scrub, field layer, open ground, edges and aquatic terrestrial transition (Elton and Miller, 1954) are observed. The major type of forest is composed of coniferous woodland mixed with Rhododendron broadleaves and a few species of Junipers. However, it gradually changes to *Rhododendron* krummholz and the alpine meadow.

Topography, Geology, and Climate

The topography of Merak Himalaya is highly mountainous with East-West oriented upland valleys with varying degrees of slopes. The lowest altitude is 3,300 m asl. and the highest is 4,510 m asl. The type of soils found in the Merak Himalaya is mostly podzols and alpine meadow soil found above 4200 m asl (Okazaki, 1987).

With regard to climate, Bhutan is most unknown region in the monsoon Asia (Eguchi, 1987). It has a wide variety of climatic conditions influenced

by topography, elevation, and rainfall. It is divided into six climatic zones. Accordingly, climate of the Merak Himalaya is alpine climate with mean temperature of 5.5^{o}C and an annual average rainfall of ≤650 mm (Department of Agriculture, 1988). No record of monthly rainfall and temperature has been recorded so far due to lack of meteorological stations both within and in the adjacent areas.

The Study Plots

Table 1: Study plots, map reference, elevation and, their vegetation characteristics

Plot Reference	Map Reference	Elevation (m)	Site Description
Plot 1	N 27º17.762′ E 091º50.268′	3320	Riverine forest
Plot 2	N 27º17.532′ E 091º50.142′	3420	Coniferous Woodland
Plot 3	N27º17.017′ E091º50.069′	3520	
Plot 4	N27º16.956′ E091º49.882′	3620	
Plot 5	N27º17.029′ E091º49.801′	3720	
Plot 6	N27º17.096′ E091º49.693′	3820	
Plot 7	N27º16.965′ E091º49.367′	3920	Coniferous Scrub
Plot 8	N27º16.878′ E091º49.311′	4020	
Plot 9	N27º16.473′ E091º49.047′	4120	Broad-leaf Rhododendron Krummholz
Plot 10	N27º16.134′ E091º48.799′	4220	
Plot 11	N27º15.183′ E091º48.490′	4320	Alpine Meadow
Plot 12	N27º15.387′ E091º48.758′	4510	

Twelve study plots (Figure 1) were chosen along the altitudinal gradient comprising of different topographies and habitats. In addition, other aspects of vegetation such as the presence of relict, pattern, and visual observation of species abundance were also taken care while choosing the plots. Table 1 depicts the characteristic properties of each study plots.

In comparison to other preserved areas in Bhutan, SWS is one of the most anthropogenically disturbed areas due to undying pressures on environment from animal grazing and extraction of forest products. Other developmental activities like construction of motor roads and erection of electric pylons also account for great destruction and reduction of the natural vegetation. Thus, the relict of vegetation is seemingly degrading, although succession of forest is very natural without any interruption by human activities like misunderstood afforestation. Owing to the fact, study plots were partially influence by the disturbance regime.

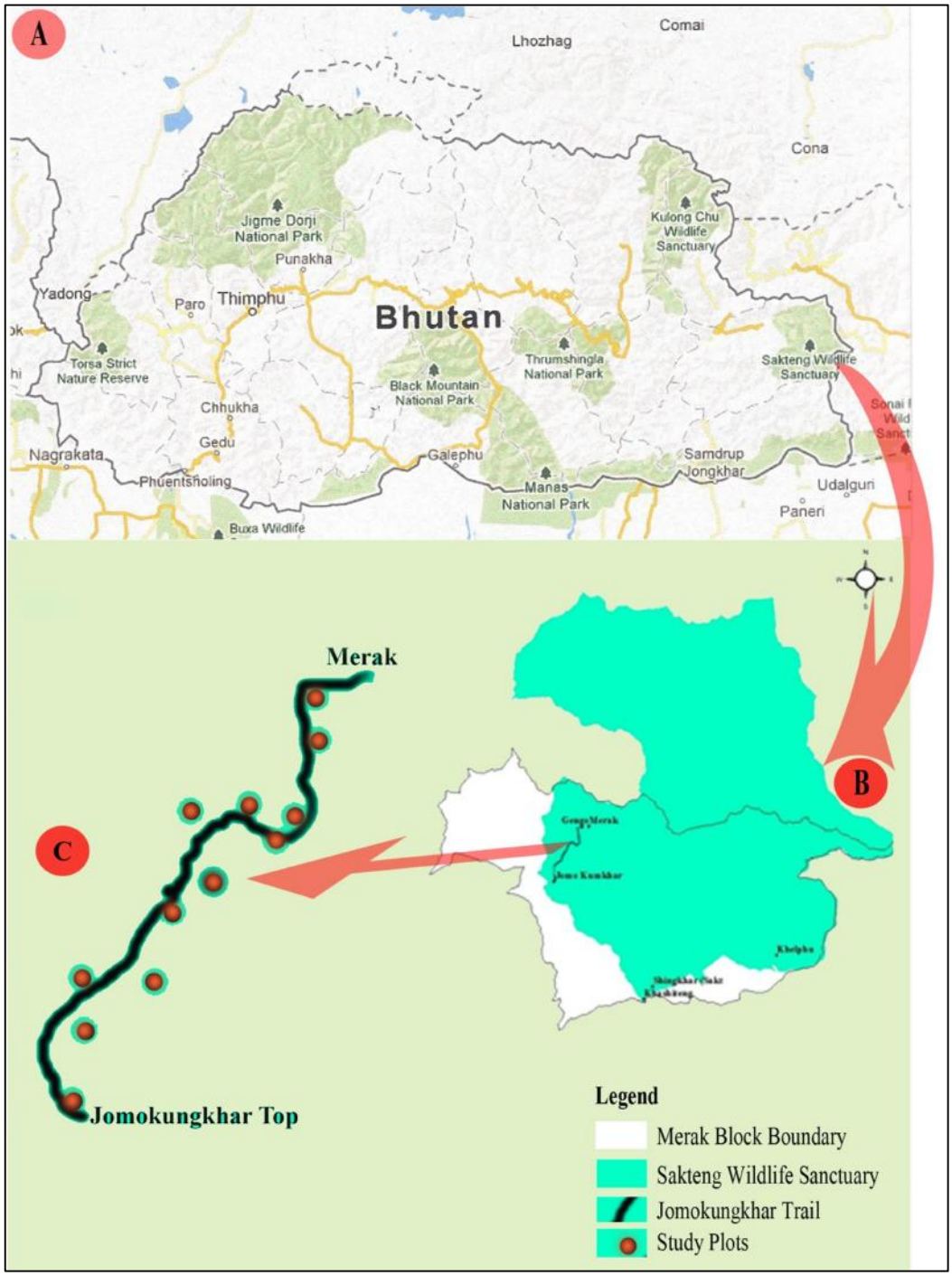


Figure 1: A. Map of Bhutan showing SWS; B. Map of SWS showing Merak and Jomokungkhar Trail; C. Jomokungkhar Trail and Study Plots.

DATA COLLECTION

Study Plot Selection

The study plots were subjectively selected following Braun-Branquet approach (Kent & Coker, 1994). The plots were chosen deliberately based on the decision of researcher on presence and absence of natural relicts or characteristically unique floristic composition from the surrounding vegetation types, if any.

Plant Collection

The data and plant specimens from the study sites were collected once a moth beginning from March to September 2012, assuring coverage of the flowering seasons for all plants. Some plant species occurring outside or in adjacent areas of the study plots were also collected in order to obtain complete checklist and precise pattern of diversity. Field notes for every collection were made reflecting basic diagnostic character for identification such as plant height, flower colour, leaf characters etc., along with the photographs. Herbarium specimens were processed accordingly as directed in "The Herbarium Handbook" (Forman & Bridson, 1998).

Vegetation Data Collection

All vascular plants occurring within the study areas were checked and noted in order to produce a complete species checklist. The position, crown height, crown area, and diameter at breast height (dbh) for the shrubs and trees were recorded to draw profile diagrams of the vegetation types. Repeated photographs were taken focusing on the structure and the pattern of vegetation in every plot.

The abundance of plant species was measured by cover-abundance estimation using the Domin-Krajina scale (Kent and Coker, 1994). The numerical scores were recorded as follows.

* = a single individual. No measurable cover

1 = 1-2 individuals with normal vigour. No measurable cover

2 = several individual but less than 1% cover.

3 = 1-4 % cover

4 = 4-10 % cover

5 = 11-25 % cover

6 = 26-33 % cover

7 = 34-50 % cover

8 = 51-75 % cover

9 = 76-90 % cover

10 = 91-100 % cover

LABORATORY STUDY

The plant specimens collected were identified and authenticated at the Herbarium of Prince of Songkla University, Thailand, using all available taxonomic literatures. Online herbarium catalogue of Royal Botanic Garden, Edinburgh, Scotland was also used to further authenticate some species. Descriptions were written in order to obtain detailed morphological and ecological data of every plant species found along the altitudinal gradient of the Merak Himalaya. Botanical/scientific names and author citations are written in strict compliance with the standards of the International Plant Name Index (IPNI), The Plant List, and tropicos.org, which are accessible online.

The voucher specimens have been deposited at the National Herbarium of Bhutan, Serbithang, Thimphu Bhutan, and the local herbarium of Sakteng Wildlife Sanctuary (SWS), Department of Forest and Park Services (DoFPS), Ministry of Agriculture, Bhutan.

VEGETATION AND FLORISTIC ANALYSIS

The Cluster Analysis was performed using PC-ORD software version 5.19 to classify the vegetation of the Merak Himalaya into different communities based on species abundances and habitats. The community types obtained from the analysis are described, photographed, and presented in profiles as well.

The floristic richness of the study areas was determined by the direct count of number of species, genera, and families recorded. The graphical and tabular distribution pattern of a group of each life form and the overall distribution pattern of vascular plants of the study areas are presented.

CHAPTER III

RESULT

PART I: FLORISTIC STUDY

Taxonomic Diversity

A total of 111 species of vascular plants belonging to 72 genera and 38 families are collected and identified (Appendix 1). Of the total, six species are pterophytes, four are gymnosperms, and 101 are angiosperms (Table 3). The dominant families with largest number of species are shown in Table 2. The most common families of Eudicots are Ericaceae (17 species, 15.32%), Asteraceae (10 species, 9.01%), Rosaceae (10 species, 9.01%), Polygonaceae (8 species, 7.21%), Ranunculaceae (7 species, 6.31%), and Primulaceae (7 species, 6.31%). Poaceae (4 species), Juncaceae (2 species, 1.80%), and Orchidaceae (2 species, 1.80 %) were the most diverse group from Monocots. Unfortunately, species of Poaceae and six other angiosperms have to be excluded from the analysis due to lack of enough literature to study them. The actual number of species collected from the study areas was 121. Very few species were recorded from pterophytes with Polypodiaceae (3 species, 2.70%) as the dominating family. It is highly possible that more species, especially angiosperms, could be recorded from the Merak Himalaya due to under-sampling of study plots, limited manpower, and limited time spent in the current study. It is estimated that over 200 species of vascular plants could be recorded from the region.

Table 2: Number of families, genera, and species in major groups of vascular plants found along the Jomokungkhar Trail

Plant groups	Families	Genera	Species	% of Total Flora
Monilophytes	4	6	6	5.41
Angiosperms				
-Eudicots	26	58	95	85.59
-Monocots	4	5	6	5.41
Pinopsida	2	3	4	3.60
Total	**38**	**72**	**111**	**100**

Table 3: Predominant families of each major group of plants found along the altitudinal gradient of the Jomokungkhar Trail

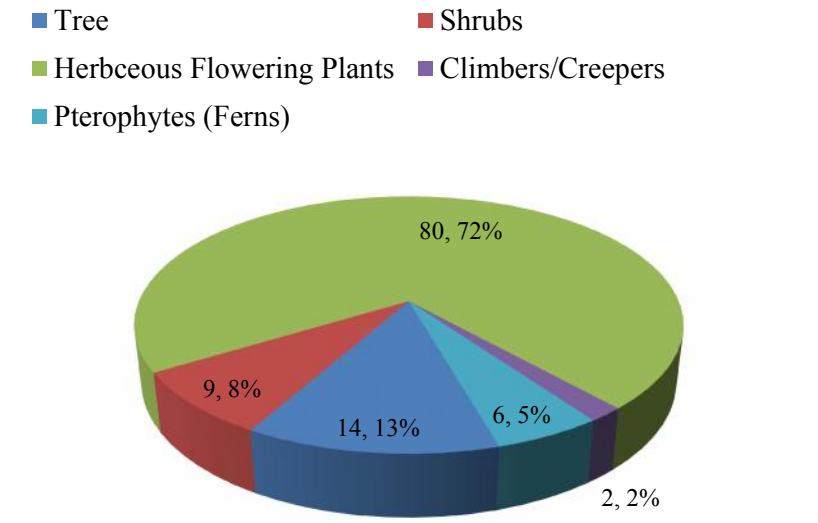
Plant Groups	Number of Species	% of Total Flora
Monilophytes		
Polypodiaceae	3	2.70
Other monilophytes	3	2.70
Pinopsida		
Cupressaceae	2	1.80
Pinaceae	2	1.80
Eudicots		
Ericaceae	17	15.32
Asteraceae	10	9.01
Rosaceae	10	9.01
Polygonaceae	8	7.21
Ranumculaceae	7	6.31
Primulaceae	7	6.31
Other Eudicots	36	32.43
Monocots		
Juncaceae	2	1.80
Orchidaceae	2	1.80
Other monocots	2	1.80
Total	**111**	**100**

Plant Habits/Life Forms

Herbaceous flowering plants (72 %) were the most abundant vascular plants in terms of habit or life form coverage among 111 vascular plants occurring in the Merak Himalaya. Shrubs and trees occupied 8 % and 14 %, respectively. Climbers/creepers (6 %) and pterophytes (ferns) (2 %) were some rare life forms found in the area (Figure 2).

Among the various habits/life forms, all groups were terrestrial except for the six species of ferns. Four species of ferns were epiphytic where as other two were terrestrial and lithophyte, respectively.

Figure 2: Pie diagram showing the coverage percentage by habit/life form of vascular plants occurring in the Merak Himalaya



Species Descriptions

109 species of vascular plants belonging to 38 families and 72 genera were identified and described. The full descriptions of 101 species along with their localities, ecological data, and distribution range are provided. Some species could not be described because of either poor collection or damage occurred while transporting from Bhutan to Thailand. However, they are included in Appendix 1. Refer the full descriptions as below.

MONILOPHYTES

DAVALLIACEAE

1. Araiostegia faberiana (C. Chr.) Ching, Fl. Reipubl. Popularis Sin. 2: 293. 959; Tagawa and Iwatsuki in Fl. Thailand 3(2): 152. 1985. – *Davallia clarkei* var. *faberiana* C. Chr., Acta Horti Gothob. 1(2): 73. 1924. – *Leucostegia clarkei* var. *faberiana* (C. Chr.) C. Chr., Contr. U.S. Natl. Herb. 26(6): 294. 1931. – *Leucostegia faberiana* (C. Chr.) Ching, Index Filic., Suppl. 3, 120**.** 1934. **Plate 26 C-D**

Rhizome long-creeping, ca. 3 mm in diam., densely scaly throughout; scales membranous, pale brown, entire or undulate at margin, ovate to sub-deltoid, ca. 4–7 mm by 2–3 mm, apex acute or attenuate, base rounded, slightly decurrent. ***Stipes*** reddish-brown, ± 8 cm long, partly jointed to rhizome on scaly phyllopode of 1 cm long, sparsely scaly. ***Lamina*** (3-) 4-pinnate, ovate to oblong-triangular, ca. 15 cm by 5 cm; rachis sparsely scaly; lateral pinnae ± 10 pairs, basal pairs largest or varying, ± 10 cm long, sub-sessile; pinnules stalked, ovate to oblong, moderately acute at apex, cuneate to oblique at base; secondary pinnules sessile, oblong to ovate, acute at apex, cuneate to oblique at base. ***Sori*** round, ca. 1 mm diam., usually born at sinus between lobes of segments; indusia membranous, covering sori or obscure at maturity, broader than length, attached at base only, apex rounded to acute, undulate at margin.

Bhutan – Trashigang district
Distribution – China, Myanmar, Thailand
Ecology – Found on the mossy understory of fir tree trunks from 2,000 – 3,500 m asl.
Specimen Examined – K. Jamtsho 178 (THIM)

DRYOPTERIDACEAE

2. Polystichum sp. **Plate 25 E-F**

Rhizome short, erect with tuft frond above, scaly; scales brown, lacerate or toothed at margin, ovate to triangular, apex acuminate, base rounded or truncate. ***Stipes*** greenish,

grooved, not articulated to rhizome, ca. 20 cm long, scaly and hairy throughout. ***Lamina*** 2-pinnate, elliptic to lanceolate, ca. 30 cm by 15 cm; rachis scaly and hairy beneath, hairy above; lateral pinnae ± 20 pairs, basal pairs slightly narrowing, ca. 6–8 cm long, sub-sessile; pinnules sessile, oblong, hairy on upper surface, lobed at apex, connate to adjacent pinnules at base, margin sinuate. ***Sori*** round, ca. 1 mm diam., born on dorsal veins and veinlets; indusia round or reniform, peltate, covering sori completely when young.

Bhutan – Trashigang district

Distribution

Ecology – Found in the moist open grounds along the stream banks from 2,000 – 3,500 m asl.

Specimen Examined – K. Jamtsho 176 (THIM)

HYMENOPHYLLACEAE

3. Hymenophyllum polyanthos Bosch, Ned. Kruidk. Arch. 5(2): 152. 1861. – *Mecodium polyanthos* (Sw.) Copel., Tagawa and Iwatsuki in Fl. Thailand 3(1): 70. 1979. – *Hymenophyllum jalapense* Schltdl. & Cham., Linnaea 5. 619. 1830. 1830. – *H. millefolium* Schlecht. & Cham., Linnaea 5. 620. 1830. 1830. **Plate 26 A**

Rhizome slender, ca. 0.15 mm in diam., brownish-black covered with brown hairs. ***Stipes*** up to 7 cm long, slender, narrowly winged on the upper half, glabrous. ***Fronds*** 2–3 pinnate, oblong or ovate, ca. 15 cm by 5 cm, apex acute, base truncate or obtuse; rachis glabrous, distinctly winged, wings crisped; pinnae linear to ovate, apex acute or rounded, base rounded, ca. 1–4 cm by 1–2 cm; ultimate segment linear, entire, apex slightly emarginate or truncate. ***Sori*** on the apices of short lateral segments; involucre bilabiate almost to base, lips elliptic to orbicular, apex obtuse to rounded, margin entire.

Bhutan – Trashigang district

Distribution – Throughout the world

Ecology – Found on the rocks and tree trunks along stream banks from 3,000 – 3,400 m asl.

Specimen Examined – K. Jamtsho 174 (THIM)

POLYPODIACEAE

4. Lepisorus contortus (H. Christ) Ching, Bull. Fan Mem. Inst. Biol. 4(3): 90-91. 1933; Tagawa and Iwatsuki in Fl. Thailand 3(4): 513-514. 1989. – *Lepisorus jinfoshanensis* Ching, Bull. Bot. Res., Harbin 3(4): 4-5. 1983. – *Pleopeltis contorta* (H. Christ) Alston & Bonner, Candollea 15(7): 209. 1956. – *Polypodium contortum* (H. Christ) H. Christ, Bot. Gaz. 51(5): 347. 1911. – *P. lineare* var. *contortum* H. Christ, Nuovo Giorn. Bot. Ital., n.s., 4(1): 98, pl. 1, f. 3 98 1897. – *P. lineare f. contortum* (H. Christ) Takeda, Notes Roy. Bot. Gard. Edinburgh 8(39): 270. 1915. **Plate 25 D**

Rhizome creeping, ca. 2.5 mm in diam., bearing fronds with intervals less than 5 mm, densely scaly throughout; scales dark brown, clathrate, toothed at margin, lanceolate or narrowly triangular, ca. 2–4 mm by 0.6–1.5 mm, apex attenuate. ***Stipes*** very short, up to 3 cm long, sometimes indistinct, glabrous. ***Fronds*** simple, linear, up to 25 cm by 1 cm; apex attenuate; base attenuate; margin recurved; lamina coriaceous; costa distinct on both sides; veins obscured. ***Sori*** round, restricted to upper half of the frond, medial or slightly closer to costa.

Bhutan – Trashigang district

Distribution – China, India, Nepal, Thailand

Ecology – Found on the mossy tree trunks from 2,000 – 3,500 m asl.

Specimen Examined – K. Jamtsho 173 (THIM)

5. Phymatopteris ebenipes (Hook.) Pic. Serm., Webbia 28(2): 462. 1973. – *Crypsinus ebenipes* (Hook.) Copel., Gen. Fil. (Copeland) 206. 1947. – *Phymatodes*

ebenipes (Hook.) Ching, Contr. Inst. Bot. Natl. Acad. Peiping 2(3): 86-87. 1933. – *P. ebenipes* (Hook.) J. Sm., Hist. Fil. 105. 1875. – *Pleopeltis ebenipes* Bedd., Ferns br. Ind. t. 138. 1866. 1866.–*Polypodium ebenipes* Hook., Sp. Fil. 5: 88. 1864. **Plate 26 B**

Rhizome long-creeping, ca. 3–4 mm diam., densely scaly throughout; scales blackish brown along the center, marginal sides thin, brownish, hardly clathrate, irregularly toothed or ciliate at margin, lanceolate or narrowly triangular, ca. 4 mm by 1 mm, apex attenuate, base rounded. ***Stipes*** dark brown, up to 8 cm long, jointed to rhizome on distinct scaly phyllopode, glabrous when dried. ***Lamina*** pinnatisect, ovate, up to 13 cm by 8 cm; rachis distinct, glabrous, winged; wings not exceeding 5 mm in breadth; lateral lobes 2–3 pairs, lowermost pair slightly deflexed; margin irregularly dentate or serrate; costae distinct on both sides with scaly streaks; main lateral veins distinct on both sides, other veins obscure, reticulate forming irregular anastomosis with included free veinlets. ***Sori*** round, ca. 3 mm diam., one between adjacent main veins of apical pairs and pinna, in a single row on each side of costa, close to costa, hardly raised on the upper surface.

Bhutan – Trashigang district
Distribution– China, India, Thailand
Ecology – Found on the mossy tree trunks from 2,000 – 3,500 m asl.
Specimen Examined – K. Jamtsho 177 (THIM)

6. Prosaptia sp. **Plate 26 E-F**

Rhizome creeping, ca. 2 mm in diam., bearing fronds at varying intervals, densely scaly throughout with long hairy roots; scales black, clathrate, toothed at margin, lanceolate, ca. 2–5 mm by 0.6–1 mm, apex long attenuate. ***Stipes*** up to 10 cm long, terete, slightly swollen at base, glabrous. ***Lamina*** 1-pinnate, lanceolate, up to 25 cm by 4 cm; apex acute; base oblique or truncate; rachis short glandular hairy above, glandular hairy and scaly below; pinnae ± 25 pairs, ± 2.5 cm long, sessile, oblong to

lanceolate, hairy on upper surface; hairy and scaly on lower surface, apex obtuse, base connate to adjacent pinnae, margin irregularly toothed. ***Sori*** round, more or less sunk in medial soral cavities.

Bhutan – Trashigang district

Distribution

Ecology – Found on the mossy trunk of fir tree from 2,000 – 3,500 m asl.

Specimen Examined – K. Jamtsho179 (THIM)

EUDICOTS

ASTERACEAE

7. Anaphalis adnata DC., Prodr. [A. P. de Candolle] 6: 274. 1838; Grierson & Spring in Fl. Bhutan 2 (3):1516–1517. 2001; Hook.f. in Fl. Brit. India 3: 282. 1882. – *Anaphalis esquirolii* H.Lév., Repert. Spec. Nov. Regni Veg. 12: 189. 1913. – *A. sericeo-albida* (H.Lév. & Vaniot) H.Lév., Fl. Kouy-Tcheou 85 (1914-15). 85. 1914. – A. sericeoalba (Vaniot) H.Lév., Fl. Kouy-Tchéou: 85 (1914) 85. 1914. – *Gnaphalium adnatum* (Wall. ex DC.) DC. ex Kitam., J. Jap. Bot. 21 (1947) 51. 1947. – *G. esquirolii* H. Lév., Repert. Spec. Nov. Regni Veg. 11: 307. 1912. – *G. formosanum* Hayata, Icon. Pl. Formosan. 8: 58. 1919. **Plate 7 A**

Shrubs, 5–15 cm tall. ***Stem*** erect, single, cottony lanate-tomentose. ***Leaves*** simple, alternate and spirally arranged; oblanceolate; 2–5 cm by 0.3–0.9 cm; sessile; margin entire; apex acute with black spiny tip; base narrowed, semi-amplexicaul; upper surface adpressed white tomentose; lower surface adpressed white tomentose or arachnoid, much thicker than upper surface; leaf 3-veined from base. ***Inflorescence*** terminal corymbs, rarely solitary; capitulum 5–15; peduncles up to 1 cm long, thick cottony lanate-tomentose. ***Phyllary*** many seriate; outer phyllaries ovate, dull brownish yellow, glabrous; inner phyllaries lanceolate, white with brownish base, glabrous. Flowers numerous, unisexual, predominantly male. ***Pappus bristles*** moderately dense, brownish, slightly longer than corolla tube, ca. 3.5 mm long.

Corolla tube narrowly campanulate, ca. 2.5 mm long, glabrous, 5-lobed. ***Stamen*** 5, ca. 2.5 mm long; filaments filiform, glabrous; anthers basifixed, ca. 1.5 mm long, base sagittate, apex acute. ***Ovary*** rudimentary with slender style and bifurcated stigma.

Bhutan – Bumthang, Thimphu, Trashigang districts
Distribution – China, India, Nepal, Pakistan
Ecology – Found on stream banks and alpines slopes 3,000 – 4,000 m asl. Flowering in June - August
Specimen Examined – K. Jamtsho 129 (THIM)

8. Anaphalis nepalensis (Spreng.) Hand.-Mazz. var. **monocephala** (DC.) Hand.-Mazz., Acta Horti Gothob. 12(9): 239. 1938; Grierson & Spring in Fl. Bhutan 2 (3):1521. 2001; Hook.f. in Fl. Brit. India 3: 282. 1882; S.W. Liu & I.D. Illar. in Fl. China 20–21: 814. 2008. – *Anaphalis monocephala* DC., Prodr. [A. P. de Candolle] 6: 272. 1838. – *A. mucronata* var. *monocephala* DC., Prodromus Systematis Naturalis Regni Vegetabilis 6: 272. 1837. – *A. nubigena* var. *monocephala* (DC.) C.B.Clarke, Compositae Indica 106. 1876. – *A. nubigena* f. *reducta-nana* Diels ex H.Limpr., "Repertorium Specierum Novarum Regni Vegetabilis, Beihefte 12:" 505. 1922. **Plate 7 B**

Perennial herbs, 5–10 cm tall. ***Stem*** erect, single, cottony lanate-tomentose. ***Leaves*** simple, alternate, forming rosette at base; narrowly oblong-lanceolate or partly spatulate; 0.5–1.5 cm by 0.2–0.3 cm; sessile; margin entire; apex acute with black spiny tip; base narrowed, not amplexicaul; upper surface white lanate-tomentose; lower surface white lanate-tomentose or arachnoid; leaf 1(–3)-veined from base. ***Inflorescence*** terminal, solitary; peduncles up to 1 cm long, thick cottony lanate-tomentose. ***Phyllary*** 8–9 seriate; outer phyllaries ovate, brownish, shorter than middle and inner phyllaries, glabrous; middle phyllaries lanceolate, white with blackish brown base, glabrous; inner phyllaries linear or narrowly oblong, white with blackish brown base. Flowers numerous, predominantly male. ***Pappus bristles*** barbellate, 10 – 15, whitish, ca. 3.5 mm long. ***Corolla*** tube narrowly campanulate, ca. 3 mm long, glabrous, 5(–6)-lobed. ***Stamen*** 5, ca. 3 mm long; filaments filiform, glabrous; anthers

basifixed, ca. 1.5 mm long, base sagittate, apex acute. ***Ovary*** rudimentary with strap-shaped bifurcated stigma.

Bhutan – Bumthang, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Found in alpine slopes from 4,300 – 4,500 m asl. Flowering in June - August
Specimen Examined – K. Jamtsho 150 (THIM)

9. Anaphalis sp. **Plate 7 F**

Herbs, 2–7 cm tall. ***Stem*** erect or sub-erect, tufted, cottony arachnoid. ***Leaves*** simple, alternate with bigger leaves towards stem terminal; oblanceolate or spatulate; 0.6–1.8 cm by 0.2–0.5 cm; sessile; margin entire; apex acute with short black spiny tip; base narrowed, semi-amplexicaul; upper surface arachnoid; lower surface adpressed white lanate-tomentose or arachnoid, much thicker than upper surface; midrib prominent on lower surface; veins inconspicuous. ***Inflorescence*** mostly terminal corymbs; capitulum 1–4; peduncles up to 1 cm long, cottony lanate-tomentose. ***Phyllary*** 5–8 seriate; outer phyllaries ovate, white with brownish base, glabrous; inner phyllaries linear or lanceolate, white with brownish portion near base, innermost phyllaries pubescent. Flowers numerous, unisexual. ***Pappus bristles*** moderately dense, white, longer than corolla tube, ca. 3.5 mm long. ***Corolla*** tube narrowly campanulate, ca. 2.3 mm long, 5-lobed; lobes pubescent. ***Ovary*** cylindrical, ca. 0.5 mm long, ± glabrous; style linear; stigma bifurcated.

Bhutan –Trashigang district
Distribution
Ecology – Found on stream banks 3,000 – 3,500 m asl. Flowering in June - July
Specimen Examined – K. Jamtsho 86 (THIM)

10. Cicerbita sp. **Plate 7 C**

Perennial herbs, 0.2–0.4 m tall. **Stem** straggling, tomentose, brown with white sap. ***Leaves*** simple, alternate; narrowly triangular in outline, ± 4–7 cm by 1–3 cm or wider; sessile; margin of upper cauline leaves ciliate; apex acute; base sagittate, auriculate, amplexicaul; upper surface puberulent; lower surface tomentose; midrib prominent underneath, strigulose; lateral veins more distinct on lower surface. ***Inflorescence*** racemiferous; capitatulum ±10, ca. 1.3–1.8 cm by 0.8–2 cm; central axis tomentose; peduncle up to 4.5 cm long, tomentose. ***Phyllaries*** 3-seriate; outer phyllaries lanceolate, up to 1.3 cm long, brownish; margin entire, imbricate; apex pubescent; inner phyllaries narrowly oblong to narrowly elliptic, up to 1.2 cm long, brownish; margins entire, imbricate; apex pubescent. ***Flower*** sessile, numerous/capitulum. ***Pappus bristles*** numerous, plumose, whitish, ca. 6 mm long. ***Corolla tube*** ca. 4 mm, hairy outside at throat; ligule strap-shaped, bluish to purplish, ca. 1.2 cm long, narrowly oblong; apex truncate or shallowly toothed. ***Stamen*** 5, ca. 5 mm long; filaments glabrous, much shorter than anthers, inserted to corolla; anthers basifixed, ca. 4 mm long. ***Ovary*** inferior, cylindrical or tubular, glabrous, ca. 1 mm long; style strap-shaped, base glabrous, tip pubescent, ca. 6 mm long; stigma cylindrical, pubescent, bifurcated. ***Achenes*** not seen.

Bhutan – Trashigang district

Distribution

Ecology – Found on river backs and swamp areas from 2,500 – 3,500 m asl. Flowering in August - September

Specimen Examined – K. Jamtsho 183 (THIM)

Note: Some parts of leaves were missing due to poor collection. Characters of leaves can be erroneous.

11. Cremanthodium reniforme (DC.) Benth., Hooker's Icon. Pl. 12(2): t. 1141. 1873; Grierson & Spring in Fl. Bhutan 2 (3):1580. 2001; Hook.f. in Fl. Brit. India 3: 330. 1882; S.W. Liu & I.D. Illar. in Fl. China 20–21: 422. 2008. – *Cineraria*

reniformis Spreng. ex DC., Prodr. [A. P. de Candolle] 6: 315. 1838. – *Ligularia reniformis* DC., Prodr. [A. P. de Candolle] 6: 315. 1838. – *Senecio reniformis* Wall., Numer. List [Wallich] n. 3141. 1831. **Plate 7 D**

Shrubs, 0.2–0.4 m tall. **Stem** erect, solitary, proximally glabrous/glabrescent and distally pilose, dark green. ***Leaves*** alternate; cordate or reniform, 1–3 cm by 0.5–3.5 cm; mid-cauline leaves oblanceolate; petiole ca. 7 cm long, pilose or pubescent, base sheathed; margin crenate to dentate; apex obtuse to rounded; base cordate, cauline leaf base cuneate, ciliate; upper surface glabrous; lower surface sparsely pilose; midrib prominently underneath; palmate lateral veins visible. ***Inflorescence*** heterogamous and radiate capitulum; capitatulum single, 2 cm by 2.7 cm; peduncle pilose-tomentose. ***Phyllaries*** elliptic, up to 1.3 cm long, 2-seriate; inner phyllaries membranous with thick and pilose middle portion, apex acute, pubescent; outer phyllaries pilose, margin ciliate, apex pubescent. ***Ray floret*** numerous, pistillate. ***Pappus bristles*** numerous, brownish, ca. 6 mm long. ***Corolla*** tube ca. 2 mm long; ligule yellowish brown, ca. 2.2 cm long, oblanceolate, apex distinctly 3-toothed. ***Stamen*** 5, filiform, rudimentary. ***Ovary*** inferior, oblong, glabrous, ca. 4 mm long; style linear, glabrous, ca. 1 cm long; stigma linear, bifurcated. ***Disc floret*** numerous. ***Pappus bristles*** similar to ray floret. ***Ovary*** similar to ray floret. ***Corolla*** campanulate, yellowish brown; corolla tube ca. 9 mm long, 5-lobed. ***Stamen*** 5, ca. 1.2 cm long; filaments glabrous, filiform, ca. 7 mm long; anthers basifixed, ca. 5 mm long, base sagittate. ***Achenes*** not seen.

Bhutan – Bumthang, Mongar, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Found in alpine slopes 3,500 – 4,300 m asl. Flowering in July - mid August
Specimen Examined – K. Jamtsho159 (THIM)

12. Ligularia fischeri Turcz., Bull. Soc. Imp. Naturalistes Moscou xx. (1847) II. 11; S.W. Liu & I.D. Illar. in Fl. China 20–21: 376. 2008; Grierson & Spring in Fl. Bhutan

2 (3):1577. 2001. – *Cacalia elata* Spreng. ex DC., Prodr. [A. P. de Candolle] 6: 314. 1838. – *Cineraria elata* Steud., Nomencl. Bot. [Steudel], ed. 2. 1: 364. 1840. – *C. fischeri* Ledeb., Ind. Sem. Hort. Dorpat. (1820) 17. – *C. speciosa* Schrad. ex Link, Enum. Hort. Berol. Alt. 2: 334. 1822. – *Hoppea speciosa* Rchb., Flora 7(1): 245. 1824. – *Ligularia glabrescens* Vorosch., in Bull. Princ. Bot. Gard. Acad. Sci. URSS No. 60, 41 (1965). – *L. racemosa* DC., Prodr. [A. P. de Candolle] 6: 314. 1838. – *L. sibirica* var. *longibracteata* Kitam., *Fauna Fl. Nepal Himal. 1: 266. 1955*. – *L. sibirica* var. *racemosa* (DC.) Kitam., *Fauna Fl. Nepal Himal. 1: 266 1955*. – *L. sibirica* var. *speciosa* (Schrad. ex Link) DC. *Prodromus Systematis Naturalis Regni Vegetabilis 6: 315. 1837*.– *L. speciosa* Fisch. & C.A.Mey., Index Seminum [St. Petersburg] v. 38. – *Senecio ligularia* Hook.f., Fl. Brit. India [J. D. Hooker] 3: 349. 1881. **Plate 7 E**

Shrubs, 0.5–1.5 m tall. ***Stem*** erect, fistulose, furrowed towards base, base puberulent, dark green. ***Leaves*** simple, alternate; sagittate or reniform, 5–10 cm by 6–13 cm; petiole 5–18 cm, fistulose, sparsely pilose or glabrous, base sheathed; margin regularly dentate; apex obtuse or rounded; base mostly sagittate; upper surface glabrous; lower surface sparsely pubescent; midrib prominently visible on both surfaces; lateral veins visible on both surfaces; 3–5 paired or more. ***Inflorescence*** racemose; capitatulum numerous, 12–20, ca. 2 cm by 1 cm; central axis tomentose; peduncle ca. 2 cm, tomentulose. ***Phyllary*** narrowly elliptic to narrowly oblong, up to 1.5 cm, middle thick portion strigulose, margin membranous, apex pubescent. ***Ray floret*** sessile, 4–6 per capitulum, pistillate. ***Pappus bristles*** numerous, brownish, ca. 6 mm long. ***Corolla*** strap-shaped ligule; ligule yellow, ca. 1.6 cm long, oblanceolate, apex truncate. ***Ovary*** inferior, strap-shaped, glabrous, ca. 4 mm long; style linear, glabrous, ca. 1.3 cm long; stigma linear, bifurcated. ***Disc floret*** sessile, numerous. ***Pappus bristles*** similar to ray floret. ***Ovary*** similar to ray floret. ***Corolla*** campanulate, yellow; corolla tube ca. 5mm long, 5-lobed. ***Stamen*** 5, ca. 1 cm long; filaments glabrous, ca. 1.3 cm long; anthers basifixed, ca. 4 mm long. ***Achenes*** not seen.

Bhutan – Bumthang, Gasa, Punakha, Thimphu, Trashigang districts

Distribution – China, India, Mongolia, Myanmar, Nepal, Russia

Ecology – Found on river backs and swamp areas from 2,500 – 3,500 m asl. Flowering in June - August

Specimen Examined – K. Jamtsho 127 (THIM)

13. Parasenecio sp. Plate 8 A-B

Shrubs, 0.5–1 m tall. ***Stem*** erect, fistulose, pubescent with base glabrescent, dull greenish yellow. ***Leaves*** alternate, palmate, 5–12 cm by 8–18 cm; petiole ca. 7 cm long, tomentose, base winged, semi-amplexicaul; margin palmatisect; apex rounded in outline; base truncate or cordate; upper surface sparsely pilose or glabrous; lower surface tomentose mainly along the veins; veins more distinct on upper surfaces. ***Inflorescence*** paniculate; capitatulum discoid, few flowered; peduncle up to 13 cm or longer, tomentose. ***Phyllaries*** 1-seriate, narrowly elliptic to narrowly oblong, up to 1 cm, sparsely tomentose or glabrous; margin membranous, imbricate. ***Flower*** 3–4 per capitulum, bisexual. ***Pappus bristles*** numerous, brownish or gray, barbellate, ca. 7 mm long. ***Corolla*** tubular-campanulate, yellow, ca. 1 cm long, 5-lobed. ***Stamen*** 5, ca. 8 cm long, inserted to corolla; filaments filiform, glabrous; anthers basifixed, ca. 3.5 mm long. ***Ovary*** inferior, cylindrical, glabrous, ca. 9 mm long; style linear, glabrous, ca. 1.2 cm long; stigma linear with slightly swollen tip, bifurcated. ***Achenes*** not seen.

Bhutan – Trashigang district

Distribution

Ecology – Found in the dgraded fir-rhododendron forest from 3,000 – 3,600 m asl. Flowering in July - August

Specimen Examined – K. Jamtsho 170 (THIM)

14. Saussurea gossypiphora D.Don., Mem. Wern. Nat. Hist. Soc. iii. (1821) 414; Grierson & Spring in Fl. Bhutan 2 (3):1436–1437. 2001; Hook.f. in Fl. Brit. India 3: 376. 1882. – *Cnicus gossypinus* Wall. ex DC., Prodr. [A. P. de Candolle] 6: 541, 542.

1838. – *Eriocoryne nidularis* Wall. ex DC., Prodr. [A. P. de Candolle] 6: 541. 1838. **Plate 8 C-D**

Perennial herbs, 5–30 cm tall, monocarpic. ***Stem*** short, erect, single, fistulose, thickly covered with long whitish woolly hairs. ***Leaves*** simple, alternate; linear to narrowly oblong or elliptic to oblanceolate; 7–15 cm by 0.3–2.5 cm; rosette leaves and lower cauline leaves petiolate, middle and upper cauline leaves sessile; margin serrate to dentate; apex acute; base narrowed; upper surface glabrous or sparsely lanate-tomentose; lower surface white lanate-tomentose, thicker than upper surface; midrib distinct on both sides, white lanate-tomentose underneath; lateral veins visible on lower surface. ***Inflorescence*** born on the upper half of stem; capitulum numerous, hidden in long white lanate-indumentum. ***Phyllary*** 3-seriate or more, ovate; outer phyllaries brownish, pilose; inner phyllaries, chartaceous, glabrous. Flowers numerous, bisexual. ***Pappus bristles*** moderately dense, 19–20, plumose, brownish, ca. 8 mm, slightly shorter than corolla tube. ***Corolla*** narrowly campanulate, ca. 1.2 mm long, glabrous, 5-lobed. ***Stamen*** 5, ca. 9 mm long, inserted to corolla; filaments filiform, glabrous; anthers basifixed, ca. 5.5 mm long. ***Ovary*** inferior, ovoid, pubescent, ca. 2 mm long; style linear, glabrous, ca. 12.5 mm long; stigma bifurcated. ***Achenes*** not seen.

Bhutan– Bumthang, Punakha, Trashigang districts
Distribution– China, India, Nepal, Pakistan
Ecology – Found in alpines slopes 4,000 – 4,500 m asl. Flowering in August - September
Specimen Examined – K. Jamtsho 172 (THIM)

15. Senecio raphanifolius Wall. ex DC., Prodr. [A. P. de Candolle] 6: 366. 1838; S.W. Liu & I.D. Illar. in Fl. China 20–21: 529. 2008; Grierson & Spring in Fl. Bhutan 2 (3):1594. 2001. – *Senecio diversifolius* Wall., Hook.f. in Fl. Brit. India 3: 466. 1882. **Plate 8 E**

Shrubs, 0.5–1 m tall. **Stem** erect, furrowed, sparsely arachnoid. ***Radical leaves*** usually present but caducous; petiole long, dentate, winged; cauline leaves alternate; oblong or elliptic in outline; 10–15 cm by 3–5 cm; sessile; blade lacerate-pinnatisect; pinnae doubly serrate; apex acute; base sagittate or auriculate; upper surface glabrous; lower surface arachnoid; midrib prominent on both surfaces; lateral veins visible on both surfaces, 5–10 paired. ***Inflorescence*** terminal corymbs; capitulum numerous; peduncles up to 3 cm long, arachnoid. ***Phyllary*** lanceolate, up to ca. 6 mm long with blackish central and marginal apex; apex acute, pubescent. ***Ray floret*** numerous, up to 20 per capitulum. ***Pappus bristles*** usually absent on ray floret; ***corolla*** tube ca. 3 mm, hairy outside and at mouth; ligule yellow, ca. 14 mm by 3mm; oblong to elliptic, apex obtuse, emarginate. ***Ovary*** inferior, obovoid or prolate, glabrous, ca. 1 mm long; style linear, glabrous, ca. 3 mm long; stigma linear, bifurcated. ***Disc floret*** numerous. ***Pappus bristles*** numerous, brown with whitish base, ca. 3 mm long. ***Ovary*** similar to ray floret. ***Corolla*** campanulate, yellow; corolla tube ca. 4 mm long, 5-lobed. ***Stamen*** 5, ca. 5 mm long; filaments filiform with bulb at tip, glabrous; anthers basifixed, ca. 2 mm long, base sagittate, apex acute. ***Achenes*** not seen.

Bhutan – Bumthang, Thimphu, Trashigang districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found on stream banks and swamp areas from 3,000 – 4,000 m asl. Flowering in June - August
Specimen Examined – K. Jamtsho 126 (THIM)

16. Soroseris hookeriana Stebbins, Mem. Torrey Bot. Club 19(3): 45. 1940; S.W. Liu & I.D. Illar. in Fl. China 20–21: 345. 2008; Grierson & Spring in Fl. Bhutan 2 (3):1460. 2001. – *Soroseris hookeriana* subsp. *typica* Stebbins*,* Memoirs of the Torrey Botanical Club 19(3): 45 1940. **–** *Crepis hookeriana* C.B.Clarke, Compos. Ind. 255. 1876. **Plate 8 F**

Perennial herbs, 5–15 cm tall. **Stem** subterranean with long taproot, fistulose, hirsute. ***Leaves*** spirally arranged, lanceolate to oblanceolate or linear, 4–9 cm by 0.3–2 cm,

petiolate; margin pinnatisect; pinnae entire or dentate; apex acute; base attenuate; upper surface sparsely tomentose or glabrous; lower tomentose or arachnoid; midrib distinct on both surfaces; lateral veins visible on lower surface. ***Inflorescence*** hemispheric; capitatula numerous, crowded; peduncle rather short, longer than capitulum sometimes. ***Phyllaries*** outer phyllaries 2, similar to upper reduced leaves, sparsely pilose, margin ciliate; inner phyllaries 4, narrowly oblong, ca. 1 cm long, glabrous or outer mid-vein sparsely pilose. ***Flowers*** sessile, 4 per capitulum. ***Pappus bristles*** numerous, greenish with brownish base, ca. 1 cm long. ***Corolla*** tube tubular, ca. 5 mm long, ligulate; ligule yellow, ca. 1 cm long, oblong-oblanceolate, apex 5-toothed. ***Stamen*** 5, ca. 7 mm long, inserted at mouth of corolla tube; filaments glabrous, filiform, ca. 2 mm long; anthers basifixed, ca. 5 mm long. ***Ovary*** inferior, obovoid, glabrous, ca. 2 mm long; style tubular or filiform, glabrous or scabrous towards tip, ca. 1.2 cm long; stigma scabrous, bifurcated. ***Achenes*** not seen.

Bhutan – Gasa, Haa, Punakha, Thimphu, Trashigang districts
Distribution – China, India, Nepal
Ecology – Found on alpine meadow from 3,500 – 4,500 m asl. Flowering in August - September
Specimen Examined – K. Jamtsho 171 (THIM)

BALSAMINACEAE

17. Impatiens laxiflora Edgew., Trans. Linn. Soc. London 20(1): 40. 1846; Grey-Wilson in Fl. Bhutan 2(1): 101.1991; Chen, Y. et al. in Fl. China 12: 43. 2007. – *Impatiens micranthemumv* Edgew., Trans. Linn. Soc. London 20(1): 40. 1846. **Plate 22 B**

Herb, ca. 10–17 cm tall. ***Stem*** erect, branched, glabrous or glandular with fibrous root stock. ***Leaves*** simple, alternate-spirally arranged, lower leaves ± opposite; mid cauline leaves shortly petiolate with a pair of glandular appendage at base of petiole; upper cauline leaves sessile, glandular appendage pair at the point of leaf attachment;

elliptic to oblanceolate or ovate to oblong, ca. 2–4 cm by 0.5–1.7 cm; margins serrate or dentate; apex acute or acuminate; base obtuse or rounded; upper surface farinose, sparsely lepidote; lower surface farinose, sparsely lepidote; midrib distinct on both surfaces, slightly impressed above; lateral veins visible distinct on lower surface, 6–8 paired, veinlet copiously divided. ***Inflorescence*** simple cyme, mostly axillary, sometimes terminal; 3–7 flowered; peduncles up to 2.5 cm long, slender, ± glandular; pedicels up to 1 cm long, ± glabrous, apex swollen; bracts, ovate, ± 3 mm by 2 mm. ***Sepals*** 3; 2 lateral sepals purplish with greenish mid vein; ovate to slightly falcate, ca. 4 mm by 2.5 mm; margin entire; apex acute; lower sepal navicular with base tapering into down-curved or incurved spur; spur up to 6 mm long. ***Petals*** 5, pink; upper petal cucullate, ± 5 mm by 4 mm; lower 4 petals united into 2 lateral pairs, ± 4 mm by 2 mm. ***Stamens*** 5; filaments ± 2–3 mm long with membranous wings narrowing towards base; anthers basifixed. ***Ovary*** superior, ellipsoid, ca. 2.5 mm long, glabrous; style cylindrical, ca. 1 mm long, glabrous; stigma reduced.

Bhutan – Chukha, Trashigang, Trongsa districts

Distribution – China, India, Nepal

Ecology – Found along the stream banks at the altitude ca. 3,300 m asl. Flowering in August

Specimen Examined – K. Jamtsho 146 (THIM)

Note: This species is doubtfully identified. No clear spots were found on the petals. Some glands were observed on leaf surfaces.

BERBERIDACEAE

18. Berberis angulosa Wall. ex Hook.f. & Thomson, Fl. Ind. [Hooker f. & Thomson] 1: 227. 1855; Grierson in Fl. Bhutan 1(2): 323. 1984; Hook.f. in Fl. Brit. India 1:111. 1875. – *Berberis angulosa* var. *fasciculata* Ahrendt, J. Bot. 79(Suppl.): 42 1941. **Plate 16 C**

Shrubs, ca. 0.5–1 m tall. ***Stem*** erect, grooved, puberulent with spinous nodes; spines usually 3-fid; internodes up to 3 cm long. ***Leaves*** in fascicles; fascicles alternate; leaf blades elliptic or obovate, 1–2 cm by 0.5–0.8 cm; subsessile; margins spinous; apex acute or mucronate; base cuneate; upper surface ± glabrous; lower surface glandular punctate; midrib conspicuous; lateral veins copiously netted. ***Flowers*** mostly axillary, solitary or fascicled, 1–2(–3) on each node, pendulous; pedicels 0.6–2 cm long, sparsely puberulent; bracts ovate, ca. 3.3 mm long, apex acuminate. ***Sepals*** 6, biseriate, yellow, elliptic or oblong, glabrous; outer sepals ca. 1 cm by 0.6 cm; inner sepals 0.8 cm by 0.6 cm. ***Petals*** 6, imbricate, yellow, obovate, glabrous, ca. 0.7 cm by 0.5 cm; glands elliptic to obovate, 2 in each petal. ***Stamens*** 6, ca. 5 mm long, adnate to base of petals; filament slender, sparsely pubescent; anthers ellipsoid or oblong, ca. 2 mm long. ***Ovary*** ellipsoid, pubescent, ca. 3 mm long; style inconspicuous or absent; stigma peltate.

Bhutan – Mongar, Punakha, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Found along the margins of Rhododendron scrub and Fir forests from 3,500 – 4,000 m asl. Flowering in May - June
Specimen Examined – K. Jamtsho 116 (THIM); F. Ludlow, G. Sherriff & J.H. Hicks 20337 (E: Online Herbarium Catalogue)

19. Berberis virescens Hook.f., Bot. Mag. (1890) t. 7116; Grierson in Fl. Bhutan 1(2): 326–327. 1984. – *Berberis belstamiana* Hort. ex Hook.f., Bot. Mag. (1890) sub t. 7116 in syn. **Plate 16 D**

Shrubs, ca. 0.5–2 m tall. ***Stem*** erect, grooved, pilose, nodes spinous; spines 1–3-fid; internodes ± 2 cm long. ***Leaves*** in fascicles; fascicles alternate; leaf blades lanceolate or obovate, 0.5–3.2 cm by 0.3–1 cm; subsessile; margins usually entire, rarely spinous; apex mucronate; base attenuate; upper surface punctiform; lower surface punctiform; midrib conspicuous; lateral veins copiously netted. ***Inflorescence*** axillary raceme, rarely solitary; flowers numerous, pendulous; pedicels 0.5–1.5 cm long, ±

glabrous; bracts linear or lanceolate, ca. 3 mm long, apex attenuate. ***Sepals*** 6, biseriate, greenish yellow, glabrous; outer sepals elliptic, ca. 0.4 cm by 0.2 cm; inner sepals obovate, up to 0.6 cm by 0.4 cm. ***Petals*** 6, imbricate, yellowish, obovate, glabrous, smaller than sepals, ca. 0.3 cm by 0.2 cm, apex notched or emarginate; glands elliptic to obovate, 2 in each petal. ***Stamens*** 6, ca. 2 mm long, adnate to base of petals; filament narrowly trullate, glabrous; anthers ellipsoid or oblong, ca. 2 mm long, connectives extended beyond apex of anthers. ***Ovary*** ellipsoid, glabrous, ± 2 mm long; style inconspicuous; stigma peltate.

Bhutan – Bumthang, Haa, Mongar, Thimphu, Trashigang districts
Distribution – China, India
Ecology – Found in Fir-Rhododendron forest and forest margins from 2,500 - 3,500 m asl. Flowering in May - June
Specimen examined – K. Jamtsho 120 (THIM); F. Ludlow, G. Sherriff & J.H. Hicks 16482 (E: Online Herbarium Catalogue)

BORAGINACEAE

20. Cynoglossum zeylanicum (Lehm.) Brand, Pflanzenr. IV, 252: 134 1921. – *Cynoglossum furcatum* Wall., Roxb. Fl. Ind., ed. Carey & Wall. ii. 6 (1824); R.R. Mill in Fl. Bhutan 2(2): 908. 1999; G.L. Zhu et al. in Fl. China 16: 423. 1995. – *C. furcatum* f. *albiflorum* (H.Hara) Yonek., J. Jap. Bot. 80: 329. 2005. – *C. furcatum* var. *villosulum* (Nakai) Riedl, Novon 4: 46. 1994. – *C. zeylanicum* f. *albiflorum* H.Hara, *Enum.* Sperm. Jap. 1: 173. 1948. – *C. villosulum* Nakai, Bot. Mag. (Tokyo) 1923, xxxvii. 6. **Plate 17 A**

Herb, ca. 20–35 cm tall. ***Stem*** erect, branched mostly on upper half, appressed retrorse pilose. ***Leaves*** elliptic to oblanceolate, upper cauline leaves sometimes lanceolate, ca. 2–10 cm by 0.5–3 cm; sub-sessile or petiole ca. 1.5 cm long, upper cauline leaves sessile; margins ciliate; apex acute; base attenuate; upper and lower surfaces

appressed pubescent or strigulose; midrib prominently raised beneath, dense appressed pubescent, slightly impressed above; lateral veins conspicuous, branched, netted; basal leaves non-persistent on anthesis. ***Inflorescence*** terminal to axillary branched/clustered monopodial; flowers numerous; pedicels ± 2.5 mm long, densely appressed pubescent or sessile. ***Calyx*** cup shaped; tube ca. 1 mm long, densely appressed pubescent; lobes ovate to lanceolate, ca. 2 mm by 1mm, appressed pubescent; margin ciliate; apex acute. ***Corolla*** cupuliform or infundibuliform, deep blue, 5-lobed; lobes ovate to orbicular, ca. 3 mm by 3 mm, glabrous; throat appendages bluish to gray. ***Stamens*** 5, ca. 1 mm long, inserted on corolla tube; filament very short, ca. 0.5 mm long; anthers oblong, ca. 8 mm long, dorsifixed. ***Ovary*** globose, 4-lobed; style conical, ca. 1 mm long, gynobasic; stigma peltate.

Bhutan – Chukha, Haa, Mongar, Sarpang, Thimphu, Trashigang, Trongsa districts
Distribution– Afghanistan, China, India, Nepal, Pakistan
Ecology – Found along the forest margins, open slopes and stream banks from 1,200 – 3,350 m asl. Flowering in June - September
Specimen Examined – K. Jamtsho 145 (THIM); C. Parker 7172; R.R. Mill 10629 (E: Online Herbarium Catalogue)

BRASSICACEAE

21. Cardamine griffithii Hook.f. & Thomson, J. Proc. Linn. Soc., Bot. 5: 146. 1861; Grierson in Fl. Bhutan 1(2): 431. 1984; T.Y. Cheo et al. in Fl. China 8:1. 2001. – *Cardamine griffithi* var. *pentaloba* W.T. Wang, Acta Bot. Yunnan. 9: 16. 1987. **Plate 22 C**

Herb, ca. 10–20 cm tall. ***Stem*** erect, ± glabrous with slightly creeping rhizome. ***Leaves*** alternate, imparipinnate; petiolate or sessile; leaflets ovate to oblong, ca. 0.5–1.2 cm by 0.3–0.8 cm; lateral leaflets sub-sessile, terminal leaflets petiolulate; margins sinuate or slightly lobed with an inconspicuous tooth on each lobe; apex acute or obtuse; base attenuate or rounded or truncate; upper surface with sparse

silvery pilose; lower surface with sparse silvery pilose, punctate; midrib and lateral veins visible on both surfaces. ***Inflorescence*** terminal or axillary cyme; ± 5–20 flowered; pedicels up to 1 cm long, pubescent, glanduliferous. ***Sepals*** 4, purplish; elliptic to oblong, ca. 3 mm by 2 mm; margin entire; apex obtuse or rounded. ***Petals*** 4, pinkish-purple; ovate to oblanceolate, ca. 8 mm by 4 mm; margin entire; apex emarginate. ***Stamens*** 6 with a pair of stamen usually shorter; four longer stamens ca. 5 mm long, usually equaling carpel; filaments flattened towards base; anthers dorsifixed. ***Ovary*** superior, ellipsoid or oblong, ca. 2.5 mm long, glabrous; style cylindrical, ca. 1.5 mm long, glabrous; stigma swollen.

Bhutan– Trashigang district

Distribution

Ecology – Found along the stream margins at 3,300 m asl. Flowering in June - August

Specimen Examined – K. Jamtsho 85 (THIM)

CAMPANULACEAE

22. Cyananthus macrocalyx subsp. **spathulifolius** (Nannf.) K.K. Shrestha, Acta Phytotax. Sin. 35: 412 1997; D.Y. Hong et al. in Fl. China 19: 508. 2011. – *Cyananthus spathulifolius* Nannf., Acta Horti Gothob. v. 30 (1930); R.A. Clement in Fl. Bhutan 2(3): 1390. 2001. **Plate 22 D**

Perennial herbs, ca. 3–5 cm tall. ***Stem*** prostate or decumbent, leafy throughout, pilose. ***Leaves*** simple, alternate; rhomboid to spatulate, ca. 3–6 mm by 2–4m, size increasing towards the apex; petiole ± 5 mm long, pilose; margin entire or undulate, ciliate; apex acute or obtuse; base cuneate; upper surface hirsute or pilose; lower surface hirsute or pilose; mid-veins visible on lower surface; lateral veins inconspicuous, copiously branched. ***Flower*** terminal, solitary; pedicel ± 5 mm long, villous. ***Calyx*** campanulate, netted with veins; tube ca. 7 mm long, glabrous; lobes 5, triangular, ca. 5 mm by 3 mm, white adpressed pilose on inner surface, margin ciliate, apex acute. ***Corolla*** tubular-campanulate; tube ca. 1.5 cm long, greenish yellow with brown

streaks on outer surface of throat, glabrous outside but villous on inner surface of throat; lobes 5, yellow, oblanceolate, up to 1.5 cm by 0.5 cm, apex mucronate. ***Stamens*** 5, ca. 1 cm long; filament filiform, glabrous; anthers ca.2.5 mm long, fused at anthesis, basifixed. ***Ovary*** elongated ovoid, up to 1 cm long, glabrous; style slender, ca. 6 mm long, glabrous; stigma obconical, pilose, 5-partite.

Bhutan – Bumthang, Mongar, Trashigang, Trongsa districts
Distribution– China, India, Nepal
Ecology – Found in the alpine slopes from 3,500 – 4,500 m asl. Flowering in July - September
Specimen Examined – K. Jamtsho 153 (THIM)

CARYOPHYLLACEAE

23. Arenaria densissima Wall., Numer. List [Wallich] n. 640. 1829; Grierson in Fl. Bhutan 1(2): 211. 1984; D.Q. Lu in Fl. China 6: 52. 2001. – *Cherleria juniperina* D.Don, Prodr. Fl. Nepal. 214. 1825. – *Dolophragma juniperinum* Fenzl, Ann. Wiener Mus. Naturgesch. i. (1836) 63. t. 71. **Plate 24 A**

Perennial cushion forming herbs, up to 5 cm tall; ***Stem*** woody, usually erect, caespitose, densely covered with remains of old leaves. ***Leaves*** simple, opposite, sometimes imbricate; narrowly elliptic to lanceolate; ca. 3–6 mm by 1–2 mm; sessile; margin entire, slightly incurved; apex acute or attenuate; base rounded or truncate, sometimes slightly fused into tube; upper surface ± glabrous; lower surface glabrous; midrib visible prominent on lower surface, slightly impressed above. ***Inflorescence*** terminal, usually solitary; pedicels up to 5 mm long, glabrous; bracts lanceolate, glabrous. ***Sepals*** 5, green; elliptic to ovate, ca. 2 mm by 1.5 mm, glabrous; margin entire; apex obtuse or rounded. ***Petals*** 5, white; spatulate or irregularly obovate, ca. 2mm by 1 mm; apex sinuate or rounded. ***Stamens*** 10, up to 1 mm long; filaments slender, those opposite to sepals with swollen glandular base, glabrous; anthers

basifixed. ***Ovary*** obovoid, ca. 1 mm long, glabrous; styles 3, slender, ca. 1 mm long; stigmas reduced.

Bhutan – Punakha, Trashigang districts
Distribution – China, India, Nepal
Ecology – Found in alpine meadow from 4,000 – 4,500 m asl. Flowering in June - July
Specimen Examined – K. Jamtsho 94 (THIM)

24. Silene nigrescens (Edgew.) Majumdar, Journ. Ind. Bot. Soc. xlii. 647 (1964): Grierson in Fl. Bhutan 1(2): 203. 1984; D.Q. Lu in Fl. China 6: 85. 2001. **Plate 24 B**

Perennial herbs, ca. 10–30 cm tall; ***Stem*** erect, mostly single, pubescent. ***Leaves*** simple, opposite; linear to lanceolate; ca. 3–8 cm by 0.2–0.7 cm; sessile; margin entire, ciliate; apex acute; base attenuate, fused into tube; upper surface punctate; lower surface sparsely lepidote; midrib visible one both surfaces; lateral veins inconspicuous. ***Inflorescence*** terminal, simple cyme or solitary; 1–2(–3)-flowered; pedicels 0.3–6.5 cm long, densely glandular hairy; bracts lanceolate, densely glandular hairy. ***Calyx*** urceolate, greenish with purplish pubescent veins; tube inflated, up to 1.3 cm long; lobes 5, ovate to triangular, ca. 4 mm by 2 mm, hairy; margin ciliate; apex acute. ***Petals*** 5, exserted from calyx, spatulate or obovate, ca. 8 mm by 4 mm; claw pubescent at base, auriculate; apex irregularly toothed; petal appendages 2, bifid or truncate or toothed. ***Stamens*** 10, up to 5 mm long, shorter stamens inserted on claw of petals; filaments narrowly triangular, pubescent at base; anthers dorsifixed. ***Ovary*** ± ovoid, ca. 3 mm long, stalked, glabrous; styles 5, slender, ca. 2 mm long; stigmas reduced.

Bhutan – Mongar, Paro, Punakha, Thimphu, Trashigang districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found along the stream banks and alpine slopes from 3,000 – 4,000 m asl. Flowering in July - August

Specimen Examined – K. Jamtsho 133 (THIM)

25. Stellaria sikkimensis Hook.f., Fl. Brit. India [J. D. Hooker] 1: 230. 1874; Grierson in Fl. Bhutan 1(2): 207. 1984. **Plate 24 C**

Perennial herbs, ± 15 cm tall; ***Stem*** decumbent or creeping or ± stoloniferous, pilose or villous throughout. ***Leaves*** simple, opposite; ovate to lanceolate; ca. 0.5–1 cm by 0.2–0.5 cm; shortly petiolate; margin entire, slightly reflexed, ciliate; apex acute; base rounded or obtuse; upper surface appressed brownish pilose, lepidote; lower surface brownish pilose; midrib visible on both surfaces, slightly raised underneath. ***Inflorescence*** terminal or axillary cyme, 2-many flowered, sometimes solitary; pedicels up to 1.5 cm long, densely pilose; bracts foliaceous, ovate to lanceolate, ciliate. ***Sepals*** 5, green; lanceolate, ca. 3 mm by 1 mm, pilose on outer surface along the veins; margin entire; apex acute. ***Petals*** 5, white, equaling or slightly shorter than sepals, bipartite nearly to base; petal lobes oblanceolate, up to 3 mm by 1 mm; apex obtuse or rounded. ***Stamens*** 10, up to 2 mm long; filaments filiform, those opposite to sepals with swollen glandular base, glabrous; anthers basifixed. ***Ovary*** ovoid with short stalk, 6-valved, ca. 1.5 mm long, glabrous; styles 3, slender, ca. 1 mm long; stigmas clavate.

Bhutan – Chukha, Mongar, Punakha, Sarpang, Trashigang districts
Distribution – India
Ecology – Found in open ground and forest margin of Fir-Rhododendron forest from 3,000 – 3,500 m asl. Flowering in July - August
Specimen Examined – K. Jamtsho 142 (THIM)
Note: *Stellaria sikkimensis* Hook.f. is an unresolved name. It differs from *S. vestita* Kurz. in not having stellate hairs.

DIAPENSIACEAE

26. Diapensia himalaica Hook.f. & Thomson, Hooker's J. Bot. Kew Gard. Misc. 9: 373. 1857; Rae in Fl. Bhutan 2 (1): 351.1991; Hook.f. in Fl. Brit. India 3:478. 1882.– *Diapensia acutifolia* Hand.-Mazz., Anz. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 60: 154. 1923 publ. 1924. – *D. himalaica* var. *acutifolia* (Hand.-Mazz.) W.E.Evans, Notes Roy. Bot. Gard. Edinburgh 15: 227. 1927. **Plate 22 D**

Shrublet, up to 5 cm tall. ***Stem*** slightly decumbent, prostate, or erect, caespitose. ***Leaves*** alternate to spirally arranged, densely crowded on stem tips; obovate to oblong or lanceolate to spatulate, 2–5 mm by 1–2.5 mm; margins entire or revolute; blade coriaceous; apex obtuse or acute; base slightly narrowed sheath; upper punctate, shiny; lower surface punctate; midrib raised underneath and impressed above; lateral veins inconspicuous. ***Inflorescence*** terminal, mostly solitary; flowers sub-sessile; ***Calyx*** 5 leaf-like sepals, imbricate; obovate; greenish with purplish red margins. ***Corolla*** campanulate, pinkish red; corolla tube ca. 4 mm by 3 mm, 5-lobed; lobes ovate-obovate, ca. 3.5 mm by 3.5 cm; apex obtuse. ***Stamens*** 5, ca. 1.5 mm long, alternately inserted on corolla lobes; filament inconspicuous, ca. 0.5 mm, winged; anthers basifixed with 2 partially divided thecae. ***Ovary*** superior, globose, ovate or oblate; glabrous, ca. 2mm long, 3- locular, placentation axile; style glabrous, 6 mm long; stigma capitate to slightly 3-lobed.

Bhutan – Bumthang, Mongar, Punakha, Trashigang, Trongsa districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found on rocky hillsides, damp rock faces and cliff edges of alpine region from 3,500 – 5,000 m asl. Flowering in May - August
Specimen Examined – K. Jamtsho 92 (THIM)

ERICACEAE

27. Cassiope selaginoides Hook.f. & Thomson, Hooker's J. Bot. Kew Gard. Misc. 7: 126, t. 4. 1855; Rae in Fl. Bhutan 2(1): 377. 1991; Hook.f. in Fl. Brit. India 3:460.

1882. – *Cassiope mairei* H.Lév., Repert. Spec. Nov. Regni Veg. 13: 342 1914. **Plate 22 C**

Shrubs 5–15 cm tall. ***Stem*** slightly decumbent, much branched, fastigiate, setose. ***Leaves*** opposite; ovate to triangular, 2–5 mm by 1–2 mm; margins serrulate, haired; apex aristate; base appressed to the stem; upper surface glabrous; lower surface fluted, groove densely tomentose; midrib and lateral veins inconspicuous. ***Inflorescence*** axillary, solitary, 1–5-flowered per stem; flowers nutant; bracts ovate, up to 3 mm long, ciliated; pedicels up to 1.7 cm long, pubescent throughout. ***Calyx*** deeply 5-lobed; lobes reddish brown, lanceolate; margins membranous. ***Corolla*** broadly campanulate, white; corolla tube ca. 8 mm by 9 mm, 5-lobed; lobes triangular, ca. 3 mm by 2 cm with reflexed tip. ***Stamens*** 10, ± equal in length, ca. 3 mm long; filament pubescent throughout; anthers basifixed, ca. 0.5 mm long with ca. 1 mm long spurs; spurs 2, linear, pubescent. ***Ovary*** superior, globose, glabrous, ca. 1mm long, 5-locular, placentation axile; style glabrous, 2.5 mm long; stigma cylindrical, much smaller than base of style.

Bhutan – Haa, Trashigang, Trongsa districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found in Rhododendron thickets, alpine slopes from 3,500 – 4,500 m asl. Flowering in May - August
Specimen Examined – K. Jamtsho 105 (THIM)

28. Gaultheria pyroloides Hook.f. & Thomson ex Miq., Ann. Mus. Bot. Lugduno-Batavi 1: 30. 1863; Rae in Fl. Bhutan 2(1): 390–391. 1991; Hook.f. ex C.B.Clarke, Fl. Brit. India [J. D. Hooker] 3(9): 457. 1882. – *Gaultheria miqueliana* Takeda, Bot. Mag. (Tokyo) 32: 195. 1918. **Plate 22 B**

Prostate shrub with short erect shoot, 0.5–5 cm tall. ***Stem*** creeping with sparsely setose leafy shoot. ***Leaves*** opposite to alternate or sometimes whorled; elliptic to obovate, 1.2–2.5 cm by 0.5–1.6 cm; petiole up to 3 mm long, glabrous or sparsely

setose; margins serrate; apex acute or rounded; base cuneate to rounded; upper surface glabrous; lower surface sparsely strigose; midrib visible on both sides, sometimes dividing into numerous veins; lateral veins prominent on both surfaces, 2–5 paired. ***Inflorescence*** terminal or axillary, raceme, 2–5 flowered or solitary sometimes; flowers nutant; pedunclate; bracteoles ca. 3 mm long, oblong to ovate, margin ciliolate; pedicels ca. 9 mm long, setose. ***Calyx*** deeply 5-(-6) lobed; lobes pinkish, fused at base, ovate, glabrous; margins entire. ***Corolla*** urceolate, pinkish; ca. 4 mm long, shallowly 5-lobed at mouth. ***Stamen*** 10, inserted at base of corolla, equal in length, ca. 2.5 mm long; filament narrowly triangular, peberulent or scabrous; anthers dorsifixed, ca. 1 mm long; spurs 4 arising 2 from each theca, linear, ca. 0.5 mm long , glabrous. ***Ovary*** superior, globose, glabrous, ca. 1mm long, 5-locular, placentation axile; style glabrous, strap-shaped, 2 mm long; stigma strap-shaped as style.

Bhutan – Trashigang, Trongsa districts
Distribution – Myanmar, Nepal
Ecology – Found in Rhododendron thickets, degraded forests and alpine slopes from 3,700 – 4,000 m asl. Flowering in May - August
Specimen Examined – K. Jamtsho 106 (THIM)

29. Gaultheria trichophylla Royle., Ill. Bot. Himal. Mts. [Royle] 260. t. 63. f. 8; Rae in Fl. Bhutan 2(1): 391. 1991; Hook.f. in Fl. Brit. India 3:457. 1882. – *Brossaea trichophylla* (Royle) Kuntze, Revis. Gen. Pl. 2: 387. 1891. – *Gaultheria nana* C.Y.Wu & T.Z.Hsu, Acta Bot. Yunnan. 3: 431. 1981. **Plate 22 A**

Prostate shrubs, 1–5 cm tall. ***Stem*** decumbent with erect setose leafy shoot. ***Leaves*** usually alternate; elliptic to oblanceolate or sometimes obovate, 4–9 mm by 1–4 mm; petiole ca. 1mm long, glabrous or rarely setose; margins ciliated; apex acute or slightly rounded; base cuneate; upper surface glabrous; lower surface glabrous; midrib visible on both sides; lateral veins slightly visible on upper surface. ***Inflorescence*** axillary, solitary, 1–2 flowers per stem; flowers nutant; bracteoles 2, ovate, ca.2 mm long, margin entire; pedicels ca. 2 mm long, glabrous. ***Calyx*** deeply 5-lobed; lobes

pinkish with greenish apex, fused at base, lanceolate or ovate, glabrous; margins entire. ***Corolla*** broadly campanulate, pinkish; corolla tube ca. 3 mm by 4 mm, 5-lobed; lobes orbicular, slightly serrate, ca. 2 mm by 2 cm with whitish marginal linings. ***Stamen*** 10, inserted at base of corolla, equal in length, ca. 1.5–2 mm long; filament spindle-shaped, glabrous; anthers dorsifixed, ca. 1 mm long; spurs 2, linear, ca. 0.7 mm long, glabrous. ***Ovary*** superior, globose, glabrous, ca. 1mm long, 5-locular, placentation axile; style glabrous, 3 mm long; stigma cylindrical.

Bhutan – Trashigang district
Distribution – China, India, Nepal
Ecology – Found in Rhododendron thickets, alpine slopes from 3,500 – 4,500 m asl. Flowering in May - August
Specimen Examined – K. Jamtsho 107 (THIM)

30. Rhododendron anthopogon var. **haemonium** (Balf. f. & R.E. Cooper) Cowan & Davidian, R.H.S. Rhodod. Year Book 2: 68. 1974.− *Rhododendron haemonium* Balf. f. & R.E. Cooper, Notes Roy. Bot. Gard. Edinburgh 9(44-45): 233-234. 1916.−*R. anthopogon* D. Don subsp. *anthopogon*, D.G. Long in Fl. Bhutan 2(1): 386.1991. **Plate 21 F**

Shrub, 0.1–0.3 m high. ***Bark*** gray to dark brown, exfoliating in thin flakes. ***Leaves*** alternate; ovate to broadly elliptic, 1–2.3 cm by 0.5–1.2 cm; petiole up to 5 mm long, glabrous; margin reflexed or revolute; blade coriaceous; apex rounded; base rounded; upper surface glabrous; lower surface lepidote/tomentose; midrib raised underneath, glabrous, slightly impressed on upper surface; lateral veins 4–6 paired, obscure underneath and slightly visible on upper surface. ***Inflorescence*** terminal, raceme; perulae obovate, lepidote, apex rounded or apiculate, pubescent; bracteoles linear or oblanceolate, ca.7 mm long, lepidote, pubescent; pedicels ca. 3–4 mm long, lepidote. ***Calyx*** cup shaped, deeply 5-lobed; lobes ca. 3 mm long, lepidote, margin hairy. ***Corolla*** campanulate or funnel shaped, pink; corolla tube ca. 6 mm by 3 mm with 5-lobes, densely hairy inside; lobes orbicular, ca. 6 mm by 6 mm, emarginate. ***Stamens***

8−10, almost equal in length, ca. 5 mm long; filaments glabrous throughout; anthers ca.1 mm long, dorsifixed. ***Ovary*** superior, conical, ±glanduliferous, ca. 2 mm long, 5-locular, placentation axile; style much shorter that stamens, glabrous, ca. 1 mm long; stigma swollen.

Bhutan – Haa, Mongar, Punakha, Thimphu, Trashigang districts
Distribution – India
Ecology – Found in thickets of Rhododendron and degraded Fir forest from 3,700 – 4,000 m asl. Flowering in mid April - July
Specimen Examined – K. Jamtsho 111 (THIM); J. Cullen & Cooper, 3903; D.G. Long & S. Wangchuk, 428 (E: Online Herbarium Catalogue)

31. Rhododendron argipeplum Balf.f. & R.E.Cooper, Notes Roy. Bot. Gard. Edinburgh 9: 213. 1916; D.G. Long in Fl. Bhutan 2: 376. 1991; M.Y.Fang et al. in Fl. China 14: 404. 2005. – *Rhododendron macrosmithii* Davidian, Rhododendron Spec. 2: 113. 1989. – *R. smithii* Nutt. ex Hook., Bot. Mag. 85: pl. 5120 1859. − *R. smithii* Nutt., Bot. Mag. 85: t. 5120. 1859. **Plate 19 F**

Shrub or small tree up to 5 m tall or higher. ***Bark*** gray with brown inner layer, glandular setose, exfoliating in flakes. ***Leaves*** opposite or whorled; elliptic or oblanceolate, 7.5–10.5 cm by 2.5–4 cm; petiole 1–1.5 cm; margin reflexed; blade coriaceous; apex apiculate-acute; base cuneate to slightly rounded; upper surface glabrous; lower surface densely tomentose with glandular setose; midrib prominently raised underneath, densely tomentose with spreading bristle at base, impressed on upper surface; lateral veins visible on upper surface, 10–16 paired. ***Inflorescence*** terminal, umbel, compact, 10–20-flowered; perulae orbicular, apex rounded, glabrous; bracteoles linear to oblanceolate, ca.2.5 cm, pubescent; pedicels 7–10 mm long, glandular hairy. ***Calyx*** saucer shaped, 5-lobed, up to 5 mm long. ***Corolla*** campanulate, red; corolla tube ca. 1.5 cm by 2 cm, 5-lobed; lobes orbicular, emarginate, ca. 1 cm by 1.5 cm. ***Stamens*** 10, unequal, 1.5–2.2 cm long; filaments glabrous; anthers ca. 2.5 mm long, dorsifixed. ***Ovary*** superior, conical, densely

glandular haired, ca. 4 mm long, 8- locular, placentation axile; style glabrous, up to 2 cm long; stigma slightly swollen.

Bhutan – Bumthang, Mongar, Punakha, Trashigang, Trongsa districts
Distribution – China, India
Ecology – Found in Fir-Rhododendron forest from 2,800 – 3,500 m asl. Flowering in May - June
Specimen Examined – K. Jamtsho 66 (THIM)

32. Rhododendron bhutanense D.G.Long & Bowes Lyon, Notes Roy. Bot. Gard. Edinburgh 45(2): 327. 1989; D.G. Long in Fl. Bhutan 2: 374. 1991. **Plate 20 D-F**

Shrub or large shrub, 3–5 m. ***Bark*** gray or blackish, exfoliating in irregular flakes, younger branches densely tomentose. ***Leaves*** opposite or whorl-like; elliptic to oblanceolate, 8–12 cm by 3–5 cm; petiole 3–8 mm long, densely tomentose; margin strongly reflexed when dry; blade coriaceous; apex apiculate; base cordate or subcordate; upper surface glabrous; lower surface with dense fawn or pale brown tomentum; midrib slightly raised underneath, tomentose, slightly impressed on upper surface; lateral veins more visible on both upper surface, 8–14 paired. ***Inflorescence*** terminal, raceme, rather dense, 10–15-flowered; perulae ovate to oblanceolate, apex apiculate, pubescent; bracteoles linear to oblanceolate, ca.2.4 cm long, pubescent; pedicels 1.8–2.2 cm long, haired. ***Calyx*** rim-like, inconspicuous, 0.5–1 mm long, glabrous or haired at margins. ***Corolla*** campanulate, pinkish with red spots inside; corolla tube ca. 2.5 cm by 3 cm with 5-(-6) lobes; lobes orbicular, emarginate, ca. 1 cm by 2 cm. ***Stamens*** 10, unequal, 1.2–2 cm long; filaments glabrous; anthers ca. 4 mm long, dorsifixed. ***Ovary*** superior, fluted, conical, glabrous, ca. 7 mm long, 7-locular, placentation axile; style glabrous, ca. 2 cm long; stigma peltate.

Bhutan – Bumthang, Mongar, Punakha, Trashigang, Trongsa districts
Distribution – Endemic to Bhutan

Ecology – Found in Rhododendron thickets and alpine slopes from 3,800 – 4,300 m asl. Flowering in May - July

Specimen Examined – K. Jamtsho 109 (THIM); D.G. Long, 3218 (E: Online Herbarium Catalogue)

Note: Closely related to *R. wightii* in its habit and length of pedicel.

33. Rhododendron campanulatum subsp. **aeruginosum** (Hook. f.) D.F. Chamb., Notes Roy. Bot. Gard. Edinburgh 37(2): 329. 1979; Hook.f. in Fl. Brit. India 3: 466. 1882. – *Rhododendron aeruginosum* Hook.f., Rhododendr. Sikkim-Himalaya t. 22. 1851; D.G. Long in Fl. Bhutan 2: 375. 1991; M.Y.Fang et al. in Fl. China 14: 400. 2005. – *R. campanulatum* var. *aeruginosum* (Hook. f.) Cowan & Davidian, Rhododendron Year Book 4: 168. 1949. **Plate 20 C**

Shrub, 1–2 m. ***Bark*** gray with dark spots, exfoliating in flakes. ***Leaves*** whorl like; elliptic to oblanceolate, 5–11 cm by 3–5 cm; petiole 0.5–1.4 cm, pubescent with dendroid hairs; margin slightly reflexed when dry; blade coriaceous; apex apiculate; base mostly cuneate or often slightly rounded; upper surface glabrous except midrib; lower surface densely covered with brown tomentum of dendroid hairs; midrib slightly raised underneath, sparsely covered with glandular dendroid hairs at base and brown tomentum towards tip, dendroid haired; lateral veins obscure, 9–13 paired. ***Inflorescence*** terminal, raceme, lax, 8–12-flowered; perulae ovate, apex rounded, brown tomentose, ciliate; bracteoles linear, ca.1 cm, pubescent; pedicels 1–2 cm long, hairy. ***Calyx*** saucer shaped, inconspicuous, 1–2 mm long, hairy. ***Corolla*** campanulate, purple; corolla tube ca. 2.3 cm by 2 cm, 5-lobed; lobes orbicular, emarginate, ca. 1.2 cm by 1.5 cm. ***Stamens*** 10, unequal, 1.5–2.8 cm long; filaments pubescent at base; anthers ca. 3 mm long, dorsifixed. ***Ovary*** superior, fluted, conic-cylindrical, glabrous, ca. 5 mm long, 6-locular, placentation axile; style glabrous; ca. 3 cm long; stigma swollen.

Bhutan – Bumthang, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts

Distribution – China, India, Nepal

Ecology – Found in Rhododendron scrub forest and alpine slopes from 3,800 – 4,200 m asl. Flowering in May - June
Specimen Examined – K. Jamtsho 115 (THIM)

34. Rhododendron campylocarpum Hook.f., Rhododendr. Sikkim-Himalaya t. 30. 1851; M.Y.Fang et al. in Fl. China 14: 347. 2005; D.J. Long in Fl. Bhutan 2: 371.1991; Hook.f. in Fl. Brit. India 3: 467. 1882. **Plate 19 C**

Shrub or small tree, 2–6 m tall. ***Bark*** grey, tip of branchlets brownish with stalked glandular hairs. ***Leaves*** simple, alternate-spiral; ovate to broadly elliptic, 4–5.5 cm by 2–3.5 cm, petiole 1.5–2.5 cm long, fluted with sparsely distributed glandular hairs; margin slightly reflexed; blade coriaceous; apex apiculate-rounded; base slightly rounded to subcordate; upper surface glabrous, greenish; lower surface glabrous; midrib raised on lower surface, impressed on upper surface; lateral veins 8–14 paired, obscure. ***Inflorescence*** terminal, racemose or umbel, lax, 4–6-flowered; inner perulae broadly elliptic, margin sparsely hairy, outer perulae ovate, emarginate; bracteoles linear, up to 0.4 cm long, sparsely stalked glandular haired; pedicels up to 2.5 cm long, fluted with glandular hairs. ***Calyx*** saucer shaped, inconspicuous, 1–2 mm long, margin with glandular hairs. ***Corolla*** campanulate, bright yellow to pale yellow, corolla tube ca. 2 cm by ca. 1.5 cm with 5-lobes; lobes orbicular, emarginate, ca. 1 cm by 1.5 cm. ***Stamens*** 10, unequal, 5 short and 5 long, shorter stamens 1.4–2.2 cm and longer stamens 2.6–2.9 cm; filaments pubescent at base; anthers ca. 2 mm long, dorsifixed. ***Ovary*** superior, conic-cylindrical, fluted with glandular hairs, 0.5 cm long, 6- locular, placentation axile; style pubescent at base, up to 3.4 cm long; stigma slightly swollen.

Bhutan – Haa, Mongar, Punakha, Thimphu, Trashigang districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found in fir-rhododendron and rhododendron scrub forests from 3,000 - 4,000 m asl. Flowering in May - June
Specimen Examined – K. Jamtsho 122 (THIM)

35. Rhododendron cinnabarinum Hook.f., Rhododendr. Sikkim-Himalaya t. 8. 1849; M.Y.Fang et al. in Fl. China 14: 300. 2005; D.J. Long in Fl. Bhutan 2: 382.1991; Hook.f. in Fl. Brit. India 3: 474. 1882. **Plate 19 B**

Small tree or shrub up to 6 m tall. ***Bark*** grey, lepidote. ***Leaves*** simple, alternate-spiral; narrowly to broadly elliptic, 4–7 cm by 1.5–2.5 cm, petiole up to 1 cm, densely lepidote; margin entire, ciliate; blade coriaceous; apex apiculate; base cuneate-rounded; upper surface glabrous, dark shining green; lower surface densely lepidote, black haired; midrib distinctly raised beneath, lateral veins 10–14 paired, inconspicuous. ***Inflorescence*** terminal, racemose, lax, usually 5–6-flowered; inner perulae elliptic-obelliptic, outer perulae obovate, lepidote, margins densely hairy; bracteoles not seen/caducous; pedicels 0.5–1 cm long, lepidote, green. ***Calyx*** saucer-shaped, inconspicuous, greenish. ***Corolla*** tubular to narrowly campanulate, orange-yellow, corolla tube up to ca. 1.5 cm by ca. 1 cm with 5-lobes; lobes rounded, up to ca. 1.5 cm by ca. 1 cm. ***Stamens*** 10, unequal, 1.8–3 cm long; filament densely haired at base; anthers ca. 2 mm long, dorsifixed. ***Ovary*** superior, conical, glandular, 0.7 cm long, 5- locular, placentation axile; style glabrous, up to 3.8 cm long; stigma slightly swollen.

Bhutan – Haa, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts.
Distribution – China, India, Nepal
Ecology – Found in fir-rhododendron forests from 2,750 - 3,700 m asl. Flowering in May - July
Specimen Examined – K. Jamtsho 117 (THIM)

36. Rhododendron fulgens Hook.f., Rhododendr. Sikkim-Himalaya t. 25. 185; D.G. Long in Fl. Bhutan 2: 377. 1991; M.Y.Fang et al. in Fl. China 14: 417. 2005; Hook.f. in Fl. Brit. India 3: 466. 1882. **Plate 19 E**

Shrub or small tree up to 5 m tall. ***Bark*** brown, glabrous, exfoliating in long flakes. ***Leaves*** opposite or whorled; broadly elliptic or oblong, 7–10 cm by 3–6 cm; petiole 1.5–2 cm long; margin revolute; blade coriaceous; apex rounded to slight apiculate; base rounded or slightly cordate; upper surface glabrous; lower surface densely tomentose with red-brown fasciculate hairs; midrib prominently raised underneath, glabrous; lateral veins visible on upper surface, 12–14 paired. ***Inflorescence*** terminal, racemose-umbellate, compact, 10–15-flowered; perulae broadly ovate-deltoid, apex rounded to acute apiculate, glabrous; bracteoles linear to oblong, ca.2 cm, pubescent; pedicels 3–5 mm long, lepidote. ***Calyx*** cup shaped, inconspicuous, 1–2.5 mm long. ***Corolla*** campanulate, blood red; corolla tube ca. 1.4 cm by ca. 2 cm, 5-lobed; lobes rounded, emarginate, ca. 1.2 cm by ca. 1.5 cm. ***Stamens*** 10, unequal, 8–13 mm long; filaments glabrous; anthers ca. 2 mm long, dorsifixed. ***Ovary*** superior, conical, lepidote, ca. 5 mm long, fluted, 8- locular, placentation axile; style glabrous, ca. 1.2 cm long; stigma tubular almost same size as style tube.

Bhutan – Mongar, Punakha, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Found in Fir-Rhododendron forest and rhododendron thickets from 3,400 – 4,300 m asl. Flowering in April - June
Specimen Examined – K. Jamtsho 78 (THIM)

37. Rhododendron hodgsonii Hook.f., Rhododendr. Sikkim-Himalaya t. 15. 185; D.G. Long in Fl. Bhutan 2: 371. 1991; M.Y.Fang et al. in Fl. China 14: 345. 2005; Hook.f. in Fl. Brit. India 3: 464. 1882. **Plate 20 A-B**

Small tree up to 10 m. ***Bark*** gray, exfoliating in flakes. ***Leaves*** opposite or whorl like; obelliptic to oblanceolate, 16–27 cm by 5–12 cm; petiole 2.5–4 cm, sparsely haired; margin entire, sometimes revolute; blade coriaceous; apex obtuse-rounded; base cuneate to rounded; upper surface glabrous; lower surface densely brown tomentose; midrib prominently raised underneath, thinly brown tomentose, slightly impressed on upper surface; lateral veins visible on both surfaces, 12–18 paired. ***Inflorescence***

terminal, umbel-racemose, dense, 15–20-flowered; perulae ovate, apex rounded, emarginate sometimes, surface white lepidote; bracteoles lanceolate, ca.3 cm, pubescent; pedicels 2–2.5 cm long, tomentose. ***Calyx*** saucer shaped, inconspicuous, 1–2 mm long, tomentose. ***Corolla*** campanulate, pinkish/purplish; corolla tube ca. 2 cm by 2 cm with 8-lobes; lobes orbicular, emarginate, ca. 1 cm by 2 cm. ***Stamens*** 16, almost equal in length, ca. 2 cm long; filaments glabrous; anthers ca. 2 mm long, dorsifixed. ***Ovary*** superior, conic-cylindrical, densely tomentose, ca. 5 mm long with 8-10 locules, placentation axile; style glabrous, up to 2.5 cm long; stigma swollen.

Bhutan – Bumthang, Haa, Mongar, Punakha, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Found in Fir-Rhododendron forest from 3,500 – 4,000 m asl. Flowering in May - June
Specimen Examined – K. Jamtsho 69 (THIM)

38. Rhododendron kesangiae D.G.Long & Rushforth, Notes Roy. Bot. Gard. Edinburgh 45(2): 331. 1989; D.G. Long in Fl. Bhutan 2: 370. 1991. **Plate 21 B-C**

Tree, 5–10 m. ***Bark*** gray to pale brown. ***Leaves*** whorl like; broadly elliptic to oblanceolate, 17–27 cm by 6–10 cm; petiole ca. 4.5 cm long, white lepidote on lower surface; margin revolute; blade coriaceous; apex mostly rounded; base cuneate to slightly rounded; upper surface glabrous; lower surface with silvery white and pale brown indumentum; midrib prominently raised underneath, glabrous, impressed on upper surface; lateral veins visible on both sides, 13–18 paired. ***Inflorescence*** terminal, raceme, 15–20-flowered; perulae obovate, apex apiculate to obcordate, glabrous, gelatinous surface; bracteoles obelliptic, ca.3.5 cm long, pubescent; pedicels ca. 3.5 cm long, glanduliferous. ***Calyx*** rim-like, inconspicuous, ca. 0.5–1 mm long, glabrous. ***Corolla*** campanulate, white or pink; corolla tube ca. 3.2 cm by 2.5 cm, 8-lobed; lobes orbicular, emarginate, ca. 1 cm by 1.5 cm. ***Stamens*** 16, unequal, 1.8–3 cm long; filaments glabrous; anthers ca. 3.5 mm long, dorsifixed. ***Ovary*** superior,

fluted, conic-cylindrical, glanduliferous, ca. 8 mm long, 12–14-locular, placentation axile; style glabrous, ca. 2.5 cm long; stigma peltate.

Bhutan – Bumthang, Chukha, Mongar, Punakha, Thimphu, Trashigang districts
Distribution – Endimic to Bhutan
Ecology – Found in Fir-Rhododendron forest from 2,900 – 3,400 m asl. Flowering in mid-April - May
Specimen Examined – K. Jamtsho 67 (THIM)

39. Rhododendron lanatum Hook.f., Rhododendr. Sikkim-Himalaya: t. 16. 1851; M.Y.Fang et al. in Fl. China 14: 398. 2005; D.J. Long in Fl. Bhutan 2: 374. 1991. – *Rhododendron lanatum* var. *luciferum* Cowan, Notes Roy. Bot. Gard. Edinburgh 19(94): 228-229. 1937 . – *R. flinckii* Davidian, Quart. Bull. Amer. Rhododendron Soc. 25: 143. 1975. – *R. luciferum* (Cowan) Cowan, Notes Roy. Bot. Gard. Edinburgh 21(3): 145-146 145 1953. **Plate 19 D**

Shrub or small tree from up to 4 m tall. ***Bark*** grey, glaucous and thick tomentose with inner brown and outer white layers. ***Leaves*** alternate-spiral; elliptic to obovate, 6–8.5 cm by 4–5 cm, petiole mostly up to 1 cm long, thick tomentose; margin slightly reflexed or revolute; blade coriaceous; apex obtuse to rounded with pointed tip; base rounded to broadly cuneate; upper surface glabrous except thickly tomentose midrib, usually at base; lower surface thickly brown tomentose; midrib prominently raised beneath, thickly brown tomentose; lateral veins 10–12 paired, conspicuous beneath. ***Inflorescence*** terminal, raceme, lax, 5–10-flowered; perulae ovate to broadly lanceolate, thickly brown tomentose; bracteoles obovate to obelliptic, up to 3 cm, pubescent; pedicels up to 1.5 cm long, densely pubescent. ***Calyx*** saucer shaped, 5-lobed, inconspicuous, ca. 1 mm long, pubescent. ***Corolla*** campanulate, yellow usually with red spots; corolla tube ca. 3 cm by ca. 4 cm with 5-lobed; lobes emarginate, rounded, up to ca. 2 cm by 3 cm. ***Stamens*** 10, unequal, 2.2–3.2 cm; filaments thickly pubescent at the base, hairs matted and look like fused; anthers ca. 4 mm long,

dorsifixed. ***Ovary*** superior, cylindrical, fluted, densely tomentose, ca. 6 mm, 6-locular, placentation axile; style glabrous, up to 3 cm long; stigma enlarged.

Bhutan – Haa, Punakha, Thimphu, Trashigang, Trongsa districts
Distribution – China, India
Ecology – Found in fir-rhododendron and rhododendron scrub forests from 3,100 - 4,300 m asl. Flowering in May - June
Specimen Examined – K. Jamtsho 72 (THIM)

40. Rhododendron nivale Hook.f., Rhododendr. Sikkim-Himalaya t. 26. 1851; D.G. Long in Fl. Bhutan 2: 381. 1991; M.Y.Fang et al. in Fl. China 14: 293. 2005; Hook.f. in Fl. Brit. India 3: 472. 1882. **Plate 21 E**

Shrub, often bushy, 0.2–0.5 m high. ***Bark*** gray, not exfoliating easily. ***Leaves*** alternate to opposite or whorl like; obovate to oblanceolate, 5–10 mm by 2–4 mm; sessile or petiole ca. 1 mm long, lepidote; margin reflexed when dry; blade coriaceous; apex rounded with pointed tip; base cuneate; upper surface lepidote, often with scale like glands; lower surface lepidote, with scale like glands; midrib slightly raised underneath, lepidote or covered with scale like glands; lateral veins inconspicuous. ***Inflorescence*** terminal, solitary, raceme; perulae ovate, apex rounded, sparsely haired; bracteoles elliptic-oblanceolate, ca.1–2 mm long, ciliated; pedicels ca. 7–10 mm long, lepidote. ***Calyx*** saucer shaped, deeply 5-lobed, lobes ca. 3 mm long, lepidote or scale like glandular surface. ***Corolla*** broad funnel shaped, pink, glanduliferous; corolla tube ca. 5 mm by 5 mm with 5-lobes; lobes orbicular, ca. 4 mm by 5 mm. ***Stamens*** 10, almost equal in length, ca. 4 mm long; filaments densely pubescent in middle portion and glabrous at base and tip; anthers ca.1.5 mm long, dorsifixed. ***Ovary*** superior, conical, base pubescent, glanduliferous throughout, ca. 2 mm long, 5-locular, placentation axile; style glabrous, ca. 4 mm long; stigma swollen.

Bhutan – Bumthang, Punakha, Thimphu, Trashigang districts
Distribution – China, India, Nepal

Ecology – Found in thickets of Rhododendron and degraded Fir forest from 3,700 – 4,500 m asl. Flowering in July - August
Specimen Examined – K. Jamtsho 169 (THIM)

41. Rhododendron setosum D.Don, Mem. Wern. Nat. Hist. Soc. iii. (1821) 408; M.Y.Fang et al. in Fl. China 14: 289. 2005; Hook.f. in Fl. Brit. India 3: 472. 1882; D.G. Long in Fl. Bhutan 2: 381. **Plate 21 D**

Shrub, 10–30 cm. ***Bark*** dark brown, exfoliating in thin flakes, branchlets setose, lepidote. ***Leaves*** usually alternate; oblong to obovate, 4–9 mm by 3–5 mm; petiole ca. 1–3 mm long, lepidote with gland like scales; margin revolute; apex rounded or obtuse or truncate, sometimes emarginate; base cuneate or rounded; upper surface lepidote with oily scales; lower surface lepidote, sparsely hairy; midrib conspicuous, sparsely lepidote, impressed on upper surface; lateral veins inconspicuous. ***Inflorescence*** terminal, raceme, 2–5-flowered; perulae obovate, apex rounded, margin ciliated; bracteoles linear, ca.1–2 mm long, ciliated; pedicels ca. 3–5 mm long, lepidote with peltate scales. ***Calyx*** deeply 5-lobed, lobes ca. 5 mm long, lepidote with gland like scales. ***Corolla*** open funnel shaped, pink; corolla tube ca. 5 mm by 9 mm with 5-lobes; lobes orbicular, ca. 7 mm by 7 mm. ***Stamens*** 10, almost equal in length, ca. 1 cm long; filaments densely pubescent at base; anthers ca.4 mm long, dorsifixed. ***Ovary*** superior, conical, pubescent base, gland like scales throughout, ca. 3 mm long, 5-locular, placentation axile; style glabrous, ca. 5 mm long; stigma swollen.

Bhutan – Bumthang, Haa, Punakha, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Found in thickets of Rhododendron and alpine slopes from 3,500 – 4,500 m asl. Flowering in Mid April - June
Specimen Examined – K. Jamtsho 97 (THIM); S. Noshiro et al, 9261210; D. Binns et al, 56; M.N. & W.R. Philipson, 6526 (E: Online Herbarium Catalogue)

42. Rhododendron thomsonii Hook.f., Rhododendr. Sikkim-Himalaya t. 12. 1851; M.Y.Fang et al. in Fl. China 14: 398. 2005; D.J. Long in Fl. Bhutan 2: 377. 1991; Hook.f. in Fl. Brit. India 3:468. 1882. **Plate 19 A**

Shrub or small tree up to 5 m tall. ***Bark*** grey-brown when old, brown in younger branch, glabrous, and exfoliating in long flakes. ***Leaves*** simple, alternate-spiral; orbicular to obovate, 5–6 cm by 6–6.5 cm, petiole 2–2.3 cm; margin reflexed; blade coriaceous; apex obtuse or rounded with a short pointed tip; base rounded to cordate; upper surface glabrous, dark shining green changing to dark brown when dry; lower surface glaucous; midrib slightly raised underneath, lateral veins visible, 10–14 paired. ***Inflorescence*** terminal, umbel, lax, 4–8-flowered; perulae broadly ovate, apex obtuse or rounded, gelatinous surfaces, late caducous; bracteoles linear, up to 4 mm long, haired; pedicels 1.8–2 cm long, green, glabrous. ***Calyx*** cup shaped, shallowly 5-lobed, red with greenish base. ***Corolla*** campanulate, crimson; corolla tube up to ca. 2.5 cm by ca. 3 cm with 5-lobed; lobes emarginate, orbicular, up to ca. 1.5 cm by ca. 2 cm with scattered dark glands. ***Stamens*** 10, unequal, 5 short and 5 long, short stamens 1.9–2.4 cm and longer stamens 2.7–3.3 cm; filament pubescent at base; anthers ca. 2–3 mm long, dorsifixed. ***Ovary*** superior, conic-cylindrical, glabrous, 0.5 cm long, fluted, 10- locular, placentation axile; style glabrous, 2.8 cm long; stigma peltate.

Bhutan – Haa, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found in the mixed woodland forest and open slopes of cool temperate region, most common in fir forests from 3,100 – 4,000 m asl. Flowering in mid April - July
Specimen Examined – K. Jamtsho75 (THIM)

43. Rhododendron sp. **Plate 21 A**

Small tree or shrub, 1–5 m. ***Bark*** pale brown to gray, glabrous, exfoliating in larger flakes. ***Leaves*** whorl-like; broadly elliptic to oblance-ovate, 10–14 cm by 5–6.5 cm; petiole ca. 1.5 cm long, glabrous; margin entire or slightly revolute when dry; blade coriaceous; apex apiculate to rounded; base cuneate to rounded; upper surface glabrous; lower surface densely covered with fawn or pale brown tomentum; midrib raised underneath, thinly tomentose or glabrous, impressed on upper surface; lateral veins visible on both sides, 10–15 paired. ***Inflorescence*** terminal, umbellate/raceme, lax, 4–8-flowered; perulae ovate, apex rounded, emarginate, sparsely ciliated, gelatinous surface; bracteoles obelliptic-oblanceolate, ca.3 cm long, pubescent; pedicels ca. 1 cm long, hairy. ***Calyx*** saucer shaped, inconspicuous, ca. 3 mm long, sparsely hairy or ±glabrous. ***Corolla*** campanulate, white or pale yellow; corolla tube ca. 2.5 cm by 2 cm, 5-lobed; lobes orbicular, emarginate, ca. 1.5 cm by 2 cm. ***Stamens*** 10, unequal, 1.5–2.5 cm long; filaments pubescent at base; anthers ca. 4 mm long, dorsifixed. ***Ovary*** superior, fluted, conic-cylindrical, densely tomentose, ca. 6 mm long, 9-locular, placentation axile; style glabrous, ca. 2.5 cm long; stigma swollen.

Bhutan – Trashignag district

Distribution

Ecology – Found in Rhododendron thickets and alpine slopes from 3,900 – 4,300 m asl. Flowering in May - July

Specimen Examined – K. Jamtsho 79 (THIM)

FABACEAE

44. Parochetus communis D.Don, Prodr. Fl. Nepal. 240. 1825; Grierson and D.G. Long in Fl. Bhutan 1(3): 728. 1987; Hook.f. in Fl. Brit. India 2: 86. 1879. – *Cosmiusa repens* Alef., Bot. Zeitung (Berlin) 24: 146. 1866. – *Parochetus maculata* Bennett, Pl. Jav. Rar. 1: 162. 1840. – *P. major* Buch.-Ham. ex D.Don, Prodr. Fl.

Nepal. 241. 1825. – *P. oxalidifolius* Royle, Ill. Bot. Himal. Mts. [Royle] 201. t. 35. f. 1. **Plate 12 E**

Perennial herbs, prostrate or ascending with roots at nodes. ***Leaves*** digitately 3-foliate; petiole slender and long, sparsely pilose; stipules entire, free or base adnate to petiole; leaflets obcordate, ca. 1.5 cm by 1.5 cm; petiolule ca. 1 mm long; margin entire; apex emarginate; base cuneate; upper surface lepidote; lower surface lepidote, pilose; midrib distinct on both sides; lateral veins visible on both sides, 3–4 paired. ***Inflorescence*** terminal simple cyme, 1–3-flowered; peduncle usually long, sparsely pilose. ***Calyx*** tube ca. 4 mm long, pilose; calyx lobes 5, unequal; anterior and lateral lobes narrowly triangular to ovate; posterior 2 lobes triangular, reduced and shorter than anterior lobes. ***Corolla*** blue, free, papilionaceous, petals 5; standard widely ovate, ca. 2 cm by 1.5 cm including claw, glabrous, emarginate, margin ± ciliate; wings obliquely obovate, ca. 1.3 cm by 0.6 cm, base auriculate, glabrous; keel falcate, ca. 1 cm by 0.4 cm, base darkened, apex acute, partially auriculate. ***Stamens*** 10, monadelphous with membranous staminal tube; filaments up to 1.2 cm long, winged; anthers pubescent, dorsifixed. ***Ovary*** superior, glabrous, ca. 7 mm long, 1-locular; style subulate, ca. 6 mm long, glabrous; stigma reduced.

Bhutan – Bumthang, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Malaysia, Myanmar, Nepal, Sri Lanka, N. Thailand, Vietnam
Ecology – Found along the river banks, thickets, forest margins, and grasslands from 2,000 – 3,500 m asl. Flowering in May - October
Specimen Examined – K. Jamtsho 134 (THIM)

GENTIANACEAE

45. Gentiana capitata Buch.-Ham. ex D.Don, Prodr. Fl. Nepal. 126. 1825; E. Aitken in Fl. Bhutan 2(2): 654. 1999; Hook.f. in Fl. Brit. India 4:113. 1897; T.N. Ho and J.S. Pringle in Fl. China 16: 91.1995. – *Gentiana andersonii* C.B.Clarke, J. Linn. Soc.,

Bot. 14: 436. 1875. – *G. marginata* Wall., Numer. List 4391.1831. – *G. baconi* Edgew., London J. Bot. 4: 20. 1845. – *G. cephalodes* var. *andersonii* (C.B.Clarke) S.Agrawal & U.C.Bhattach., J. Econ. Taxon. Bot. 3: 998.1982. – *Ciminalis capitata* (Buch., Ham. ex D.Don) Omer, Edinburgh J. Bot. 50: 72 1993. **Plate 15 E**

Annual herbs, ca. 1–3 cm tall. ***Stem*** erect with long slender taproot, obscured within leaves, much branched, papillose. ***Leaves*** simple, opposite; elliptic to obovate, ca. 0.3–1 cm by 0.1–0.6 cm, bigger leaves basal; subsessile or lower leaves with petiole ca. 2 mm long; margin uniformly membranous; apex acute, aristate; base narrowed; upper surface punctate; lower surface glabrous or punctate; mid-veins 3–5, reticulate. ***Inflorescence*** simple cyme; flowers 1–3, subsessile; bracts foliaceous, linear or lanceolate, punctate. ***Calyx*** tubular campanulate, sparsely papillose; tube ± 3 mm long; lobes 5, narrowly triangular, ca. 3 mm by 1.5 mm, margin membranous, apex acute or caudate. ***Corolla*** tubular campanulate, ± 6 mm long, glabrous, blue with greenish yellow inside tube, 5-lobed; lobes triangular, ca. 2 mm by 1 mm, apex acute; plicae ± 1 mm by 1.5 mm, sometimes irregularly toothed. ***Stamens*** 5, ca. 3 mm long, inserted below middle of corolla tube; filament narrowly triangular, glabrous; anthers ca.1 mm long, basifixed. ***Ovary*** obovoid, membranous covering, ca. 4 mm long; ovary stalk ca. 2 mm long; style slender, ca. 0.5 mm long; stigma bipartite, strongly hamate.

Bhutan – Mongar, Punakha, Trashigang, Trongsa districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found along the margins of forest, stream banks, mountain slopes from 3,000 – 4,000 m asl. Flowering in May - June
Specimen Examined – K. Jamtsho 62 (THIM)

46. Gentiana prostrata var. **karelinii** (Griseb.) Kusn., Trudy Imp. S.-Peterburgsk. Bot. Sada 15: 368. 1904; T.N. Ho and J.S. Pringle in Fl. China 16: 65.1995. – *Gentiana karelinii* Griseb., Prodr. 9: 106. 1845; E. Aitken in Fl. Bhutan 2(2): 650. 1999; Hook.f. in Fl. Brit. India 4:110. 1897. – *G. longipes* Turcz., Vestn. Estestv. Nauk Moskovsk. Obshch. Isp. Prir. 1860: 1246 1860.– *G. variabilis* Rupr., Sert.

Tianschan. 60 1869. – *Ciminalis karelinii* (Griseb.) Zuev, Bot. Zhurn. (Moscow & Leningrad) 75: 1302 1990. **Plate 15 C-D**

Annual herbs, ca. 3–5 cm tall. ***Stem*** prostate or decumbent, shortly branched, papillose or scabrous. ***Leaves*** simple, opposite, sometimes whorled below inflorescence; narrowly elliptic to oblong or obovate to spatulate, ca. 0.5–1.3 cm by 0.3–0.4 cm, longer leaves below inflorescence; petiole inconspicuous, forming petiole tube of ± 2 mm long, papillose or scabrous; margin membranous, papillose; apex acute or obtuse; base narrowed; upper surface ± glabrous; lower surface papillose or scabrous; mid-veins usually 3, inconspicuous. ***Flower*** terminal or axillary, solitary; subsessile; bracts foliaceous, lanceolate, glabrous or papillose. ***Calyx*** campanulate, papillose; tube ca. 1 cm long; lobes 5, linear or oblanceolate, ca. 8 mm by 2 mm, margin papillose, apex acute. ***Corolla*** tubular, ca. 3.5 cm long, glabrous, blue with base greenish yellow, 5-lobed; lobes triangular, ca. 5 mm by 4 mm, apex acute; plicae ± 1.5 mm by 2.5 mm. ***Stamens*** 5, ca. 1 cm long, inserted middle of corolla tube; filament narrowly triangular, glabrous; anthers ca.2 mm long, basifixed. ***Ovary*** cylindrical or ellipsoid, glabrous, up 1. 4 cm long; ovary stalk ca. 1.3 cm long; style cylindrical, ca. 2 mm long, glabrous; stigma bipartite, lobes oblong.

Bhutan – Bumthang, Punakha, Trashigang, Trongsa districts
Distribution – China, India, Mongolia, Nepal, Russia
Ecology – Found along the margins of Fir-Rhododendron forest from 3,500 – 4,500 m asl. Flowering in August - October
Specimen Examined – K. Jamtsho 168 (THIM)

47. Gentiana sikkimensis C.B.Clarke, Fl. Brit. India 4: 114 1883; E. Aitken in Fl. Bhutan 2(2): 645. 1999; T.N. Ho and J.S. Pringle in Fl. China 16: 55.1995. – *Gentiana pseudosikkimensis* C.Marquand ex Wilkie, Gentians 163, nomen subnudum; Marquand in Kew Bull. 1937, 162, in syn. 1936. – *Gentianodes sikkimensis* (C.B.Clarke) Á.Löve & D.Löve**,** Bot. Not. 125(3): 257 (1972). **Plate 15 F**

Perennial herbs, ca. 5 cm tall. ***Stem*** prostrate or stoloniferous, scabrous or sparsely glandular pilose. ***Leaves*** simple, opposite; basal leaves forming rosette, subtended by remains of old leaves, obovate, ca. 9 mm by 7 mm; middle and upper cauline leaves oblong to spatulate, ca. 0.6–2 cm by 0.4–0.7 cm; petiole tube ca. 1mm long; margin sparsely papillose; apex obtuse or rounded; base narrowed; upper surface glabrous; lower surface glabrous; mid-veins usually 3, reticulate. ***Inflorescence*** terminal cymose; flowers 5–10, never solitary, subsessile; bracts foliaceous, oblong or oblanceolate, glabrous. ***Calyx*** tubular campanulate, glabrous; tube ± 6 mm long; lobes 5, triangular or lanceolate, ± 3 mm by 1 mm, margin entire, apex acute. ***Corolla*** tubular with mouth slightly constricted, ± 2 cm long, glabrous, blue with greenish base, 5-lobed; lobes triangular, ca. 2 mm by 2 mm, apex acute; plicae ± 1 mm by 2 mm. ***Stamens*** 5, ca. 4 mm long, inserted above middle of corolla tube; filament narrowly triangular, glabrous; anthers ca.2 mm long, basifixed. ***Ovary*** ellipsoid, glabrous, ca. 4 mm long; ovary stalk ca. 7 mm long; style conical, ca. 2 mm long; stigma bipartite, strongly hamate.

Bhutan – Mongar, Punakha, Thimphu, Trashigang districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found along the forest margins, mountain slopes from 3,000 – 4,000 m asl. Flowering in August - September
Specimen Examined – K. Jamtsho 180 (THIM)

48. Halenia elliptica D.Don, Trans. Linn. Soc. London 17(4): 529. 1837; E. Aitken in Fl. Bhutan 2(2): 611. 1999. Hook.f. in Fl. Brit. India 4: 130. 1897. – *Swertia centrostemma* Wall., Numer. List [Wallich] n. 4385. 1831. – *Swertia peloria* Griff., Itin. Pl. Khasyah Mts. 197. 1848 ; Posth. Papers, ii. **Plate 16 A**

Annual herb, ca. 10–30 cm tall. ***Stem*** erect, usually single. ***Leaves*** opposite; ovate or elliptic, ca. 0.5–3 cm by 0.5–1 cm; petiole of lower leaves up to 1 cm, upper leaves sessile; margins entire; apex acute; base cuneate; upper surface punctate; lower surface lepidote; 3-5-veined from base, conspicuous. ***Inflorescence*** terminal umbel to

axillary simple cyme, 3–7-flowered; peduncles ± 6 mm long; pedicels ±1 cm long; bracts ovate to elliptic, apex acute. ***Calyx*** 4-lobed; tube ca. 1 mm long; lobes elliptic to ovate, ca. 5 mm by 2 mm, glandular punctate, margin entire, apex acute. ***Corolla*** purple to blue, 4-lobed; tube ca. 1–3 mm long; lobes ovate or elliptic, ca. 6mm by 5 mm, apex mucronate; spurs 4, ± 5 mm long. ***Stamens*** 4, ca. 5 mm long, inserted on base of corolla; filament narrowly triangular, glabrous; anthers ± 1mm long, fused into cordate, basifixed. ***Ovary*** ovoid or ellipsoid, sparsely hairy, ca. 3 mm long; style conical; stigma reduced.

Bhutan – Bumthang, Haa, Punakha, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found along the forest margins and stream banks from 2,000 – 4,500 m asl. Flowering in July - September
Specimen Examined – K. Jamtsho 135 (THIM)

49. Swertia assamensis Harry Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 4: 248. 1970; E. Aitken in Fl. Bhutan 2(2): 631. 1999. **Plate 16 B**

Perennial, ca. 20–40 cm tall. ***Stem*** erect, single, robust, quadrangular or slightly grooved. ***Basal leaves*** rosulate; ovate or elliptic or spatulate, ca. 4–5 cm by 2–2.5 cm, petiole broad, ± 4 cm long; cauline leaves whorled, elliptic to ovate, ca. 2–6 cm by 1–2 cm, sessile; margins lacerate or ciliate; apex acute; base cuneate to narrowed; upper surface punctate; lower surface ± glabrous; mid and lateral veins conspicuous. ***Inflorescence*** terminal or axillary whorls or on short whorled peduncle, 1–3 flowered; pedicels ca.1.5–4 cm long; bracts foliaceous. ***Calyx*** lobes 4, glabrous, overlapping, ovate, ca. 1.2 cm by 0.5 cm, margin lacerate or erose, apex acute. ***Corolla*** 5-lobed, obovate, ca. 2.5 cm long, glabrous, greenish yellow with red strip; gland 1 per lobe, orbicular, membranous, rim irregularly dentate; apex truncate or slightly emarginate. ***Stamens*** 4, ca. 1.2 cm long, inserted on base of corolla lobe; filament connate or narrowly triangular, ± glabrous; anthers ca. 4 mm long, basifixed. ***Ovary*** ovoid, glabrous, up 1. 3 cm long; style inconspicuous; stigma capitate.

Bhutan – Trashigang district

Distribution – India (Assam)

Ecology – Found along the alpine slopes from 3,500 – 4,200 m asl. Flowering in July - August

Specimen Examined – K. Jamtsho 162 (THIM)

LAMIACEAE

50. Clinopodium umbrosum (M.Bieb.) Kuntze, Revis. Gen. Pl. 2: 514. 1891. – *Clinopodium umbrosum* (M.Bieb.) C.Koch, Linnaea 11: 673. 1848; R.A. Clement in Fl. Bhutan 2(2): 977. 1999. – *Calamintha biebersteinii* K.Koch ex Ledeb., Fl. Ross. 3: 355. 1849. – *C. nepalensis* Fisch. & C.A.Mey., Index Seminum (LE) 11: 53. 1846. – *C. umbrosa* (M.Bieb.) Rchb., Fl. Germ. Excurs. 329. 1831. – *C. umbrosa* (M. Bieb.) Fisch. & C.A. Mey., Index Sem. (St. Petersburg) 6: 66. 1839. – *Melissa umbrosa* M.Bieb., Fl. Taur.-Caucas. 2: 63. 1808. **Plate 12 D**

Perennial herbs, ca. 20 cm tall. ***Stem*** slender, usually erect, pilose with slender rootstock. ***Leaves*** simple, opposite; petiole up to 1 cm long, villous; ovate to elliptic or oblong, ca. 0.5–2.5 cm by 0.3–1.5 cm; margin serrate or crenate, ciliate; apex acute or obtuse; base obtuse or cuneate; upper surface pilose; lower surface pilose; midrib visible on both sides; lateral veins slightly visible, 4–6 paired. ***Inflorescence*** verticillaster on the axils of upper leaves or terminal, many flowered; pedicel 1–2 mm long, pubescent; bracteoles linear, ca. 5 mm long, pilose. ***Calyx*** tubular; calyx tube ca. 4 mm long, slightly inflated on the anterior, distinctly (12–)15 veined, pilose; calyx lobes 5, unequal; anterior 2 lobes narrowly triangular, ca. 3 mm long, pilose; posterior 3 lobes triangular, shorter than anterior lobes, pilose. ***Corolla*** pink, showy, up to 9 mm long, bilabiate, pilose or pubescent; upper lip emarginate or shallowly 2-lobed; lower lip 3-lobes, slightly longer than upper lip; corolla tube not annulate within. ***Stamens*** 4, inserted on base of lips, didynamous, anterior pair longer than posterior pair, included within corolla; filaments slender, glabrous; anthers 2-celled, glabrous,

basifixed. ***Ovary*** globose, 4-lobed, glabrous, ca. 1 mm long; style slender, gynobasic, ca. 5 mm long, glabrous; stigma unequally bifid.

Bhutan – Bumthang, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts. Expected in all districts of Bhutan
Distribution – Afghanistan, China, India, Myanmar, Nepal, Pakistan
Ecology – Grown as weeds in orchards. In natural forest it is found along the river banks and open forests from 200 – 3,400 m asl. Flowering in May - September
Specimen Examined – K. Jamtsho 130 (THIM); V.S. Kumar, BM000778849 (BM)

51. Phlomis tibetica C.Marquand & Airy Shaw, J. Linn. Soc., Bot. xlviii. 218 (1929); R.A. Clement in Fl. Bhutan 2(2): 959. 1999; Li and Hedge in Fl. China 17: 149. 1994. **Plate 12 B**

Perennial herbs, ca. 40 cm tall. ***Stem*** quadrangular, erect, appressed villous. ***Leaves*** simple, opposite; petiole ± 8 cm long, reducing towards apex, uniformly appressed villous; ovate to oblong, ca. 5–9.5 cm by 3–7 cm; margin crenate, ciliate; apex obtuse; base cordate; upper surface white pilose; lower surface whitish pilose; midrib clearly visible on both surfaces; lateral veins distinct on both surfaces, further divided. ***Inflorescence*** terminal, congested, subtended by a pair of leaves; flowers 1– many, sessile; bracts narrowly triangular, ca. 6 mm long, pilose. ***Calyx*** tubular, regular; calyx tube ± 6 mm, villous usually along the veins, hairy on inside of mouth, regularly toothed; tooth ca. 1 mm by 3 mm; apex truncate or shallowly lobed, ciliate with apical spines. ***Corolla*** purple, ca. 2–2.4 cm long; tube hairy towards base from inside; limb bilabiate; upper lip hooded, pilose on outer surface, densely villous on inside; lower lip 3-lobed, recurved; middle lobe orbicular, glabrous, entire; 2 lateral lobes reduced, glabrous. ***Stamens*** 4, inserted on corolla, included within upper lip; filaments slender without appendages, pubescent; anthers 2-celled, glabrous. ***Ovary*** globose, 4-lobed, glabrous, ca. 2 mm long; style slender, gynobasic, ± 2 cm long, glabrous; stigma swollen, slightly lobed.

Bhutan – Bumthang, Haa, Punakha, Thimphu, Trashigang districts

Distribution – China, India

Ecology – Found along the margins and open grounds of Fir forest from 3,300 – 3,500 m asl. Flowering in July - August

Specimen Examined – K. Jamtsho 144 (THIM)

52. Prunella vulgaris L., Sp. Pl. 2: 600. 1753; R.A. Clement in Fl. Bhutan 2(2): 955. 1999; Li and Hedge in Fl. China 17: 50. 1994. **Plate 12 C**

Perennial herbs, up to 30 cm tall. ***Stem*** slender, erect, pilose with short creeping rootstock. ***Leaves*** simple, opposite; petiole up to 2 cm long, reducing towards apex, villous; ovate to oblong, ca. 1–3 cm by 0.5–1.5 cm; margin undulate or shallowly dentate, ciliate; apex acute or obtuse; base obtuse or cuneate; upper surface shiny white pilose; lower surface pilose; midrib visible on both sides; lateral veins conspicuous, 4–5 paired. ***Inflorescence*** terminal cylindrical spike, many flowered; pedicel up to 3 mm long, pilose; bracts wieldy ovate or sub-cordate, ca. 6 by 10 mm, pilose. ***Calyx*** tubular campanulate, bilabiate, pilose; calyx tube ca. 3 mm; upper lip truncate with 3 short mucronate teeth, veins reticulate; lower lip deeply divided into 2 triangular lobes, veins ± parallel. ***Corolla*** blue, ± 9 mm long, bilabiate; upper lip entire, pilose on outer surface; lower lip 3-lobes, recurved; middle lobe irregularly dentate, smaller than upper lip, 2 lateral lobes highly reduced. ***Stamens*** 4, inserted on corolla, included within upper lip; filaments slender with apical spur, glabrous; anthers 2-celled, glabrous, basifixed. ***Ovary*** globose, 4-lobed, glabrous, ca. 1 mm long; style slender, gynobasic, up to 7 mm long, glabrous; stigma bifid.

Bhutan – Bumthang, Chukha, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts

Distribution – China, India, Myanmar, Nepal, Pakistan

Ecology – Found along the river banks, mountain slopes and open forest from 1,000 – 3,400 m asl. Flowering in May - August

Specimen Examined – K. Jamtsho 125 (THIM); L. A. Lauener, E00284315 (E: Online Herbarium Catalogue)

ONAGRACEAE

53. Epilobium gouldii P.H.Raven, Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 371. 1962; Grierson and D.G. Long in Fl. Bhutan 2(1): 321. 1991; Chen et al. in Fl. China 13: 421. 2007. **Plate 23 F**

Perennial herb, ca. 10–25 cm tall with brown leathery scales of turions. ***Stem*** erect with 2 raised hairy lines of densely appressed pilose. ***Leaves*** simple, opposite; elliptic to ovate, ca. 1–3 cm by 0.3–1.3 cm; sub-sessile; margins serrate, ciliate; apex acute to obtuse; base rounded or truncate; upper surface sparsely pilose usually along the veins; lower surface ± glabrous; midrib distinct on both surfaces, pilose; lateral veins conspicuous on both surfaces, pilose. ***Inflorescence*** mostly terminal simple cyme, slightly nutant; flowers slightly nutant; pedicle ± 0.5 cm long, appressed pilose. ***Sepals*** 4, ca. 6 mm by 2.5 mm, lanceolate or narrowly triangular, pilose; margin entire, ciliate; apex acute. ***Petals*** 4, purple, ca. 8 mm by 6 mm, obovate to orbicular, numerously veined, glabrous; margin entire; apex emarginate or incised. ***Stamens*** 8, 4 tall and 4 short; taller stamens inserted on base of sepals, ca. 5 mm long; shorter stamens inserted on base of petals, ca. 3.5 mm long; filaments filiform, hairy; anthers hairy, dorsifixed. ***Ovary*** inferior, slender, pilose, ca. 2 cm long; styles slender, ca. 4 mm long; stigma clavate to subcapitate. ***Capsules*** up to 7 cm long.

Bhutan – Trashigang district

Distribution – China, India

Ecology – Found along the stream banks from 3,300 – 4,000 m asl. Flowering in June - August

Specimen Examined – K. Jamtsho 138 (THIM)

OROBANCHACEAE

54. Pedicularis siphonantha D.Don, Prodr. Fl. Nepal. 95. 1825; R.R. Mill in Fl. Bhutan 2(3): 1164. 2001; D.Y. Hong et al. in Fl. China 18: 207. 1998; Hook.f. in Fl. Brit. India 4: 313. 1897. **Plate 24 F**

Perennial herbs. ***Stem*** ± erect, a few to numerous, sparsely pilose. ***Leaves*** mostly basal, cauline leaves a few; oblanceolate to oblong in outline, ca. 1–5cm by 0.7–1.5 cm, pinnatisect; petioles up to 4cm long, pilose; lamina lobes oblong to ovate, margin serrate, mucronate; upper surface sparsely pilose; lower surface lepidote; midrib prominently raised on lower surface. ***Flower*** axillary, numerous on each stem; pedicels ca. 5 mm long, glabrous; bracts foliaceous. ***Calyx*** tubular; tube ± 5 mm long, cut to more than half on one side, pilose; lobes mostly 2, if 3 one lobe always smaller than other two, foliaceous, serrate, lepidote. ***Corolla*** narrowly cylindrical, crimson with whitish throat and base of lobes; tube erect, ± 4 cm long, pubescent; 2 lateral lobes obovate, ca. 0.6 cm by 1 cm, shallowly lobed, ciliate; upper lobe rolled into galea; galea strongly curved or falcate, puberulent; lip obcordate, ca. 0.7 cm by 0.7 cm, ciliate. ***Stamens*** 4, ca. 1 m long, inserted on throat; filament filiform; anthers shortly tailed, dorsifixed. ***Ovary*** ovoid, ca. 2 mm long, glabrous; style filiform, ca. 5.5 cm long, extending from base of corolla tube to tip of galea; stigma capitate.

Bhutan – Bumthang, Haa, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Found in the alpine slopes and moist ground of Fir-Rhododendron forests from 3,000 – 4,000 m asl. Flowering in July - September
Specimen Examined – K. Jamtsho 140 (THIM)

OXALIDACEAE

55. Oxalis leucolepis Diels, Notes Roy. Bot. Gard. Edinburgh 5: 223. 1912; D.G. Long in Fl. Bhutan 1(3): 742. 1987. – *Oxalis acetosella* subsp. *leucolepis* (Diels) C.C. Huang & L.R. Xu, Fl. Reipubl. Popularis Sin. 43(1): 9-10. 1998. **Plate 18 F**

Stemless herb with creeping underground rhizome. ***Leaves*** 3-foliate; petiole slender, ca. 6–16 cm long, sparsely pilose; leaflets obcordate, 0.5–1 cm by 0.5–1.3 cm; subsessile; margins entire; apex emarginate; base cuneate to obtuse; upper surface glabrous; lower surface whitish tomentulose to pilose; midrib distinct on both surfaces; lateral veins conspicuous on both surfaces, copiously divided. ***Flowers*** solitary, nutant; peduncle ca. 5–15 cm long, pilose with thick tomentose below flower; bracts 2, ovate, borne on upper half of the peduncle. ***Calyx*** cup shaped, green, 5-lobed; tube ca. 1.5 mm long, tomentose; lobes elliptic, ca. 5 mm by 2 mm, margin ciliate, apex haired. ***Corolla*** white with greenish yellow base, veined; tube ca. 1.5 mm long, 5 lobed; lobes oblong or oblanceolate, ca. 8 mm by 3.5 mm, margin entire, apex irregularly toothed. ***Stamens*** 10, 5 tall and 5 short; taller stamens ca. 3 mm long; shorter stamens ca. 2 mm long; filaments filiform, glabrous; anthers basifixed. ***Ovary*** ovoid, pubescent, ca. 1.5 mm long; styles 5, filiform, ca. 3 mm long; stigma slightly swollen.

Bhutan – Bumthang, Mongar, Punakha, Trashigang, Trongsa districts
Distribution – China, Nepal, Pakistan
Ecology – Found in the shady and moist slopes of Fir-Rhododendron forest and along the stream banks from 2,500 – 4,000 m asl. Flowering in June - August
Specimen Examined – K. Jamtsho 131 (THIM); G. Forrest 4287 (E: Online Herbarium Catalogue)

PAPAVARACEAE

56. Corydalis crispa Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 65(1): 30. 1896; Grierson and D.G. Long in Fl. Bhutan 1(2): 395. 1984; M.L. Zhang et al. in Fl. China 7: 341. 2008. **Plate 16 F**

Perennial herb, ca. 20–40 cm tall. ***Stem*** erect or slightly diffuse, much branched, ± glabrous, branchlets scabrous. ***Leaves*** numerous, biternatisect or bipinnatisect; petiole

± 5 mm long; leaflets obovate; sub-sessile; lateral leaflets ± 3 mm by 3 mm; terminal leaflets slightly larger than the later leaflets, ± 4 mm by 4 mm; apex obtuse or truncate to emarginate; base attenuate; upper surface punctate; lower surface densely pubescent; midrib and veins visible on lower surface. ***Inflorescence*** terminal or axillary raceme; 5–15 flowered; pedicels ± 8 mm long, slightly pubescent, rugose; bracts foliaceous, oblanceolate to obovate, equaling or half of the pedicles, usually 3-lobed. ***Sepals*** membranous, rounded, deeply lacerate or irregularly dentate. ***Petals*** yellow; upper petal ca. 1 cm long including spur with irregularly sinuous broad rounded crest; spur ca. 6 mm long, strongly curved upward; nectar gland ca. 3 mm long; lateral petals ca. 2.5 mm long, bluish, claw ca. 3 mm long; lower petal ca. 5 mm long, with irregularly sinuous crest. ***Stamens*** 6 in 2 bundles, ca. 4 mm long; filament filiform, connected by membranous wings into bundle of three; anthers slightly capitate. ***Ovary*** narrowly oblong, ca. 3.5 mm long, glabrous; style slender, ± 2 mm long, glabrous; stigma 3, fused to form obovate head.

Bhutan – Punakha, Thimphu, Trashigang districts
Distribution – China
Ecology – Found along the stream banks, moist forest margins, and grazed grounds from 3,300 – 4,500 m asl. Flowering in July - September
Specimen Examined – K. Jamtsho 137 (THIM)

57. Meconopsis paniculata Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 64: 316. 1896; D.G. Long in Fl. Bhutan 1(2): 406. 1984; M.L. Zhang et al. in Fl. China 7: 265. 2008. – *Meconopsis paniculata* var. *elata* Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 64:*316. 1896.* – *M. napaulensis* DC., Prodr. [A. P. de Candolle] 1: 121. 1824. – *M. wallichii* Hook., Bot. Mag. 78: t. 4668. 1852. – *Papaver paniculatum* D.Don, Prodr. Fl. Nepal. 197. 1825. – *Stylophorum nepalense* Spreng., Syst. Veg. (ed. 16) [Sprengel] 4(2, Cur. Post.): 203. 1827. – *S. paniculatum* G.Don, Gen. Hist. 1: 135. 1831. **Plate 16 E**

Monocarpic herb, ca. 0.5–1.5 m tall. ***Stem*** erect, usually single, barbellate pilose with numerous stellate hairs; ***Basal leaves*** elliptic, pinnatifid, ca. 20–30 cm by 4–10 cm; petiole ca. 10–20 cm long; margins with barbellate and stellate hairs; apex acute; base attenuate; upper and lower surfaces barbellate pilose with stellate hairs; midrib prominently raised beneath, stellate hairy; lateral veins conspicuous on lower surface, branched; cauline leaves similar to basal leaves but lower cauline leaves shortly petiolate and upper cauline leaves sessile. ***Flowers*** numerous, pendulous; pedicels ± 3 cm long, barbellate/stellate pubescent. ***Sepals*** 2, densely barbellate/ stellate hairy, caducous, non-persistent on flowering. ***Petals*** 4, yellow changing to blue when dried, orbicular to obovate, glabrous, ca. 3 cm by 2.5 cm. ***Stamens*** numerous, ca. 1 cm long; filament filiform, slightly winged, glabrous; anthers oblong, yellow-orange, ca. 3 mm long. ***Ovary*** sub-globose, densely barbellate hairy; style ± 5 mm long, glabrous; stigma usually more than 6-lobed.

Bhutan – Haa, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Found along the forest margins, grassy slopes and stream banks from 3,300 – 4,000 m asl. Flowering in June - August
Specimen Examined – K. Jamtsho 123 (THIM)

PLANTAGINACEAE

58. Hemiphragma heterophyllum Wall., Trans. Linn. Soc. London 13(2): 612. 1822; R.R. Mill in Fl. Bhutan 2(3): 1129. 2001; D.Y. Hong et al. in Fl. China 18: 56. 1998; Hook.f. in Fl. Brit. India 4: 289. 1897. **Plate 24 D**

Perennial herbs. ***Stem*** prostate or creeping, sparsely pubescent, exfoliating. ***Leaves*** dimorphic; summer leaves orbicular, ± 1 cm by 0.9 cm, persistent during winter; subsessile; margin serrate; apex obtuse; base cuneate; upper surface pubescent; lower surface puberulent, lepidote; midrib slightly visible on lower surface; lateral veins inconspicuous, copiously divided; winter leaves linear, involute into needle-like

fascicles, ± 6 mm long, hairy, sessile. ***Flower*** borne on axillary branchlets, solitary; pedicel ± 4 mm long, pilose. ***Calyx*** deeply 5-lobed to base; tube inconspicuous; lobes ca. 4 mm long, involute into needle-like, villous. ***Corolla*** tubular-campanulate, purplish; tube ca. 3 mm long, glabrous; lobes 5, ovate, ca. 3 mm by 2 mm, apex acute to obtuse, sometimes shallowly lobed. ***Stamens*** 4, ca. 2.5 mm long, inserted on base of corolla tube; filament filiform, ± glabrous; anthers fused at apex, dorsifixed. ***Ovary*** globose, ca. 1 mm long, glabrous; style slender, ca. 1.5 mm long, glabrous; stigma reduced.

Bhutan – Bumthang, Mongar, Samdrupjongkhar, Thimphu, Trashigang, Trongsa districts. Expected to occur throughout Bhutan

Distribution – China, India, Nepal

Ecology – Found in along the margins and open grounds of temperate forests and alpine slopes from 2,000 – 4,400 m asl. Flowering in Febraury - June

Specimen Examined – K. Jamtsho 73 (THIM)

POLYGONACEAE

59. Aconogonon campanulatum (Hook.f.) Hara, Fl. E. Himalaya [H. Hara] 67 (1966). Grierson and D.G. Long in Fl. Bhutan 1(1): 154. 1983. – *Persicaria campanulata* (Hook.f.) Ronse Decr., Bot. J. Linn. Soc. 98: 367. 1988. – *Aconogonon campanulatum* var. *oblongum* (Meisn.) H.Hara, Enum. Fl. Pl. Nepal 3: 172.1982.– *Polygonum campanulatum* Hook.f., Fl. Brit. India 5: 51.1886.– *Reynoutria campanulata* (Hook.f.) Moldenke, Bull. Torrey Bot. Club 68: 675.1941. **Plate 11 F**

Herb or subshrub, ca. 30 cm tall. **Stem** prostate, sub-erect or decumbent with fibrous roots on the nodes, villous. ***Leaves*** simple; elliptic to lanceolate, 2.5–6.5 cm by 1–2.5 cm; petiole ca. ±1cm, pilose; margin entire, ciliate; apex acute; base rounded to obtuse or cuneate to attenuate; upper surface white adpressed pilose; lower surface with brownish tomentum; midrib prominent on both sides; lateral veins pinnate, conspicuous, ±10- paired. ***Ocrea*** clasping, green, ±1 cm long, pilose, apex lacerate.

Inflorescence terminal or axillary branched panicle; peduncles up to 1 cm long, pilose; flowers numerous; bracts ovate, 2–3 per flower, margin ciliate, membranous; pedicel ca. 2 mm long. ***Tepals*** campanulate, white or purple, 5-lobed; lobes broadly oblong, ca. 2 by 1.5 mm. ***Stamens*** 8, ca.3 mm long; filament filiform, glabrous; anthers whitish, dorsifixed. ***Ovary*** trigonous, ca. 3 mm long; styles 3; stigmas capitate or globose.

Bhutan – Bumthang, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found in the damp fir forests from 3,500 – 4,000 m asl. Flowering in July - August
Specimen Examined – K. Jamtsho 143 (THIM)

60. Bistorta griffithii (Hook.f.) Grierson, Notes Roy. Bot. Gard. Edinburgh 40(1): 128. 1982; Grierson and D.G. Long in Fl. Bhutan 1(1): 168.1983. – *Polygonum griffithii* Hook.f., Fl. Brit. India [J. D. Hooker] 5: 54. 1886; A.J. Li et al in Fl. China 5: 299. 2003. **Plate 11 B**

Herbs, 5–30 cm tall. **Stem** erect, reddish brown with thick root stock, glabrous. ***Leaves*** simple, alternate; basal leaves ovate to broadly lanceolate; 5−15 cm by 3−7 cm; petioles ±10 cm long, base winged; upper leaves lanceolate, much smaller than basal leaves, sessile; margin entire, reflexed or revolute; apex acute to obtuse; base rounded or slightly cordate; upper surface glabrous; lower surface brown tomentulose; midrib prominent on both surfaces; lateral veins numerous, visible on both surfaces. ***Ocrea*** reddish brown, ca. 1−5 cm long, lepidote or glabrous, entire. ***Inflorescence*** mostly terminal raceme, axillary sometimes, nutant; peduncles ± 3 cm long, glabrous; flowers numerous; pedicel ca. 5 mm long, glabrous; bracts brownish, ovate, apex acute. ***Tepals*** 5-lobed; lobes pink; elliptic to oblanceolate, shorter than styles, ca. 5 mm long, apex acute or obtuse-rounded. ***Stamens*** 8, ca. 1.5 mm long; filaments slender to conical, tip constricted, glabrous; anthers dorsifixed. ***Ovary*** superior, triquetrous, ca. 1.5 mm long, pubescent; styles 3, ca. 4 mm long, glabrous; stigmas capitate.

Bhutan – Bumthang, Mongar, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, North Myanmar
Ecology – Found along the margins rhododendron scrub forest and rock crevices of alpine slopes from 4,000 – 4,300 m asl. Flowering in July - August
Specimen Examined – K. Jamtsho 110 (THIM)

61. Bistorta macrophylla (D.Don) Soják, Preslia 46(2): 152 (1974); Grierson and D.G. Long in Fl. Bhutan 1(1): 168.1983. – *Polygonum macrophyllum* D.Don, Prodr. Fl. Nepal. 70. 1825; Hook.f. in Fl. Brit. India 5: 32. 1884. – *P. macrophyllum* D. Don var. *macrophyllum,* A.J. Li et al in Fl. China 5: 298. 2003. **Plate 11 D**

Herbs, 5–15 cm or taller. **Stem** erect, slender with stout underground rhizome, glabrous. ***Basal leaves*** lanceolate or narrowly oblong; 1.5−5 cm by 0.5−1.5 cm; petioles ±7 cm long, glabrous; cauline leaves linear or lanceolate, much smaller than basal leaves, sessile; margin strongly reflexed or enrolled; apex acute; base cuneate or slightly rounded/cordate; upper surface glabrous, coriaceous, sometimes punctate; lower surface strigulose; midrib prominent, much raised on lower surface, glabrous; lateral veins slightly visible on both sides, copiously netted. ***Ocrea*** membranous, brownish, ± 2 cm long, sparsely strigulose, entire. ***Inflorescence*** terminal raceme, elongated; peduncles ± 1.5 cm long, ±glabrous; flowers numerous; pedicel ca. 2 mm long, glabrous, jointed to perianth; bracts pale brown, membranous, broadly elliptic or ovate, apex lacerate. ***Tepals*** 5-lobed; lobes pink; obovate or oblance-ovate, ca. 2.5 mm long, apex rounded. ***Stamens*** 8, ca. 1−1.5 mm long; filaments slender, tip constricted, base pubescent; anthers biparted, basifixed. ***Ovary*** superior, triquetrous, ± 1 mm long, glabrous; styles 2−3, ca. 3 mm long, glabrous; stigmas capitate.

Bhutan – Bumthang, Haa, Thimphu, Trashigang districts
Distribution – China, India, Nepal
Ecology – Found along the stream banks and open patches of Fir forests from 3,000 – 3,500 m asl. Flowering in May - August

Specimen Examined – K. Jamtsho 61 (THIM); Pendry, C.A., JRS A119; M. Mikage & K. Yunekura, 9552450 (E: Online Herbarium Catalogue)

62. Bistorta vacciniifolia Greene, Leafl. Bot. Observ. Crit. i. 21.; Grierson and D.G. Long in Fl. Bhutan 1(1): 167.1983. − *Polygonum vacciniifolium* Wall. ex Meisn., Pl. Asiat. Rar. 3: 54. 1832; Hook.f. in Fl. Brit. India 5:33.1886; A.J. Li et al in Fl. China 5: 299. 2003. **Plate 11 A**

Prostate or shrubby, 5–10 cm tall. **Stem** prostate, branchlets erect or sub-erect, brownish; bark ±glabrous, exfoliating in longer flakes. ***Leaves*** simple, alternate; narrowly-elliptic to elliptic; 0.5–2 cm by 0.5–1 cm; sub-sessile; margin entire, slightly reflexed; apex acute to obtuse or sub-rounded; base cuneate to obtuse; upper surface glabrous; lower surface glabrous; midrib prominent on both sides, slightly impressed on upper surface; veins inconspicuously spread with blade. ***Ocrea*** yellowish brown, ca. 1 cm long, glabrous, lacerate. ***Inflorescence*** terminal raceme; peduncles ±8 mm long, ±pilose; flowers numerous; pedicel ca. 3mm long, glabrous, bracteate. ***Tepals*** 5-lobed; lobes pinkish; mostly elliptic, ca. 5 mm long, apex obtuse or rounded. ***Stamens*** 8, ca. 5 mm long; filaments slender, tip constricted, inserted to tepals, glabrous; anthers dorsifixed. ***Ovary*** superior, triquetrous, ±1 mm long, sparsely pubescent or glabrous; styles 3, ca. 3 mm long; stigmas swollen, globose.

Bhutan – Bumthang, Ha, Mongar, Thimphu, Trashigang districts
Distribution – China, India, Nepal, Pakistan
Ecology – Found in the thickets of rhododendron and rock crevices of alpine slopes from 3,500 – 4,400 m asl. Flowering in August - September
Specimen Examined – K. Jamtsho 158 (THIM); A.J.C. Grierson & D.G. Long, 19616 (E: Online Herbarium Catalogue)

63. Bistorta sp. Plate 11 C

Herbs, 5–13 cm tall. **Stem** erect, brownish, scabrous. ***Leaves*** simple, alternate; leaves linear or narrowly lanceolate; 4–11 cm by 0.1–0.3 cm; sub-sessile; margin strongly revolute, sinuate or undulate; apex acute; base cuneate; upper surface glabrous; lower surface slightly tomentulose or glabrous; midrib prominent on both surfaces; lateral veins inconspicuous. ***Ocrea*** reddish brown or pinkish, up to ca. 4 cm long, ± pubescent. ***Inflorescence*** terminal raceme; peduncles up to 3 cm long, glabrous; flowers numerous; pedicel ca. 1−4 mm long, glabrous, jointed to perianth; bracts ovate, apex cuspidate. ***Tepals*** 5-lobed; lobes pinkish; elliptic to ovate, shorter than styles and anthers, ca. 4 mm long, apex rounded. ***Stamens*** 8, ca. 3.5 mm long, fertile stamens a few and shorter; filaments slender, slightly constricted towards tip, pubescent; anthers dorsifixed. ***Ovary*** superior, triquetrous, ca. 2 mm long, glabrous; styles 3, ca. 4 mm long, pubescent; stigmas capitate.

Bhutan – Trashigang

Distribution

Ecology – Found in alpine meadows from 4,300 – 4,500 m asl. Flowering in July - August

Specimen Examined – K. Jamtsho 186 (THIM)

64. Persicaria nepalensis (Meisn.) Miyabe, J. Fac. Agric. Hokkaido Imp. Univ. 26: 514 1934; Grierson and D.G. Long in Fl. Bhutan 1(1): 164. 1983.− *Polygonum nepalense* Meisn., Monog. Polyg. 84, pl. 7, f. 2. 1826; Hook.f. in Fl. Brit. India 5: 41. 1886. **Plate 12 A**

Herbs, 5–30 cm tall. **Stem** erect, base prostate, green with brown tinged near nodes, glabrous. ***Leaves*** simple; ovate, 1−3.5 cm by 0.5−2 cm, sessile or petiolate; petiole ca. 1cm, winged with base auriculate or semi-amplexicual; margin ciliate or praemorse; apex acute; base rounded or slightly truncate; upper surface punctate, strigose usually along midrib; lower surface with glandular scales, strigulose along midrib and veins;

midrib prominent on both sides; lateral veins distinct on both sides, up to 15-pairs. ***Ocrea*** clasping, membranous, brown, up to 1 cm long, pubescent at base, apex truncate. ***Inflorescence*** terminal or axillary corymbose head subtended by involucral leaf; peduncles usually up to 2 cm long, glandular hairy towards apex; flowers numerous, bracteate; bracts ovate-elliptic, glabrous, margin membranous; pedicel ca. 0.5 mm long. ***Tepals*** 4-lobed; lobes pinkish; broadly ovate, ca. 1.5 mm long. ***Stamens*** 5 or 6, ca. 0.5−1.5 mm long; filament filiform, ca. 1.4 mm long, glabrous; anthers black-purple, basifixed. ***Ovary*** inferior, biconvex, ca. 2 mm long; styles 2; stigmas capitate.

Bhutan – Bumthang, Chukha, Mongar, Punakha, Thimphu, Trashigang districts (possible in all 20 districts)
Distribution – Afghanistan, China, India, Myanmar, Nepal, Pakistan
Ecology – Found along the margin and open patches of temperate forests and subalpine community from 750 – 3,500 m asl. Flowering in June - August
Specimen Examined – K. Jamtsho 139 (THIM)

65. Rheum acuminatum Hook.f. & Thomson, Bot. Mag. 81: t. 4877. 1855; Grierson and D.G. Long in Fl. Bhutan 1(1): 172.1983; Hook.f. in Fl. Brit. India 5:57.1884; A.J. Li et al in Fl. China 5: 227. 2003. − *Rheum orientalixizangense* Y.K. Yang, J.K. Wu & Gasang., Acta Bot. Boreal.-Occid. Sin. 12(4): 313 313 1992. **Plate 11 E**
Herbs, 0.5–1.5 m tall. **Stem** erect, purple-red, fistulous, glabrous. ***Basal leaves*** 1−3. ***Mid cauline*** leaves simple, alternate, broadly ovate to cordate, 10−15 cm by 6−15 cm. ***Upper cauline*** leaves smaller; petiole purple-red, slight shorter than or as long as leaf blade, pilose near blade; margin entire; apex acuminate; base cordate; upper surface glabrous; lower surface sparsely pubescent, muricate or scabrous along the veins; midrib prominent on both sides; veins usually 4−5. ***Ocrea*** clasping, brown, ca. 4.5 cm long, glabrous or muricate, scabrous when dry. ***Inflorescence*** terminal and axillary panicle; peduncles usually >3 cm long, scabrous or strigulose; flowers small and fascicled, numerous; pedicel ca. 3mm long, scabrous. ***Tepals*** 6-lobed; lobes purple-red; outer 3 lobes smaller, broadly elliptic, ca. 1.8mm long; inner 3 lobes larger,

orbicular or broadly ovate, 2−2.5 mm long. ***Stamens*** numerous, shorter than perianth; filament slightly swollen, ca. 2 mm long, adnate to tepals, glabrous; anthers blackish, peltate, basifixed. ***Ovary*** superior, triquetrous; styles 3, very short; stigmas large, peltate.

Bhutan – Bumthang, Mongar, Punakha, Thimphu, Trashigang districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found along the margin and open patches of rhododendron scrub forests from 3,500 – 4,100 m asl. Flowering in July - August
Specimen Examined – K. Jamtsho 167 (THIM); F. Ludlow, G. Sherriff & J.H. Hicks, 19386 (E: Online Herbarium Catalogue).

66. Rumex nepalensis Spreng., Syst. Veg. 2: 159. 1825; Grierson and D.G. Long in Fl. Bhutan 1(1): 173. 1983; A.J. Li et al in Fl. China 5: 339. 2003; Hook.f. in Fl. Brit. India 5: 60. 1884. – *Rumex bequaertii* De Wild., Pl. Bequaert. 5: 2. 1929. – *R. bequaertii* var. *quarrei* (De Wild.) Robyns, Fl. Spermat. Parc Natl. Albert 1: 117. 1948. – *R. camptodon* Rech. f., Beih. Bot. Centralbl. 49: 76. 1932. – *R. peregrinus* Boiss., Diagn. Pl. Orient., ser. 1 1(5): 46. 1844. – *R. quarrei* De Wild., Pl. Bequaert. 5: 3. 1929. **Plate 10 F**

Perennial herbs, 0.4–1 m tall. **Stem** erect, branched, fistulous, glabrous. ***Leaves*** basal leaves ovate to oblong, ca. 10–15 cm by 4–8 cm; cauline leaves reducing in size towards apex, ovate to lanceolate, 2–10 cm by 1–8 cm; petiole of basal leaves up to 10 cm long, ca. 2.5 cm long for cauline leaves; margin partially dentate throughout; apex acute; base rounded or slightly cordate; upper surface glabrous or ± lepidote; lower surface glabrous or ± lepidote; midrib prominent on both sides; veins visible on both sides, anastomosing. ***Ocrea*** membranous, fugaceous, brown and glabrous when dry. ***Inflorescence*** terminal and axillary verticil; flowers in fascicles, numerous; pedicel ca. 1 mm long, glabrous with node near base. ***Tepals*** 6-lobed; outer 3 lobes smaller, oblong, ca. 2mm by 1 mm, glabrous, margin entire, apex rounded; inner 3 lobes larger, oblong or elliptic, 4 mm by 2 mm, margin teethed usually on the lower

half, teeth hooked at apex, apex obtuse or rounded. ***Stamens*** 6, very short, ± 1 mm; filament slender, adnate to each side of inner tepals, glabrous; anthers basifixed. ***Ovary*** superior, trigonous, ca. 2.5 mm by 1.5 mm, glabrous; styles 3, reclinate; stigmas branching and spreading.

Bhutan – Chukha, Mongar, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Myanmar, Nepal, Pakistan
Ecology – Found along the mountain slopes, grazed grounds, marshy places from 1,000 – 4,000 m asl. Flowering in June - August
Specimen Examined – K. Jamtsho 128 (THIM)

PRIMULACEAE

67. Primula capitata Hook., Bot. Mag. 76: t. 4550. 1850; Grierson and D.G. Long in Fl. Bhutan 2(2): 550. 1999; Q. Hu and S. Kelso in Fl. China 15: 180. 1996; Hook.f. in Fl. Brit. India 3:486. 1882. **Plate 14 D**

Perennial herbs, 5–20 cm tall including peduncle with fibrous rootstock covered with remains of old leaves. ***Leaves*** rosette, basal; oblanceolate to spatulate; ca. 4–7 cm by 1–1.5 cm; sessile; margins irregularly dentate or doubly seriate; apex acute to obtuse; base narrowed; upper surface brownish farinose; lower surface glandular puberulent; midrib prominently rose below and slightly impressed above; lateral veins conspicuous on both sides, copiously divided. ***Inflorescence*** umbellate or capitate, flowers numerous; peduncle single, ± 20 cm long, puberulent or farinose, old peduncle persistent on flowering; bracteoles lanceolate to triangular, puberulent or farinose, ca. 4 mm long, margin hairy; pedicels 0.5 mm long, glandular puberulent. ***Calyx*** cup-shaped, deeply 5-lobed; lobes triangular or ovate, puberulent, sometimes tinged red; margins hairy. ***Corolla*** tubular, blue, glandular puberulent; corolla tube ca. 5 mm long with yellowish mouth, 5-lobed; lobes oblong; apex emarginate, bifid. ***Stamen*** ca. 5 mm long; filament strap-shaped, adnate to corolla tube; anthers ca. 1

mm long, basifixed. ***Ovary*** globose, glabrous, ca. 1mm long; style slender, glabrous, ca. 2 mm long; stigma capitate.

Bhutan – Bumthang, Thimphu, Trashigang, Trongsa district
Distribution – China, India
Ecology – Found along the alpine slopes and rhododendron scrub forest from 3,500 – 4,500 m asl. Flowering in July - August
Specimen Examined – K. Jamtsho 163 (THIM)

68. Primula deuteronana Craib, Notes Roy. Bot. Gard. Edinburgh 6: 251. 1917; Grierson and D.G. Long in Fl. Bhutan 2(2): 528. 1999. **Plate 15 B**

Perennial herbs, 1–3 cm tall including short peduncle, rootstock with persistent bud scales during flowering. ***Leaves*** basal forming rosette; obovate to elliptic; ca. 1.5–3 cm by 0.5–1 cm; sessile; margins irregularly dentate; apex obtuse or rounded; base attenuate; upper surface farinose and sparsely punctate; lower surface farinose, glandular hairy, rugose; midrib prominent on both surfaces; lateral veins conspicuous. ***Inflorescence*** umbellate, 2–6-flowered; peduncle very short hidden in leaves, ca. 5 mm long, sparsely glandular hairy; bracteoles lanceolate, glandular hairy, up to 8 mm long, margin glandular hairy; pedicels ca. 1–1.5 mm long, glandular hairy. ***Calyx*** tubular-campanulate, 5-lobed; lobes triangular, glandular hairy; margins glandular hairy. ***Corolla*** tubular-campanulate, purple; corolla tube ca. 1.2 cm long, throat greenish yellow with outer grey, 5-lobed; lobes obovate to orbicular; apex irregularly toothed. ***Stamen*** ca. 2.2 mm long; filament very short, adnate to corolla tube; anthers ca. 2 mm long, basifixed. ***Ovary*** globose, glabrous, ca. 1.5 mm long; style slender with membranous covering , ca. 5 mm long; stigma capitate.

Bhutan – Bumthang, Haa, Mongar, Thimphu, Trashigang, Trongsa districts
Distribution – India
Ecology – Found along the margins of Fir-Rhododendron forest from 2,500 – 3,800 m asl. Flowering in March - June

Specimen Examined – K. Jamtsho 74 (THIM)

Note: *Primula deuteronana* Craib is an unresolved name. It is very similar to *P. gracilipes* Craib, however, differs by

- ✓ having a few (2–6) flowers per plant.
- ✓ lacking yellow farinose on plant body.
- ✓ persistent bud scales during flowering.
- ✓ short developed peduncle hidden in the rosette of leaves.

69. Primula dickieana Watt, J. Linn. Soc., Bot. 20: 9. 1882; Grierson and D.G. Long in Fl. Bhutan 2(2): 538. 1999; Hook.f. in Fl. Brit. India 3:491. 1882. – *Primula dickieana* var. *chlorops* W.W. Sm. & Forrest, Notes Roy. Bot. Gard. Edinburgh 14(68): 39.1923. – *P. dickieana* var. *gouldii* H.R. Fletcher, J. Linn. Soc., Bot. 52(344): 338-339. 1942. **Plate 14 B**

Perennial herbs, 3–10 cm tall including peduncle, roots slender with blackish linear or lanceolate bud scales. ***Leaves*** rosette basal; oblanceolate to spatulate; 3–5 cm by 0.3–0.7 cm; sessile; margins entire or partly dentate; apex acute; base narrowed; upper surface numerously dark lepidote; lower surface lepidote with scattered glandular pits; midrib visible on both sides; lateral veins inconspicuous. ***Inflorescence*** umbellate, 1–5 (–6)-flowered; flowers slightly nutant; peduncle usually single, ± 10 cm long, sparsely tomentose; bracteoles narrowly triangular, ca.6 mm long, margin entire, membranous; pedicels 0.3–1.2 cm long, tomentose. ***Calyx*** campanulate, 5-lobed; lobes triangular, sparsely tomentose; margins entire, membranous. ***Corolla*** campanulate, yellow; corolla tube ca. 5 mm long, hairy at mouth, 5-lobed; lobes obovate; apex emarginate, bilobed or sometimes irregularly lobed in thrum flowers. ***Stamen*** ca. 5 mm long, adnate to corolla; filament filiform, short, glabrous; anthers ca. 1 mm long, basifixed. ***Ovary*** sub-globose, glabrous, ca. 1mm long; style slender, glabrous, 6 mm long; stigma capitate.

Bhutan – Mongar, Trashigang districts

Distribution – China, India, Myanmar, Nepal

Ecology – Found in the marshy slopes of alpine community from 3,500 – 4,300 m asl. Flowering in June - July

Specimen Examined – K. Jamtsho 100 (THIM)

70. Primula gambeliana Watt, J. Linn. Soc., Bot. 20: 3. 1882; Grierson and D.G. Long in Fl. Bhutan 2(2): 536–537. 1999; Q. Hu and S. Kelso in Fl. China 15: 162. 1996; Hook.f. in Fl. Brit. India 3:483. 1882. **Plate 14 E**

Perennial herbs up to 20 cm tall including peduncle, rootstock fibrous with yellow farinose bud scales. ***Leaves*** rosette, basal; ovate or elliptic; ca. 0.5–1.5 cm by 0.5–1.4 cm; petiole ± 5 cm, glabrous, base slightly winged; margins crenate; apex obtuse or slightly rounded; base mostly cordate, sometimes truncate; upper surface ± glabrous; lower surface farinose; midrib conspicuous on both surfaces; lateral veins slightly visible on both sides, rugose. ***Inflorescence*** umbellate, usually 2–5 flowers per umbel; peduncle single, ± 20 cm long, slightly farinose just below the umbel, old peduncle sometimes persistent on flowering; bracteoles lanceolate, puberulent, ca. 5 mm long, margin hairy towards apex; pedicels 5 mm long, puberulent. ***Calyx*** cup-shaped, deeply 5-lobed; lobes narrowly triangular, puberulent; margins hairy. ***Corolla*** tubular-campanulate, purple; corolla tube ± 1.5 cm long, 5-lobed; lobes oblong; apex irregularly dentate. ***Stamen*** ca. 2.2 mm long; filament very short, adnate to corolla tube; anthers ca. 2 mm long, basifixed. ***Ovary*** globose, glabrous, ca. 2 mm long; style slender, glabrous, ca. 4 mm long; stigma capitate.

Bhutan – Trashigang district

Distribution – China, India, Nepal

Ecology – Found in the crevices of rocks and alpine slopes from 3,500 – 4,000 m asl. Flowering in June - July

Specimen Examined – K. Jamtsho 98 (THIM)

71. Primula glabra Klatt, Linnaea 37: 500. 1872; Grierson and D.G. Long in Fl. Bhutan 2(2): 544. 1999; Q. Hu and S. Kelso in Fl. China 15: 162. 1996; Hook.f. in Fl. Brit. India 3:487. 1882. **Plate 15 A**

Perennial herbs, 2–5 cm tall including peduncle, rootstock covered with remains of few old leaves. ***Leaves*** basal forming rosette; outer leaves obovate, inner leaves oblanceolate to spatulate; ca. 0.5–1.5 cm by 0.3–0.5 cm; sessile; margins irregularly dentate on the upper half portion; apex acute to obtuse; base cuneate or attenuate; upper surface farinose usually along the veins; lower surface sparsely scabrous; midrib prominently raised beneath, rugose; lateral veins inconspicuous, pinnate. ***Inflorescence*** umbellate, many flowered; peduncle ca. 5 cm long, glabrous or sometimes scabrous; bracteoles ovate, punctate with slightly gibbous at base, ca. 1.5 mm long, margin entire; pedicels up to 1.5 mm long, ± glabrous. ***Calyx*** campanulate, 5-lobed; lobes oblong to obovate, farinose; margins entire with shallowly toothed apex. ***Corolla*** tubular-campanulate, blue; corolla tube ca. 3 mm long, throat yellowish, 5-lobed; lobes obovate; apex mostly bilobed. ***Stamen*** ca. 1.5 mm long; filament very short, adnate to corolla tube; anthers ca. 1 mm long, basifixed. ***Ovary*** globose or obovoid, glabrous, ca. 1 mm long; style slender, glabrous, ca. 2 mm long; stigma swollen.

Bhutan – Bumthang, Haa, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found along the margins of Fir-Rhododendron forest and mountains slopes from 3,500 – 4,500 m asl. Flowering in May - August
Specimen Examined – K. Jamtsho 71 (THIM)

72. Primula Primulina (Spreng.) Hara, J. Jap. Bot. xxxvii. 99 (1962); Grierson and D.G. Long in Fl. Bhutan 2(2): 545–546. 1999; Q. Hu and S. Kelso in Fl. China 15: 175. 1996. – *Androsace primulina* Spreng., Syst. Veg. (ed. 16) [Sprengel] 4(2, Cur. Post.): 56. 1827. – *Primula pusilla* Wall., Roxb. Fl. Ind., ed. Carey & Wall. ii. 22

(1824); Hook.f. in Fl. Brit. India 3:492. 1882. – *P. pusilla* var. *flabellata* W.W. Sm., Notes Roy. Bot. Gard. Edinburgh 19(93): 173. 1936. **Plate 14 F**

Perennial herbs ca. 7 cm tall including peduncle, rootstock covered with remains of old leaves. ***Leaves*** basal; obovate or spatulate; ca. 1–5 mm by 3–5 mm; petiole ± 5 mm, scabrous, base narrowly winged; margins pinnatifid or deeply toothed, ciliate; apex obtuse or rounded; base cuneate or attenuate; upper surface scabrous; lower surface glandular puberulent; midrib prominently raised beneath, scabrous; lateral veins inconspicuous, pinnate. ***Inflorescence*** umbellate, 2–4-flowered; peduncle up to 7 cm long, puberulent; bracteoles ovate, puberulent or pubescent, ca. 4 mm long, margin hairy, sometimes lobed; pedicels up to 1mm long, glandular puberulent. ***Calyx*** cup-shaped, deeply 5-lobed; lobes oblong or triangular, glandular hairy. ***Corolla*** tubular-campanulate, blue; corolla tube up to 6 mm long, throat obscured by dense white wooly hairs, 5-lobed; lobes obovate; apex mostly bilobed or sometimes with lobules. ***Stamen*** ca. 1 mm long; filament very short, adnate to corolla tube; anthers ca. 9 mm long, basifixed. ***Ovary*** globose or obovoid, glabrous, ca. 1 mm long; style slender, glabrous, ca. 7 mm long; stigma capitate.

Bhutan – Bumthang, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Found along the margins of Rhododendron scrub forest and alpine slopes from 4,000 – 4,500 m asl. Flowering in July - August
Specimen Examined – K. Jamtsho 164 (THIM)

73. Primula sp. Plate 14 C

Herbs, 4–15 cm tall including peduncle with fibrous rootstock. ***Leaves*** rosette, basal; obovate to spatulate; 3.5–6.5 cm by 1–1.3 cm; sessile; margins irregularly dentate or seriate; apex acute; base narrowed; upper surface farinose; lower surface farinose; midrib visible on both sides; lateral veins slightly visible on both sides, copiously divided. ***Inflorescence*** umbellate, 3–10-flowered per umbel; peduncle single, ca. 15

cm long, puberulent; bracteoles cup-shaped with triangular lobes; lobes ± pubescent or farinose, ca.2–3 mm long, margin glandular hairy, membranous; pedicels up to 1.5 cm long, glandular hairy or puberulent. ***Calyx*** broadly campanulate, deeply 5-lobed; lobes triangular or ovate, densely puberulent or glandular hairy; margins glandular hairy. ***Corolla*** tubular-campanulate, yellow; corolla tube ± 1 cm long with bright yellow mouth, 5-lobed; lobes widely elliptic or orbicular; apex rounded or very slightly emarginate. ***Stamen*** ca. 2 mm long, adnate to corolla; filament very short, ⅛ of length of anthers; anthers ca. 1.8 mm long, basifixed. ***Ovary*** hemispherical, ± glabrous, ca. 1mm long; style slender, narrowly tapering towards tip, glabrous or farinose, ca. 8 mm long; stigma capitate.

Bhutan – Trashigang district

Distribution

Ecology – Found along the alpine slopes from 3,500 – 4,500 m asl. Flowering in May - July

Specimen Examined – K. Jamtsho 93 (THIM)

RANUNCULACEAE

74. Anemone rupestris Wall. ex Hook.f. & Thomson**,** Fl. Ind. 1: 21 1855; Grierson in Fl. Bhutan 2 (2): 294.1984; Fl. Wencai et al. in China 6: 323. 2001. – *Anemone bhutanica* Tamura, Acta Phytotax. Geobot. 19: 75. 1962. – *A. obtusiloba* var. *lobata* Brühl, Ann. Roy. Bot. Gard. (Calcutta) 5: 78. 1896. – *A. obtusiloba* subsp. *Saxicola* Brühl , Ann. Roy. Bot. Gard. (Calcutta) 5(2): 78. 1896. – *A. rupestris* var. *wallichii* Brühl, Ann. Roy. Bot. Gard. (Calcutta) 5(2): 90. 1896. – *A. rupestris* var. *wallichii* (Brühl) Lauener*,* Notes Roy. Bot. Gard. Edinburgh 23(2): 200. 1960. – *A. saxicola* (Brühl) Tamura & Kitam.*,* Fl. Nep. Him. 125. 1955. **Plate 13 A**

Herb with slender rootstock surrounded by leaf remains. ***Leaves*** basal, caespitose, trifoliate; leaflets obovate or orbicular in outline; 4–6 mm by 3 –5 mm; petiole up to 2 cm long; petiolule 2–3 mm long; margin deeply toothed; apex obtuse to rounded in

outline; base slightly cordate or truncate; upper surface adpressed pilose; lower surface ± glabrous; midrib slightly visible on lower surface; laterals veins inconspicuous. ***Inflorescence*** mostly solitary or few flowered on scapes; scapes up to 7 cm long, pubescent; bracts foliose, 3, ovate, sometimes toothed at apex. ***Calyx*** showy, white or blue, 6-lobed usually with 3 small and 3 large; lobes obovate or oblanceolate, ca. 5 mm by 3 cm, glabrous; margin entire; apex rounded. ***Corolla*** absent. ***Stamens*** 8–12, ca. 3 mm long; filament strap-shaped, glabrous; anthers ca.1 mm long, glabrous, basifixed. ***Ovary*** flat turbinate, glabrous, ca. 2 mm long; style ca. 1 mm long; stigma reduced.

Bhutan – Bumthang, Haa, Mongar, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Along stream banks and mountain slopes from 3,000 – 4,000 m asl. Flowering in May - August
Specimen Examined – K. Jamtsho 77 (THIM); Sara Hoot, 4696, (E: Online Herbarium Catalogue)

75. Caltha palustris L., Sp. Pl. 1: 558. 1753; Grierson in Fl. Bhutan 1(2): 305.1984; Hook.f. in Fl. Brit. India 2:21.1879.− *Caltha alpestris* Schott, Nyman & Kotschy, Analect. Bot. 33. 1854.− *C. alpina* Schur, Enum. Pl. Transsilv. 25. 1866.− *C. arctica* R.Br., Chlor. Melvill. 7. 1823 Journ. Voy. Discovery north-west passage. − *C. asarifolia* DC., Syst. Nat. [Candolle] 1: 309. 1817.− *C. caespitosa* Schipcz., Not. Syst. Herb. Hort. Petrop. ii. 165 (1921). − *C. confinis* Greene, Pittonia 4: 76. 1899. – *C. cornuta* Schott, Nyman & Kotschy, Analect. Bot. 31. 1854. − *C. coronata* Schur, Enum. Pl. Transsilv. 25. 186.− *C. crenata* Belyaeva & Sipliv., Bot. Zhurn. (Moscow & Leningrad) 60(6): 819. 1975. **Plate 13 B**

Herb, ca. 3−20 cm tall. ***Stem*** erect, green, glabrous with fibrous rootstock. ***Leaves*** mostly basal caespitose with few cauline leaves, reniform or deltate; 1.5−2.5 cm by 2−3 cm; petiole up to 10 cm long, cauline leaf petiole much shorter, glabrous; margin dentate; apex obtuse to rounded; base cordate or sagittate; upper surface numerously

punctate; lower surface glabrous; midrib and laterals veins prominent on both surfaces, copiously netted. ***Inflorescence*** monochasium or simple-cyme, mostly 1–2-flowered; pedicel up to 4 cm long, sparsely pubescent. ***Calyx*** showy, yellow, 5-lobed; lobes free, ovate to oblong, ca. 1.5 cm by 1 cm, numerously veined, glabrous; margin entire; apex orbicular or rounded. ***Corolla*** absent. ***Stamens*** numerous, ca. 5 mm long; filament slender, glabrous; anthers ca.1.5 mm long, glabrous, basifixed. ***Ovary*** flattened turbinate, glabrous, ca. 4 mm long; style very short, ca. 0.5 mm long; stigma dark, globose.

Bhutan – Bumthang, Mongar, Thimphu, Trashigang, Trongsa districts
Distribution – China, India
Ecology – Grassy slopes and valleys from 3,000 – 3,500 m asl. Flowering in June - August
Specimen Examined – K. Jamtsho 119 (THIM); F. Ludlow and G. Sherriff, 3171 (E: Online Herbarium Catalogue)

76. Clematis montana Buch.-Ham. ex DC., Syst. Nat. 1: 164 1817; Grierson in Fl. Bhutan 1(2): 286.1984; Hook.f. in Fl. Brit. India 1:2.1875. − *Anemone curta* Wall., Numer. List [Wallich] n. 4690. 1831. − *Clematis anemoniflora* D.Don, Prodr. Fl. Nepal. 192. 1825. − *C. insularialpina* Hayata, Icon. Pl. Formosan. 3: 3. 1913. – *C. kuntziana* H.Lév. & Vaniot, Bull. Acad. Int. Géogr. Bot. 11: 171. 1902. – *C. montana* var. *incisa* Kuntze, Verh. Bot. Vereins Prov. Brandenburg 26: 141 1885.– *C. montana* var. *brevipedunculata* Kuntze, Verh. Bot. Vereins Prov. Brandenburg 26: 141 1885. **Plate 13 C**

Climber. ***Stem*** dark brown, sulcate, sparsely puberulent. ***Leaves*** opposite, ternate; petiole ± 3.5 cm long, villous; leaflets ovate or trullate or elliptic in outline, 2–4 cm by 1.5–2 cm; petiolule ca.0.5 cm; margin toothed; apex acute; base cuneate or sub-rounded; upper surface adpressed puberulent; lower surface adpressed pilose or villous; midrib and laterals veins prominent on both surfaces. ***Inflorescence*** axillary fascicle of 2–7-flowers; pedicel up to 4–7.5 cm long, tomentose. ***Calyx*** showy, white

with purple tinged abaxially, 4-lobed; ovate or elliptic, ca. 3 cm by 1.5 cm glabrous; margin slightly ciliate, apex obtuse, orbicular or emarginate. ***Corolla*** absent. ***Stamens*** numerous, ca. 8 mm long; filament strap-shaped or ensiform, glabrous; anthers ca.2 mm long, glabrous, basifixed. ***Ovary*** ovoid, pubescent, ca. 1 mm long; style slender, ca. 6 mm long, densely white plumose; stigma slightly hamate.

Bhutan – Haa, Mongar, Punakha, Trashigang districts
Distribution – Afghanistan, China, India, Nepal, Pakistan
Ecology – Found in Fir-rhododendron forest from 3,000 – 4,000 m asl. Flowering in May - July
Specimen Examined – K. Jamtsho 102 (THIM)

77. Delphinium viscosum Hook.f. & Thomson, Fl. Ind. [Hooker f. & Thomson] 52. 1855; Grierson in Fl. Bhutan 1(2): 311.1984; Hook.f. in Fl. Brit. India 1:27.1875. − *Delphinium conocentrum,* Kew Bull. 3: 57. 1948. – *D. trilobatum* Huth, Bull. Herb. Boissier 1: 330. 1893. **Plate 13 D**

Woody shrub, ca. 15−40 cm tall. ***Stem*** erect, pubescent. ***Leaves*** alternate; orbicular or reniform in outline, 2−4.5 cm by 3.5−8 cm, divided into 5−7 lobes; petiole of the basal leaves ca. 17 cm long, cauline leaf petiole shorter, base winged, semi-amplexicual, densely pubescent; Lobes ca. 2 cm by 2.5 cm; apex 3(−5) toothed; base mostly cordate; upper surface pubescent; lower surface pubescent usually along the veins; veins palmately distributed, distinct on lower surface. ***Inflorescence*** terminal or axillary; (1−) 2-flowered; pedicel up to 5 cm long, densely pubescent; bracts foliose, usually 3-lobed; bracteoles broadly lanceolate, pubescent, margin ciliate. ***Calyx*** bluish to purplish, pubescent; upper sepal slight hooded, 1.5 cm by 1 cm, spurred; spur ca. 1.2 cm long; other sepals broadly ovate, ca. 1.5 cm by 1.2 cm. ***Corolla*** bluish or purplish, ± glabrous, apex bifid. ***Stamens*** numerous, ± 5 mm long; filament broadened at base, glabrous; anthers ca.2 mm long, glabrous, basifixed. ***Ovary*** usually 3, conical, glabrous, ca. 2.5 mm long; style ca. 1 mm long; stigma similar to style.

Bhutan – Bumthang, Mongar, Thimphu, Trashigang, Trongsa districts

Distribution – China, India

Ecology – Along the stream banks, mountain slopes from 3,000 – 3,500 m asl. Flowering in July - October

Specimen Examined – K. Jamtsho 141 (THIM)

78. Oxygraphis endlicheri (Walp.) Bennet & Sum.Chandra, Indian Forester 108(5): 374 (1982); Grierson in Fl. Bhutan 1(2): 304.1984; Wencai et al. in Fl. China 6: 434. 2001. − *Callianthemum endlicheri* Walp., Repert. Bot. Syst. 1: 33 1842.− *Oxygraphis polypetala* (Royle) Hook. f. & Thomson, Fl. Ind. 27 27 1855. – *Ranunculus polypetalus* Royle, Ill. Bot. Himal. Mts. 54, pl. 11, f. 2 54 1834. **Plate 14 A**

Stem-less herbs with rootstock surrounded with fibrous leaf remains. ***Leaves*** usually basal; orbicular or reniform or ovate, 0.5−1.5 cm by 1−1.3 cm; petiole ca. 4 cm long, base vaginate, scabrous; margin dentate; apex obtuse or rounded; base sub-cordate or truncate; upper surface densely punctate; lower surface glabrous; veins distinct on lower surface. ***Inflorescence*** single flowered; scape ca. 1.5−5.5 cm long, scabrous. ***Calyx*** 5-lobed, greenish, ovate or oblong, ca. 4−6 mm long, glabrous or sparsely scabrous; upper sepal slight hooded. ***Corolla*** ca. 13, yellow, narrowly elliptic or oblanceolate, 4−9 mm by 1−2 mm, apex acute. ***Stamens*** numerous, ca. 4 mm long; filament broaden, glabrous; anthers ca.0.5 mm long, quadrifid, glabrous, basifixed. ***Ovary*** numerous, conical, pubescent, ca. 1.5 mm long; style ca. 0.5 mm long; stigma slightly hamate.

Bhutan – Bumthang, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts

Distribution – China, India, Nepal, Pakistan

Ecology – Mountain slopes, along the forest margins, meadows from 3,000 – 4,200 m asl. Flowering in May - June

Specimen Examined – K. Jamtsho 65 (THIM)

79. Ranunculus brotherusii Freyn, Bull. Herb. Boissier vi. 885; Grierson in Fl. Bhutan 1(2): 302-303.1984; Fl. Wencai et al. in China 6: 409. 2001. **Plate 13 E**

Herbs, up to 20 cm tall. ***Stem*** sericeous, slightly grooved. ***Leaves*** 2–3 partite; leaflets copiously partite into linear or oblanceolate lobules; petiole up to 2 cm long, base broaden, adpressed pilose; upper cauline leaves sessile; margins entire; apex acute; base cuneate; upper surface glabrous; lower surface sparsely adpressed pilose; midrib and veins slightly visible on lower surface. ***Inflorescence*** terminal or axillary simple cyme, 1–3 flowered; pedicel ca. 4 cm long, sericeous. ***Calyx*** 5-lobed, green with brownish margin, ovate, ca. 4.5 mm by 2 mm, sericeous; margin ciliate; ***Corolla*** yellow, 5-lobed; lobes orbicular, 5 mm by 5 mm, apex rounded or slightly emarginate. ***Stamens*** numerous, ca. 3 mm long; filaments broaden, glabrous; anthers ca.1 mm long, quadrifid, glabrous, basifixed. ***Ovary*** numerous, aggregated to form fruit; globose, pubescent, ca. 0.2 mm long; style conical, ca. 0.5 mm long; stigma much smaller than style.

Bhutan – Thimphu, Punakha, Bumthang, Mongar, Trashigang districts
Distribution – China
Ecology – Along the stream banks from 3,000 – 3,500 m asl. Flowering in June - August
Specimen Examined – K. Jamtsho 80 (THIM)

80. Ranunculus sp. Plate 13 F

Herbs, 10–30 cm tall. ***Stem*** slender, pilose. ***Leaves*** widely ovate in outline, ca. 2.7 cm by 3.3 cm, 3-partite; leaflets elliptic or rhombic in outline; petiole up to 5 cm long, base sheathing, pilose; margins deeply dentate; apex acute; base truncate; upper surface adpressed pilose; lower surface sparsely adpressed pilose; veins conspicuous on both surfaces. ***Inflorescence*** terminal simple cyme, 1–2 flowered; pedicel ca. 2.5 cm long, tomentose. ***Calyx*** 5-lobed, green, ovate or oblong, ca. 4.5 mm by 2 mm, pilose; margin membranous. ***Corolla*** yellow, 5-lobed; lobes obovate or oblong, 6 mm

by 3 mm, apex rounded. ***Stamens*** numerous, ca. 2 mm long; filaments strap-shaped, glabrous; anthers ca.0.5 mm long, glabrous, basifixed. ***Ovary*** numerous, prolate, glabrous, ca. 0.8 mm long; style conical, ca. 0.5 mm long; stigma much smaller than style.

Bhutan –Trashigang district

Distribution

Ecology – Along the stream banks from 3,000 – 3,500 m asl. Flowering in May - July

Specimen Examined – K. Jamtsho 88 (THIM)

ROSACEAE

81. Fragaria daltoniana J.Gay, Ann. Sci. Nat., Bot. sér. 4, 8: 204. 1857; D.G. Long in Fl. Bhutan 1(3): 1987; Hook.f. in Fl. Brit. India 2: 345. 1897. – *Fragaria sikkimensis* Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 44(2):206. 1875. **Plate 9 A-B**

Herbs, ca. 2–3 cm tall. ***Stem*** slender, erect or prostate, nearly glabrous or sparsely appressed pilose. ***Leaves*** 3-foliate; petiole ca. 1 cm long, adpressed pilose; stipules brownish, 2-lobed, apex acute or cuspidate; leaflets shortly petiolulate; obovate, ca. 0.8–1.5 cm by 0.6–1 cm; margin with 4–6 teeth on each side, ciliate; apex acute or rounded; base obtuse or cuneate; upper surface sparsely adpressed pilose or subglabrous; lower surface adpressed pilose along midrib; midrib distinct on both sides; lateral veins conspicuous, 5–8 paired. ***Flower*** axillary, solitary; pedicel 2–5 cm long, adpressed pilose. ***Calyx*** saucer-shaped; calyx lobes 5, ovate or triangular, ca. 4 mm by 2 mm, sparsely adpressed pilose; margin ciliate, 1–3-fid; apex acute. ***Epicalyx*** segment 5, oblong to elliptic, ca. 3 mm by 1 mm, sparsely pilose; margin toothed, ciliate; 2–3-fid. ***Corolla*** white, 5-lobed; lobes free, orbicular, ca. 5–6 mm by 5–6 mm; apex rounded. ***Stamens*** numerous, up to 2 mm long, inserted on calyx cup; filament narrowly triangular, glabrous; anthers up to 0.7 mm long, glabrous, dorsifixed. ***Ovary*** reniform or globose, glabrous, ca. 0.5 mm long; style sub-basal, constricted towards base, ca. 1 mm long, glabrous; stigma slightly constricted.

Bhutan – Bumthang, Mongar, Punakha, Thimphu, Trongsa, Trashigang districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found in thickets, alpine slopes and meadows from 3,300 – 4,500 m asl. Flowering in May - July
Specimen Examined – K. Jamtsho 76 (THIM)

82. Fragaria nubicola (Hook. f.) Lindl. ex Lacaita, J. Linn. Soc., Bot. 43(293): 467-468 467 1916; D.G. Long in Fl. Bhutan 1(3): 1987. – *Fragaria vesca* var. *nubicola* Hook. f., Fl. Brit. India 2(5): 344.1878. **Plate 9 C-D**

Herbs, ca. 2–3 cm tall. ***Stem*** prostate with white sericeous. ***Leaves*** 3-foliate; petiole ca. 1.2 cm long, pilose; stipules brownish, 2-lobed, apex acute; leaflets sessile or with short petiolule; obovate, ca. 0.5–1.5 cm by 0.4–1 cm; margin with ±5 teeth on each side, ciliate; apex rounded; base cuneate; upper surface sparsely white adpressed pilose; lower surface white sericeous along midrib and veins; midrib distinct lower surface; lateral veins distinct on lower surface, 5–7 paired. ***Inflorescence*** axillary, compound cyme or sometimes solitary flower; pedicel ±1cm long, white sericeous. ***Calyx*** saucer-shaped; calyx lobes 5, ovate, ca. 5 mm by 3 mm, white sericeous; margin ciliate, entire; apex acute. ***Epicalyx*** segment 5, elliptic, ca. 3 mm by 1.3 mm, dense white sericeous; margin entire, ciliate. ***Corolla*** white, 5-lobed; lobes free, orbicular, ca. 6–8 mm by 4–6 mm; apex rounded. ***Stamens*** numerous, 2–3 mm long, inserted on calyx cup; filament narrowly triangular, glabrous; anthers up to 1.2 mm long, glabrous, dorsifixed. ***Ovary*** globose, sparsely haired or glabrous, ca. 0.3 mm long; style sub-basal, base constricted, ca. 1.2 mm long, pubescent; stigma dilated.

Bhutan – Bumthang, Chukha, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts
Distribution – Afghanistan, China, India, Myanmar, Nepal, Pakistan
Ecology – Found along forest margin, riverbank, and meadows from 3,500 – 3,500 m asl. Flowering in May - July

Specimen Examined – K. Jamtsho 60 (THIM)

83. Potentilla coriandrifolia D. Don, Prodr. Fl. Nepal. 232.1825; Grierson and D.G. Long in Fl. Bhutan 1(3):573.1987; Hook.f. in Fl. Brit. India. 2: 353. 1879. **Plate 10 C**

Herbs, 5–10 cm tall. ***Stem*** erect, short and tufted with enlarged rhizomatous root. ***Leaves*** 2-pinnate with 2–5 pairs of leaflets; petiole ±1.5 cm long, villous; stipule with appressed villous underneath, margin dissected into linear segments; leaflets opposite, sub-sessile, pinnatisect, segmented; apex of segments with 1–2 haired; base cuneate; upper surface sparsely appressed pilose or glabrescent; lower surface densely appressed villous, or glabrescent and hairy along midrib; midrib slightly visible on both surfaces. ***Inflorescence*** terminal, 1–2-flowered; pedicel ±2 cm long, reddish brown, tomentose. ***Calyx*** saucer-shaped, ± spreading; calyx lobes 5, ovate, ca. 4 mm by 2 mm, sparsely pilose, margin ciliate, apex acute. ***Epicalyx*** segment 5, attached alternately with calyx lobes, lanceolate or oblong, ca. 3.5 mm by 1 mm, pilose at base, margin entire, apex 2–3 toothed. ***Corolla*** white with reddish base, 5-lobed; lobes free, orbicular, ca. 7 mm by 8 mm, apex emarginate. ***Stamens*** 10–20, ca.1.5 mm long; filament slender, glabrous; anthers up to 0.5 mm long, glabrous, dorsifixed. ***Ovary*** oblong, pilose at base, ca. 1 mm long; style lateral, slightly constricted towards tip, ca. 8 mm long, glabrous; stigma dilated.

Bhutan – Bumthang, Haa, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Found in thickets and alpine slopes from 4,200 – 4,300 m asl. Flowering in July - August
Specimen Examined – K. Jamtsho 154 (THIM)

84. Potentilla cuneata Wall. ex Lehm., Nov. Stirp. Pug. [Lehmann] 3: 34. 1831; alt. title: Pugillus 3: 34. Jan-Apr 1831; Grierson and D.G. Long in Fl. Bhutan 1(3): 566.1987. – *Potentilla ambigua* Cambess., Voy. Inde [Jacquemont] 4(3): 51 (t. 62).

1844; Hook.f. in Fl. Brit India 2:348.1879. – *P. dolichopogon* H.Lév., Bull. Acad. Int. Géogr. Bot. 25: 68. 1915. **Plate 21 F**

Herbs, ca. 2–5 cm tall. ***Stem*** short, mat-forming with slender, naked rhizome. ***Leaves*** 3-foliate; petiole up to 3 cm long, adpressed pilose; stipules leaf-like, adpressed pilose, apex acute; leaflets obovate, ca. 6–12 mm by 4–10 mm; margin ciliate; apex 3-toothed; base cuneate; upper surface pilose; lower surface adpressed pilose usually along the veins; midrib raised on lower surface, slightly impressed on upper surface, adpressed pilose; lateral veins conspicuous. ***Inflorescence*** terminal, flower solitary; pedicel ca. 4 cm long, sericeous. ***Calyx*** saucer-shaped, ± spreading; calyx lobes 5, ovate, ca. 6 mm by 2 mm, adpressed pilose, margin ciliate, apex acute. ***Epicalyx*** segment 5, attached alternately with calyx lobes, ca. 5 mm by 3 mm, elliptic, pilose, margin ciliate, apex obtuse or acute. ***Corolla*** yellow, 5-lobed; lobes free, orbicular, ca. 0.5–1 cm by 0.5–0.7 cm; apex slightly emarginate. ***Stamens*** numerous, ca. 1 cm long; filament conical, base pubescent; anthers up to 1 mm long, cordiform, glabrous, basifixed. ***Ovary*** globose, white pilose, ca. 0.3 mm long; style lateral or basal, slender, ca. 0.4 mm long, glabrous; stigma dilated or peltate.

Bhutan – Bumthang, Haa, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts

Distribution – China, India, Nepal

Ecology – Found in thickets and alpine slopes from 3,500 – 4,500 m asl. Flowering in June - August

Specimen Examined – K. Jamtsho 82 (THIM)

85. Potentilla fruticosa var. **arbuscula** (D. Don) Maxim., Mélanges Biol. Bull. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg 9: 158.1873. – *Potentilla arbuscula* D.Don, Prodr. Fl. Nepal. 256. 1825; Grierson and D.G. Long in Fl. Bhutan 1(3):565–566.1987. – *Potentilla lespedeza* H.Lév., Le Monde des Plantes xviii. 54 (1917). – *P. rigida* Wall. ex Lehmann, Nov. Stirp. Pug. [Lehmann] 3: 3. 1831. **Plate 10 A**

Shrub, 0.3–0.7 m tall. ***Stem*** erect, soboliferous with brown scaly exfoliating bark. ***Leaves*** alternate, pinnately (3–4)–5-foliate; petiole ±6 mm long, pilose, stipulate;

stipule adnate to petiole, pilose; leaflets elliptic, 0.5–1.5 cm by 3–5cm; margin entire, ciliate; apex acute to rounded or orbicular with black pointed tip; base rounded or obtuse; upper surface villous; lower surface sparsely pilose or glabrous with lower half of midrib densely pilose; midrib prominent on lower surface; lateral veins prominent underneath, 3–5 paired. ***Flower*** solitary, terminal or on short lateral shoot; bract 1–2, reddish brown, persistent at middle of petiole; flower showy, slightly nutant; pedicel up to 4.5 cm long with dense pilose. ***Calyx*** saucer-shaped; calyx lobes 5, lanceolate or lance-ovate, ca. 5 mm by 3 mm, reddish-brown, pilose, apex attenuate. ***Epicalyx*** segments 5, attached alternately with the calyx lobes, ca. 6 mm by 4 mm, elliptic to lanceolate, sparsely pilose, margin ciliate. ***Corolla*** yellow, 5-lobed; orbicular, ca. 1–1.4 cm by 0.7–1.3 cm. ***Stamens*** numerous, 2–4 mm long; filament slender, glabrous; anthers up to 1 mm long, glabrous, basifixed. ***Ovary*** obovoid or globose, pilose, ca. 0.5 mm long; style slender, base constricted, ca. 1.5 mm long, glabrous; stigma dilated.

Bhutan – Gasa, Haa, Punakha, Thimphu, Trashigang districts
Distribution – China, India, Nepal
Ecology – Found in thickets and alpine slopes from 3,500 – 4,200 m asl. Flowering in July - August
Specimen Examined – K. Jamtsho 161 (THIM)

86. Potentilla microphylla D.Don, Prodr. Fl. Nepal. 231. 1825; Grierson and D.G. Long in Fl. Bhutan 1(3): 572.1987; Hook.f. in Fl. Brit India 2:352.1897. **Plate 10 E**

Herbs, ca. 2–3 cm tall. ***Stem*** short, tufted with long slender taproot. ***Leaves*** basal pinnate; petiole ±8 mm long, villous; stipules brownish, adnate to petiole, membranous with free 2-lobed apex. Cauline leaves single, sessile with 1–3-lobed; leaflets elliptic or oblong, ca. 1–3 mm by 2–4 mm; margin pinnately 3–5-lobed, ciliate; apex acute or obtuse; base cuneate; upper surface glabrous; lower surface villous; midrib slightly visible on both sides; lateral veins inconspicuous. ***Inflorescence*** terminal; flower mostly solitary or sometimes 2-flowered; pedicel ±1.5

cm long, tomentose. ***Calyx*** saucer-shaped, ± spreading; calyx lobes 5, ovate, ca. 3 mm by 2 mm, pilose, margin entire, ciliate, apex acute. ***Epicalyx*** segment 5, attached alternately with calyx lobes, ca. 2 mm by 0.5 mm, elliptic, sparsely pilose, margin ciliate, apex acute or sometimes lobed. ***Corolla*** yellow, 5-lobed; lobes free, obovate, ca. 5–6 mm by 4–5 mm; apex rounded. ***Stamens*** numerous, ca. 1.5–2 mm long; filament constricted towards tip, glabrous; anthers up to 0.5 mm long, glabrous, dorsifixed. ***Ovary*** reniform, hairy at base, ca. 0.6 mm long; style lateral, constricted towards base, ca. 0.8 mm long, glabrous; stigma dilated.

Bhutan – Bumthang, Mongar, Punakha, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Found in thickets and alpine slopes from 3,500 – 4,500 m asl. Flowering in June - August
Specimen Examined – K. Jamtsho 96 (THIM)

87. Potentilla monanthes var. **sibthorpiodes** Hook.f., Grierson and D.G. Long in Fl. Bhutan 1(3): 568.1987; Hook.f. in Fl. Brit. India 2:358.1897.
Herbs, ca. 1–3 cm tall. ***Stem*** short stout, dark brown, mat-forming, rhizomes covered with remains of old brownish stipules. ***Leaves*** 3-foliate; petiole up to 5 mm long, pilose; stipules leaf-like, pilose, apex acute or toothed, ciliate; leaflets obovate or obtriangular in outline, ca. 4–5 mm by 3–4 mm, 5–7-toothed; base cuneate; upper surface pilose; lower surface pilose usually along the veins, glandular hairy; midrib conspicuous on lower surface, slightly visible on upper surface; lateral veins conspicuous on lower surface. ***Flower*** terminal, mostly solitary; pedicel ca. 6 mm long, lanate-tomentose. ***Calyx*** saucer-shaped, ± spreading; calyx lobes 5, lanceolate, ca. 3 mm by 1 mm, pilose, margin ciliate, apex acute. ***Epicalyx*** segments 5, attached alternately with calyx lobes, ca. 2 mm by 1.5 mm, elliptic, pilose, margin ciliate, apex obtuse. ***Corolla*** yellow, 5-lobed; lobes free, obovate or spatulate, ca. 2–3.5 mm by 2–2.5 mm; apex emarginate. ***Stamens*** 8–12, ca. 1.5 mm long; filament slender, glabrous; anthers up to 0.3 mm long, reniform, glabrous, basifixed. ***Ovary*** globose or reniform,

glabrous, ca. 0.5 mm long; style apical, slender, ca. 0.8 mm long, glabrous; stigma dilated.

Bhutan – Mongar, Punakha, Trashigang districts

Distribution – India, Nepal, Pakistan

Ecology – Found along the stream banks and margins of Fir forests from 2,500 – 3,500 m asl. Flowering in May - August

Specimen Examined – K. Jamtsho 64 (THIM); Grierson, A.J.C. & Long, D.G. E0010759 (E: Online Herbarium Catalogue).

88. Potentilla saundersiana var. **caespitosa** (Lehm.) Th. Wolf, Biblioth. Bot. 16(Heft 71): 243. 1908. – *Potentilla caespitosa* Lehm, Index Sem. (Hamburg) 1849: *10.1849. – P. sinonivea* Hultén, Bot. Not. 2: 138.1945. – *P. forrestii* var. *caespitosa* (Wolf) Sojak; Grierson and D.G. Long in Fl. Bhutan 1(3): 569.1987. **Plate 10 D**

Herbs, ca. 6 cm tall. ***Stem*** sub-erect or spreading, tufted with slender roots. ***Leaves*** palmately 3-foliate; petiole ±5 mm long, tomentose; stipules brown with greenish apex, membranous, white villous underneath. Cauline leaves with greenish 2–3-fid stipule adnate to petiole. Leaflets oblong to ovate, 4–5 mm by 4–5 mm; margin incised, serrate, ciliate; apex rounded; base cuneate; upper surface white sericeous; lower surface sparsely pilose, lepidote; midrib and lateral veins prominent on both sides. ***Inflorescence*** terminal cymose, 1–2 flowered; pedicel ±2 cm long, tomentose, glandular hairy. ***Calyx*** saucer-shaped, ± spreading; calyx lobes 5, lanceolate or narrowly oblong, ca. 4 mm by 2 mm, reddish-brown with greenish base, pilose, margin ciliate, apex acute. ***Epicalyx*** segment 5, attached alternately with calyx lobes, ca. 3 mm by 2 mm, ovate in outline, pilose, margin ciliate, apex 3-fid. ***Corolla*** yellow, 5-lobed; lobes free, obovate, ca. 0.8–1.1 cm by 0.8–1.1 cm; apex emarginate. ***Stamens*** ca. 15–20, ca. 2 mm long; filament slender, glabrous; anthers up to 0.5 mm long, glabrous, dorsifixed. ***Ovary*** reniform, hairy at base, ca. 0.5 mm long; style lateral, constricted towards tip, ca. 1 mm long, glabrous; stigma dilated.

Bhutan – Bumthang, Mongar, Trashigang districts

Distribution – China, India, Nepal

Ecology – Found in thickets and alpine slopes from 3,000 – 4,500 m asl. Flowering in June - August

Specimen Examined – K. Jamtsho 112 (THIM)

89. Potentilla sp. Plate 10 B

Herbs, ± 5 cm tall. ***Stem*** erect, short or subterranean with rhizomatous taproot, caespitose. ***Leaves*** alternate, pinnate with 4–15 pairs of leaflets; leaflets oblanceolate; petiole ±1.5 cm long, sericeous, base sheathing, stipulate; stipule tomentose, margin on upper half densely ciliate, sometimes irregularly dentate; leaflets sessile, broadly elliptic or oblong, 1–7 mm by 1–3.5 mm; margin serrate, ciliate; apex acute to obtuse or rounded with tip densely ciliate; base rounded; upper surface silky sericeous; lower surface densely silky sericeous usually along midrib and veins; midrib prominent on both surfaces, slightly impressed above; lateral veins slightly visible, 4–7 paired. ***Inflorescence*** axillary, terminal in bud, paniculate; bract leaf-like, serrate, margin ciliate; flower showy; pedicel ± 1.2 cm long, sericeous. ***Calyx*** saucer-shaped, ± spreading; calyx lobe 5, entire, ovate or lance-ovate, ca. 4.5 mm by 3 mm, pilose, apex acute. ***Epicalyx*** segments 5, attached nearly on the mouth of calyx tube alternate to the calyx lobes , ca. 3.5 mm by 2 mm, elliptic in outline, pilose, margin serrate, ciliate. ***Corolla*** yellow, 5-lobed; lobes free, orbicular, ca. 8 mm by 7 mm, apex emarginate. ***Stamens*** numerous, ca. 2 mm long; filament slightly conical, glabrous; anthers up to 1 mm long, glabrous, dorsifixed. ***Ovary*** globose with lateral pilose, ca. 0.5 mm long; style slender, sub-basal, base slightly constricted, ca. 1.5 mm long, glabrous; stigma colliculate.

Bhutan – Trashigang

Distribution

Ecology – Found in thickets and alpine slopes from 3,500 – 4,000 m asl. Flowering in June - August

Specimen Examined – K. Jamtsho 103 (THIM)

SAXIFRAGACEAE

90. Bergenia purpurascens (Hook.f. & Thomson) Engl., Bot. Zeitung (Berlin) 26: 841. 1868; Grierson in Fl. Bhutan 1(3): 492. 1987; J.T. Pan et al. in Fl. China 8: 278. 2003. – *Bergenia delavayi* Engl., Nat. Pflanzenfam. [Engler & Prantl] iii. 2a. (1890) 50. – *Saxifraga purpurascens* Hook.f. & Thomson, J. Proc. Linn. Soc., Bot. 2: 61. 1857. – *S. delavayi* Franch., Bull. Soc. Bot. France 32: 6. 1885. **Plate 17 C**

Perennial herb, ca. 15–30 cm tall; ***Stem*** erect, reddish brown, glandular pubescent. ***Leaves*** mostly basal; widely elliptic to obovate; ca. 5–10 cm by 4.5–8.5 cm; petiole up to 7 cm long, ± glabrous, base sheathing; margins sinuate or slightly toothed; apex obtuse to rounded; base rounded; upper surface punctate; lower surface lepidote; midrib distinct on lower surface; lateral veins distinct on lower surface, branched; cauline leaves if present irregularly lobed, sessile. ***Inflorescence*** terminal cyme; 4–8-flowered; pedicels ca. 8 mm long, densely glandular haired. ***Calyx*** reddish brown; tube ca. 5 mm long, densely glandular haired; lobes 5, ovate to oblong, ca. 9 mm by 5 mm, punctate, glandular hairy; margin entire; apex rounded or slightly emarginate. ***Corolla*** composed of 5 free petals; petals arising from calyx tube, alternate to calyx lobes, pink, oblanceolate or spatulate, ca. 1.7 cm by 0.8 cm, glabrous; margin entire; apex rounded to slightly lobed. ***Stamens*** 10, ca. 1.1 cm long, inserted on calyx tube; filaments slender, ca. 1 cm long; anthers oblong, dorsifixed. ***Ovary*** ovoid, ca. 6 mm long, 2-locular, glabrous; style 2, cylindrical-conic, ca. 8 mm long; stigmas partially 3-lobed.

Bhutan – Bumthang, Haa, Punakha, Trashigang districts

Distribution – China, India, Myanmar, Nepal

Ecology – Found in the Rhododendron forests and alpine slopes from 4,000 – 4,500 m asl. Flowering in May - July

Specimen Examined – K. Jamtsho 114 (THIM)

91. Saxifraga hispidula D.Don, Trans. Linn. Soc. London 13(2): 380. 1822; Grierson in Fl. Bhutan 1(3): 500. 1987; J.T. Pan et al. in Fl. China 8: 317. 2003. – *Saxifraga evolvuloides* Wall. ex Ser., Prodr. [A. P. de Candolle] 4: 46. 1830. – *S. hispidula* var. *dentate* Franch.; Nouv. Arch. Mus. Hist. Nat., sér. 2, 8:232. 1933. – *S. hispidula* var. *doniana* Engl.; Monogr. Gatt. Saxifraga 222. 1872. – *S. potentilliflora* H. Lév.; Repert. Spec. Nov. Regni Veg. 13(368-369): 341.1914. – *Hirculus hispidulus* Losinsk., in Bull. Jard. Bot. Princ. URSS, xxvii. 602 (1928). **Plate 17 D**

Perennial herb, ca. 5–15 cm tall; ***Stem*** erect or sometimes decumbent, single or slightly caespitose with dense glandular pilose throughout. ***Leaves*** simple, alternate; elliptic to lanceolate; ca. 0.5–1.5 cm by 0.2–0.5 cm; sessile; margins distinctly 3-lobed, minutely toothed, ciliate; apex acute; base obtuse rounded; upper surface hispid; lower surface glandular hirsute; midrib and lateral veins inconspicuous. ***Inflorescence*** terminal, mostly solitary, rarely simple cyme of 2 flowers; pedicels ca. 1 cm long, densely glandular pilose. ***Calyx*** 5-lobed; lobes ovate, ca. 3 mm by 2 mm, densely glandular haired; margin entire; apex acute. ***Petals*** 5, free, yellow, glabrous; obovate, ca. 4–7 mm by 3–5mm, glabrous; margin entire; apex rounded. ***Stamens*** 10, up to 1 cm long; filaments tapering towards apex, united at base; anthers basifixed. ***Ovary*** superior, carpels 2, united at base and tapering into 2 free styles; styles 2, conical, ca. 1.5 mm long; stigmas reduced.

Bhutan – Bumthang, Haa, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Myanmar, Nepal
Ecology – Found along the forest margins, mountain slopes and rock crevices from 4,000 – 4,500 m asl. Flowering in July - September
Specimen Examined – K. Jamtsho 166 (THIM)

TAMARICACEAE

92. Myricaria rosea W.W.Sm., Notes Roy. Bot. Gard. Edinburgh 10: 52. 1917; Grierson in Fl. Bhutan 2(1): 233. 1991; Q.E. Yang and Gaskin in Fl. China 13: 66. 2007. **Plate 25 A**

Bushy shrub, ca. 15–30 cm tall. ***Stem*** prostate, with dense leafy branches, grooved, glabrous. ***Leaves*** lanceolate on main branch, lanceolate to linear on branchlets; ca. 5–10 mm by 0.5–2.5 mm; sessile; margins of branch leaves membranous, entire, involute in branchlet leaves; apex acute; base narrowed; upper surface glabrous; lower surface ± glabrous; midrib slightly visible on lower surface; lateral veins inconspicuous. ***Inflorescence*** terminal clustered racemes; flowers numerous; pedicels ca. 3 mm long, glabrous; bracts foliaceous, ca. 8 mm by 2.5 mm. ***Sepals*** 5, lanceolate, ca. 6 mm by 2 mm, glabrous; margin membranous; apex acute. ***Petals*** 5, pinkish, oblanceolate or obovate, ca. 6 mm by 3 mm, glabrous; margin entire; apex obtuse or rounded. ***Stamens*** 10, up to 4 mm long, base fused; filament narrowly triangular, ca. 2 mm long; anthers globose. ***Ovary*** conical, ca. 3 mm long, glabrous; style cylindrical, ca. 1 mm long; stigma slightly peltate.

Bhutan – Haa, Thimphu, Trashigang, Trongsa districts

Distribution – China, India, Nepal

Ecology – Found along the stream banks from 3,000 – 4,000 m asl. Flowering in June - August

Specimen Examined – K. Jamtsho 121 (THIM)

VIOLACEAE

93. Viola biflora L., Sp. Pl. 2: 936. 1753; Grierson in Fl. Bhutan 2(1): 224–225. 1991; Hook.f. in Fl. Brit. India 4: 182. 1897; Y.S. Chen et al. in Fl. China 13: 108. 2007. – *Chrysion biflorum* (L.) Spach, Hist. Nat. Vég. (Spach) 5: 510. 1836. – *Dischidium biflorum* Opiz, Seznam 38. 1852. **Plate 25 B**

Perennial herb, ca. 4–15 cm tall. ***Stem*** erect or straggling, glabrous with whitish globose rhizome. ***Leaves*** simple, alternate; reniform or widely ovate, 0.5–1 cm by 0.8–1.5 cm; petiole ± 3 cm long, glabrous; margins serrate, ciliate; apex rounded; base cordate; upper surface pilose; lower surface sparsely tomentose especially along veins, farinose; midrib conspicuous on both surfaces; lateral veins conspicuous, branching; stipules foliaceous, ovate to elliptic, ca. 4 mm by 2.5 mm, serrate, ciliate. ***Flowers*** terminal or axillary, solitary; peduncle ca. 5–8 cm long, sparsely glandular hairy; bracts ovate, dentate. ***Sepals*** 5, lanceolate or narrowly triangular, ca. 5 mm by 1 mm, margin ciliate, apex acute. ***Petals*** 5, yellow; upper 4 oblanceolate, ca. 1 cm by 0.3 cm, reflexed; lower petal ovate or spatulate, ca. 1 cm by 0.5 cm, inner surface with brownish dendritic streak, spurred; spur saccate, ca. 2mm long. ***Stamens*** 5, ca. 1.5 mm long; filaments inconspicuous, ca. 0.1 mm long; anthers with membranous appendage, basifixed. ***Ovary*** ovoid, lepidote, ca. 1.5 mm long; style falcate, apex folded into hippocrepiform, ca. 2 mm long; stigma hidden inside apex of style.

Bhutan – Bumthang, Haa, Mongar, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Pakistan
Ecology – Found in the shady grounds of Fir-Rhododendron forest and along the stream banks from 2,500 – 3,500 m asl. Flowering in June - September
Specimen Examined – K. Jamtsho 81 (THIM)

MONOCOTS

ARACEAE

94. Arisaema elephas Buchet, Notul. Syst. (Paris) 1: 370. 1911; Noltie in Fl. Bhutan 3(1):154. 1994; H. Li in Fl. China 23: 55. 2010. **Plate 25 C**

Dioecious herb. ***Subterranean stem*** a globose or oblate corm with fibrous root, ca. 4 cm across. ***Pseudostem*** ca. 1.5 cm tall; roots fibrous. ***Leaves*** usually 1–2; cataphylls mostly 2, falcate, chartaceous; petiole ca. 10–30 cm long,; leaf blade trifoliate; leaflets orbicular to rhomboid, ca. 9 cm by 8 cm, sessile, lateral leaflets asymmetrical; margin

± undulate with red lining; apex caudate; base cuneate. ***Inflorescence*** below leaves on independent peduncle; peduncle much shorter than petiole, pale green with sparse reddish brown streaks. ***Spathe*** tube slightly obconical, ± 5 cm long with whitish longitudinal stripes; limb incurved, dark purple, ca. 8 cm long, apex caudate. ***Spadix*** appendix blackish-purple, exerted from the spathe, base shortly stipitate, swollen, apex sigmoid, tapering into whip-like ending. ***Fertile zone*** staminate or pistillate; staminate flowers moderately loose, anthers 3, stalked; pistillate flowers numerous, ovary urceolate, style cylindrical, stigma enlarged, ± penicillate. ***Infructescence*** not seen.

Bhutan – Bumthang, Paro, Thimphu, Trashigang districts
Distribution – China, Myanmar
Ecology – Found in the moist fir-rhododendron forest from 3,500 – 3,800 m asl. Flowering in June
Specimen Examined – K. Jamtsho 118 (THIM)

LILIACEAE

95. Lloydia flavonutans Hara, J. Jap. Bot. 49(7): 202 (1974); Noltie in Fl. Bhutan 3(1): 110-111. 1994; Chen, X. et al. in Fl. China 24: 73. 2000. **Plate 18 E**

Herbs, ca. 5–15 cm tall; scapes erect, green, ± glabrous; bulb globose or ellipsoid, ± 2 mm by 2 mm, tunics whitish. ***Leaves*** mostly basal, simple; strap-shaped, 4–15 cm by 0.1–0.2 cm; sessile; margin revolute; ciliate; apex blunt; base slightly narrowed; upper cauline leaves a few or reduced to foliaceous bracts. ***Flowers*** terminal, simple cyme or solitary, 1–2 (–3) per scape, nutant; pedicel ca. 0.3–2 cm long. ***Tepals*** campanulate, yellow with light green strap along the mid-vein, base reddish brown, 6-lobed, biseriate, glabrous; outer 3 lobes elliptic or oblong, ca. 1.3 by 0.4 cm, apex retuse; inner 3 lobes obovate, ca. 1.5 cm by 0.6 cm, apex acute, partly lobed. ***Stamens*** 6, ca. 9 mm long; filament slender, villous; anthers ca. 2.5 mm long, basifixed. ***Ovary*** ovoid, ca. 3 mm long; styles ca. 7 mm long; stigma partly 3-lobed.

Bhutan – Haa, Punakha, Thimphu, Trashigang, Trongsa districts

Distribution – China, India, Nepal

Ecology – Found in open grounds of rhododendron and mountain slopes from 3,800 – 4,500 m asl. Flowering in May - July

Specimen Examined – K. Jamtsho 108 (THIM)

ORCHIDACEAE

96. Chusua pauciflora (Lindl.) P.F.Hunt, Kew Bull. 26 (1): 175 (1971); N.R. Pearce and P.J. Cribb in Fl. Bhutan 3(3): 134–136. 2002.– *Orchis chusua* D. Don, Prodr. Fl. Nepal. 23. 1825. – *O. pauciflora* Fisch. ex Lindl., Gen. Sp. Orchid. Pl. 280. 1835. – *O. giraldiana* Kraenzl., Bot. Jahrb. Syst. 36(5, Beibl. 82): 25. 1905. – *O. delavayi* Schltr., Repert. Spec. Nov. Regni Veg. 9: 433. 1911. – *O. beesiana* W.W.Sm., Notes Roy. Bot. Gard. Edinburgh 8: 193. 1914. – *O. mairei* H.Lév., Cat. Pl. Yun-Nan 197. 1916. – *O. tenii* Schltr., Repert. Spec. Nov. Regni Veg. 17: 22. 1921. – *O. unifoliata* Schltr., Repert. Spec. Nov. Regni Veg. 17: 22. 1921. – *O. pulchella* Hand.-Mazz., Symb. Sin. Pt. VII. 1325 (1936). – *O. parcifloroides* Hand.-Mazz., Symb. Sin. Pt. VII. 1327 (1936). – *Ponerorchis chusua* (D.Don) Soó, Acta Bot. Acad. Sci. Hung. 12: 352. 1966. – *Gymnadenia pauciflora* Lindl., Gen. Sp. Orchid. Pl. 280. 1835.– *G. puberula* Lindl., Numer. List [Wallich] n. 7059. 1832. **Plate 22 E**

Terrestrial orchid, 5–20 cm tall with small, tuber ellipsoid. ***Stem*** erect, dark brown to reddish brown, glabrous bearing bladeless sheath at base. ***Leaves*** narrowly oblong, 3–15 cm by 0.5–1.8 cm; margin glandular crenulate; apex acute; base sheathing; lower surface glabrous or sometimes sparsely haired. ***Inflorescence*** secund, 3–6-flowered; rachis glabrous, 2–4 cm long; bracts lanceolate, 1–1.4 cm by 0.2–0.3 cm, apex acute to acuminate, base decurrent, margin minutely glandular; flowers uniformly purple-pink, 1.5–2 cm across; pedicel fusiform. ***Sepals*** dorsal sepal oblong, 4–7 mm by 2.2–3 mm, hooded, apex obtuse; lateral sepals ovate to slightly falcate, 7–8 mm by 2.5–4 mm, oblique, recurved. ***Petals*** broadly ovate, 4–6 mm by 2.2–3 mm, hooded,

asymmetric, apex acute, base truncate. ***Labellum*** distinctly 3-lobed, 0.8–1.1 cm by 0.7–1.3 cm; lateral lobes diverging, orbicular or ovate, margin serrate; mid lobe orbicular or rounded, margin serrate; spur cylindrical, up to ca. 4 mm, subclavate, appressed to ovary; mouth wide. ***Column*** ca. 2 mm tall. ***Pollinia*** 2, ovoid-globose, ca. 1mm long; caudicle long, tapering; viscida small, ovate-oblique, within bursicle; staminoides large, rugulose, ovate. ***Ovary*** sub-sessile, glabrous; stigmas conjoined. ***Capsule*** not seen.

Bhutan – Bumthang, Trashigang districts
Distribution – China, India, Nepal
Ecology – Found along grassy trail and degraded Fir-Rhododendron forest from 3,200 – 3,600 m asl. Flowering in mid July - August
Specimen Examined – K. Jamtsho 147 (THIM)

97. Satyrium nepalense var. **ciliatum** (Lindl.) Hook.f., Fl. Brit. India 6: 168 1890; N.R. Pearce and P.J. Cribb in Fl. Bhutan 3(3): 195. 2002. – *S. ciliatum* Lindl., Gen. Sp. Orchid. Pl. 341. 1838. – *S. setchuenicum* Kraenzl. ex Diels, Bot. Jahrb. Syst. 29(2): 266. 1900. – *S. yunnanense* Rolfe, Notes Roy. Bot. Gard. Edinburgh 8: 28. 1913. – *S. mairei* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 4: 54. 1919. – *S. tenii* Schltr., Repert. Spec. Nov. Regni Veg. 17: 63. 1921. – *S. pycnostachyum* Schltr., Repert. Spec. Nov. Regni Veg. 17: 63. 1921. – *S. microcephalum* Kraenzl., Repert. Spec. Nov. Regni Veg. 17: 109. 1921. – *S. aceras* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 12: 339. 1922. – *S. tschangii* Schltr., Repert. Spec. Nov. Regni Veg. 19: 374. 1924.– *Satyrium nepalense* subsp. *yunnanense* (Rolfe) Soó, Ann. Hist.-Nat. Mus. Natl. Hung. 26: 380 1929. **Plate 22 F**

Terrestrial orchid, 10–20 cm tall; tuber 1 or 2, ovoid to cylindrical. ***Stem*** erect, red with light tinge of purple, glabrous. ***Leaves*** alternate, sub-basal; lanceolate to oblong, 5–10cm by 1–2.5 cm; margin entire, membranous; apex acute; base sheathing; lower surface glabrous or sparsely lepidote. ***Inflorescence*** raceme, many-flowered; rachis glabrous, up to 7 cm long; bracts obovate, reflexed, ca. 1–1.5 cm by 0.3–0.6 cm, apex

acute to acuminate, base obtuse, margin shortly ciliate towards apex; flowers fragrant, pink-white, .8–1.5 cm across; pedicel fusiform, 5 mm long. ***Sepals*** dorsal sepal oblanceolate to spatulate, 6 mm by 1.5 mm, apex obtuse; lateral sepals oblong, 5.5 mm by 2.5 mm. ***Petals*** oblanceolate to narrowly oblong, ca. 3.5 mm by 1 mm, erose or slightly ciliate, apex orbicular, base narrowed. ***Labellum*** conspicuous, 0.7 cm by 1 cm, orbicular or sub globose, keeled on the back, hooded, tip and margin recurved; spur 2, conical, up to ca. 3.5 mm, parallel, extending up to middle of ovary. ***Column*** short, ca. 3 mm tall, curved, enclosed within labellum. ***Pollinia*** (1–?) 2 or rudimentary, attached to viscidium within bursicle, obovoid, ca. 1mm long; caudicle slender, ca. 1 mm long; rostellum rather large, 3-lobed. ***Ovary*** sub-sessile, glabrous, ca 6 mm long; stigmas confluent. ***Capsule*** not seen.

Bhutan – Bumthang, Mongar, Punakha, Thimphu, Trashigang, Wangdue Phodrang districts

Distribution – China, India, Nepal

Ecology – Found in grassy bank in *Abies and Rhododendron* forest from 1,800 – 4,000 m asl. Flowering in late August - early October

Specimen Examined – K. Jamtsho 184 (THIM)

PINOPSIDA

CUPRESSACEAE

98. Juniperus recurva Buch.-Ham. ex D.Don, Prodr. Fl. Nepal. 55. 1825; Grierson and D.G. Long 1(1): 54. 1983. – *Juniperus butanensis* Wender., Pfl. Bot. Gärt. 36. 1851. – *J. incurve* Buch.-Ham. ex Endl., Syn. Conif. 18.1847. – *J. lambertiana* Wall. ex Endl., Syn. Conif. 19. 1847. – *J. lorulasi* K.Koch, Dendrologie 2(2): 135. 1873. – *J. nepalensis* Rinz. ex Gordon, Pinetum 106. 1858. – *J. procumbens* Siebold ex Lindl., J. Hort. Soc. London 5: 228. 1850. – *J. religiosa* Royle, Ill. Bot. Himal. Mts. 351. 1839. – *J. repanda* Carrière, Traité Gén. Conif. 27. 1855. – *J. uvifera* Loudon, Encycl. Trees Shrubs 1088. 1842. – *Sabina recurva* (Buch.-Ham. ex D.Don) Antoine, Cupress.-Gatt. 67. 1857. – *S. recurva* (Buch.-Ham. ex D. Don) Nakai, Chosen Sanrin

Kaiho 165: 14. 1938. – *Sabinella recurva* (Buch.-Ham. ex D.Don) Nakai, Tyosen Sanrin Kaiho 165: 14. 1938. **Plate 17 E**

Tree, ca. 10–20 m tall; bark brown, exfoliating in flakes. ***Leaves*** simple, appressed, borne in whorl of 3; narrowly triangular to lanceolate, ca. 8 mm by 2 mm; sessile; margins entire, involute; apex acute, sharply pointed; base slightly narrowed, decurrent; inner surface slightly punctate; outer surface glabrous; midrib slightly raised on inner surface, impressed on outer surface. ***Female cones*** globose at maturity, ovoid when young, black-brown, rugose; up to 7 mm by 5 mm; scales usually 8. ***Seeds*** 1 per cone, oblong. ***Male cones*** oblong, ca. 4 mm by 2 mm; scales 10–15 per cone.

Bhutan – Bumthang, Mongar, Haa, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Nepal, Pakistan
Ecology – Found in fir forests and rhododendron scrub community from 3,000 – 4,000 m asl.
Specimen Examined – K. Jamtsho 181 (THIM)

99. Juniperus squamata Buch.-Ham. ex D.Don, Descr. Pinus 2: 17. 1824; Grierson and D.G. Long 1(1): 54. 1983. – *Juniperus densa* (Carrière) Gordon, Pinetum Suppl.: 32. 1862. – *J. franchetiana* H.Lév. ex Kom., Bot. Mater. Gerb. Glavn. Bot. Sada RSFSR 5: 30. 1924. – *J. recurva* var. *densa* Carrière, Traité Gén. Conif. 27. 1855. – *J. recurva* var. *squamata* (Buch.-Ham. ex D.Don) Parl., Prodr. 16(2): 482. 1868. – *J. squamata* var. *hongxiensis* Y.F.Yu & L.K.Fu, Novon 7: 444. 1997 publ. 1998. – *J. squamata* var. *meyeri* Rehder, J. Arnold Arbor. 3: 207. 1922. – *J. squamata* var. *parvifolia* Y.F.Yu & L.K.Fu, Novon 7: 444. 1997 publ. 1998. – *Sabina recurva* var. *densa* (Carrière) Antoine, Cupress -Gatt. 67. 1857. – *S. squamata* (Buch.-Ham. ex D.Don) Antoine, Cupress.-Gatt. 66.1857. **Plate 17 F**

Shrub, ca. 20–40 cm tall; bark brown, exfoliating. ***Leaves*** simple, slightly spreading to appressed, borne in whorl of 3; triangular to lanceolate, up to 4 mm by 1.5 mm;

sessile; margins entire, involute; apex acute, pointed; base slightly narrowed, shortly decurrent; inner slightly punctate; outer surface glabrous; midrib slightly raised mostly at base of outer surface. ***Female cones*** globose at maturity, black, rugose; up to 6 mm by 4 mm; scales 3. ***Seeds*** 1 per cone. ***Male cones*** globose to oblong, ca. 4 mm by 2.5 mm; scales ± 10 per cone.

Bhutan – Punakha, Thimphu, Trashigang districts
Distribution – Afghanistan, China, India, Nepal, Pakistan
Ecology – Found in fir forests and montane scrub community from 3,200 – 4,500 m asl.
Specimen Examined – K. Jamtsho 182 (THIM)

PINACEAE

100. Abies densa Griff., Not. Pl. Asiat. 4: 19. 1854; Grierson and D.G. Long in Fl. Bhutan 1(1): 50–51. 1983; Hook.f. in Fl. Brit. India 1:654. 1875; T.S. Elias et al. in Fl. China 4: 50. 1999. – *Abies spectabilis* subsp. *densa* (Griff.) Silba, J. Int. Conifer Preserv. Soc. 15: 46. 2008. – *Abies spectabilis* var. *densa* (Griff.) Silba, Phytologia Mem. 7: 10. 1984. **Plate 18 A**

Tree, ca. 10–40 m tall with wide spreading branches; bark scaly. ***Leaves*** simple, borne singly, spirally arranged; linear, ca. 3 cm by 0.2 cm; sub-sessile; margins strongly revolute; apex retuse or emarginate; base slightly narrowed; upper surface glabrous; lower surface white farinose; midrib prominently raised beneath, impressed above. ***Female cones*** cylindrical at maturity, blackish purple; sub-sessile; ca. 10–15 cm by 4–7 cm; ovuliferous scales orbicular, ± 2 cm broad, apex involute. ***Seeds*** 2 per ovuliferous scale, winged; wings blackish brown, apex ± truncate; bract scales spatulate, slightly longer than ovuliferous scales, apex pointed. ***Male cones*** not seen.

Bhutan – Haa, Mongar, Paro, Thimphu, Trashigang, Trongsa districts
Distribution – China, India, Nepal

Ecology – Found along the mountain ridges forming major woodland forest from 3,000 – 4,000 m asl.
Specimen Examined – K. Jamtsho 175 (THIM)

101. Larix griffithii Hook.f., Himal. J. (Hooker f.) 1:255-256; 2:44, 481. 1854; Ill. Himal. t. 21. Jul 1855; T.S. Elias et al. in Fl. China 4: 33. 1999; Hook.f. in Fl. Brit. India 5:655. 1884. – *Larix griffithiana* Carrière, Traité Gén. Conif. 278. 1855; Grierson and D.G. Long in Fl. Bhutan 1(1): 46–48. 1983. – *L. griffithii* subsp. *Kongboensis* (R.R.Mill) Silba, J. Int. Conifer Preserv. Soc. 15: 51. 2008. – *L. kongboensis* R.R.Mill, Novon 9: 79. 1999. – *Pinus griffithiana* Voss, Mitt. Deutsch. Dendrol. Ges. 16: 93. 1907. **Plate 18 B**

Tree up to 20 m tall with long pendulous branches; bark grooved longitudinally. ***Leaves*** simple, borne in fascicles of 10–50 on short lateral shoot; linear, up to 4 cm by 0.1 cm; sessile; margins entire; apex obtuse; base narrowed; upper and lower surfaces glabrous; midrib raised on both the surfaces. ***Female cones*** ellipsoid to slightly conical at maturity, brown; sub-sessile; ca. 5–7 cm by 2–2.5 cm; ovuliferous scales oblong, ca. 1 cm broad, apex emarginate, irregularly toothed. ***Seeds*** 2 per ovuliferous scale, winged; wings brownish, apex obtuse; bract scales ovate, exserted, apex reflexed cuspidate. ***Male cones*** not seen.

Bhutan – Bumthang, Haa, Mongar, Trashigang, Trongsa districts
Distribution – China, India, Nepal
Ecology – Found in the cool temperate forest from 2,500 – 3,500 m asl.
Specimen Examined – K. Jamtsho 165 (THIM)

PART II: VEGETATION STUDY

The Vegetation of the Merak Himalaya

Twelve study plots identified along the Jomokungkhar Trail of the Merak Himalaya were grouped into community types by cluster analysis using PC-ORD. The hierarchical cluster analysis at similarity index 63% showed five types of communities (Figure 3; Table 4). The analysis was performed based on the species abundances and their habitats.

Figure 3: Cluster Analysis dendrogram based on species abundances and habitats.

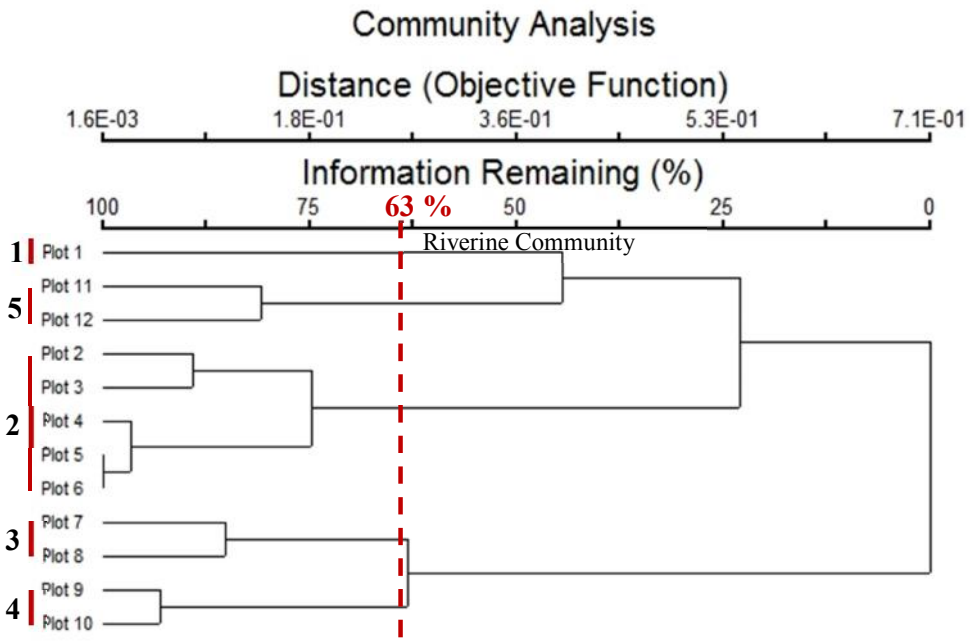


Table 4: Plant communities and dominant species

No	Plant Community	Dominant Species
1	Riverine Community	*Rumex nepalensis* Spreng*, Senecio raphanifolius* Wall*., Rhododendron campylocarpum* Hook.f.
2	*Abies-Rhododendron* woodland Community	*Abies densa* Griff.
3	*Juniperus* Scrub Community	*Juniperus recurva* Buch.-Ham. ex D.Don and *J. squmata* Buch.-Ham. ex D.Don
4	*Rhododendron* krummholz	*Rhododendron* spp.
5	Alpine Community	*Potentilla coriandrifolia* D. Don, *Bistorta* sp., *Cyananthus macrocalyx* subsp. *spathulifolius* (Nannf.) K.K.Shrestha, and *Rhododendron setosum* D.Don.

Riverine Community (Table 1 Plot 1; Figure 4; Plate 1)

This type of community usually occurs alongside the river/streams, where some of its portion experiences severe flooding during the heavy monsoon. It is composed of multiple microhabitats such as terrestrial scrub, open ground, and aquatic-terrestrial transition. Most common terrestrial plants adorning such community are *Senecio raphanifolius* Wall. ex DC., *Rhododendron campylocarpum* Hook.f., *Rumex nepalensis* Spreng., *Pedicularis siphonantha* D.Don, and *Geranium* spp. *Myricaria rosea* W.W.Sm, *Cardamine griffithii* Hook.f. & Thomson, and *Epilobium gouldii* P.H.Raven are some aquatic-terrestrial transition plants. *Fragaria nubicola* (Hook.f.) Lindl. ex Lacaita and *Anaphalis* spp. are among the herbaceous plants that occupy the open ground habitat.

***Abies-Rhododendron* Community** (Table 1 Plots 2-6; Figure 5; Plate 2)

This type of community is rather restricted to the woodland habitat with sparse epiphytic ferns and dense bryophytes. It is mainly composed of a single

high canopy tree species, *Abies densa* Griff., and *Rhododendron* spp. as moderate occupants forming its understory vegetation. Such vegetation is usually hilly with slopes of ± 45 degrees. Very few species of shrubs like *Rosa sericea* Lindl., *Juniperus* sp., *Rhododendron* sp., and *Berberis* spp.; and herbaceous plants like *Fragaria daltoniana* J. Gay, *Primula* spp., *Gaultheria trichophylla* Royle., and *Arisaema elephas* Buchet are seen on its ground floor.

***Juniperus* Scrub Community** (Table 1 Plots 7 & 8; Plate 3)

This is a small community forming above timberline vegetation (3,820 m asl.). Mainly composed of *Juniperus recurva* Buch.-Ham. ex D.Don and *J. squamata* Buch.-Ham. ex D.Don, it is moderately to highly scattered vegetation. *Gentiana* spp. and *Rhododendron nivale* Hook.f. are some other common species found in this community.

***Rhododendron* Krummholz Community** (Plots 9 & 10; Plate 4)

The *Rhododendron* krummholz is another type of community forming above timberline vegetation with rich growth of bryophytes on its ground floor. Krummholz here is referred to as the crooked and contorted forest formed by the effect of the wind current. It is a fairly mixed vegetation with sparse and dense distribution of *Rhododendron* spp. Open grounds, gaps, and margins of such community usually have a high diversity of herbaceous vascular plants. *Potentilla saundersiana* var. *caespitosa* (Lehm.) Th. Wolf, *Primula* spp., *Bergenia purpurascens* (Hook.f. & Thomson) Engl., *Oxygraphis endlicheri* (Walp.) Bennet & Sum. Chandra are some other taxa found in this type of community.

Alpine Community (Table 1 Plots 11 & 12; Plate 5)

The Alpine Community of the Merak Himalaya has a high diversity of herbaceous vascular plants. This fragile natural mountain meadow is mostly adorned by the luxurious growth of *Potentilla coriandrifolia* D. Don, *Bistorta* sp., *Cyananthus macrocalyx* subsp. *spathulifolius* (Nannf.) K.K.Shrestha, shrubby *Rhododendron setosum* D.Don, and species of Poaceae.

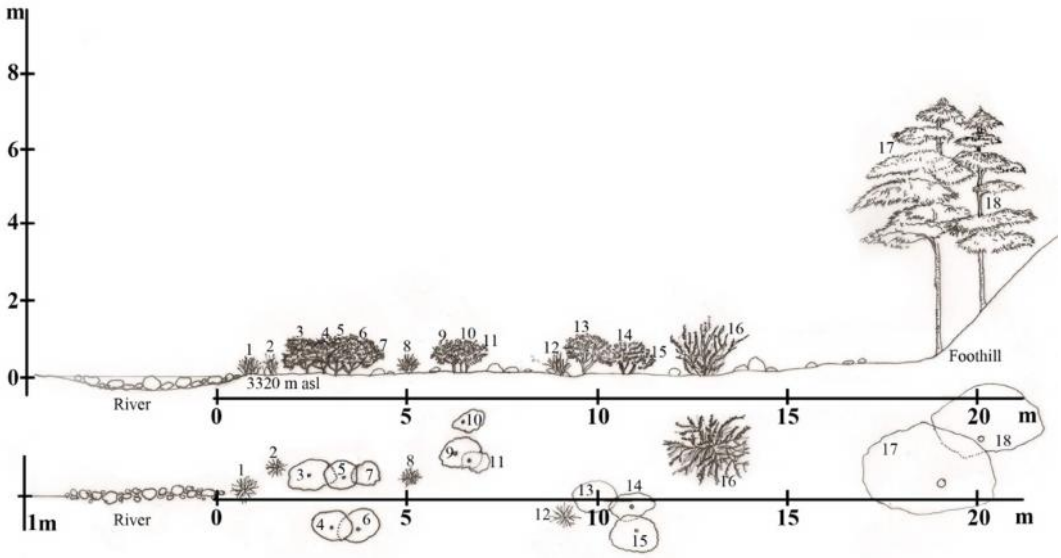


Figure 4: Profile diagram of the Riverine Community: 1, 2, 8, 12- *Myricaria rosea* W.W.Sm; 3, 4, 5, 6, 7, 9, 10, 11, 13, 14, 15 – *Rhododendron campylocarpum* Hook.f.; 16– *Berberis virescens* Hook.f.; 17, 18- *Abies densa* Griff.

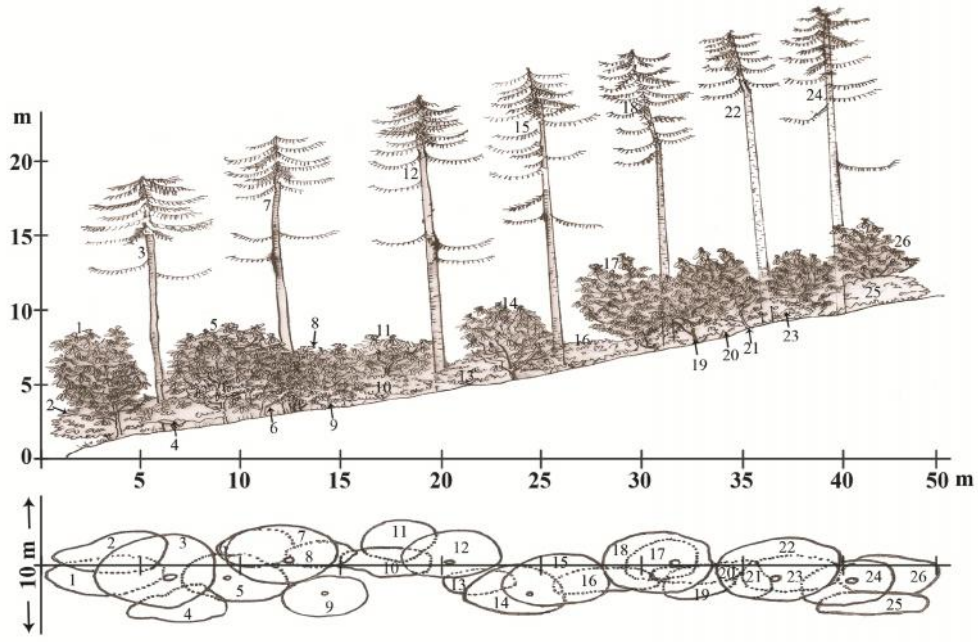


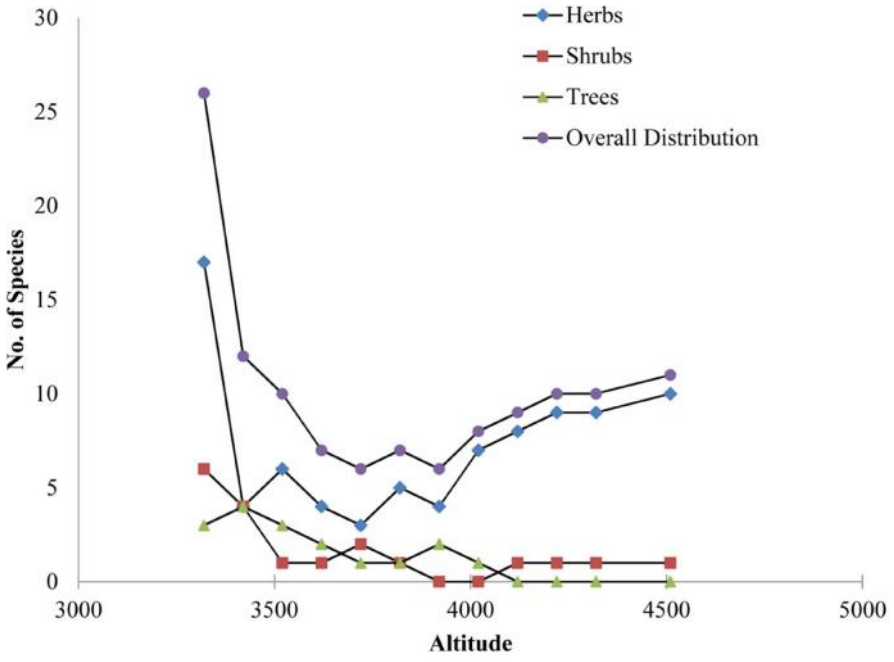
Figure 5: Profile diagram of the *Abies-Rhododendron* Community: 3, 7, 12, 15, 18, 22, 25- *Abies densa* Griff.; 2, 8, 19, 25- *Rhododendron argipeplum* Balf.f. & R.E. Cooper; 6, 11, 26, 23- *Rhododendron lanatum* Hook.f.; 9, 21, 26- *Rhododendron hodgsonii* Hook.f.; 4, 10, 13, 16- *Rhododendron fulgens* Hook.f.; 1, 5, 14, 17- *Rhododendron kesangaie* D.G. Long & Rushforth

The distribution pattern and species richness along the altitudinal gradient of the Merak Himalaya

Table 5: Showing study sites, elevations, degree of slopes, vegetation types, and number of species in each community

Study Sites	Altitude (m)	Degree of Slope	Vegetation	Number of Species		
				Tree	Shrubs	Herbs
Plot 1	3320	Flat	Riverine forest	3	6	17
Plot 2	3420	Slope <45°		4	4	4
Plot 3	3520			3	1	6
Plot 4	3620	Slope >45°	Fir-Rhododendron woodland forest	2	1	4
Plot 5	3720			1	2	3
Plot 6	3820			1	1	5
Plot 7	3920		Juniper scrub forest	2		4
Plot 8	4020	Slope ≤45°		1		7
Plot 9	4120		Rhododendron krummholz		1	8
Plot 10	4220				1	9
Plot 11	4320	Slope >50°	Alpine meadow		1	9
Plot 12	4510				1	10

Figure 6: Graphical representation of plant (herbs, shrubs & trees) distribution patterns along the altitudinal gradient of the Jomokungkhar Trail



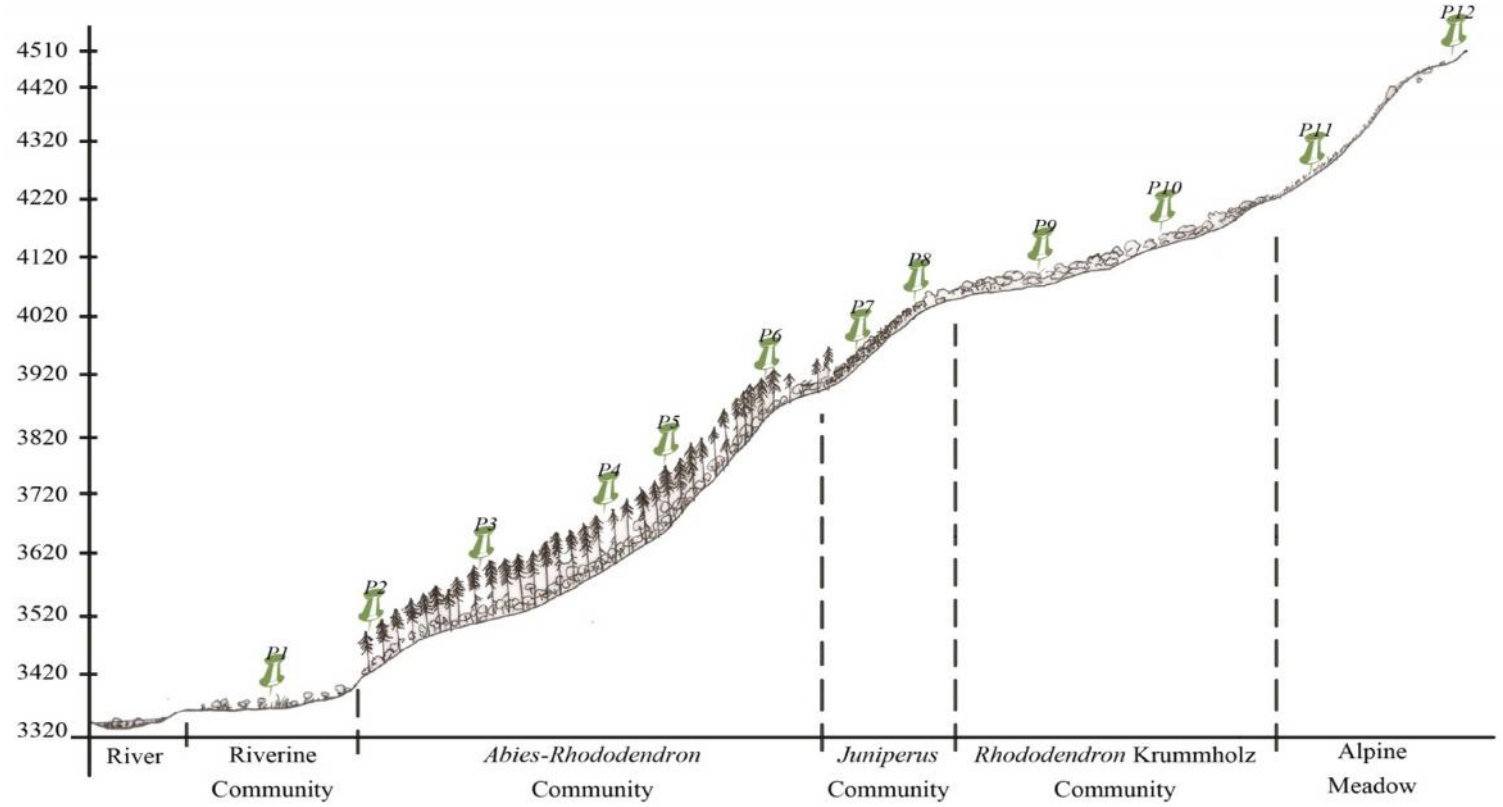


Figure 7: Schematic profile of vegetation communities occurring along the altitudinal gradient of the Jomokungkhar Trail in the Merak Himalaya

CHAPTER IV

DISCUSSION

Taxonomic Diversity/Species Richness VS Vegetation Type

111 species (excluding 10 unidentified species) of vascular plants belonging to 38 families and 72 genera were recorded from twelve study sites that were identified along the Jomokungkhar Trail of the Merak Himalaya. It is expected that over 200 species of vascular plats can be recorded from this area, although no comparable survey of the same kind has been conducted before. This presumption is based on the fact that plot sampling and observable species may have overlooked in the present study due to limited time spent in the field, manpower, and inaccessibility of some areas due to geographical and weather conditions. On the other hand, in the general survey of Sakteng Wildlife Sanctuary conducted in 2005 by Adhikari, only 203 species of vascular plants including herbs, shrubs, climbers, and trees were recorded. The survey has very less coverage of flora and vegetation of the Merak Himalaya, thereby, many new taxa have been recorded form the area by the current study. It gives a strong empirical support to adjudge under-sampling of the areas and indicates the existence of more plant species, possibly endemic, rare, new records or new species in the region due presence of different floristic zones within the vicinity of the sanctuary.

Species richness of communities differed significantly from each other. The riverine community showed richest diversity of herbaceous vascular plants as compared to rest of the communities, despite the influence of anthropogenic disturbances (Plate 6). Some factors like soil quality, forest productivity, flat favorable topography, and overlapping of different plant assemblages forming an ecotone of evergreen coniferous forest and mixed broadleaved forest of the lower elevational region attribute for its rich floristic diversity. When compared to rest of the communities, this community is much similar to alpine community (Figure 3) due to commonness in the species occurrences between the two communities.

The coniferous woodland community, *Abies-Rhododendron*, is the least species rich community. Adhikari (2005) reported that seedling establishment of the dominant species, *Abies densa* Griff., was thriving well under its own canopy with fairly distributed *Rhododendron* spp. in its understory. However, the fact is not the same for other shrubs and herbaceous species. With the richness of epiphytic vascular plants dwindling with increasing altitude, edaphic factor and local topography of the community also further contribute for the decline. *Abies-Rhododendron* community of the Merak Himalaya has steep slopes of 45 degree or more. Such steep topography slows down the rate of seedling establishment and makes the soil poor by easy surface runoff both during summer monsoon and winter snowfall. Another apparent factor of low diversity in such community is the anthropogenic disturbance: animal grazing, tree felling, and deliberate burning of forest/individual species (Plate 6). It is also expected that the high canopy (as high as 40 m) of *Abies densa* Griff. and broadleaved *Rhododendron* spp. in its understory obstruct the light penetration to the ground, which is required by every plant for their successful growth and propagation (Figure 5).

The *Rhododendron* krummholz/scrub (Plate 4) of the Merak Himalaya provides special conditions for the different plant species to co-exist in the same community through niche gapping. Therefore, this community also has rich diversity of herbaceous plants along with rigorous growth of *Rhododendron* L. itself. e.g. *Bistorta griffithi* (Hook.f.) Grierson (Polygonaceae), *Potentilla saundersiana* var. *caespitose* (Lehm.) Th. Wolf (Rosaceae), *Bergenia purpurascens* (Hook.f. & Thomson) Engl. (Saxifragaceae) flower in June. Within the same niche, species of the same families drawing the same nutrients, *Rheum acuminatum* Hook. f. & Thomson, *Potentilla fruticosa* var. *arbuscula* (D. Don) Maxim., and *Saxifraga hispidula* D. Don flower in August approximately within the gap of one month. However, the pride of its richness is counterbalanced by animal grazing. Palatable plants are consumed and unpalatable plants are trampled.

The alpine soil is characteristically poor in nutrients and easily degraded significantly by global climate change, grazing, human activities, and rodents (Wen et al. 2010). However, no mystical phenomenon was observed. Growth of herbaceous plants in the alpine community of the Merak Himalaya was well supported by less degree of anthropogenic disturbances and its topography. Slopes of this community are steep and over 45 degree where animals cannot access easily for grazing. There was also not any sign of impact to environment by rodents. In the Himalayan Merak, human intervention in the succession of natural alpine environment is comparatively low as long as grazing practice is void.

With regard to the species distribution along the altitudinal gradient, an unusual pattern has been obtained. In general, unimodal (hump-shaped) or monotonically decreasing pattern of plant distribution along the increasing altitude is strongly supported by many researchers both on empirical and theoretical grounds (e.g. Lomolino, 2001; Bhattarai & Vetaas, 2003; Grau et al., 2007). According to the data, the species distribution pattern of the Merak Himalaya showed neither of the abovementioned patterns, rather it changed irregularly and randomly from high to low and vice-versa clearly showing fall in the richness at mid-elevational ranges. However, richness of the trees and shrubs decreased irregularly from low to high altitude partially following the unimodal rule. This clearly indicates that the loss of herbaceous biomass in the Merak Himalaya is very high. This could be mainly due animal grazing.

Distribution Range of Plants found along the Altitudinal Gradient of the Jomokungkhar Trail

Vascular plants of the Merak Himalaya can be classified into three major groups based on their distribution range as below.

Group 1: Species with wide distribution range

Parochetus communis D.Don (Fabaceae), *Prunella vulgaris* L. (Lamiaceae), and *Hymenophyllum polyanthus* Bosch (Hymenophyllaceae) are the species widely spread around the world. Their distribution is so successful and extends far to India, China, Myanmar, Vietnam, Thailand, Malaysia, and also Europe and Africa. Records of such species in the Merak Himalaya indicate an invasion of exotic species.

Group 2: Endemic species of Bhutan

Rhododendron kesangiae D.G. Long & Rushforth, *R. bhutanense* D.G. Long & Boyes Lyon (unresolved name), and *Pinus bhutanica* Grierson, D.G. Long & C.N. Page are endemic to Bhutan and are found in Sakteng Wildlife Sanctuary. Among those, the two species of *Rhododendron* L. are found in the Merak Himalaya. With the high mountains and other physical factors limiting the distribution of species (Cox and Moore, 2010), the Himalayan Merak may be housing more endemic species constituting its oroboreal flora.

Group 3: Species distributed along the Himalayan Range

Of the total vascular plants recorded from the Merak Himalaya, ca. 91% of them are Himalayan elements. Most of them are distributed along the Himalayan Ranges of India, Nepal, Bhutan, and China. Distribution of some species, *Senecio raphanifolius* Wall. ex DC, *Parsicaria nepalensis* (Meisn.) Miyabe, *Rumex nepalensis* Spreng etc., extends from the Himalayan Ranges to Myanmar. The distribution of *Juniperus recurva* Buch.-Ham.ex.D.Don, *Juniperus squamata* Buch.-Ham.ex.D.Don, *Cynoglossum zeylanucum* (Lehm.) Brand etc. (Appendix 2) is concentrated more towards the west Himalaya than the East. It is expected that their center of distribution is to the West.

Conservation and Recommendations

A tremendous effort has been put by the management of Sakteng Wildlife Sanctuary to preserve the pristine natural environment of the region since its inception in 2003. Further, in view of identifying ecologically important areas and protecting them, SWS was divided into four functional zones: core zone, multiple-use zone, buffer zone, and recreational zone (World Wildlife Fund Bhutan and Sakteng Wildlife Sanctuary, 2011). As per the regulation of the zonation, grazing, pasture improvement, migrating herds, and logging are strictly prohibited (also see World Wildlife Fund Bhutan and Sakteng Wildlife Sanctuary, 2011). Despite the strict regulations in place, grazing practices and trespassing of animal migrations are still seen around the Jomophodrang core zone. Such activities if continued would pose threat to the fragile alpine ecosystem, where growth of many species, e.g. *Panax pseudogensing* Wall., is confined to a very small restricted habitat. It will also accelerate displacement and removal of other rare species in the area and might extend far into the web of ecological interactions within the ecosystem. Total protection of ecosystem would be difficult as long as the anthropogenic pressure persists.

Everywhere on the earth, human activities are sole cause for the destruction of natural ecosystem. The modern economic development particularly the motor road (Plate 6) has both direct and indirect impacts on the natural environment. Further, it may cause increased habitation, habitat fragmentation, logging, and introduction of invasive alien species. SWS is likely to face an unprecedented human disturbance like camping and hiking as it is now open to the tourists. Therefore, more and detailed scientific research in such transitional areas should be conducted in order to obtain records of species diversity and ecological regulations to frame strong policies for effective conservation of both the nomadic culture and the fragile environment.

Possibility for the New Taxa

The Merak Himalaya has rich diversity of flora, but it is least studied. New records of taxa from both its vicinity and adjacent areas are reported recently (also see Gyeltshen et al. 2012). It is highly expected that many other new records and new taxa can possibly be discovered from the area due to the fact that most ecologically important areas remain untouched yet.

Possibly the new genus and species, yet to be identified is a member of Orchidaceae (Plate 27 E-F). Despite having morphological similarities with the genus *Galearis* Raf. or sometimes *Aochis* Verm., it deserves further taxonomic studies and authentication of the legitimate taxonomic ranking and name. The present study could not furnish enough data for this taxon due to poor collection of the specimen.

There are some other taxa, mainly *Rhododendron* sp. and *Primula* sp., whose specific epithet is difficult to confer using the regional Floras. It is possible that some among them could prove to be the new records, new species or endemics in Bhutan.

Limitations of the Study

About 10 species of angiosperms could not be identified due to lack of literatures. Specific epithet for a few species could not be determined due to poor collection of specimens or damage occurred during transportation. Some are doubtfully identified for the same reasons. The details of distribution of taxa could not be compared with the Western floras due to inaccessibility of their Floras.

Time spent in the field was limited and this study does not guarantee the complete collection of plants. As mentioned earlier, plot sampling and collections may have overlooked in ecologically important areas.

Other factors of constrain were scarce manpower for field work. Due to the study area located in the far-flung region of the country, it was difficult to find field assistants and guides. In addition, the financial implications also affected the study.

Another inevitable factor affected the field work was weather. Due to lack of meteorological facility in the region, no weather forecast information was accessible. Many a time, field visits were just a no-win expedition due to irregularly changing alpine weather.

CHAPTER V

SUMMARY

Study on the diversity of vascular plants along the altitudinal gradient of the Jomokungkhar Trail in Merak was conducted with an aim to obtain precise data/information on the flora and vegetation of the area. The plant specimens collected from the area are identified using available Floras and compared with pictures of online herbarium specimens of Royal Botanic Garden, Edinburgh. 101 species out of 111 are described in order to make identification of the same easier in future. Descriptions for ten species could not be enumerated due to poor collection or partial destruction to the specimens. The vegetation of the area was classified into five communities based on species abundances and habitats. Each of them is described in detail and few are represented in profile diagrams (Figures 4 & 5). Schematic profile diagram for the overall vegetation composition is also given (Figure 7).

In terms of richness based on habit/life forms, 72% of vegetation of the Merak Himalaya is composed of herbaceous plants. Rests are trees (13%), shrubs (8%), ferns (5%), and climbers/creepers (2%) (Figure 2). Distribution pattern of these species along the altitudinal gradient was unique. The overall distribution was high at the lowest and the highest elevations, clearly showing the fall in mid elevation ranges (Figure 6).

Out of 38 families, Ericaceae was the biggest family found in the area and *Rhododendron* L. with 14 species was the biggest genus among 72 genera. Therefore, most common species encountered along the trail of Jomokungkhar Trail are *Rhododendron* spp.

On the analysis of the distribution ranges of each species, many species (91%) were found to be the Himalayan elements (native/endemic). However, distribution of a few species was restricted towards the western Himalaya indicating their center of distribution to the West or even far. Nine percent of species had wide distribution range spreading from extreme East to the extreme West of the earth.

Thus, it can be concluded that presence of these species indicates exotic invasion and the beginning of displacement of native species.

Despite so many constrains encountered, objectives of this study are well addressed. The updated plant checklist of the area is obtained, plant species are described, and vegetation composition and patterns are clearly explained along with the pictures and diagrams.



Plate 1: A. The Riverine Community; B. Some dominating species of the Riverine Community



Plate 2: *Abies – Rhododendron* Community



Plate 3: *Juniperus* Scrub Community



Plate 4: *Rhododendron* Krummholz Community



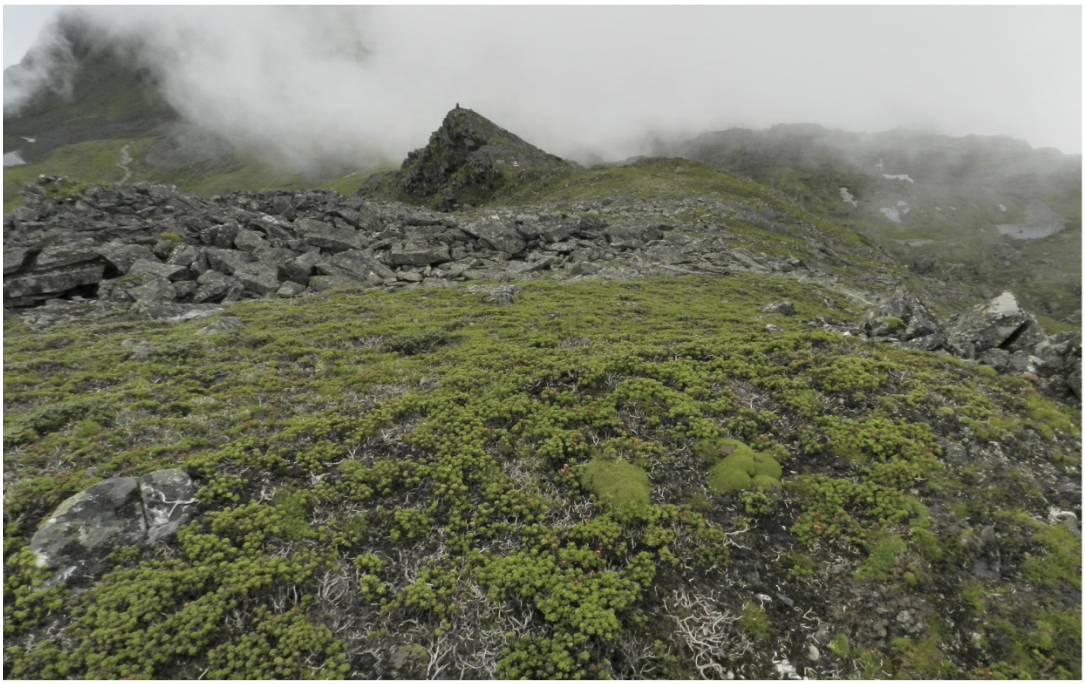


Plate 5: Alpine Meadow



Plate 6: A–E. Anthropogenic activities; F. Landslide along the sloped of Fir-Rhododendron Forest



Plate 7: A. *Anaphalis adnata* DC.; B. *Anaphalis nepalensis* var. *monocephala* (DC.) Hand.-Mazz.; C. *Cicerbita* sp.; D. *Crematodium renoforme* (DC.) Benth.; E. *Ligularia fischeri* Turz.; F. *Anaphalis* sp.

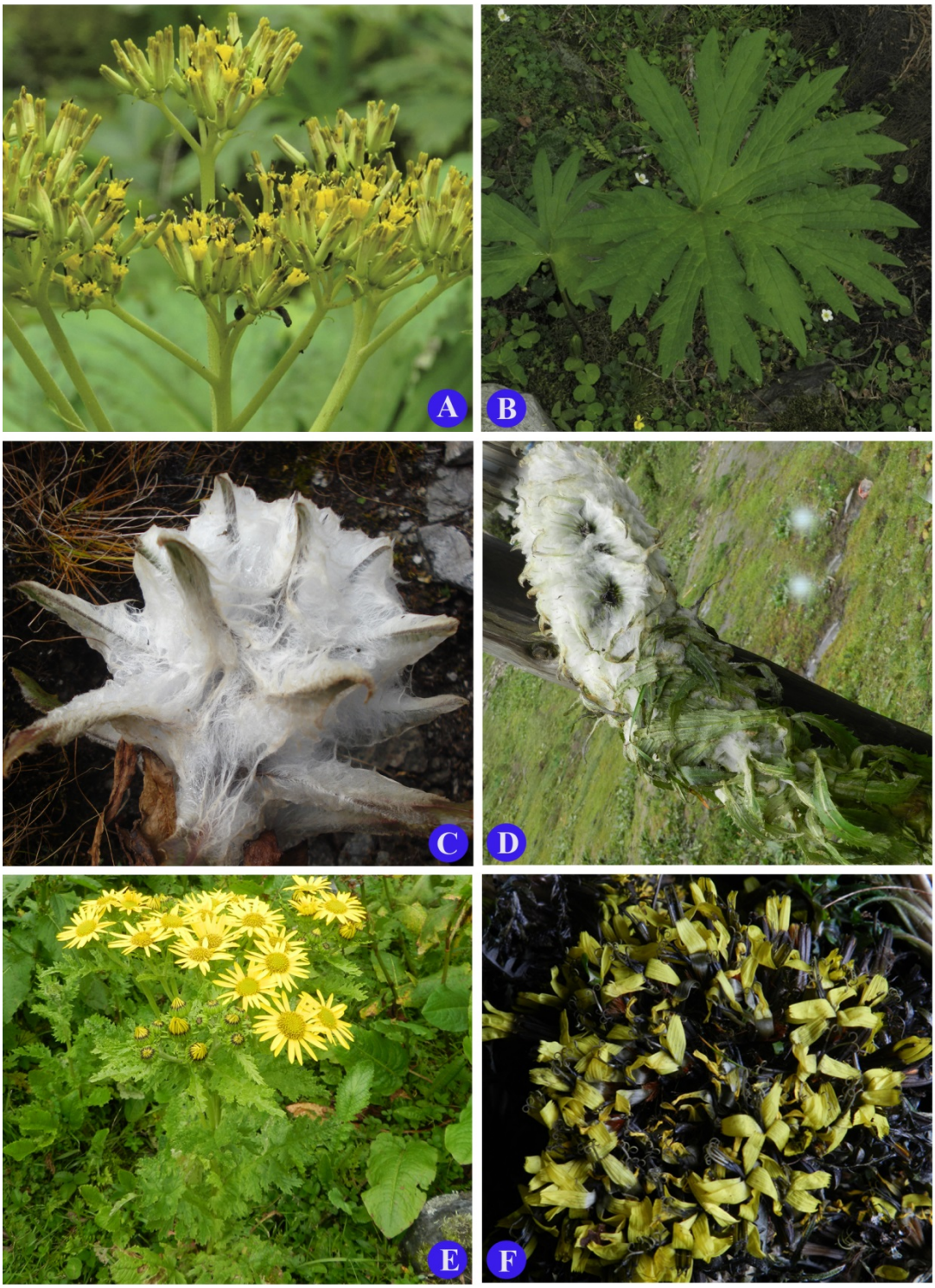


Plate 8: A-B. *Parasenecio* sp.; C-D. *Saussurea gossypiphora* D.Don; E. *Senecio raphanifolius* Wall. ex DC.; F. *Soroseris hookeriana* Stebbins



Plate 9: A-B. *Fragaria daltoniana* J.Gay; C-D. *Fragaria nubicola* (Hook.f.) Lindl.; E-F. *Rosa sericea* Lindl.



Plate 10: A. *Potentilla fruticosa* var. *arbuscula* (D. Don) Maxim.; B. *Potentilla* sp.; C. *Potentilla coriandrifolia* D. Don; D. *Potentilla saundersiana* var. *caespitosa* (Lehm.) Th. Wolf; E. *Potentilla microphylla* D.Don; F. *Rumex nepalensis* Spreng.



Plate 11: A. *Bistorta vacciniifolia* Greene; B. *Bistorta griffithii* (Hook.f.) Grierson; C. *Bistorta* sp.; D. *Bistorta macrophylla* (D.Don) Soják; E. *Rheum acuminatum* Hook.f. & Thomson; F. *Aconogonon campanulatum* (Hook.f.) Hara



Plate 12: A. *Persicaria nepalensis* (Meisn.) Miyabe; B. *Phlomis tibetica* C.Marquand; C. *Prunella vulgaris* L.; D. *Clinopodium umbrosum* (M.Bieb.) Kuntze; E. *Parochetus communis* Buch.; F. *Trifolium repens* L.

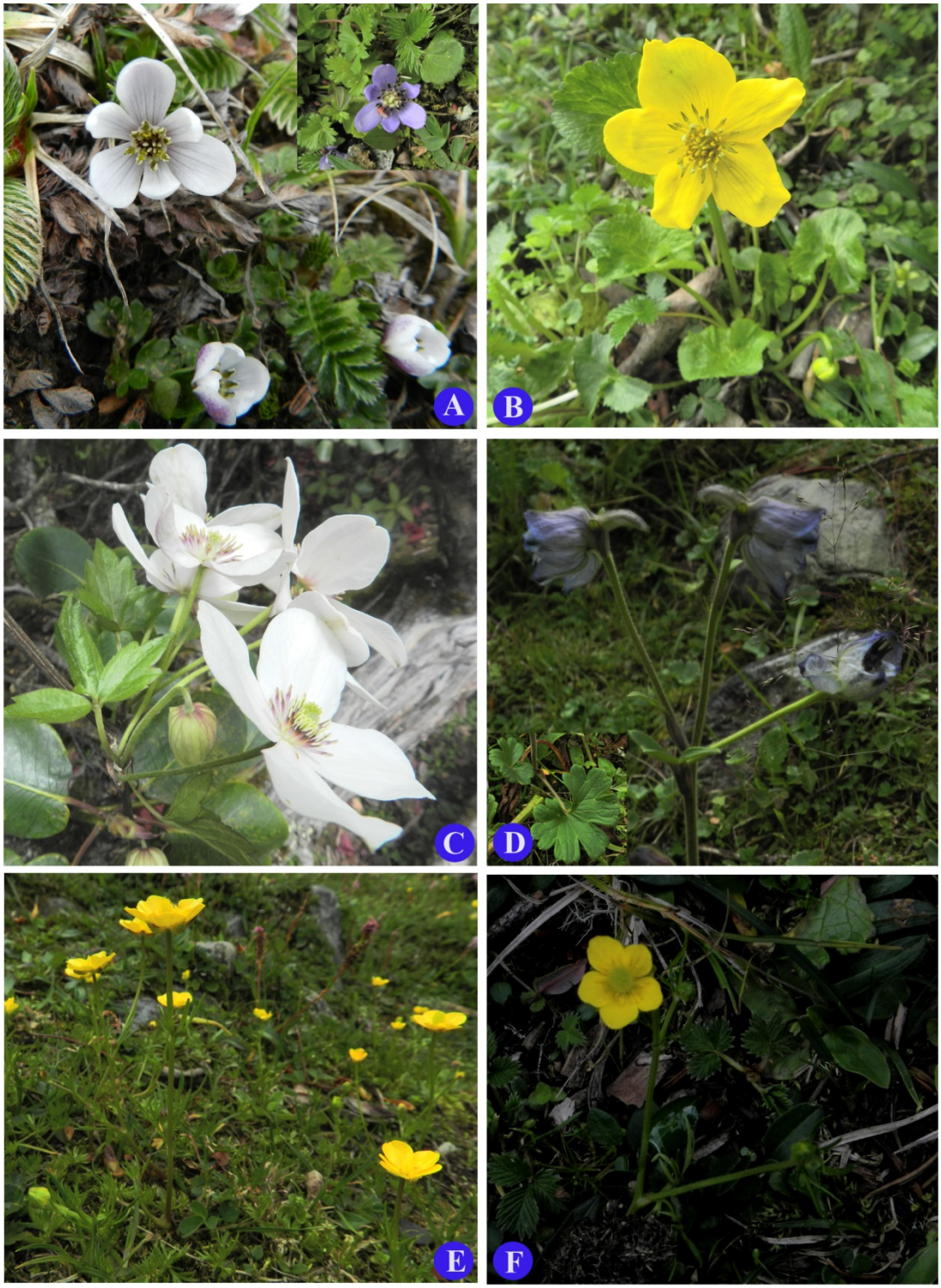


Plate 13: A. *Anemone rupestris* Wall.; B. *Caltha palustris* L.; C. *Clematis montana* Buch.-Ham. ex DC.; D. *Delphinium viscosum* Hook.f. & Thomson; E. *Ranunculus brotherusii* Freyn; F. *Ranunculus* sp.



Plate 14: A. *Oxygraphis endlicheri* (Walp.) Bennet & Sum.Chandra; B. *Primula dickieana* Watt.; C. *Primula* sp.; D. *Primula capitata* Hook.; E. *Primula gambeliana* Watt.; F. *Primula primulina* (Spreng.) Hara



Plate 15: A. *Primula glabra* Klatt; B. *Primula deuteronana* Craib; C-D. *Gentiana prostrata* var. *karelinii* (Griseb.) Kusn.; E. *Gentiana capitata* Buch., Ham. ex D.Don; F. *Gentiana sikkimensis* C.B.Clarke



Plate 16: A. *Halenia elliptica* D.Don; B. *Swertia assamensis* Harry Sm.; C. *Berberis angulosa* Wall. ex Hook.f. & Thomson; D. *Berberis virescens* Hook.f.; E. *Meconopsis paniculata* Prain; F. *Corydalis crispa* Prain

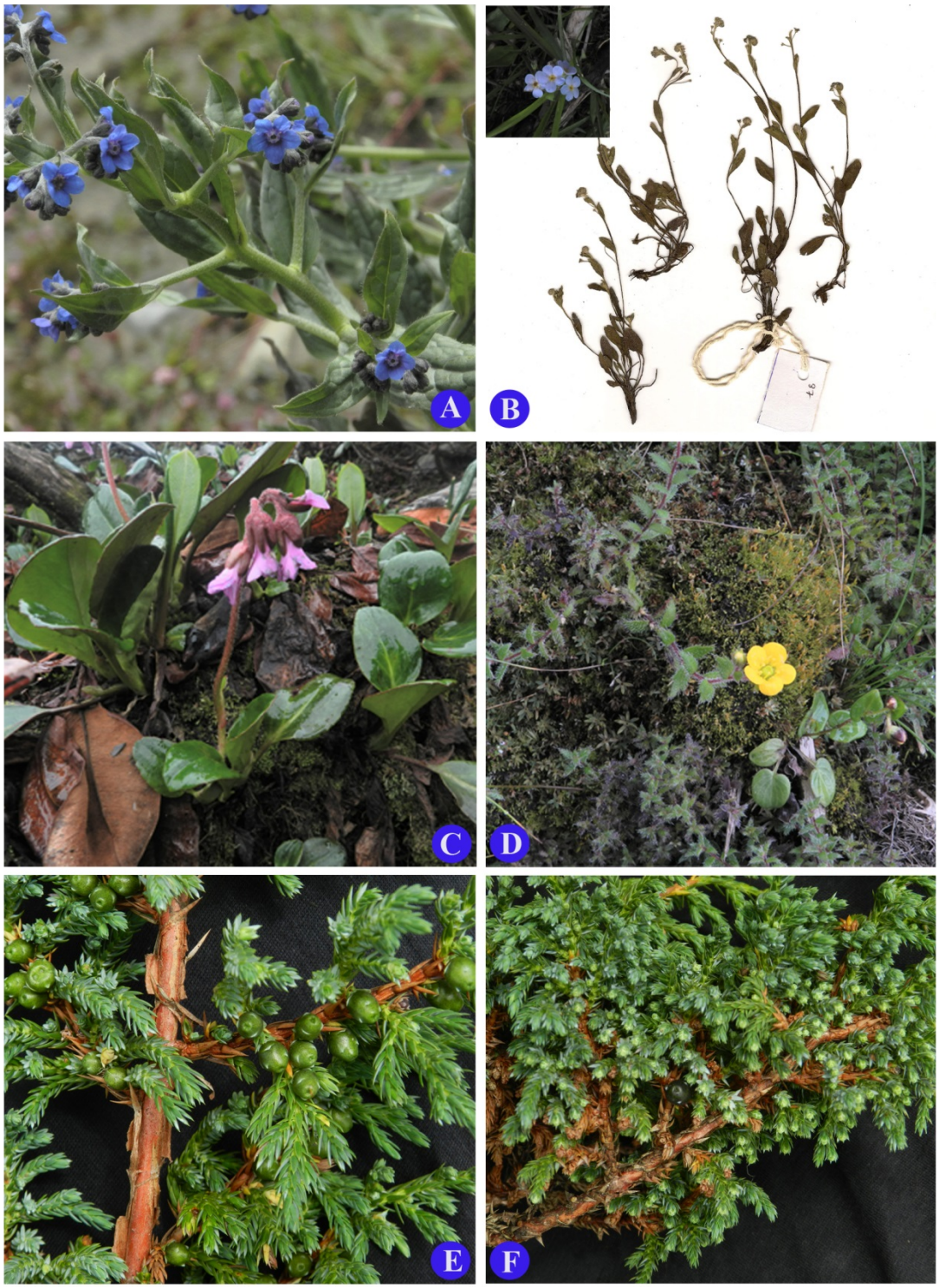


Plate 17: A. *Cynoglossum zeylanicum* (Lehm.) Brand; B. *Setulocarya diffusa* (Brand) R.R. Mill & D.G. Long; C. *Bergenia purpurascens* (Hook.f. & Thomson) Engl.; D. *Saxifraga hispidula* D.Don; E. *Juniperus recurva* Buch.-Ham. ex D.Don; F. *Juniperus squamata* Buch.-Ham. ex D.Don



Plate 18: A. *Abies densa* Griff.; B. *Larix griffithii* Hook.f.; C. *Geranium donianum* Sweet; D. *Geranium nepalense* Sweet; E. *Lloydia flavonutans* Hara; F. *Oxalis leucolepis* Diels



Plate 19: A. *Rhododendron thomsonii* Hook.f.; B. *Rhododendron cinnabarinum* Hook.f.; C. *Rhododendron campylocarpum* Hook.f.; D. *Rhododendron lanatum* Hook.f.; E. *Rhododendron fulgens* Hook.f.; F. *Rhododendron argipeplum* Balf.f. & R.E.Cooper



Plate 20: A-B. *Rhododendron hodgsonii* Hook.f.; C. *Rhododendron campanulatum* subsp. *aeruginosum* Hook.f.; D-F. *Rhododendron bhutanense* D.G.Long & Bowes Lyon



Plate 21: A. *Rhododendron* sp.; B-C. *Rhododendron kesangiae* D.G.Long & Rushforth; D. *Rhododendron setosum* D. Don; E. *Rhododendron nivale* Hook.f.; F. *Rhododendron anthopogon* var. *haemonium* (Balf. f. & R.E. Cooper) Cowan & Davidian



Plate 22: A. *Gaultheria trichophylla* Royle.; B. *Gaultheria pyroloides* Hook.f. & Thomson ex Miq.; C. *Cassiope selaginoides* Hook.f. & Thomson; D. *Diapensia himalaica* Hook.f. & Thomson; E. *Chusua pauciflora* (Lindl.) P.F.Hunt; F. *Satyrium nepalense* var. *ciliatum* (Lindl.) Hook.f.

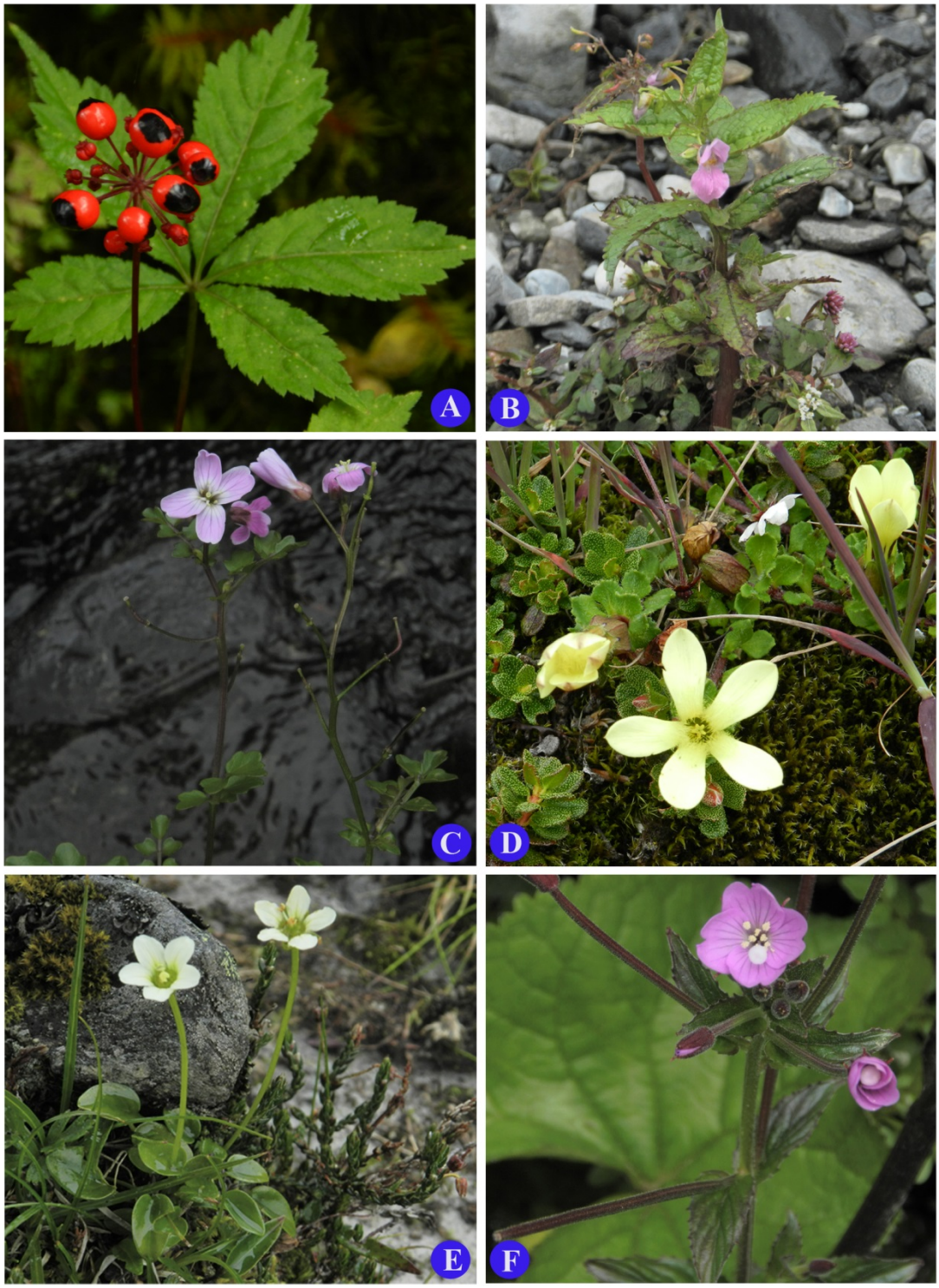


Plate 23: A. *Panax pseudoginseng* Wall.; B. *Impatiens laxiflora* Edgew.; C. *Cardamine griffithii* Hook.f. & Thomsom; D. *Cyananthus macrocalyx* subsp. *spathulifolius* (Nannf.) K.K. Shrestha.; E. *Parnassia chimense* Franch.; F. *Epilobium goudii* P.H. Raven



Plate 24: A. *Arenaria densissima* Wall.; B. *Silene nigrescens* (Edgew.) Majumdar; C. *Stellaria sikkimensis* Hook.f.; D. *Hemiphragma heterophyllum* Wall.; E. *Oreosolen wattii* Hook.f.; F. *Pedicularis siphonantha* D. Don



Plate 25: A. *Myricaria rosea* W.W. Sm.; B. *Viola biflora* L.; C. *Arisaema elephas* Buchet; D. *Lepisorus contortus* (H. Christ) Ching; E-F. *Polystichum* sp.

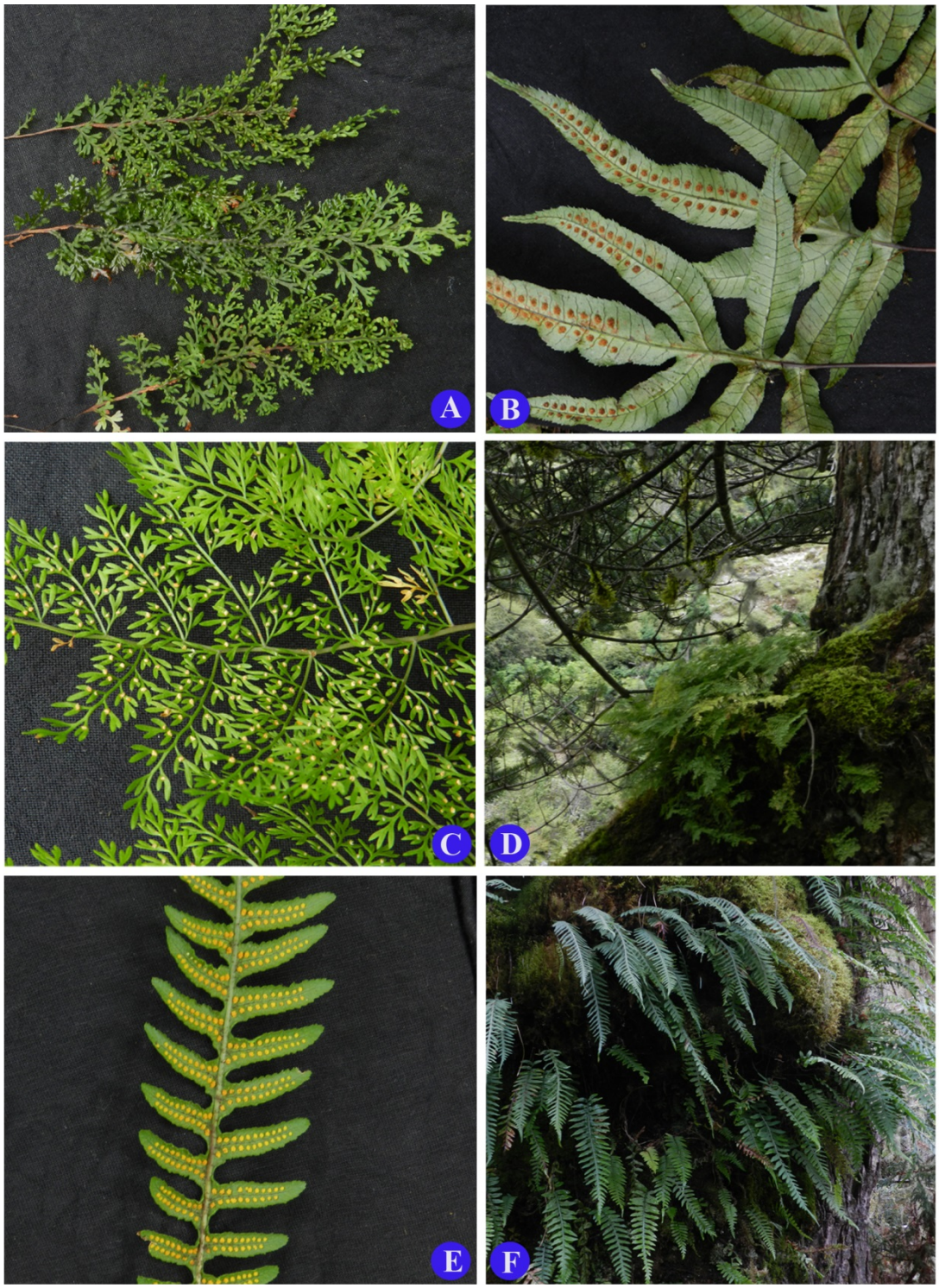


Plate 26: A. *Hymenophyllum polyanthos* Bosch; B. *Phymatopteris ebenipes* (Hook.) Pic. Serm.; C-D. *Araiostegia faberiana* (C. Chr.) Ching; E-F. *Prosaptia* sp.



Plate 27: A.*Potentilla cuneate* Wall. ex Lehm.; B. *Potentilla monanthes* var. *sibthorpiodes* Hook.f.; C. *Juncus* sp 1; D. *Juncus* sp 2; E-F. Unknown sp. (Orchidaceae)

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Appendix 1: List of vascular plants occurring along the Jomokungkhar Trail and their abundances.

Family	Scientific Name	Habit	Study Plots												Voucher
			1	2	3	4	5	6	7	8	9	10	11	12	
Monilophytes															
Davalliaceae	*Araiostegia faberiana* (C. Chr.) Ching	E. Fern		2											K.J[1], K.D, T.G. 178
Dryopteridaceae	*Polystichum* sp.	T. Fern		2											K.J, K.D[2], T.G. 176
Hymenophyllaceae	*Hymenophyllum polyanthos* Bosch	L. Fern	2												K.J, K.D, T.G[3]. 174
Polypodaceae	*Lepisorus contortus* (H. Christ) Ching.	E. Fern	2												K.J, K.D, T.G. 173
	Phymatopteris ebenipes (Hook.) Pic. Serm.	E. Fern	1												K.J, K.D, T.G. 177
	Prosaptia sp.	E. Fern		2											K.J, K.D, T.G. 179
Eudicots															
Araliaceae	*Panax pseudoginseng* Wall.	Herb		1											K.J, K.D, T.G. 185
Asteraceae	*Anaphalis adnata* DC.	Herb	2												K.J, K.D, T.G. 129
	Anaphalis nepalensis var. *monocephala* (DC.) Hand.-Mazz.	Herb												1	K.J, K.D, T.G. 150
	Anaphalis sp.	Herb	2												K.J, K.D, T.G. 86
	Cicerbita sp.	Herb	*												K.J, K.D, T.G. 183
	Cremanthodium reniforme (DC.) Benth.	Herb									*				K.J, K.D, T.G. 159

[1] Karma Jamtsho
[2] Kezang Duba
[3] Tashi Gyeltshen

Appendix 1: List of vascular plants occurring along the Jomokungkhar Trail and their abundances.

Family	Scientific Name	Habit	Study Plots												Voucher
			1	2	3	4	5	6	7	8	9	10	11	12	
	Ligularia fischeri Turcz.	Herb	7												K.J, K.D, T.G. 127
	Parasenecio sp.	Herb			3										K.J, K.D, T.G. 170
	Saussurea gossypiphora D.Don.	Herb												2	K.J, K.D, T.G. 172
	Senecio raphanifolius Wall. ex DC	Herb	8												K.J, K.D, T.G. 126
	Soroseris hookeriana Stebbins	Herb												2	K.J, K.D, T.G. 171
Balsaminaceae	*Impatiens laxiflora* Edgew.	Herb	1												K.J, K.D, T.G. 146
Berberidaceae	*Berberis angulosa* Wall. ex Hook.f. & Thomson	Shrub								2					K.J, K.D, T.G. 116
	Berberis virescens Hook.f.	Shrub	2												K.J, K.D, T.G. 120
Boraginaceae	*Cynoglossum zeylanicum* (Lehm.) Brand	Herb	1												K.J, K.D, T.G. 145
	Setulocarya diffusa (Brand) R.R. Mill & D.G. Long	Herb	1												K.J, K.D, T.G. 87
Brassicaceae	*Cardamine griffithii* Hook.f. & Thomson	Herb	3												K.J, K.D, T.G. 85
Campanulaceae	*Cyananthus macrocalyx* subsp. *Spathulifolius* (Nannf.) K.K. Shrestha	Herb										3	7		K.J, K.D, T.G. 153
Caryophyllaceae	*Arenaria densissima* Wall.	Herb											2		K.J, K.D, T.G. 94
	Silene nigrescens (Edgew.) Majumdar	Herb	3												K.J, K.D, T.G. 133
	Stellaria sikkimensis Hook.f.	Herb			1										K.J, K.D, T.G. 142

Appendix 1: List of vascular plants occurring along the Jomokungkhar Trail and their abundances.

Family	Scientific Name	Habit	Study Plots												Voucher
			1	2	3	4	5	6	7	8	9	10	11	12	
Celastraceae	*Parnassia chinensis* Franch.	Herb									2				K.J, K.D, T.G. 160
Diapensiaceae	*Diapensia himalaica* Hook.f. & Thomson	Herb											4		K.J, K.D, T.G. 92
Ericaceae	*Cassiope selaginoides* Hook.f. & Thomson	Herb							2	3				2	K.J, K.D, T.G. 105
	Gaultheria pyroloides Hook.f. & Thomson ex Miq.	Herb							2	3					K.J, K.D, T.G. 106
	Gaultheria trichophylla Royle.	Herb							2	2					K.J, K.D, T.G. 107
	Rhododendron anthopogon var. *haemonium* (Balf. f. & R.E Cooper) Cowan & Davidian	Shrub									2				K.J, K.D, T.G. 111
	Rhododendron argipeplum Balf.f. & R.E.Cooper	Tree				3									K.J, K.D, T.G. 66
	Rhododendron bhutanense D.G. Long & Bowes Lyon	Tree								2					K.J, K.D, T.G. 109
	Rhododendron campanulatum subsp. *aeruginosum* (Hook. f.) D.F. Chamb.	Tree									5	10	3		K.J, K.D, T.G. 115
	Rhododendron campylocarpum Hook.f.	Tree	7												K.J, K.D, T.G. 122
	Rhododendron cinnabarinum Hook.f.	Tree					1								K.J, K.D, T.G. 117
	Rhododendron fulgens Hook.f.	Tree								6					K.J, K.D, T.G. 78

Appendix 1: List of vascular plants occurring along the Jomokungkhar Trail and their abundances.

Family	Scientific Name	Habit	Study Plots												Voucher
			1	2	3	4	5	6	7	8	9	10	11	12	
	Rhododendron hodgsonii Hook.f.	Tree				7									K.J, K.D, T.G. 69
	Rhododendron kesangiae D.G. Long & Rushforth	Tree			3										K.J, K.D, T.G. 67
	Rhododendron lanatum Hook.f.	Tree				4									K.J, K.D, T.G. 72
	Rhododendron nivale Hook.f.	Shrub						2							K.J, K.D, T.G. 169
	Rhododendron setosum D.Don	Shrub									2	2	7	8	K.J, K.D, T.G. 97
	Rhododendron thomsonii Hook.f.	Tree						4							K.J, K.D, T.G. 75
	Rhododendron sp.	Tree							3						K.J, K.D, T.G. 79
Fabaceae	*Parochetus communis* D.Don	Herb	2	2	2	2	2	2							K.J, K.D, T.G. 134
	Trifolium repens L.	Herb	3	2		2	1								K.J, K.D, T.G. 124
Gentianaceae	*Gentiana capitata* Buch., Ham. ex D.Don	Herb	1												K.J, K.D, T.G. 62
	Gentiana prostrate var. *karelinii* (Griseb.) Kusn.	Herb		1			1	1							K.J, K.D, T.G. 168
	Gentiana sikkimensis C.B Clarke	Herb		2											K.J, K.D, T.G. 180
	Halenia elliptica D.Don	Herb	3												K.J, K.D, T.G. 135
	Swertia assamensis Harry Sm.	Herb									5				K.J, K.D, T.G. 162
Geraniaceae	*Geranium donianum* Sweet	Herb	2	2	1	1									K.J, K.D, T.G.124(a)
	Geranium nepalense Sweet	Herb	2												K.J, K.D, T.G.136

Appendix 1: List of vascular plants occurring along the Jomokungkhar Trail and their abundances.

Family	Scientific Name	Habit	Study Plots												Voucher
			1	2	3	4	5	6	7	8	9	10	11	12	
Lamiaceae	*Clinopodium umbrosum* (M.Bieb.) Kuntze	Herb	2												K.J, K.D, T.G. 130
	Phlomis tibetica C.Marquand & Airy Shaw	Herb		*											K.J, K.D, T.G. 144
	Prunella vulgaris L.	Herb	2												K.J, K.D, T.G. 125
Onagraceae	*Epilobium gouldii* P.H.Raven	Herb	2												K.J, K.D, T.G. 138
Orobanchaceae	*Pedicularis siphonantha* D.Don	Herb	4	2	2	2									K.J, K.D, T.G. 140
Oxalidaceae	*Oxalis leucolepis* Diels	Herb	2	1	1										K.J, K.D, T.G. 131
Papavaraceae	*Corydalis crispa* Prain	Herb	2												K.J, K.D, T.G. 137
	Meconopsis paniculata Prain	Herb	*												K.J, K.D, T.G. 123
Plantaginaceae	*Hemiphragma heterophyllum* Wall.	Herb			1										K.J, K.D, T.G. 73
Polygonaceae	*Aconogonon campanulatum* (Hook.f.) Hara	Creeper				2									K.J, K.D, T.G. 143
	Bistorta griffithii (Hook.f.) Grierson	Herb								1	1				K.J, K.D, T.G. 110
	Bistorta macrophylla (D.Don) Soják	Herb	2	2		2	2								K.J, K.D, T.G. 61
	Bistorta vacciniifolia Greene	Herb										3			K.J, K.D, T.G. 158
	Bistorta sp.	Herb										1	3		K.J, K.D, T.G. 186
	Persicaria nepalensis (Meisn.) Miyabe	Herb	2												K.J, K.D, T.G. 139
	Rheum acuminatum Hook.f. & Thomson	Herb								2					K.J, K.D, T.G. 167
	Rumex nepalensis Spreng.	Herb	7												K.J, K.D, T.G. 128

Appendix 1: List of vascular plants occurring along the Jomokungkhar Trail and their abundances.

Family	Scientific Name	Habit	Study Plots												Voucher
			1	2	3	4	5	6	7	8	9	10	11	12	
Primulaceae	*Primula capitata* Hook.	Herb									2				K.J, K.D, T.G. 163
	Primula deuteronana Craib	Herb			2	2	2								K.J, K.D, T.G. 74
	Primula dickieana Watt, J. Linn. Soc.	Herb										2			K.J, K.D, T.G. 100
	Primula gambeliana Watt	Herb										2			K.J, K.D, T.G. 98
	Primula glabra Klatt	Herb			1						2	2			K.J, K.D, T.G. 71
	Primula primulina Spreng.	Herb									2				K.J, K.D, T.G. 164
	Primula sp.	Herb											2		K.J, K.D, T.G. 93
Ranunculaceae	*Anemone rupestris* Wall.	Herb						1							K.J, K.D, T.G. 77
	Caltha palustris L.	Herb				2									K.J, K.D, T.G. 119
	Clematis montana Buch.	Climber					1								K.J, K.D, T.G. 102
	Delphinium viscosum Hook.f. & Thomson	Herb	2												K.J, K.D, T.G. 141
	Oxygraphis endlicheri (Walp.) Bennet & Sum. Chandra	Herb	2	2	2	2	2	2	7						K.J, K.D, T.G. 65
	Ranunculus brotherusii Freyn	Herb	2												K.J, K.D, T.G. 80
	Ranunculus sp.	Herb	1												K.J, K.D, T.G. 88
Rosaceae	*Fragaria daltoniana* J.Gay	Herb	2		2										K.J, K.D, T.G. 76
	Fragaria nubicola (Hook. f.) Lindl. ex Lacaita	Herb	2												K.J, K.D, T.G. 60

Appendix 1: List of vascular plants occurring along the Jomokungkhar Trail and their abundances.

Family	Scientific Name	Habit	Study Plots												Voucher
			1	2	3	4	5	6	7	8	9	10	11	12	
	Potentilla coriandrifolia D.Don	Herb								2	2	4	1		K.J, K.D, T.G. 154
	Potentilla cuneata Wall. ex Lehm.	Herb	2												K.J, K.D, T.G. 82
	Potentilla fruticosa var. *arbuscula* (D. Don) Maxim.	Shrub									6				K.J, K.D, T.G. 161
	Potentilla microphylla D.Don	Herb											5		K.J, K.D, T.G. 96
	Potentilla monanthes var. *sibthorpiodes* Hook.f.	Herb	2												K.J, K.D, T.G. 64
	Potentilla saundersiana var. *caespitosa* (Lehm.) Th. Wolf	Herb								2					K.J, K.D, T.G. 112
	Potentilla sp.	Herb						2							K.J, K.D, T.G. 103
	Rosa sericea Lindl.	Shrub	1	1	1										K.J, K.D, T.G. 101
Saxifragaceae	*Bergenia purpurascens* (Hook.f. & Thomson) Engl.	Herb								2	2		2		K.J, K.D, T.G. 114
	Saxifraga hispidula D.Don	Herb									1				K.J, K.D, T.G. 166
Scrophulariaceae	*Oreosolen wattii* Hook. f.	Herb												2	K.J, K.D, T.G. 90
Tamaricaceae	*Myricaria rosea* W.W.Sm.	Shrub	9												K.J, K.D, T.G. 121
Violaceae	*Viola biflora* L.	Herb	2												K.J, K.D, T.G. 81

Appendix 1: List of vascular plants occurring along the Jomokungkhar Trail and their abundances.

Family	Scientific Name	Habit	Study Plots												Voucher
			1	2	3	4	5	6	7	8	9	10	11	12	
Monocots															
Araceae	*Arisaema elephas* Buchet	Herb			1										K.J, K.D, T.G. 118
Juncaceae	*Jancus* sp.	Herb												1	K.J, K.D, T.G. 152
	Jancus sp.	Herb												1	K.J, K.D, T.G. 152(a)
Liliaceae	*Lloydia flavonutans* Hara	Herb								2					K.J, K.D, T.G. 108
Orchidaceae	*Chusua pauciflora* (Lindl.) P.F.Hunt	Herb	2	2											K.J, K.D, T.G. 147
	Satyrium nepalense var. *ciliatum* (Lindl.) Hook.f.	Herb	2	2											K.J, K.D, T.G. 184
Pinopsida															
Cupressaceae	*Juniperus recurva* Buch.-Ham. ex D.Don	Tree	1	4					9	9		3	1		K.J, K.D, T.G. 181
	Juniperus squamata Buch.-Ham. ex D.Don	Tree		4					8	8		2			K.J, K.D, T.G. 182
Pinaceae	*Abies densa* Griff.	Tree		9	9	9	9	9	4	3					K.J, K.D, T.G. 175
	Larix griffithii Hook.f.	Tree	2												K.J, K.D, T.G. 165

E.F.- Epiphytic Fern; L. F.- Lithophytic Fern; T. F.- Terrestrial Fern

Appendix 2: Distribution ranges of plant species found along the altitudinal gradient of Jomokungkhar trail in Sakteng Wildlife Sanctuary.

Family	Species	PaK	AfG	InD	NeP	Chi	MyM	MoG	RuS	SrL	Tha	Vie	Mal
Monilophytes													
Hymenophyllaceae	*Hymenophyllum polyanthos* Bosch	x	x	x	x	x	x	x	x	x	x	x	x
Davalliaceae	*Araiostegia faberiana* (C. Chr.) Ching					x	x						
Polypodaceae	*Lepisorus contortus* (H. Christ) Ching.			x	x	x							
	Phymatopteris ebenipes (Hook.) Pic. Serm.			x		x							
Eudicots													
Asteraceae	*Anaphalis adnata* DC.	x		x	x	x							
	Anaphalis nepalensis var. *monocephala* (DC.) Hand.-Mazz.			x	x								
	Cremanthodium reniforme (DC.) Benth.			x	x	x							
Asteraceae	*Saussurea gossypiphora* D.Don.	x		x	x	x							
	Senecio raphanifolius Wall. ex DC			x	x	x	x						
	Soroseris hookeriana Stebbins			x	x	x							
Balsaminaceae	*Impatiens laxiflora* Edgew.			x	x	x							
Berberidaceae	*Berberis angulosa* Wall. ex Hook.f. & Thomson			x	x	x							
	Berberis virescens Hook.f.			x		x							
Boraginaceae	*Cynoglossum zeylanicum* (Lehm.) Brand	x	x	x		x							
	Setulocarya diffusa (Brand) R.R. Mill & D.G. Long												

Appendix 2: Distribution ranges of plant species found along the altitudinal gradient of Jomokungkhar trail in Sakteng Wildlife Sanctuary.

Family	Species	PaK	AfG	InD	NeP	Chi	MyM	MoG	RuS	SrL	Tha	Vie	Mal
Brassicaceae	*Cardamine griffithii* Hook.f. & Thomson			x	x								
Campanulaceae	*Cyananthus macrocalyx* subsp. *spathulifolius* (Nannf.) K.K. Shrestha			x	x	x							
Caryophyllaceae	*Arenaria densissima* Wall.			x	x	x							
	Silene nigrescens (Edgew.) Majumdar			x	x	x	x						
Celastraceae	*Parnassia chinensis* Franch.			x	x	x	x						
Diapensiaceae	*Diapensia himalaica* Hook.f. & Thomson			x	x	x	x						
Ericaceae	*Cassiope selaginoides* Hook.f. & Thomson			x	x	x	x						
	Gaultheria trichophylla Royle.			x	x	x							
	Gaultheria pyroloides Hook.f. & Thomson ex Miq.				x		x						
	Rhododendron anthopogon var.*haemonium* (Balf. f. & R.E Cooper) Cowan & Davidian			x									
	Rhododendron argipeplum Balf.f. & R.E.Cooper			x		x							
	Rhododendron campanulatum subsp. *aeruginosum* (Hook. f.) D.F. Chamb.			x	x	x							
	Rhododendron campylocarpum Hook.f.			x	x	x	x						
	Rhododendron cinnabarinum Hook.f.			x	x	x							
	Rhododendron fulgens Hook.f.			x	x	x							
	Rhododendron hodgsonii Hook.f.			x	x								
	Rhododendron lanatum Hook.f.			x		x							
	Rhododendron nivale Hook.f.			x	x	x							
	Rhododendron thomsonii Hook.f.			x	x	x	x						

Appendix 2: Distribution ranges of plant species found along the altitudinal gradient of Jomokungkhar trail in Sakteng Wildlife Sanctuary.

Family	Species	PaK	AfG	InD	NeP	Chi	MyM	MoG	RuS	SrL	Tha	Vie	Mal
Fabaceae	*Parochetus communis* D.Don			x	x	x	x			x	x	x	x
Gentianaceae	*Gentiana prostrate* var. *karelinii* (Griseb.) Kusn.			x	x	x		x	x				
	Gentiana capitata Buch., Ham. ex D.Don			x	x	x	x						
	Gentiana sikkimensis C.B Clarke			x	x	x	x						
	Halenia elliptica D.Don			x	x	x	x						
	Swertia assamensis Harry Sm.			x									
Lamiaceae	*Clinopodium umbrosum* (M.Bieb.) Kuntze	x	x	x	x	x							
	Phlomis tibetica C.Marquand & Airy Shaw			x		x							
	Prunella vulgaris L.	x	x	x	x	x	x		x				
Onagraceae	*Epilobium gouldii* P.H.Raven			x		x							
Orobanchaceae	*Pedicularis siphonantha* D.Don			x	x	x							
Oxalidaceae	*Oxalis leucolepis* Diels	x			x	x							
Papavaraceae	*Corydalis crisp*a Prain					x							
	Meconopsis paniculata Prain			x	x	x							
Plantaginaceae	*Hemiphragma heterophyllum* Wall.			x	x	x							
Polygonaceae	*Aconogonon campanulatum* (Hook.f.) Hara			x	x	x	x						
	Bistorta vacciniifolia Greene	x		x	x								
	Bistorta griffithii (Hook.f.) Grierson			x		x	x						
	Bistorta macrophylla (D.Don) Soják			x	x	x							
	Persicaria nepalensis (Meisn.) Miyabe	x	x	x	x	x	x						
	Rheum acuminatum Hook.f. & Thomson			x	x	x	x						
	Rumex nepalensis Spreng.	x		x	x	x	x						

Appendix 2: Distribution ranges of plant species found along the altitudinal gradient of Jomokungkhar trail in Sakteng Wildlife Sanctuary.

Family	Species	PaK	AfG	InD	NeP	Chi	MyM	MoG	RuS	SrL	Tha	Vie	Mal
Primulaceae	*Primula dickieana* Watt			x	x	x	x						
	Primula capitata Hook.			x		x							
	Primula gambeliana Watt			x	x	x							
	Primula glabra Klatt			x	x	x	x						
	Primula deuteronana Craib			x									
	Primula primulina Spreng.			x	x	x							
Ranunculaceae	*Anemone rupestris* Wall.			x	x	x							
	*Caltha palustri*s L.			x		x							
	Clematis montana Buch.	x	x	x	x	x							
	Delphinium viscosum Hook.f. & Thomson			x	x								
	Oxygraphis endlicheri (Walp.) Bennet & Sum. Chandra	x		x	x	x							
	*Ranunculus brotherusi*i Freyn					x							
Rosaceae	*Fragaria daltoniana* J.Gay			x	x	x	x						
	Fragaria nubicola (Hook. f.) Lindl. ex Lacaita	x	x	x	x	x	x						
	Potentilla cuneata Wall. ex Lehm.			x	x	x							
	Potentilla fruticosa var. *arbuscula* (D. Don) Maxim.			x	x	x							
	Potentilla coriandrifolia D.Don			x	x	x							
	Potentilla saundersiana var. *caespitosa* (Lehm.) Th. Wolf			x	x	x							
	Potentilla microphylla D.Don			x	x	x							
	Potentilla monanthes var. *sibthorpiodes* Hook.f.	x		x	x								

Appendix 2: Distribution ranges of plant species found along the altitudinal gradient of Jomokungkhar trail in Sakteng Wildlife Sanctuary.

Family	Species	PaK	AfG	InD	NeP	Chi	MyM	MoG	RuS	SrL	Tha	Vie	Mal
Saxifragaceae	*Bergenia purpurascens* (Hook.f. & Thomson) Engl.			x	x	x	x						
	Saxifraga hispidula D.Don			x	x	x	x						
Scrophulariaceae	*Oreosolen wattii* Hook. f.			x	x								
Tamaricaceae	*Myricaria rosea* W.W.Sm.			x	x	x							
Violaceae	*Viola biflora* L.	x		x		x							
Monocots													
Araceae	*Arisaema elephas* Buchet					x	x						
Liliaceae	*Lloydia flavonutans* Hara			x	x	x							
Orchidaceae	*Chusua pauciflora* (Lindl.) P.F.Hunt			x	x	x							
	Satyrium nepalense var. *ciliatum* (Lindl.) Hook.f.			x	x	x							
Gymnosperms (Pinopsida)													
Cupressaceae	*Juniperus recurva* Buch.-Ham. ex D.Don	x		x	x	x							
	Juniperus squamata Buch.-Ham. ex D.Don	x	x	x	x	x							
Pinaceae	*Abies densa* Griff.			x	x	x							
	Larix griffithii Hook.f.			x	x	x							

Pak-Pakistan; **AfG**- Afghanistan; **InD**- India; **NeP**- Nepal; **Chi**- China; **MyM**- Myanmar; **MoG**- Mongolia; **RuS**-Russia; **SrL**-Sri Lanka; **Tha**- Thailand; **Vie**- Vietnam; **Mal**- Malaysia

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A note on the anthropogenic impacts on the native vascular plants in the Himalayan Range of Merak, Sakteng Wildlife Sanctuary, Bhutan *(Publication accepted)*