

Chapter 5
DISCUSSION
AND
ANALYSIS

5. Discussion and conclusion

The wealth of vegetation of Zemu and Lhonak Valley, particularly the richness of the flowering plants has been recognized through present study. The studied area covers about 828 sq. km. Long back Smith and Cave (1911) had recorded about 855 species of angiosperms from this region. This account is strictly restricted to the Zemu and Lhonak valley. The specimens collected from Toong, Chungthang, Tista Valley, Lachung, Namchi by Smith and Cave (1911) are excluded as these are not the part of the Zemu and Lhonak valley. Among 855 species, 734 species belong to the Dicotyledones, whereas, rest 121 species are from Monocotyledones.

Presently a maneuvers inventory of the flowering plant flora of the region was lead during 2012 to 2015. The region is primed with endemic, endangered, threatened and thousands of botanically interesting plant species. Extensive explorations of the region led to the portrayal of some new taxa, few rediscoveries of certain plant species after 100 years, new records of some species for India and Typification of two plant names. An account of flowering plants of the region is presented in Table 3. It comprises 889 taxa in 347 genera belonging to 89 families. In regards to the endemic 19 taxa (Table 9) were enlisted at present. The present study has documented five new taxa (Table 8), rediscovery of four taxa (Table 10) and two species are considered as new record for India (Table 9). Typification has been done for two names.

This region is highly disturbing causing threat to several species considered as endangered category as per IUCN guideline. A list of 19 taxa (Table 12) is provided under different categories for indicating future strategies of conservation.

Furthermore, hazards to the biodiversity and potential conservation actions are suggested to devise the protection strategies to re-establish the plant genetic properties of this unique unprecedented region.

5.1. Analysis of Flora

Botanical exploration covering pre-monsoon, monsoon and post monsoon were made in the Zemu and Lhonak Valley during 2013–2015. A total of about 1500 field numbers consist of mostly 3 specimens each have been collected and deposited at CUH. The analysis of flora of the Zemu and Lhonak Valley reveals that, angiosperm comprises 889 species under 347 genera belonging to 89 families. This includes 15 families of monocot (67 genera and 129 species) and 74 families of dicot (280 genera and 759 species). Gymnosperms are represented by eight species belonging to six genera and three families.

Table 3. Flowering plant diversity of Zemu and Lhonak Valley

Sl. No.	Plant Group	Family	Genera	Species
1	Gymnosperms	3	6	8
2	Angiosperms	89	347	889
	Monocotyledones	15	67	129
	Dicotyledones	74	280	760
Total		92	353	897

There are 17 families with more than 5 genera. Family Asteraceae rank first with 34 genera, followed by Orchidaceae with 19 genera, Brassicaceae with 18 genera, Apiaceae with 17 genera, Poaceae with 16 genera, Rosaceae with 15 genera, Ranunculaceae with 13 genera, Lamiaceae with 12 genera, Fabaceae and Boraginaceae with 10 genera each, Ericaceae with 9 genera and Polygonaceae with 8 genera.

The floristic components of the vascular plants of Zemu and Lhonak valley is analyzed under Tables IV to XII. Among the dicotyledones families Asteraceae is with maximum number of species (87) and stand first followed by Rosaceae (52 spp.), Ranunculaceae (41 spp.), Scrophulariaceae (40 spp.), Saxifragaceae (39 spp.), etc. (Table 4).

Table 4. List of five Dominant Families of Dicotyledones reported from Zemu and Lhonak Valley based on number of species

Sl. No.	Name of the Family	Number of Genera	Number of Species
1	Asteraceae	34	88
2	Rosaceae	15	52
3	Ranunculaceae	13	41
4	Scrophulariaceae	09	40
5	Saxifragaceae	05	39

In regards to the species diversity of the Zemu and Lhonak valley *Saxifraga* is in the first position to have 33 species and then *Pedicularis* with 28 species, *Primula* 24 species, *Rhododendron* 16 species, etc. (Table 5).

Table 5: List of five dominant genera of Dicotyledones reported from Zemu and Lhonak Valley based on number of species

Sl. No.	Name of the Genus	Number of Species
1	<i>Saxifraga</i>	33
2	<i>Pedicularis</i>	28
3	<i>Primula</i>	24
4	<i>Rhododendron</i>	16
5	<i>Gentiana</i>	15

The species diversity in monocotyledons is mostly concentrated within five families (Table 6) among which Orchidaceae has maximum representatives (28 spp.) followed by Cyperaceae (23 spp.), Poaceae (15 spp.), etc.

Table 6. Diversity of five dominant families of Monocotyledones reported from Zemu and Lhonak Valley based on number of species

Sl. No.	Name of the Family	Number of Genera	Number of Species
1	Orchidaceae	19	28
2	Cyperaceae	7	23
3	Juncaceae	2	16
4	Poaceae	16	15
5	Convallariaceae	4	10

Juncus of the family Juncaceae is most diversified genus among Monocotyledones having 14 representative species followed by *Carex* (13 spp.), *Allium*, *Kobresia* and *Polygonatum* (5 spp. each) (Table VII).

Table 7. Diversity of five dominant genera of Monocotyledones reported from Zemu and Lhonak Valley based on number of species

Sl. No.	Name of the Genus	Number of Species
1	<i>Juncus</i>	14
2	<i>Carex</i>	13
3	<i>Allium</i>	05
4	<i>Kobresia</i>	05
5	<i>Polygonatum</i>	05

5.1.1 Species/taxa new to science

In this present study several taxa new to science are discovered from this region. Two new species of *Kuepferia* (Gentianaceae), viz. *K. pringlei* D. Maity & S. K. Dey and *K. kanchii* D. Maity, S. K. Dey & Adr.Favre are described. Apart from this two new varieties of *K. pringlei* are also described from this region. One new species of *Lomatogonium* is also discovered from Zemu and Lhonak valley (Table 8).

Table 8. List of new taxa described in the present study

Sl. No.	Name of the species	Family
1	<i>Kupferia pringlei</i> D. Maity & S. K. Dey	Gentianaceae
2	<i>Kupferia kanchii</i> D. Maity, S. K. Dey & Adr.Favre.	Gentianaceae
3	<i>Kuepferia pringlei</i> D. Maity & S. K. Dey var. <i>lhonakensis</i> D. Maity, S. K. Dey & Adr.Favre	Gentianaceae
4	<i>Kuepferia pringlei</i> D. Maity & S. K. Dey var. <i>cavei</i> D. Maity, S. K. Dey & Adr.Favre	Gentianaceae
5	<i>Lomatogonium cherukurianum</i> S. K. Dey & D. Maity	Gentianaceae

5.1.2 Addition to the flora of India

In the present study after critical analysis of the collected specimens two species have been identified as new to the Indian flora and these are presented in Table 9.

Table 9: Name of species new to the *Flora of India*

Sl. No.	Name of the species	Family
1	<i>Gentiana oreodoxa</i> Harry Sm.	Gentianaceae
2	<i>Gentiana macrauchena</i> C. Marquand	Gentianaceae

5.1.3 Rediscovery of species in India

During survey and exploration of the floristic elements of the Zemu and Lhonak valley several species are rediscovered in their natural habitat. All these species are recollected after more or less 100 years in India. Few of them are collected from their type localities. A list of such species is presented in Table 10.

Table 10: Name of species rediscovered after more or less 100 years in India

Sl. No.	Name of the species	Family	Collected after (years)
1	<i>Diplarche multiflora</i> J.D. Hooker & T. Thomson	Ericaceae	65
2	<i>Diplarche pauciflora</i> J.D. Hooker & T. Thomson	Ericaceae	105
3	<i>Pseudoyoungia simulatrix</i> (Babc.) D. Maity & Maiti	Compositae	105
4	<i>Youngia atripappa</i> (Babc.) N. Kilian	Compositae	105

5.1.4 Typification

In this study two names, viz., *Gentiana incompta* Harry Sm. in Hand.-Mazz. (synonym of *Gentiana macrauchena* C. Marquand) of the family Gebtianaceae and *Crepis atripappa* Babc. [= *Youngia atripappa* (Babc.) N. Kilian] of the family Asteraceae have been lectotypified with the respective specimens. The present study has confirmed that the holotype of the name *Gentiana incompta* Harry Sm. is missing, and that name, therefore, is lectotypified with the specimen: “CHINA: W. Hubei, IV. 1904, *Wilson, Veitch Exp. 2764* (K, K000843586)” (Dey *et al.*, 2015). During this study it is also noticed that the species *Crepis atripappa* Babc. was primarily described based on at least 24 specimens of two gatherings – the syntypes. Therefore, lectotypification of the species with the specimen “Himalayas: Sikkim, 3000 to 3600 m. alt. (type locality), *Hook. f. and Thomson* GH [GH00006291a]” has been done under the provisions of the present Code (Dey and Maity, 2016a).

5.1.5 Endemic Plants

North-eastern region being a center of active speciation harbours large number of endemic taxa (Rao, 1994; Hajra & Mudgal, 1997; Singh & Singh, 2002). Many of the endemic species of Sikkim or NE India are confined to the regions of Zemu, Lhonak, Lachen valleys. Some of the endemic taxa of Sikkim Himalaya and other north-eastern states growing in this region are appended in the Table 11.

Table 11. List of Endemic species of Zemu and Lhonak Valley

Sl. No.	Species	Family	Collection locality
1	<i>Angelica nubigena</i>	Umbelliferae	Zemu Valley
2	<i>Aphyllorchis pantingii</i>	Orchidaceae	Zemu Valley
3	<i>Arenaria thanguensis</i>	Caryophyllaceae	Lhonak Valley
4	<i>Astragalus Zemuensis</i>	Leguminosae	Zemu Valley

5	<i>Catabrosa sikkimensis</i>	Poaceae	Lhonak valley
6	<i>Clematis zemuensis</i>	Ranunculaceae	Zemu Valley
7	<i>Cochleria serpens</i>	Cruciferae	Lhonak valley
8	<i>Codonopsis foetans</i>	Campanulaceae	Lhonak valley
9	<i>Erysium funiculosum</i>	Brassicaceae	Lhonak valley
10	<i>Gentiana ornata</i> var. <i>meiantha</i>	Gentianaceae	Lhonak valley
11	<i>Listera alternifolia</i>	Orchidaceae	Zemu Valley
12	<i>Parajaeschkea smithii</i>	Gentianaceae	Lhonak Valley
13	<i>Potentilla sericea</i> var. <i>compacta</i>	Rosaceae	Upper Lhonak Valley
14	<i>Potentilla sericea</i> var. <i>segmentata</i>	Rosaceae	Zemu and Lhonak Valley
15	<i>Primula flagellaris</i>	Primulaceae	Zemu Valley
16	<i>Salix viminalis</i> var. <i>smithiana</i>	Salicaceae	Zemu Valley
17	<i>Saxifraga inconspicua</i>	Saxifragaceae	Lhonak valley
18	<i>Sibbaldia coarctata</i>	Rosaceae	Lhonak valley
19	<i>Spongiocarpella purpurea</i> var. <i>lhonakia</i>	Leguminosae	Lhonakh Valley

5.1.6 Rare, Endangered and Threatened (RET) Plants

Sikkim Himalaya is part of the “Himalaya Hotspot” of the country. Thus the plant diversity of this region is threatened due to various natural and biotic factors. While incidences of earth quakes, landslides, biological factors such as natural competition between species etc. have contributed to some extent to alteration of vegetation types. It is the man made threats such as destruction of natural habitats for agriculture, road constuction, urbanisation, grazing and over exploitation of germplasm, etc. are responsible for the rapid transformation of land scape in the region. The destruction of forest and high rate of soil degradation are the threats towards loss of the species diversity. Consequently, the population of several taxa have been departed considerably and some of the native plants are under great danger (Rai *et al.*, 1998; Bansat, 1998; Maiti, 2000; Maity & Chauhan, 2002). A list of such taxa is given in the Table 12.

Table 12. List of the Rare, Endangered and Threatened species of Zemu and Lhonak Valley

Sl. No.	Species	Family	Status	Location
1	<i>Aristolochia griffithii</i>	Aristolochiaceae	VU	Zemu Valley
2	<i>Arenaria thangoensis</i>	Caryophyllaceae	VU	Lhonak Valley

3	<i>Bryocarpum himalicum</i>	Primulaceae	LR	Zemu Valley
4	<i>Ceropegia hookeri</i>	Asclepiadaceae	EN	Zemu Valley
5	<i>Cypripedium himalicum</i>	Orchidaceae	EN	Zemu Valley
6	<i>Didiciea Cunninghamsii</i>	Orchidaceae	EN	Zemu Valley
7	<i>Diplarche multiflora</i>	Ericaceae	EN	Upper Thangu
8	<i>Diplarche pauciflora</i>	Ericaceae	EN	Upper Thangu
9	<i>Gentiana macrauchena</i>	Gentianaceae	CR	Above Kalapathar
10	<i>Gentiana oreodoxa</i>	Gentianaceae	CR	Upper Thangu
11	<i>Kuepferia kanchii</i>	Gentianaceae	EN	Lhonak valley
12	<i>Kuepferia pringlei</i>	Gentianaceae	CR	Lhonak valley
13	<i>Kuepferia pringlei</i> var. <i>lhonakensis</i>	Gentianaceae	CR	Lhonak valley
14	<i>Kuepferia pringlei</i> var <i>cavei</i>	Gentianaceae	CR	Lhonak Valley
15	<i>Listera alternifolia</i>	Orchidaceae	EN	Lhonak Valley
16	<i>Lomatogonium cherukurianum</i>	Gentianaceae	CR	Lhonak Valley
17	<i>Oreopteris elwesi</i>	Thelypteridaceae	R	Zemu Valley
18	<i>Pseudoyoungia simulatrix</i>	Compositae	CR	
19	<i>Rhododendron setosum</i>	Ericaceae	VU	Zemu Valley

EN = Endangered, R = Rare, Vu = Vulnerable, LR = Lower risk, CR = Critically endangered

5.1.7 Major Medicinal Plants

Zemu and Lhonak valley is one of the native places of novel medicinal plants. Particularly the alpine forest is very rich in pioneer medicinal plants. It has great potential to become a medicinal plant germplasm centre through scientific management. Some of the plant with great medicinal values are *Aconitum* spp., *Digitalis purpurea*, *Ephedra gerardiana*, *Nardostachys gradiflora*, *Picrorhiza scrophulariiflora*, *Podophyllum hexandrum*, *Taxus wallichiana*, etc.

5.1.8 Threats and conservation strategies

Threats to phytodiversity:

The era of appearance of human has marked the display of an ongoing biodiversity reduction. Many scientific reports have stated the cause of this reduction to be principally done by human impacts particularly habitat destruction. Moreover edifice of building and cattle grazing also destroys the natural resources (Pl.32A,B). This led to a great worry for the scientists



Plate 32: Destruction of Vegetation: A & B- Grazing, C & D- Landslide, E- Exploitation by Villagers, F- Construction of Roadways.

worldwide as it may bring about the extinction of natural resources. Thereafter, alternative strategies to prevent further eco-system degradation are to be found and implemented since a large portion of the population depends on natural resources for their livelihood. Landslide is severe in this region, which causes mass destruction of species at a time. This incident is very common in monsoon season (Pl.32C,D). Unscientific collection of food plants, fodder plants and medicinal plants causes destruction of species and thus population of many species depleted at alarming rate (Pl.32E).

Lachen and Thangu are the most popular tourist spots providing shelter to many endemic species. But its beauty and natural ecological balance both are getting reduced day by day due to tourism and commercialization. Over exploitation of natural resources also hampers vegetation and wildlife (Pl.32E). As a result the habitats of such endemic species of this unique biodiversity are getting lost and they seem to be disappearing from their natural habitats. Developmental activities by Indian Army also have adverse effect on the biodiversity of this region (Pl.32F).

Conservation strategies

Awareness among people can be brought about by interactions with the same and making them realize the importance of saving the diverse biodiversity of the region that will help them serve their lives in a much better way.

In the world of commercialization we can't stay back dated. Hence, advancement is a necessity. But that developmental change must be in a proper planned way so that the natural vegetation can no way be jeopardized.

When it comes to economy care should be taken that the steps are in no way coming in the path of our nature and its resources. Though the region is well known for its scenic beauty that attracts many tourists every year but proper planning can let both ecotourism and maintenance of ecological balance go hand in hand. Scientific collection of minor forest produces (MFPs) including the medicinal plants is important to save this unique biodiversity.

Grazing is a common activity of the cattle but when done in a proper planned way it will not be a cause of destruction of the resources of the region.

In order to fulfill the desire of saving and conserving the richness of plant species of the region measures are to be taken. Among different measures *ex situ* conservation strategies are primarily the important ones that will help in maintaining the proper growth and safety of various plant species in the region.