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RESEARCH ARTICLE

MEDICINAL PLANTS GENETIC RESOURCES OF KYONGNOSLA ALPINE SANCTUARY, SIKKIM, INDIA

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ABSTRACT

Medicinal Plants Genetic Resources of Kyongnosla Alpine Sanctuary and adjacent areas were studied during the year 2016-17, which records an occurrence of 120 species of medicinal plants, of which herbs represent the highest number of species (103 species) followed by shrubs / shrublets (16 species). Trees were sparse in the area and only two tree species of medicinal value *viz., Abies densa* and *Betula utilis* were recorded. Enumeration of species includes scientific names along with common name(s), local name(s), family, part (s) used, uses and system(s) of medicine where they are used. 79 species were found to be used in Tibetan System of Medicine, 48 species in Traditional Nepali Medicine and 13 species in Lepcha Traditional Medicine and 8 species were found to be used by local Folk healers. Some of the globally rare and threatened alpine medicinal plants such as *Sassurea gossipiphora, Gentiana elwesii, Neopicrorhiza scrophulariiflora, Veratrilla bailonii, Nardostachys jatamansii* etc. were recorded during the present study. *Aconitum,* the highly potential and globally threatened taxa of medicinal plant of the Himalayas, of which six species were recorded during the present study. From the conservation point of view Kyongnosla Alpine Sanctuary has remarkable relevance in preservation of subalpine and alpine gene bank of Sikkim in the form of protected area. For better conservation and management of rare and threatened medicinal plants in their natural habitat, the sanctuary and the surrounding area can be recommended to keep untouched in terms of tourism and any kind of construction works. The better management of the rare and threatened species especially of sub-alpine and alpine areas can be done by *ex-situ* conservation through tissue culture.

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INTRODUCTION

The state of Sikkim is located on the Eastern Himalaya in between 27°5' - 28° 10' N latitudes and 88°4'-88°55' E longitudes covering an area of 7096sq. It falls under Himalayan (2) Bio-geographic zone and Central Himalaya (2c) biotic province. Its altitude varies from 225m in the south to 6100m in the north and north-east and 8598m in the north-west. The state is a rich repository of biological diversity harbouring tropical, subtropical, temperate, sub alpine and alpine vegetations. The population of Sikkim comprise of Lepcha, Bhutia and Nepali communities. The Nepalese are numerically dominant community and comprises of a number of groups and tribes such as Chettri, Bahun, Rai, Manger, Limboo, Tamang, etc. Bhutias are the next numerically larger community in the state which are people of Tibetan origin and mainly settled in the northern region. The people of Sikkim have great faith in the traditional system of medicine. A large section of the population in rural areas still relies on native systems of medicine for their healthcare management. The native system of healing is practiced by the Amchi, Lama and Pow in the Bhutia community. Amchi, a Tibetan herbal practitioner and Lama, a Buddhist priest, practices ritual therapies which are highly respected and accepted by the Bhutia community. Baidhay are the Nepali traditional herbal practitioners. In the western part of Sikkim majority of the people believes in magico-ritual therapies practiced by Dhami or Jhakri, a traditional folk healers of Nepali community. The Lepcha traditional practitioners are known as Bungthing. The Lepchas are animistic and are mainly settled in the Dzongu valley in North Sikkim. Similarly, traditional ethno-veterinary practices are also in vogue in the rural areas of the state for the treatment of various ailments of their live stocks such as bone fracture, poisonous bites, retention of placenta, fever of cattle, dog bites of cattle, diarrhoea, etc. (Sharma *et al.,* 2012). India is known for rich repository of plant wealth having more than 17,500 wild plant species and of these over 4,000 species have medicinal values (Ayensu 1996). Himalayan region of India, especially the North eastern part including Sikkim state have

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been the source of traditional medicine in conventional use since long directly or indirectly in the modern medicine system, hence plays an imperative role in the cultural and economic expansion of the region (www.nmpb.nic.in). Sikkim being an integral part of eastern Himalaya is known as one of the mega hot spot zones of country and has more than 490 species of medicinal and aromatic plants (Sharma and Sharma, 2010). Despite being the store house of medicinal and aromatic plants and the related traditional knowledge, their documentation especially in the sub-alpine and alpine regions is yet to be accomplished properly. Hence, present work was initiated as an attempt to document the medicinal plants of Kyongnosla Alpine Sanctuary along with their uses in different traditional systems of medicine in Sikkim.

Study Area

Sikkim has always been an attraction for the local, national as well as the international visitors due to its uniqueness in terms of landscape like snow covered mountains ending to cold deserts. There lies a famous Kyongnosla Alpine Sanctuary, Barsey Rhododendron Sanctuary, Shingba Rhododendron Sanctuary, Kitam Birds Sanctuary, beautiful valleys of Yumthang - Yumey Samdong, Tamzey, Tsomgo – Nathula, several high altitude lakes *viz*., Gurudongmar, Tsho Lhamu, Johr Pokhari, Hans pokhari, Gyam Tshona Lake, (the only high altitude brackish water lake) and others. The state of Sikkim have always been an explorers paradise since many centuries and have been visited by the famous explorers like Sir J.D. Hooker (1847-49), G. Gammie (1892), J.C. White (1887 - 1908) and others, the account of which is beautifully described in *Himalayan Journal, Account of Botanical Tour in Sikkim during 1892*. Present study area Kyongnosla Alpine Sanctuary, is located in the Eastern Himalaya of Sikkim in between 27°22' N – 27°24' N latitude and 88°44' E – 88°45' E longitude (Figure 1). The area of the sanctuary is 31 km^2 with sub-alpine – alpine forests (Figure 2a, 2b) and the altitude ranges from 2900 m to 4400 m. The area around the sanctuary is, however, notified as the Eco-Sensitive Zone by the Central Government with the purpose of protection and conservation of biodiversity of the sanctuary and its environment. The extent of this zone varies from 25 m to 200 m from the boundary of the Kyongnosla Alpine Sanctuary. The Eco-Sensitive Zone is bounded by 27°22'5" N latitude and 88°41'54" E longitude towards east, 27°23'41" N latitude and 88°42'48" E longitude towards west, 27°25'13" N latitude and 88°43'49" E longitude towards north and 27°22'36" N latitude and 88°43'50" E longitude towards south. The significance of this sanctuary is that it harbours a good number of scheduled animals (specified in Schedule I of the Wildlife Protection Act, 1972) which includes Red Panda and different species of Gallinaceous Birds and Pheasants. The wide range of habitat diversity of the sanctuary harbours several rare, endangered species along with high value medicinal plants *viz., Aconitum violaceum, A. novoluridum, A. disectum, A.bisma, Neopicrorhiza scrophulariflora, Nardostachys jatamansii, Valeriana jatamansii*, *V. hardwickii*, *V. grandiflora*, *Panax bi-pinnatifidus, Sassurea gossipiphora, S. obvallata, Rheum acuminatum, R. novile, Gentiana elwesii*, several species of *Junipers*, *Rhododendrons,* etc. The lower elevation is occupied by bushy bamboo thickets and junipers.

MATERIALS AND METHODS

Field works were undertaken in the Sanctuary during the month of August 2016 with the aim to develop a database on the medicinal plants of the area along with their traditional medicinal uses. Prior to field work, literatures were scrutinised to have a general idea about the vegetation of the area (Polunin and Stainton, 1984; Stainton, 1988; Hooker, 1871-1897; Sharma and Sharma, 2010, Sabita Dahal et al. 2017, Dahal S, Sharma TP & Borthakur SK, 2017 etc.) including web references such as (www.efloras.org*;* www.flowersofindia.net etc.). The checklist of the species (both medicinal and otherwise) was prepared and was taken to the field to confirm their presence in the study area. During the field work, all the species occurring in the area (both medicinal and otherwise) were recorded to have fair knowledge on the vegetation of the area. Important medicinal plants were collected and made into herbarium specimens following standard herbarium techniques (Jain and Rao, 1977) and were deposited in the herbaria at Botanical Survey of India, Sikkim Circle (BSHC) for future references. Specimens collected were identified with the help of literature (Polunin and Stainton, 1984; Stainton, 1988; Hooker, 1871-1897; Sharma and Sharma, 2010, etc.) and by consulting herbarium specimens deposited in BSHC and web references (www.efloras.org*;* www.flowersofindia.net etc.. Information on traditional usage, parts used, local names, etc. were recorded with the help of the local herbal practitioners in the field, which were further authenticated through cross verifications and personal observations.

RESULTS AND DISCUSSION

An enumeration of 120 medicinal plants occurring in the area is provided here with their scientific names along with common names, local names, families, altitudinal range, part(s) used and uses (Table 1). Herbs represent the highest number of species (103 species) followed by shrubs/shrublets (16 species). Trees were sparse in the area and only two tree *viz., Abies densa* and *Betula utilis* of medicinal value were recorded from the area. The forest being sub-alpine and alpine type, herbs were predominating in the area and the species include *Rheum nobile, R. acuminatum, Sassurea obvallata, S. nepalensis, S. gossypiphora, Juncus thomsonii, Potentila arbuscula, P. peduncularis, Geum elatum, Tanacetum coccineum, Iris clerki, Gentiana* sps*., Geranium polyanthes, Impatiens* sps . During the present study, the sanctuary has been found to be a rich repository of potential and rare medicinal shrubs and herbs including 6 species of *Aconitum* namely *A. novoluridum*, *A.violaceum*, *A.bisma*, *A. ferox*, *A.laciniatum* and *A.disectum* (Plate 1). Despite being the highly potential medicinal plant of the Himalayas**,** no much attention has been paid by the taxonomist so far to study the taxon *Aconitum* occurring in the area. There are six species with gregarious growth and comparatively good number of populations except *A.novoluridum* was recorded from the area. However, among all the Aconites *A.novoluridum* is very rare in the area. There are no authentic literatures on the Aconites of the area except the publication of Stape (1905). In case of *Polygonatum*, 3 species were recorded from the area viz. *P.verticellatum*, *P. Singalilense, and P. Cirrhifolium*. High altitude Gentians (Gentianaceae) such as *Gentiana elwesii, G.algida, G.prolata, G.sikkimensis, G.stylophora, Swertia hookeri, Veratrilla baillonii* and *Halenia elliptica* occur in the sanctuary. Of all the Gentians *viz., Gentiana elwesii* is a threatened medicinal and recorded for the first time from the area during the study. Since its record of occurrence in Lachung to Yumthang in North Sikkim in 1885 there is no record of its occurrence from any other areas of Sikkim (Hooker 1885).

Table 1. Habit diversity of species recorded in Kyongnosla Alpine Sanctuary, East Sikkim

Habit	Species	Genus	Family
Trees	2	2	2
Shrubs / Shrublets	16	7	4
Herbs	102	61	32
Total	120	70	38

Table 2. A list of medicinal plants including highly potential, rare and threatened species of Kyongnosla Alpine Sanctuary, East Sikkim

Sl.no	Botanical name	Common / Local names	Family	System of Medicine	Part(s) used	Medicinal uses/ Other uses
Trees						
1.	*Abies densa* Griff.	Himalayan Fir Gobre Salla (N)	Pinaceae	AU, NTM, LTM	Leaves and leaf juices	Leaves astringent, carminative, expectorant, stomachic and tonic. The leaf juice used in the treatment of asthma, bronchitis, etc. An essential oil obtained from the leaves is used to treat colds, rheumatism and nasal congestion.
2.	**Betula utilis* D.Don	Himalayan Birch / Bhoj Patra (N)	Betulaceae	AU, NTM, TMS, LTM	Bark	Useful to treat wounds, skin diseases, ear diseases, ear problems, epilepsy, hysteria, diarrhea and dysentery. In Ayurveda, the species have been reported to be useful for Kapha diseases, ear diseases, pitta and rakta diseases and various psychological disorders.
Shrubs / Shrublets						
1.	*Berberis angulosa* Wall.	Large Flowered Barberry / Karay chutro (N); Kyer Pa Nag Po (Ti).	Berberidaceae	TMS, NTM	Root, flower fruit	Roots antibacterial, used for cough, cold, fever and dysentery. Cures conjunctivitis accompanied by pain and redness of the eyes. Treats irritation of urinary tract, heals sores and skin infection.
2.	*Cassiope fastigiata* (Wall.) D.Don	Himalayan Heather / Sunthangni (N); Pelawa (B).	Ericaceae	NTM	Leaves Flowers	Leaf paste is applied to cuts and itches. Flower paste is applied to skin allergies. It is a herb having potent anti-herpes viral activity.
3.	*C.selaginoides* Hook. & Thoms.	Himalayan Heather / Sunthangni (N); Pelawa (B).	Ericaceae	NTM	Leaves	Leaf past is applied to cuts and itch. Flowers paste is applied to skin allergies. It is a herb having potent anti-herpes viral activity.
4.	*Gaultheria nummularioides* D.Don	Coinwort Snowberry / Kaaligedi (N)	Ericaceae	NTM	Leaves	Fruits edible. Leaf juice is taken to cure painful urination.
5.	*G.trichophylla* Royle.	Himalayan Snowberry / Kaaligedi (N)	Ericaceae	NTM	Fruit	Presence of important phyto-constituents such as gallic acid, rutin and quercetin has been reported, which has strong antioxidant properties and use in foods and medicines to replace synthetic antioxidants. Ripe fruits edible. Traditionally, the leaves and fruits are used to treat wounds, cough and cold.
6.	*Juniperus recurva* Buch.-Ham. Ex D.Don	Drooping Juniper Dhoop (N)	Cupressaceae	TMS, AU, NTM, LTM	Leaves, twigs, berries and wood	In Tibetan Medicine, Junipers are used to prevent and treat cancer. Throughout the Himalayan region, Juniper is considered to be a sacred . In Nepali and Tibetan culture the woods, leaves and twigs are used as incense because of the beliefs that it can recharge with energies both indoor and outdoor of households.
7.	*J. coxii* A.B.Jackson Syn., *J. recurva* var. *coxii* (A.B.Jackson) Melville	Dhoop (N),	Cupressaceae	TMS, AU, NTM, LTM	Leaves, twigs, berries and wood	In Tibetan Medicine System, Junipers are used to prevent and treat cancer. Throughout the Himalayan region, Juniper is considered to be a sacred tree. In Nepali and Tibetan culture the woods, leaves and twigs are used as incense because of the beliefs that it can recharge with energies both indoor and outdoor of households.
8.	*Lyonia ovalifolia* (Wall.) Drude	Oval Leaved Staggerbush Angeri (N)	Ericaceae	AU, NTM	Tender leaves and shoots	Tender leaves and buds have antioxidant and antimicrobial properties and are considered as toxic, Infusion of leaves and buds is used externally to treat skin diseases. Leaves have insecticidal properties. Fresh juice of leaves and tender shoots are used externally in infestation of ticks in dog and calf. (Sharma et al., 2012).

9.	*Rhododendron anthopogon* D.Don	Dwarf Rhododendron / Sunpati (N), Palu (B).	Ericaceae		TMS, NTM	Whole plant except roots	Infusion of tender leaf is taken to treat cough, cold and fever. Wood, leaves and twigs used as incense.
10.	*R.campanulatum* D.Don subsp. *aeruginosum* (Hook.f.), Syn. *Rhododendron aeruginosum* Hook.f.	Aeruginose Rhododendron / Nilo Patey Chimal (N)	Ericaceae		Poisonous plant	Whole plant	All parts of this plant contain poison called grayanotoxin, eating this plant leads to severe stomachache, liver damage and pneumonia.
11.	*Rhododendron campanulatum* subsp.*campanulatum* D.Don	Bell-flowered Rhododendron Nilo Chimal (N)	Ericaceae		TNM	Stems, leaves	In Nepal, powder of dried stem and leaves is used as snuff to cure cold and hermicrania. Also used in curing chronic rheumatism and syphilis. Dried twigs and wood are used by the Nepalese against phthisis and chronic fever (Rajeshkoirala.worldpress.com)
12.	*R.hypenanthum* Balf. f.	Yellow Dwarf Rhododendron	Ericaceae		TMS	Stems, leaves	Antitussive, digestive, febrifuge, diaphoretic and tonic and are used as appetizer and to treat cough and cold, pulmonary disorders and various skin diseases. The dried leaves are used as incense.
13.	*R.lepidotum* Wall.ex G.Don	Scaly Rhododendron / Bhaley Sunpati (N)	Ericaceae		Folk, AU, TMS	Ariel parts	Used locally as an incense by the Buddhist in monasteries. It is one of the major ingredients of an Ayurvedic herbal oil "*Pinda Thailam*, a cooling massage oil" which is particularly useful for rheumatoid arthritis.
14.	*Rhododendron thomsonii* Hook.f.	Dr. Thomson's Rhododendron Dr. Thomson ko Gurans (N)	Ericaceae		Poisonous plant	Leaves, stems	Used as insecticide, reported toxic to human beings (Rajeshkoirala.worldpress.com). Alcoholic extraction from the vegetative parts is used as an effective insecticide in North Sikkim (Pradhan and Lachungpa, 1990)
15.	*R.setosum* D.Don	Bristly Rhododendron / Jhusey Sunpati (N), Tsalluo (B)	Ericaceae		TNM, Folk, AU	Whole plant except roots	Useful in inflammation of throat and muscle tissues, also heals sexually transmitted infections (Wangchuk *et al*. 2016). Paste of tender leaves is applied to wounds. Wood, leaves and twigs are used as incense.
16.	*Rosa sericea* Lindley	Silky Rose	Rosaceae		Folk, TMS, AU	Root and Flowers	Root paste is applied to wounds. Decoction of petals is used to wash the eyes in ophthalmia and used aso an aphrodisiac. It slows down ageing, increases smoothness, reduces wrinkles on the face and keeps complexion glowing.
Herbs							
1.	*Aconitum laciniatum* (Bruhl) Stapf. Syn., *A.ferox* var.*laciniata* Bruhl	Kalo Bikhma (N)		Ranunculaceae	AU, TMS, NTM	Tuberous root	Efficacious remedy in many fabric diseases, particularly fever of children resulting from inflammation, such as tonsillitis, laryngitis, pharyngitis, quinsy ,etc. In Ayurveda, *Aconitum* is used to increase pitta (fire, bile), dosha.
2.	*Aconitum violaceum* Jacquem.ex Stapf	Dudhia (N)		Ranunculaceae	AU, TMS, NTM	Tuberous root	In Ayurveda, *Aconitum* is used to increase pitta (fire, bile), dosha.
3.	*Aconitum bisma* (Buch.-Ham.) Rapaics	Bikh, Bikhma		Ranunculaceae	AU, TMS, NTM	Tuberous root	In Ayurveda, *Aconitum* is used to increase pitta (fire, bile), dosha.
4.	*Aconitum ferox* Wall.ex Ser.	Bikh, Bikhma		Ranunculaceae	AU, TMS, NTM	Tuberous root	In Ayurveda, *Aconitum* is used to increase pitta (fire, bile), dosha.
5.	*Aconitum disectum* D.Don			Ranunculaceae	AU, TMS, NTM	Tuberous root	In Ayurveda, *Aconitum* is used to increase pitta (fire, bile), dosha.
6.	*Aconitum novoluridum* Munz.	Tchendook (B), Surya Banshi (N)		Ranunculaceae	AU, TMS, NTM	Tuberous root	In Ayurveda, *Aconitum* is used to increase pitta (fire, bile), dosha.
7.	*Aletris pauciflora* (Klotzsch) Hand.-Mazz.	Few Flowered Colic Root		Nartheciaceae	TMS	Aerial parts	Used to cure lung and liver disorders, respiratory diseases, pneumonia, bronchitis, cuts and wounds.
8.	*Allium prattii* C.H.Wright	Jangali piaz (N); Gok Pa, Ruk Pa (Ti).		Amaryllidaceae	NTM	Leaves	Warmed leaf juice is used as body massage to get relieve from body ache. It is also used as a flavouring agent.
9.	*A.wallichii* Kunth	Himalaya Onion / Banlasun (N)		Amaryllidaceae	NTM	Leaves	Infusion of leaves is used against vomiting.
10.	*Anaphalis contorta* D.Don	Eared Leaf Pearly Everlasting / Buki phul (N)		Asteraceae	TMS, NTM	Whole plant	Root paste is applied to boil. Plant paste is taken with honey to cure cough. Essential oil extracted is used medicinally in various ailments.
11.	*A.triplinervis* (Sims) Cl.	Woolly Pearly Everlasting / Ta.god (Ti)		Asteraceae	TMS, NTM	Whole plant	Treats illnesses caused by compounded poison, anaemia and relieves swelling.
12.	*Arisaema erubescens* (Wall.) Schott	Blushing Cobra Lily / Sanp ko makai (N)		Araceae	AU, TMS	Corm	Used in bone diseases. For its irritant effect applied to skin diseases with infection and swelling; it damages the bacteria and stimulates healing.

13.	*Arisaema griffithii* Schott	Griffith's Cobra Lily / Sanp ko Makai (N)	Araceae	AU, TMS	Corm	Used in bone diseases. For its irritant effect applied to skin diseases with infection and swelling; it damages the bacteria and stimulates healing.
14.	*Arisaema jacquemontii* Bl.	Jacquemont's Cobra Lily / Sanp ko makai (N)	Araceae	TMS	Corm	Used in bone diseases. For its irritant effect applied to skin diseases with infection and swelling; it damages the bacteria and stimulates healing
15.	*Bergenia ciliata* (Haw.) Sternb.	Frilly Bergenia, Winter begonia, Pakhenbed (N)	Saxifragaceae	AU, TMS, NTM, LTM	Whole plant	Useful in treating urinary troubles, cough and cold, asthma, boils , ophthalmia, backache and dissolve kidney stones.
16.	*Bergenia purpurascens* (Hook. & Thoms .) Engler	Purple Bergenia / Lekhko Pakhanbed (N)	Saxifragaceae	AU, TMS, NTM	Whole plant	It has antibacterial property. Decoction of rhizome is used against body and stomach pain. Fresh rhizome is chewed to cure cough and toothache. Leaf juice is taken orally to dissolve kidney stone. In Tibetan medicine, the plant is used for the treatment of neuropsychiatric disorders. It is a source of drug *Bergenin.*
17.	*Bistorta affinis* (D.Don) Greene	The Himalayan Bistort / La.gang Men. Pa (Ti).	Polygonaceae	AU, TMS	Roots	Cures hoarseness of voice, pulmonary and intestinal diseases. Also used in emaciation, senility and pulmonary affections.
18.	*B.amplexicaulii* (D.Don) Greene	Red Bistort	Polygonaceae	AU, TMS, LMS		Cures hoarseness of voice , pulmonary and intestinal diseases
19.	*Codonopsis foetens* Hook. & Thoms.	Stinging Bunnet Bellflower / Luptic (B).	Campanulaceae	AU, TMS	Whole plant	Decoction is used against constipation and gastritis.
20.	*Codonopsia clematidea* (Schrenk) Cl.	Clematis Bonnet Bellflower	Campanulaceae	AU, TMS,	Whole plant	Useful to treat rheumatism. Seed paste is used externally to treat inflammation of body parts.
21.	*Clematis napaulensis* DC.	Anemone clematis	Ranunculaceae	Folk, AU, TMS, LMS	Leaves, stems	Useful in treatment of epilepsy and fever. Stimulate menstrual discharge and promote lactation.
22.	*Cynoglossum zeylanicum* (Vahl) Thunb. ex Lehm	Ceylon Forget Me Not / Kanike Kuro (N)	Boraginaceae	TMS, NTM, AU	Leaves	Leaf paste is applied to cuts and wounds.
23.	*Dracocephalum heterophyllum* Edgeworth ex Benth.	White Dragonhead	Lamiaceae	TMS, AU	Leaves, Young shoots	Essential oil extracted from the plant posses various pharmacological properties such as anti-hepatitis, antioxidant, anti-inflammatory, etc.
24.	*Erigeron multiradiatus* (Lindl.ex DC.) Benth.ex Cl.	Himalayan Fleabane	Asteraceae	TMS	Whole plant	Useful to treat various diseases related to inflammation (Yakugaku Zasshi, 2008)
25.	*Euphorbia wallichii* Hook.f.	Wallich Spurge	Euphorbiaceae	TMS, Folk.	Roots	Effective in treating skin diseases. Possess considerable anti-cancer and anti-oxidant potential (Ihsan UI-Haq *et al*. 2012.)
26.	*Fragaria nubicola* Lindley ex Lacaita	Himalayan Strawberry / Bhui Aiselu (N)	Rosaceae	TMS, AU	Leaves, flowers and fruit	Unripe fruit is chewed to treat blemishes on the tongue. Leaves juices are used to treat profuse menstruation.
27.	*Fritillaria cirrhosa* D. Don	Yellow Himalayan Fritillary / Kakoli (N).	Liliaceae	AU	Bulb leaves	Dried bulb or decoction of bulb is taken to prevent and cure asthma and bronchitis. Leaves are eaten to cure stomach pain. The plant is used as a substitute of *Lilium polyphyllum*, one from the *Astavarga* group in preparation of an Ayurvedic formulations such as Astavarga churna, Chyavanprash rasayana, etc.
28.	*Galinsoga parviflora* Cavanilles	Gallant Soldier/ Udasay (N)	Asteraceae	AU, TMS	Leaves	Leaf juice or paste is applied to burn injuries and to wound and cuts.
29.	*Galium* sp.		Rubiaceae	NT M	Whole plant	Treats painful urination.
30.	*Gentiana algida* Pallas	Whitish Gentian	Gentianaceae	AU, TM	Leaves	Leaf paste is applied to cuts and wounds. It is also used in stomach complaints.
31.	*G. elwesii* Cl.	--	Gentianaceae	NTM	Young shoots, leaves	Leaf decoction is taken as tea to reduce high altitude sickness. As such medicinal uses of this species have not been recorded so far.
32.	*G. prolata* I.B.Balfour	--	Gentinaceae	NTM	Young shoots, leaves	Leaf decoction is taken as tea to reduce high altitude sickness. As such medicinal uses of this species have not been recorded so far.
33.	*G.sikkimensis* Cl.	--	Gentinaceae	NTM	Young shoots, leaves	Leaf decoction is taken as tea to reduce high altitude sickness. As such medicinal uses of this species have not been recorded so far.
34.	*G.stylophora* Cl.	Yellow Gentian Lily	Gentinaceae	NT M	Root	Root paste is applied as a poultice to cure wounds and swellings.
35.	*Geranium wallichianum* Don ex. Sw.	Wallich Geranium / Rakla Mool (N)	Geraniaceae	AU,TMS, NTM	Whole plant except root	The plant has astringent properties. Decoction of whole plant is taken against back and joints pain.
36.	*Acomastylis elata* var. *elata* Wall. ex G. Don	High Avens / Belocha (N)	Rosaceae	AU, TMS	Leaves	Used as an astringent in diarrhoea and dysentery. In Ayurveda, used as an ingredient in an Anti-Cancer Herbal Formulations.
37.	*Gymnadenia orchidis* Lindl.	Himalayan Fragrant Orchid / Panch amlay (N)	Orchidaceae	AU, TMS	Tubers	Astringent, demulcent and highly nutritious. Eaten with honey as an aphrodisiac and tonic. It is also useful in gastric, liver and urinary disorders.

38.	*Halenia elliptica* D.Don	Spurred Gentian / Tikta (N)	Gentianaceae	AU, TMS	Whole plant	Reported to be of anti-oxidant, anti-amoebic and anti-inflammatory. Useful in the treatment of liver inflammations, stomach complaints and fever due to contagious diseases.
39.	*Impatiens urticifolia* Wall.	Garden Balsam / Tiuree (N)	Balsaminaceae	AU, TMS	Whole plant	Fermented extract of flower is reported to possess marked antibiotic activity against some pathogenic fungi and bacteria. It is an astringent, expectorant and diuretic and used in urinary disorders, diarrhoea, etc.
40.	*Impatiens racemosa* DC.	Yellow Long-Tailed Balsam / Anchirna (N)	Balsaminaceae	TMS, AU (Vaterinary)	Whole plant	Stem juice is an antidote to poison ivy. Impatiens contain 2-methoxy-1,4-napthoquinone, an anti-inflammatory and fungicide napthoquinone which constitutes an active ingredient in some formulations (Morris *et al.* 2006.).
41.	*Impatiens radiata* Hook.f.	Spreading Rays Balsam	Balsaminaceae	AU, TMS (Vaterinary)	Whole plant	Stem juice is an antidote to poison ivy. Some of the species of *Impatiens* contain 2-methoxy-1,4-naphthoquinone, an anti-inflammatory and fungicide naphthoquinone that which constitutes an active ingredient in some formulations (Morris & Keilty 2008)
42.	*Impatiens bicornuta* Wall.	Horned Balsam / Raja Babu (N)	Balsaminaceae	AU, TMS (Vaterinary)	Whole plant	Some of the species of *Impatiens* contain 2-methoxy-1,4-naphthoquinone, an anti-inflammatory and fungicide naphthoquinone that which constitutes an active ingredient in some formulations (Morris & Keilty 2008)
43.	*Iris clarkei* Baker ex Hook.f.	Clark's Iris	Iridaceae	AU		Bibenzyl derivatives (methoxy-hydroxy-dihydrostilbenes including alfoliol, gigantol), is a compound obtained synthetically from it used against cancer (Aggarwal *et al*. 2004.)
44.	*Jurinea dolomiaeia* Boiss	Jhari – Dhoop (N)	Asteraceae	Folk, AU, TMS	Roots	The plant is used as incense. Roots are stimulant and given in fever after childbirth. Bruised roots are applied to skin eruptions. Aromatic oil extracted from the root is useful in arthritic pain.
45.	*Ligularia fischeri* (Ledeb.) Turcz.	Fischer's Ligularia	Asteraceae	AU	Leaves	Leaves are used to treat jaundice, scarlet – fever, rheumatoid arthritis, and hepatic diseases. Extract of the plant has been reported to be having number of biological activities, including anti-mutagenic activities and anti - genotoxic activities and cancer prevention activities.
46.	*Ligularia amplexicaulis* DC.	Stem Clasping Ligularia / Ri. Sho (Ti).	Asteraceae	AU, TMS	Shoots, leaves and roots	Astringent, digestive, emetic and cooling ; used in the treatment of vomiting due to indigestion.
47.	*Lilium nanum* Klotzsch & Garcke	Tiny Lily, Dwarf Lily	Liliaceae	AU, NTM	Whole plant	Antidote against poisonous bites; also heals bone fracture and injuries.
48.	*Maharanga emodi* (Wall.) DC. A.		Boraginaceae	AU, TMS, NTM	Roots, Flowers and seeds	Cooling, laxative and anthelmintic. Useful in eye diseases, ear problems, oil from seeds is applied as hair tonic.
49.	*Meconopsis paniculata* (D.Don) Prain	Panicled Yellow Poppy / Gyashur (N)	Papaveraceae	NTM, TMS	Flower, leaves, roots	Used for the treatment of swelling, diarrhoea, fever and cough.
50.	*M.simplicifolia* (D.Don) Walpers	Common Blue Poppy	Papaveraceae	----------		----------
51.	*M.horridula* Hook.f.& Thoms,	Prickly Blue Poppy	Papaveraceae	TMS, NTM	Whole plant	Leaf paste is applied to wounds. Infusion of flower is taken in fever, cough and cold. Plants are used as antidote against poisonous bites and also to treat lungs and skin diseases.
52.	*Myricaria rosea* Sm. W. (W.)	Rose False Tamarisk / Jillethi (N)	Tamaricaceae	TMS	Leaves and flowers	Used to treat fever, headache, stomachache, uterinary bleeding and food poisoning. .
53.	*Nardostachys jatamansii* (D.Don) DC.A.	Spikenard Jatamansi (N.); Pong-phe (B).	Valerianaceae	AU,TMS, NTM	Roots and rhizomes	Root eaten as tonic. Root oil is well known hair tonic and also applied over the paralysis and swelling. Rhizome paste is applied to treat piles. Plant is also used as incense.
54.	*Neopicrorhiza scrophulariiflora* Pennell	Figwort Picrorhiza / Kutki (N); Lhaie-tikta (B).	Scrophulariaceae	AU, NTM, TMS, LTM	Rhizome	Useful in dropsy, fever, anaemia and jaundice. Decoction of rhizome is taken as an antipyretic.
55.	*Nepeta floccosa* Benth.	Wolly Catmint	Lamiaceae	AU	Aerial parts	Anti-oxidant Flavonoids were reported to be extracted from the plant (Ali *et al.* 2015.)
56.	*Oxyria digyna* (L.) Hill	Mountain Sorrel / Lug. -Sho (Ti).	Polygonaceae	T MS	Leaves, flowers and stems	Useful in fever, sore throat and smallpox.
57.	*Paris polyphylla* Sm.	Himalayan Paris / Satua (N)	Melanthiaceae	AU, NTM,	Whole plant	Plant is analgesic, antipyretic, antispasmodic, depurative, febrifuge and narcotic and is useful in treatment of snake bites, boils, ulcers, cuts and wounds.

58.	*Pedicularis megalantha* D.Don		Orobanchaceae	TMS	Whole plant	Used as an antidote and for intestinal disorder in Bhutan (Phurba Wangchuk *et al*. 2016)
59.	*Pedicularis oederi* Vahl	Oeders Lousewort / Dhuk-zer (Ti).	Orobanchaceae	TMS	Stems, leaves, flowers and seeds	Heals water retention, constipation and breathlessness. Good for malnutrition, heals sores and relives severe pain due to serous fluids.
60.	*Pedicularis siphonantha* D.Don		Orobanchaceae	TMS	Whole plant	Antidote, anti-diarrheal and febrifuge ,used for stomach disorders (Phurba Wangchuk *et al*. 2016)
61.	*Parnassia nubicola* Wall.ex Royle	Himalayan Bog Star / Mamira (N)	Saxifragaceae	TMS		
62.	*Pleurospermum hookeri* Cl.		Apiaceae	TMS	Whole plant	Antidote against poisonous bites, anti-inflammatory, and cures heart disorders (Phurba Wangchuk et al. 2016).
63.	*Sinopodophyllum hexandrum* (Royle) T.S.Ying	Himalayan May Apple / Panchpatey (N), Yomha-si-se (B).	Lardizabalaceae	AU, NTM,TMS,LTM	Roots, rhizomes, leaves and fruits	Rhizomes and roots are considered purgative, stimulant, hepatic and blood purifier. Leaf juice is taken to vermifuge. Ripe fruit is eaten as laxative.
64.	*Polygonatum cirrhifolium* (Wall.) Royle	Coiling Leaf Solomon's Seal / Meda (N).	Asparagaceae	AU, NTM	Rhizome	Rhizome used as tonic and carminative. Used against loss of vigour, pain in the kidneys and hips, accumulation of fluids in bone joints.
65.	*P.singalilense* H.Hara	--	Asparagaceae	AU	--	--
66.	*P. verticellatum* (L.) All.	Whorled Solomon's Seal / Meda (N).	Asparagaceae	AU, NTM	Rhizomes	The plant has Tracheorelaxant and anti-inflammatory activities (H.Khan *et al*. 2013). Rhizome paste is given to dogs as a health tonic.
67.	*Polygonum vaccinifolium* Wall. ex Meisner	Rose Carpet Knotweed / Pulunge Jhar (N).	Polygonaceae	NT M	Whole plant	Useful in dysentery and fever
68.	*Ponerorchis chusua* D.Don	Chusua Orchis	Orchidaceae	AU, TMS	--	---
69.	*Potentila arbuscula* D.Don	Conquefoil	Rosaceae	TMS	Ariel parts	Useful in, fever, cough and cold
70.	*P.cuneata* Wall. ex Lehm.	Five Finger Cinquefoil	Rosaceae	TM S	Ariel parts	Useful in fever, cough and cold.
71.	*P.peduncularis* D.Don	East Himalayan Cinquefoil	Rosaceae	T MS	Ariel parts	Useful in fever, cough and caugh
72.	*Primula capitata* Hook.	Capitata Primrose	Primulaceae	TMS, AU	Flowers	Flowers of *Primula* treats vascular diseases and controls fever. It is particularly effective against fever and diarrhea in children.
73.	*Primula sikkimensis* Hook.f.	Sikkim Primrose / Shang. Dril Ser. Po (Ti)	Primulaceae	TMS, AU	Flowers	Flowers of *Primula* treats vascular diseases and controls fever. It is particularly effective against fever and diarrhea in children.
74.	*P. primulina* (Sprengel)H.Hara	Hairy Throated Primrose	Primulaceae	TMS, AU	Flowers	Flowers of *Primula* treats vascular diseases and controls fever. It is particularly effective against fever and diarrhea in children.
75.	*P. reticulata* Wall.		Primulaceae	TMS, AU	Flowers	Flowers of *Primula* treats vascular diseases and controls fever. It is particularly effective against fever and diarrhea in children.
76.	*Rheum acuminatum* Hook.f.& Thoms .ex Hook.	Ornamental Rhubarb / Padamchal (N)	Polygonaceae	TMS, LTM, NTM	Rhizome	Used against diarrhea and dysentery.
77.	*R.nobile* Hook.f. & Thoms.	Sikkim Rhubarb / Padamchal(N), Tchuka (L), Tsu.pa.ka (B).	Polygonaceae	TMS, LTM	Flower, Rhizome and leaves	Decoction of rhizome is taken against gastritis, piles and dysentery. Leaf juice is applied to cuts and wounds.
78.	*Rhodiola cretinii* Raymond-Hamet	Cretin's Rhodiola	Crassulaceae	TMS		Used in the treatment of lungs diseases
79.	*R. himalensis* (D. Don) S. H. Fu	Himalayan Rhodiola	Crassulaceae	TMS		Used in the treatment of lungs diseases
80.	*Sedum roseum* (L.) Scop.	Golden Root	Crassulaceae			
81.	*Rumex* sp.	Sho.mang (Ti)	Polygonaceae	TMS	Roots	Useful in fever, constipation, relieves swelling and diphtheria.
82.	*Sassurea gossipiphora* D.Don	Snowball Plant / Kasturi Kamal	Asteraceae	AU, NTM, TMS, LTM	Inflorescence	Decoction taken against body ache, sexual problems and stomach disorders. It is useful in cuts and wounds.
83.	*S. nepalensis* Sprengel	Nepal Saw-Wort	Asteraceae	--	--	---
84.	*S.obvallata* (DC.) Edgew.	Brahma Kamal (N)	Asteraceae	AU, NTM, TMS, LTM	Flower, rhizome, leaves	Used in arthritis, intestinal ailments, as antiseptic, in cough and cold, urinary tract problems, cardiac affections, etc.
85.	*Satyrium nepalense* D.Don	Nepal Satyrium	Orchidaceae	AU, NTM	Tubers	Used as an energizing tonic (www.flowersofindia.net)
86.	*Saxifraga brachypoda* D.Don	Saxifrage	Saxifragaceae	--		
87.	*Saxifraga engleriana* Harry Smith	Engler's Saxifrage	Saxifragaceae	--		
88.	*Saxifraga stenophylla* Royle	Ladakh Saxifrage	Saxifragaceae	TMS	Whole plant	Used to purify blood
89.	*Selenium wallichianum* (DC.) Raizada & H.O.Saxena	Milk Parsley / Bhut Kesh(N); Soreep (L).	Apiaceae	NTM, AU	Whole plant	Decoction of roots is taken against cough and fever. Leaves are carminative.
90.	*Senecio graciliflorus* DC.	Graceful Senecio	Asteraceae	AU,	Leaves, flowers	Used to treat Dermatitis and Stomachache by the Mongol tribe (Bhat T A, Nigam G. & Majar M. 2012). The plant has been reported to be of Cancer prevention and cure.

91.	*Senecio raphanifolius* Wall.ex DC.	Radish leaved Senecio	Asteraceae	--	--	Most of the *Senecio* species has been reported to be poisonous (E.Roeder, H.Wiedenfeld. 2009).
92.	*S. scandens* Buch.Ham. ex D. Don	Climbing senecio	Asteraceae	TMS, NTM	Whole plant	Diuretic, febrifuge, ophthalmic. Used in the treatment of epidemic influenza, malaria boils and abscesses. It contains an toxic alkaloids neoplatyphylline.
93.	*Silene nigrescens* L.		Caryophyllaceae	TMS	Roots	Used in deafness, nasal blockage and constipation.
94.	*Soroseris hookeriana* (Cl.) Stebbins	Hooker's Soroseris	Asteraceae	TMS	Whole plant	Relieves fever due to poisoning, also used in bone fracture (Phurba Wangchuk et all, 2009.
95.	*Streptopus simplex* D.Don	Simple Twisted Stalk	Liliaceae	AU	--	--
96.	*Swertia hookeri* Cl.	Indian Gentian / Lekh Chiraito (N).	Gentianaceae	AU,NTM, TMS	Roots	Sedative, nervine tonic, febrifuge. Roots used for treating bone fracture. Decoction of roots taken against fever and body ache.
97.	*Taraxacum officinale* Weber	Common Dandelion / Tukiphool (N).	Asteraceae	TMS	Roots and leaves	Roots juice taken against jaundice. Leaf juice useful in gastritis.
98.	*Thalictrum cultratum* Wall.	Knife Like Meadow Rue / La. Wa Sad Ma (Ti).	Ranunculaceae	AU, TMS, Folk	Whole plant	Treats infectious diseases, diphtheria and fever. Heals sores, dries serous fluids and is effective against intestinal fever.
99.	*T.foliolosum* DC.	Leafy Meadow Rue	Ranunculaceae	AU,TMS, Folk	Roots, leaves	Root paste taken to expel intestinal worms. Useful in treating eye diseases, indigestion, toothache.
100.	*Valeriana hardwickii* Wall.	Indian Valerian / Nakali Jatamasi (N).	Caprifoliaceae	AU,NTM, LTM	Roots and leaves	Decoction of roots is taken to cure mental disorder and also used as a hair tonic. Leaf paste is applied on boils.
101.	*V.jatamansii* Jones	Valerian / Jatamasi (N) Pong-phe (B).	Caprifoliaceae	AU,NTM, LTM	Rhizomes	Rhizome paste applied to treat gout and also taken against hysteria, epilepsy and nervous disorders. Used locally as incense in religious rites.
102.	*Veratrilla baillonii* Franchet		Gentianaceae	AU		An ethanol extract has been reported to reduce blood glucose in animals (Huang et al. 2016.). In Chinese Medicine System, it is used for treating liver-related disorders. Its antitoxic effect on mice induced by *Aconitum brachyopodum* Diels has also been reported (Ge YB et al. 2015).

TMS: Tibetan Medicinal System, **NTM**: Nepali Traditional Medicine, **LTM**: Lepcha Traditional Medicine, **AU**: Ayurveda

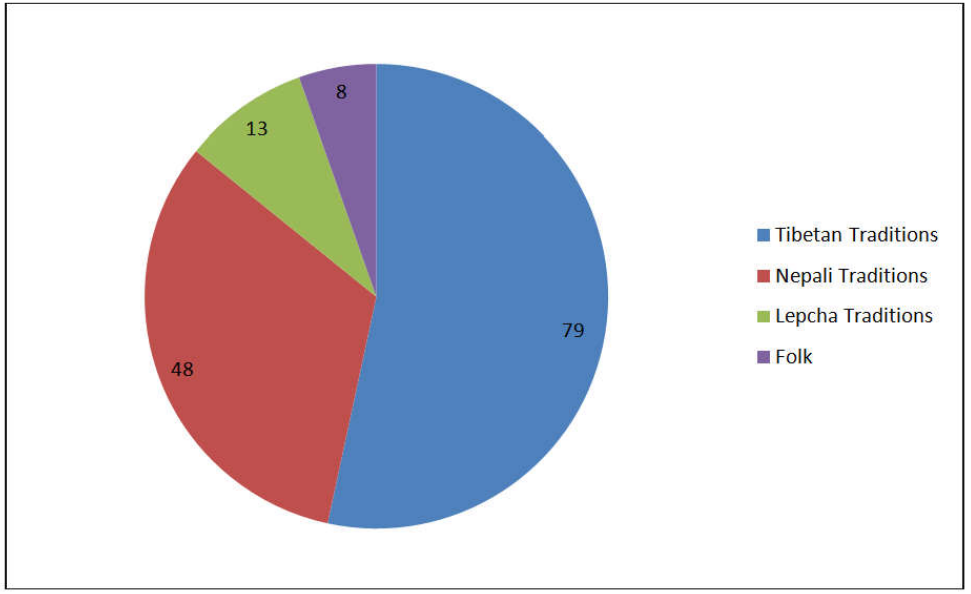

Chart 1. Number of species used in different systems of medicine in Kyongnosla Alpine Sanctuary

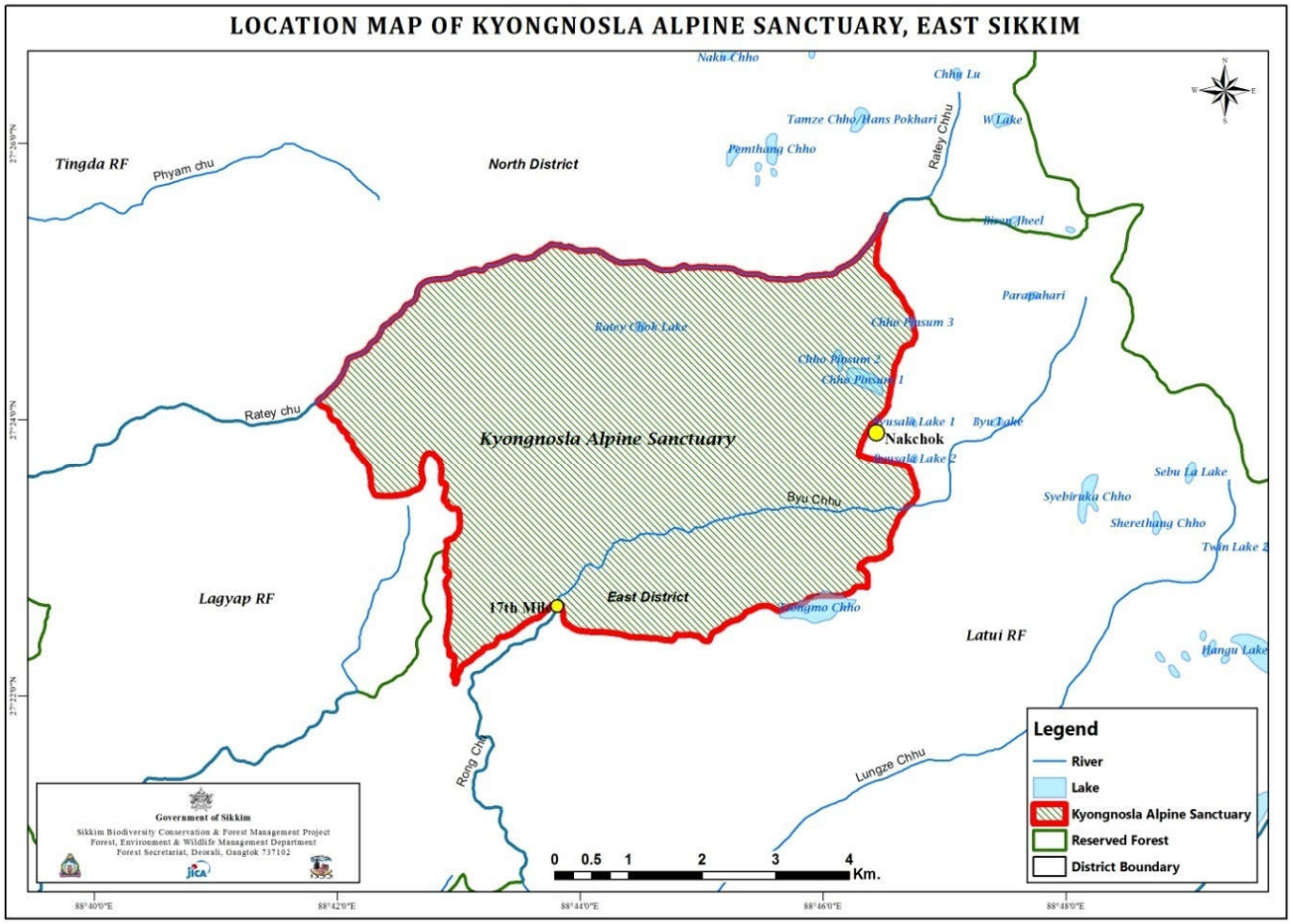

Figure 1. Location map of Kyongnosla Alpine Sanctuary, East Sikkim

Figure 2a. Alpine pasture at Nakchok in Kyongnosla Alpine Sanctuary with Jhor Pokhari Lake

Figure 2b. Sub-Alpine Forest dominated by bushy Rhododendrons and Iris and scattered Abies densa

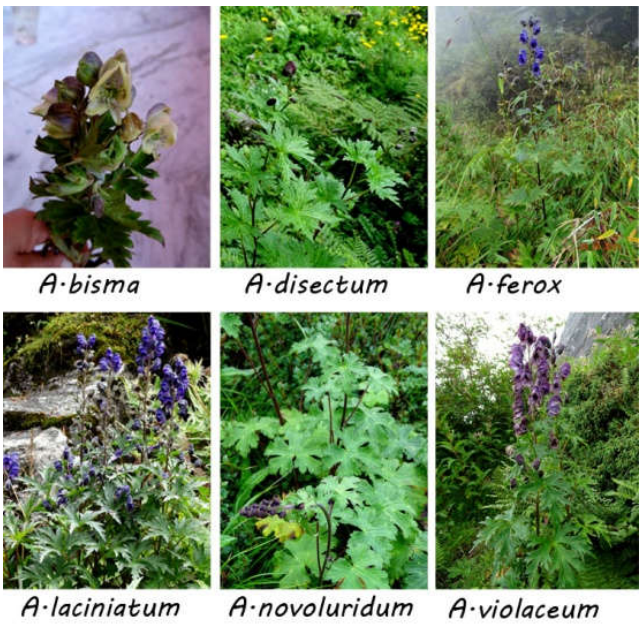

Plate 1. Aconitum species in Kyongnosla Alpine Sanctuary, East Sikkim India

Plate 2. Some important Medicinal Plants of Kyongnosla Alpine Sanctuary

The Sanctuary is also a habitat of some high value medicinal herbs such as *Neo-picrorhiza scrophularia*, *Sassurea obvallata*, *S.gossipiphora*, *Lagotis crassifolia*, *Bergenia purpurascens*, *B.ciliata*, *Valeriana jatamansi, V. hardwickii*, *Codonopsis foetans*, C. *Clematidea, Panax bipinnatifidus*, *Paris polyphylla*, *Meconopsis horridula*, *M.simplicifolia*, *M.paniculata*, *Ligularia fischeri, L. Amplexicaulis, Jurinea dolomiaeia* etc. *Sassurea gossipiphora* and *S. obvallata,* both are highly threatened medicinal herbs of the Himalayas are also found occurring along the banks of rivers and streams in the area. Occurrences of other two species of *Sassurea viz.*, *Sassurea nepalensis* and *S. simpsoniana* have also been recorded from the area. *Lagotis crassifolia* found growing abundantly in association with *Sassurea obvallata. Rheum nobile*, a threatened Tibetan Medicinal herb inhabit the area towering all the shrubs and herbs and visible from miles away across the valley. *Rheum acuminatum* is the common Rhubarb available in the region. Other important medicinal herbs in the area are *Rhodiola cretinii, R.himalensis*, *Sedum roseum*, *Potentila arbuscula*, *P.cuneata*, *P.peduncularis*, *Primula capitata*, *P.sikkimensis*, *P.primulina*, *P.reticulata*, *Ponerorchis chusua, Polygonum vaccinifolium, Sinopodophyllum hexandrum, Pleurospermum hookeri, Parnassia nubicola, Pedicularis siphonantha, p. Oederi, P. Megalantha, Oxyria digyna, Nepeta floccosa, Myricaria rosea, Maharanga emodi, Lilium nanum, Impatiens radiata, I.bicornuta, I. racemosa, I.urticifolia, Acomastylis elata, Geranium wallichianum*, *Fritillaria cirrhosa, Fragaria nubicola*, *Euphorbia wallichii, Erigeron multiradiatus, Dracocephalum heterophyllum*, *Cynoglossum zeylanicum, Clematis napaulensis, Bistorta affinis*, *Arisaema jacquemontii, A. Griffithii, Arisaema erubescens, Anaphalis contorta, A.triplinervis, Allium prattii, A.wallichii* etc. Important medicinal shrubs available in the area are *Gaultheria nummularioides*, *G.trichophylla*, *Cassiope fastigiata*, C.*selaginoides*, *Berberis insignis, Berberis angulosa, Juniperus recurva, J.coxii, Rhododendron anthopogon, R.campanulatum* subsp *campanulatum, R.campanulatum* subsp *aeruginosum, R.hypenanthum, R.lepidotum, R.thomsonii* and *Rosa sericea*. Some important medicinal plants of the sanctuary are shown in Plate 2. *Rhododendron hypenanthum*, a Tibetan Medicinal shrub has also been recorded from the area for the first time from the Sikkim Himalaya, resulting in addition to the previous list of 38 species of Sikkim Himalayan Rhododendrons (Dahal, S. 2015-16).

As far as the uses of the recorded medicinal plants is concerned 79 species has been recorded to be used in Tibetan Medicine System,48 species in Traditional Nepali Medicine, 13 species in Lepcha Traditional Medicine and 8 species were recorded to be used by local healers of the area which are presented by Chart 1. Most of the listed species (Table 2) have been used in Ayurvedic system of medicine. Since this is the first attempt to enumerate the floral diversity of Kyongnosla Alpine Sanctuary and documentation of medicinal usages of the species in different healing traditions of different communities of Sikkim an in depth study is required to have a complete database of medicinal plants resources of the area.

Conclusion

Kyongnosla Alpine Sanctuary has been found to be the rich repository of medicinal plants genetic resources. Traditional herbal practices are vibrant traditions among all the communities inhabited in Sikkim. Very few medicinal plants used by the local healers of the state are scientifically validated through phyto-chemical and pharmacological studies and hence their detail ethno-medicinal as well as phyto-chemical and pharmacological studies are essential. Since the present study area is away from the human habitations, the anthropogenic pressures is still not pronounced and for which biodiversity of the area still remain intact to a considerable extent. Species such as *Juniperus recurva*, *J.coxii*, *Rhododendron campanulatum*, *R. campanulatum* subsp.*aeruginosum, Rhododendron hypenanthum, R. anthopogon*, *R. lepidotum, Iris clarkei, Bergenia purpurescens*, *Bistorta amplexicaulii*, *Rheum acuminatum, Nardostachys jatamansi*, *Sassurea nepalensis, Juncus* spp., etc. are flourishing well in the area with good number of populations. However, some high valued and rare medicinal herbs of the area *viz., Aconitum laciniatum, Aconitum novoluridum, Aconitum bisma, Aconitum disectum, Neopicrorhiza scrophularia*, *Gymnadenia orchidis, Fritillaria cirrhosa, Sassurea gossipiphora, S. obvallata, Rheum nobile, Allium prattii, Bergenia ciliata, Sinopodophyllum hexandrum, Swertia hookeri, Lilium nanum, Codonopsis foetans, Gentiana elwesii, G. algida*, *G. prolata*, *G. stylophora*, *Acomastylis elata, Meconopsis horridula, Polygonatum cirrhifolium*, *P. verticellatum,* etc. observed to be very rare in the area, which may be due to an unauthorized trade of commercially important species through porous national and international border along West Bengal, Nepal, China and Bhutan (Source: traders-collectors survey), and prooting of entire plants, immature plants, etc.; hence proper management and conservation strategies is needed to maintain the gene bank of these precious wealth of the Himalayas along with their natural habitat. Towards the conservation initiatives of some threatened species of the Himalayas, such as *Nardostachys jatamansi, Podophyllum hexandrum, Bergenia ciliata*, *Valeriana jatamansi, V. Hardwickii, Panax bipinnatifidus, Paris polyphylla* etc. have been given priority for commercial cultivation by National Medicinal Plants Board through Sikkim State Medicinal Plants Board, under the Department of Forest, Environment and Wildlife Management, Government of Sikkim. The practice of domestication, cultivation and commercialization of the high value medicinal plants preferably some rare and threatened species are recommended for their sustainability, instead of practicing unsustainable harvesting from the wild. Natural disturbances of habitat including the effect of climate change needs to be addressed as well.

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