



An Overview of genus *Saxifraga* L. in Indian Himalayas

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Abstract: The paper deals with the enumeration of genus *Saxifraga* in Indian Himalayan region. A total of 64 species with 4 sub-species and 5 varieties have been recorded from Indian Himalayas, out of which 23 are confined to Western Himalaya and 17 are found in Eastern Himalaya, while 40 are common in both the areas. The maximum diversity has been observed between 4000-4500m. asl. The genus forms the group of sub-nival vegetation and are inhabitant of one of the most fragile ecosystem of Himalaya, the hot spot of biodiversity and it is urgently needed to document the diversity in the natural habitat and assess the conservation status of the taxa of the genus *Saxifraga* L.

Keywords: Saxifraga, Indian Himalayan Region, Diversity

Introduction

The genus *Saxifraga* L. of the family Saxifragaceae is circumboreal in origin. The genus comprises of 440 species generally known as Saxifrages and it derives its name from latin word Saxifraga, which means 'Stone breaker'. As its name indicates it is medicinally used for treatment of renal calculi and has several other ethnobotanical uses (Ali & Qaiser, 2009; Kumar et al, 2010; Malik et al., 2010; Malla & Chhetri, 2009, Singh, 2008). The genus is largest and most complex in the family (Engler & Irmscher, 1919; Spongberg, 1972; Kohlein, 1984; Webb & Gornall, 1989; Webb, 1993; Webb & Press, 1987; Parlo et al., 1999) and on the basis of morphology, cytology and biogeography 15 sections have been identified in the genus (Webb & Gornell, 1989), however these sectional boundaries do not reflect accurately the phylogenetic history of the genus as from phylogenetic data it is strongly suggested that it is not monophyletic in origin (Morgan & Soltis, 1993; Soltis et al, 1966a). The genus is typical inhabitant of arctic-alpine ecosystem and hardly a few in tropics (Hook, 1879). In India, *Saxifraga* is represented by 64 species, 4 subspecies and 5 varieties, which are chiefly distributed in the temperate and alpine zones of the Indian Himalaya. These taxa have been enumerated from different regions of Himalaya from Kashmir to North East India in floristic inventories by several workers (Hooker, 1879; Polunin & Stainton, 1984; Aswal & Mehrotra, 1999; Kaur & Sharma, 2004; Kapur & Sarin, 1990; Gupta, 1968; Nair, 1977; Ohasi, 1975; Hara, 1966; Hajra & Balodi,

1995; Coventry, 1927; Sharma & Jamwal, 1988; Singh & Rawat, 2000; Blatter, 1984; Dhaliwal & Sharma, 1999).

Being a hotspot of biodiversity, Himalayan mountains are always matter of great concern and holds ca. 10,000 species of the plants of which 3160 plant species (1.1% of the total world endemic plant species) are endemic to the region. This diversity is ultimate destination for local communities in various forms such as medicine, edibles, fuel, fodder, timber, agricultural tools, etc. In recent years, the biotic pressure on natural resources has increased many folds due to ever increasing population, agricultural expansion, harvesting of fuel and timber wood, grazing in the forest and forest fire, overexploitation of medicinal and economic plants, developmental activities such as construction of buildings, dams, roads, etc., on the cost of hundreds of species.

Methodology:

The present study on the genus *Saxifraga* of Indian Himalayan Region (IHR) is based on general literature surveys, which was made in different states of Indian Himalaya. All the species have been listed alphabetically with altitude, distribution, other regions and threat categories. The species of *Saxifraga* are calculated and enumerated in state wise representation. For the enumeration of species, the study area is divided into two Himalayan regions, i.e. the Eastern Himalaya and the Western Himalaya. The Eastern Himalaya includes the states of

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West Bengal (Darjeeling district), Sikkim, Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. In the same way, the Western Himalaya covers Himachal Pradesh, Uttarakhand and Jammu & Kashmir.

Results and Discussion

A total of 64 species of *Saxifraga* covering 4 subspecies (*S. flagellaris* ssp. *crassiflagellata*, *S. flagellaris* ssp. *komarovii*, *S. flagellaris* ssp. *euflagellaris*, *S. nakaoi* ssp. *asiatica*) and 5 varieties (*S. brachypoda* var. *fimbriata*, *S. hirculus* var. *alpina*, *S. poluniniana* var. *mucronata*, *S. subspatulata* var. *kumaonensis*, *S. stella-aurea* var. *polyadena*) have been recorded from Indian Himalaya (Table 1). The genus *Saxifraga* has wide distributional range and most of the taxa (40) are commonly distributed in both the flanks of Indian Himalaya, 23 species are found in Western Himalaya while 17 species are confined to Eastern Himalaya (Figure 1). Out of total taxa of the genus *Saxifraga* in India, 19 taxa

(30%) are endemic. The maximum concentration of the species is observed in Sikkim Himalaya (61%), out of which 2 species namely, *S. viscidula* and *S. umbellata* are endemic to Sikkim at global level, while 17 others are endemic for India and share their distribution with neighboring countries, such as, Bhutan, China, Nepal and Tibet. After Sikkim, Uttarakhand is identified as having most favorable habitats for Saxifrages, where 37 species grow and 5 species are restricted to the area, further, 5 species find their way to Kashmir Himalaya, out of which 2 species *S. duthiei* and *S. tanguitica* are highly endemic to the region, while one species *S. androsacea* shares its distribution with the adjacent Pakistan and widely separated Europe, as in Kashmir Himalaya floral elements of Eurasia have been identified. One species *S. brachypoda* is found in West Bengal and Nagaland while another species *S. diversifolia* extends to Assam besides the Himalayan region.

Table 1: The genus *Saxifraga* in Indian Himalayan Region

S.No.	Name of the Taxa	Altitude (in meter)	Distribution	
			India	Other countries
1.	<i>S. andersonii</i> Engl.	3600 -5200	Sikkim	Nepal, Bhutan, Tibet
2.	<i>S. asarifolia</i> Sternb.	3500 - 4500	H.P.; Uttarakhand	-
3.	<i>S. androsacea</i> L.	3600- 4300	Kashmir	Pak, Europe
4.	<i>S. aristulata</i> Hook.f. & Thoms.	4200-5600	Uttarakhand, Sikkim	Nepal, Bhutan
5.	<i>S. brachypoda</i> D.Don	3600-4800	Uttarakhand, H.P., W.B., Nagaland	China, Burma, Tibet
6.	<i>S. brachypoda</i> D.Don var. <i>fimbriata</i> (Wall. ex Ser.) Engl. & Irmsch.	3500-4500	Uttarakhand, Sikkim	Nepal, Bhutan, Myanmar
7.	<i>S. brunonis</i> Wall. ex Ser.	2000 - 5000	Kashmir, Uttarakhand, Sikkim	H.P., Pak, S.W.China
8.	<i>S. cernua</i> L.	4000 - 5650	Kashmir, Uttarakhand	H.P., -
9.	<i>S. cordigera</i> Hook. f. & Thoms.	3600-4200	Sikkim,	Nepal, Tibet
10.	<i>S. caveana</i> W.W. Smith	4200-5000	Sikkim	Nepal, Bhutan, S.W.China
11.	<i>S. ciliata</i> Royle	2200 - 3500	H.P.	-
12.	<i>S. diversifolia</i> Wall. ex Ser.	2000- 4500	H.P., Uttarakhand, Sikkim	Kashmir, Assam, Bhutan
13.	<i>S. duthiei</i> Gandoger	3300	Kashmir	-
14.	<i>S. engleriana</i> H. Sm.	3600 - 4700	Sikkim	Bhutan, Nepal, S.E.Tibet
15.	<i>S. flagellaris</i> Willd.	3500- 4800	H.P., Uttarakhand	-
16.	ssp. <i>crassiflagellata</i> Hulten	3500- 4500	H.P., Uttarakhand	-
17.	ssp. <i>Komarovii</i> (A.Los.) Hulten	4500 -5000	H.P.	-
18.	ssp. <i>euflagellaris</i> Engl. & Irmsch.	2500 - 6500	Kashmir, Uttarakhand, Sikkim	H.P., -
19.	<i>S. fimbriata</i> Wall. ex Ser.	3500- 4800	Sikkim, Uttarakhand	-

20.	<i>S. filicaulis</i> Wall. ex Ser.	2000 – 4000	H.P., Uttarakhand	-
21.	<i>S. hirculus</i> L. var. <i>alpina</i> Engl.	4000 – 4800	H.P. , Sikkim, Kashmir	-
22.	<i>S.hirculoides</i> Decne.	4300 - 5800	Kashmir, Uttarakhand	Pak, Nepal, Tibet
23.	<i>S.hispidula</i> D.Don	3200 – 4200	Uttarakhand, W.B., Sikkim	China, Burma, Nepal, Tibet
24.	<i>S. hemisphaerica</i> Hook.f. & Thoms.	4500 - 5100	Uttarakhand, Sikkim	Bhutan
25.	<i>S. hookeri</i> Engl. & Irmsch.	3300- 4800	Sikkim	Nepal , Bhutan
26.	<i>S. granulifera</i> H.Sm.	3000 – 4000	Uttarakhand	Nepal, Bhutan, Tibet
27.	<i>S. gageana</i> W.W. Smith	4400	Sikkim	Nepal
28.	<i>S. glabricaulis</i> H.Sm.	3500	Sikkim	Nepal , Bhutan, Tibet
29.	<i>S. Jacquemontiana</i> Decne.	4000 -5200	H.P., Kashmir,	Pak, Tibet,
30.	<i>S.kingiana</i> Engl. & Irmsch.	3200 - 4200	Sikkim	Nepal , Bhutan, Tibet
31.	<i>S. kumanensis</i> Engl.		Uttarakhand	-
32.	<i>S. lychnitis</i> Hook.f.& Thoms.	4500-5000	Kashmir, Uttarakhand, Sikkim	Tibet,
33.	<i>S. lilacina</i> Duthie	2800 – 4500	Uttarakhand, Kashmir	-
34.	<i>S.latiflora</i> Hook.f. &Thoms.	3900 -4000	Sikkim	Bhutan
35.	<i>S. melanocentra</i> Franchet	4100 – 4900	Kashmir, Sikkim	Nepal ,Bhutan
36.	<i>S.mucronulata</i> Royle	3800 – 4800	Uttarakhand, Kashmir, Sikkim	Bhutan, China
37.	<i>S. moorcroftiana</i> (Ser.) Wall. ex Sternb.	3600-4500	H.P., Uttarakhand, Kashmir, Sikkim	Pak., Bhutan, Tibet, China
38.	<i>S.meeboldii</i> Engl. &Irmsch.	4000 -4800	Kashmir	Tibet
39.	<i>S.microvirides</i> Hara	3800 – 4800	Kashmir, Uttarakhand	Nepal
40.	<i>S.minutissima</i> D.S.Rawat	4600 - 4800	Uttarakhand	-
41.	<i>S. nigroglandulifera</i> N.P.Balacr.	4200-4900	Sikkim	Nepal, China
42.	<i>S. nakaoui</i> Kitam. ssp. <i>asiatica</i> Engl. & Irmsch.	4000	Kashmir, Uttarakhand	Tibet, Siberia, Turkestan
43.	<i>S. pallida</i> Wall ex Ser.	3200 – 4800	Kashmir, Uttarakhand, H.P., Sikkim	Pak , Nepal, China
44.	<i>S. palpebrata</i> Hook. f. & Thoms.	4300 – 5000	H.P., Uttarakhand, Sikkim	-
45.	<i>S. pilifera</i> Hook. f. & Thoms.	4800	Sikkim	Nepal, Bhutan
46.	<i>S. perpusilla</i> Hook. f. & Thoms.	3700 – 5800	Sikkim	Nepal, Bhutan
47.	<i>S. pseudo – pallida</i> Engl. & Irmsch.	3600 -5200	Kashmir	China
48.	<i>S. parnassifolia</i> D.Don	1900 - 4800	H.P., Uttarakhand, Sikkim	Bhutan, Nepal
49.	<i>S. pulvinaria</i> H. Sm.	4300 - 5200	Kashmir, Uttarakhand, Sikkim	Nepal
50.	<i>S. punctulata</i> Engl.	4900- 5800	Sikkim	Nepal , S.E. Tibet
51.	<i>S. poluniniana</i> H. Sm.var. <i>mucronata</i> U.C.Bhattach. & M.V.Viswan.	3300- 3500	Uttarakhand	Nepal
52.	<i>S. roylei</i> H.Sm.	3300- 3800	Uttarakhand	Nepal
53.	<i>S. ramulosa</i> Wall. ex Ser.	6000	Kashmir, Uttarakhand, Sikkim	-
54.	<i>S. stenophylla</i> Royle	3600-5000	Kashmir, Uttarakhand, Sikkim	Pak, C.Nepal
55.	<i>S. strigosa</i> Wall ex Ser.	2500-4300	Uttarakhand, Sikkim, W.B.,	Bhutan, China
56.	<i>S. saginoides</i> Hook.f. & Thoms.	3600-5200	H.P., Uttarakhand, Sikkim	China
57.	<i>S.stolitzkae</i> Duthie ex Engl. & Irmsch.	3000 -4000	Uttarakhand	Bhutan, Nepal

58.	<i>S.sub-spathulata</i> Engl. & Irmsch. var. <i>kumaonensis</i> Engl. & Irmsch.	3000 -4000	Uttarakhand, Sikkim	Bhutan
59.	<i>S. sibirica</i> L.	3000 -5000	Kashmir, Uttarakhand	H.P., Pak , C. Nepal
60.	<i>S.sphaeradena</i> H.Sm.	2100- 3400	Sikkim	Tibet, Nepal
61.	<i>S.stella-aurea</i> Hook.f. & Thoms. var. <i>polyadena</i> H.Sm.	3000-5800	Sikkim	Bhutan,Nepal, Tibet
62.	<i>S.tanguitica</i> Engl.	5000-5600	Kashmir	-
63.	<i>S.viscidula</i> Hook.f. & Thoms.	4300 – 5000	Sikkim	-
64.	<i>S. umbellata</i> Hook.f. & Thoms.	4000 – 4700	Sikkim	-

The distribution of Saxifrages in relation to altitude is depicted in figure 3. Maximum taxa of the genus *Saxifraga* are found between 4000-4500 m. asl. As evident from figure, most of the taxa are found in sub-alpine and alpine zones of the Himalaya and forms the group of high altitude flowering plants. Few taxa like *S. ramulosa*, *S. punctulata*, *S. flagellaris* ssp. *euflagellaris* are present at 6000-6500 m., the maximum height attained by the flowering plants, *S. flagellaris* ssp. *euflagellaris* is also endemic to India. While very few taxa *S. strigosa*, *S. ciliata*, *S. filicaulis* find their way towards lower reaches in temperate zone. Some taxa such as *S. brunonis*, *S. diversifolia*, *S. stella-aurea* var. *polyadena*, *S. parnassifolia* have long altitudinal range of distribution and cover the various altitudinal gradients, while others such as *S. tanguitica*, *S. umbellata*, *S. pilifera*, *S. minutissima*, *S. poluniana* var. *mucronata* have very narrow range of altitudinal distribution and prefers a specific micro-habitat.

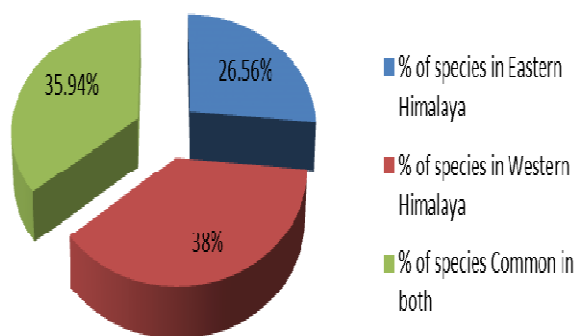


Figure.1: Distribution of Saxifrages in IHR

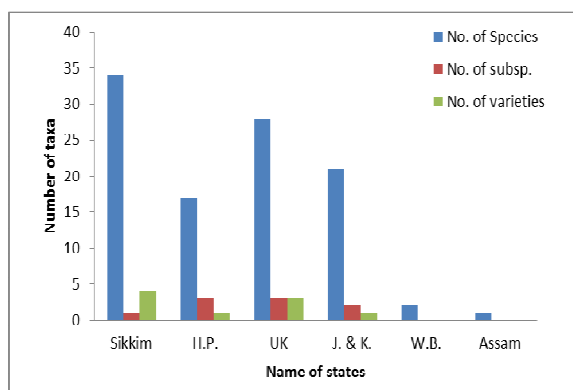


Figure.2: Distribution of Saxifrages in different states of IHR

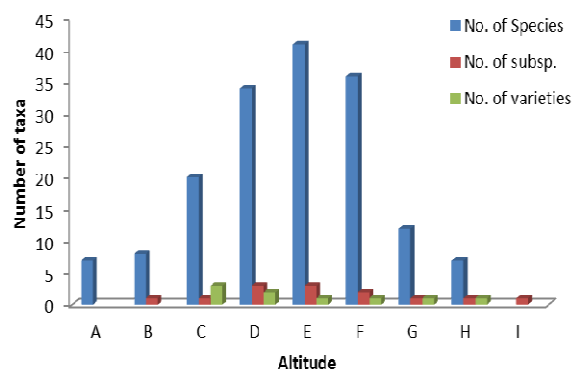


Figure.3: Altitudinal distribution of Saxifrages in IHR

Globally, ca. 450 species of *Saxifraga* are widely distributed in alpine regions of Asia, Europe North America and South America. In context of Asian continent, maximum diversity (216 species) of *Saxifraga* is found in China, of which 139 species are endemic to the region, while in Bhutan, Nepal and Pakistan the diversity of *Saxifraga* is low. The species of *Saxifraga* exhibit significant diversity in habit and attain a broad range of altitude from 1900-6500 m. asl. Most of the taxa are confined to high alpine meadows and grass land pastures in IHR and sub-nival conditions are identified as the most suitable for the survival and multiplication of *Saxifraga*

taxa. Mountain summits in IHR is considered a hyper optimal extreme above the tree line (Mani, 1994) characterized by cold and arid climate (Gupta, 1994) with rich and varied biotic potential (Sharma, 1994). Every altitudinal rise in Himalaya generates different conditions, supporting unique and isolated ecosystem with maximum plant diversity (Mountain Partnership, 2008). High alpine mountain ecosystem are particularly more vulnerable (Markham et al., 1993) and climate change effects on alpine and nival vegetation are more pronounced than the lower altitude vegetation (Pauli et al., 2003). Since, Saxifrages representing the alpine-nival ecotone, found at transition between alpine and nival environment, are also at great risk of extinction due to habitat loss and it is urgently needed to document the diversity and assessment of the conservation status of this representative of high alpine vegetation. Several taxa of the genus *Saxifraga* from Morocco, Spain, Italy, USA, etc. are included in IUCN Red List of Threatened Plants but no attempt has been made to evaluate the conservation status of Indian Saxifrages, while most of the Indian taxa of *Saxifraga* are endemic to the Indian sub-continent.

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